PEAC
PRIVATE EDUCATION ASSISTANCE COMMITTEE
Trustee of the Fund for Assistance to Private Education

DepED
DEPARTMENT OF EDUCATION

2017

LEARNING MODULE

Science G8| Q2

Earth and Space: Faults and Earthquakes

PEAC
PRIVATE EDUCATION ASSISTANCE COMMITTEE
Trustee of the Fund for Assistance to Private Education

PEAC National Secretariat
Units 2505-2507, 25th Floor Philippine AXA Life Centre
1286 Sen. Gil Puyat Avenue corner Tindalo St., Makati City
Tel No.: (02) 8-570-7322
Fax No.: (02) 8-511-7695

NOTICE TO THE SCHOOLS

This learning module (LM) was developed by the Private Education Assistance Committee under the GASTPE Program of the Department of Education. The learning modules were written by the PEAC Junior High School (JHS) Trainers and were used as exemplars either as a sample for presentation or for workshop purposes in the JHS In-Service Training (INSET) program for teachers in private schools.

The LM is designed for online learning and can also be used for blended learning and remote learning modalities. The year indicated on the cover of this LM refers to the year when the LM was used as an exemplar in the JHS INSET and the year it was written or revised. For instance, 2017 means the LM was written in SY 2016-2017 and was used in the 2017 Summer JHS INSET. The quarter indicated on the cover refers to the quarter of the current curriculum guide at the time the LM was written. The most recently revised LMs were in 2018 and 2019.

The LM is also designed such that it encourages independent and self-regulated learning among the students and develops their 21st century skills. It is written in such a way that the teacher is communicating directly to the learner. Participants in the JHS INSET are trained how to unpack the standards and competencies from the K-12 curriculum guides to identify desired results and design standards-based assessment and instruction. Hence, the teachers are trained how to write their own standards-based learning plan.

The parts or stages of this LM include Explore, Firm Up, Deepen and Transfer. It is possible that some links or online resources in some parts of this LM may no longer be available, thus, teachers are urged to provide alternative learning resources or reading materials they deem fit for their students which are aligned with the standards and competencies. Teachers are encouraged to write their own standards-based learning plan or learning module with respect to attainment of their school's vision and mission.

The learning modules developed by PEAC are aligned with the K to 12 Basic Education Curriculum of the Department of Education. Public school teachers may also download and use the learning modules.

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SCIENCE 8

Module 2: Earth and Space

Lesson 1: Faults and Earthquakes

INTRODUCTION AND FOCUS QUESTION(S):

Have you ever seen a crack in the walls of your house? What could have caused these cracks to appear? How about in your neighborhood, have you seen any crack on the road? Ever wondered why these cracks appear on the road or on the surface of the earth? What effects do earthquakes have?

The cracks that you see on the earth's surface are called faults. These faults may have come from the movement of the plate tectonics or as a result of an earthquake. Studying the dynamics between these two will you to come-up with a proposal for the community on where to build buildings and other structures that are capable of withstanding earthquakes and their effects.

In this module, you will find out about faults and earthquakes, the kinds of faults, the processes that create and them, earthquake terminologies, dynamics between faults and earthquakes and preparing for earthquakes.

Remember to search for the answers to the question: Why are there earthquakes?

LESSON COVERAGE:

In this lesson, you will take the following topics:

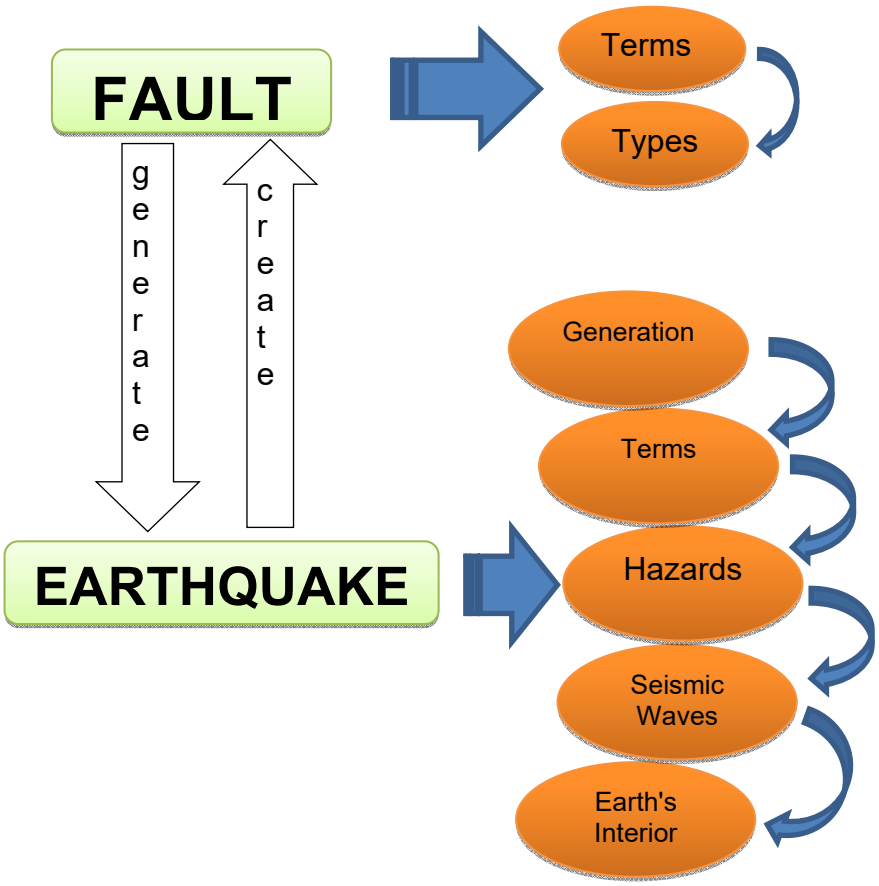
Lesson 1.1 – Faults
- *A. Definition of a fault*
- *B. Terminologies Associated with faults*
- *C. Types of Faults*

Lesson 1.2 –Earthquakes
- *A. Generation of Earthquakes*
- *B. Earthquake focus and epicenter*
- *C. Magnitude and intensity*
- *D. Earthquake hazards*
- *E. Seismic waves*
- *F. Earth's interior*

In this lesson, you will learn the following:

Lesson 1.1	The learner: • Makes a multimedia presentation of the viability of building structures within the community using the knowledge of the relationship between faults and earthquakes.
Lesson 1.2	The Learner: • Creates emergency plans and kits that will be used at home and in the community.

MAP OF THE LESSON:
Here is a simple map of the above topics you will cover:



EXPECTED SKILLS:

To do well in this lesson, you need to remember and do the following:

1. Do the exploratory activities carefully. Always write down your observations during the activities using Evernote. If you have some questions in mind during the performance of the activity, write them down and remember to go back to the questions as you progress in each lesson.
2. Read the contents of this module carefully. When in doubt, read again and try to understand the directions clearly.
3. When asked to view a documentary video, write the guide questions in advanced and then while watching the video, listen carefully and write down notes. If you do not understand the video on the first viewing, you can always view the video again and pause in between significant lines or dialogues in the video.
4. This module provides you with a list of internet sites which you could browse through for clarification. Visit the sites and read thoroughly the contents of the site.
5. When doing the performance tasks, bear in mind that these tasks are applications to what you've gone through in this module. When asked to make a brochure or any campaign material, always bear in mind the intended audience.
6. Keep an open-mind like any other follower of science. When in doubt, consult other reliable sources of information and counter check.
7. Do the Web test for several times and don't forget to click on the correct answer for your reference.

Lesson 1. 1: Faults

In this lesson, you shall:

1. Identify the different types of faults that are found on the Earth's surface,
2. Distinguish between active and inactive faults,
3. Locate and classify faults in the community, and
4. Create campaign materials such as brochures and pamphlets informing members of the community about relocating homes away from faults.

PRE-ASSESSMENT:

Read, analyze and answer each of the questions below by choosing the letter of the MOST APPROPRIATE answer.

1. What is the epicenter of an earthquake? The epicenter is ____.
   a. a seismic wave that travels along the surface of the earth
   b. the last place that motion in an earthquake is detected
   c. the point on the earth's surface directly above the earthquake's focus
   d. the location along a fault where the first motion of an earthquake occurs

2. The Richter magnitude of an earthquake is determined from the _____.
   a. duration of an earthquake
   b. intensity of an earthquake
   c. arrival of P waves and S waves
   d. measurement of the amplitude of the largest seismic waves

3. Which of the following is an evidence that the Earth's inner core is solid and the outer core is liquid?
   a. Refraction of seismic waves as they encounter different mediums.
   b. The wave shadow effect of P- and S- waves as they encounter the solid and liquid core.
   c. The wave shadow effect of P- and S- waves and the increase in velocity of P-waves as they encounter the solid inner core.
   d. The wave shadow effect of P- and S- waves and the increase in velocity of S-waves as they encounter the solid inner core.

4. While walking towards school, a student of Inabanga National High School in Inabanga, Bohol saw cracks on the road with no uplift running for about 1 kilometer. What would be the best explanation for the presence of this crack?
   a. The road experienced tensional stress causing it to rupture.
   b. A shearing stress was applied to the land mass causing it to rupture.
   c. Reverse faulting happened as a result of compressional stress
   d. Normal faulting happened as a result of shearing stress.

5. A road in Industrial Valley, Marikina City has a 10-meter long crack with part of it being lifted up and away from the other block. A motorist noticed that as years passed by, the separation between the two blocks became higher and higher. What do you think is happening to the road?
   a. The road is experiencing tensional stress causing the two blocks to be separated.
   b. Compressional stress is acting underneath the two blocks thus moving them away from each other.
   c. The amount of shearing force applied to the two blocks is so great that these blocks become separated from each other.
   d. A combination of vertical and horizontal forces causes the two blocks to move away from each other.
6. As you jog through a stretch of the national highway, you notice a block of rock over another with cracks in between the two. Which of the processes could have caused this rock to be in that position?
   a. Tension underneath the road surface has caused one block to move up on top of the other.
   b. Right under the road blocks is a shearing force that causes one block to move below the other.
   c. One block is less dense than the other causing it to subduct below the other.
   d. Compressional forces caused this thrust fault thus one block is on top of the other.

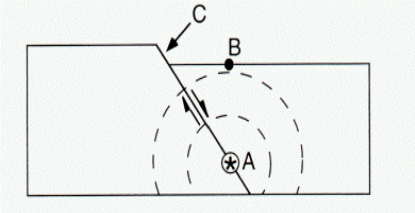
7. Your classmate wants to demonstrate how underwater earthquakes create tsunamis. He intends to use two blocks of wood “submerged” in water that is in a basin. How will you improve his demonstration?
   a. Change the kind of material that represents the seafloor.
   b. Keep the two blocks of wood on the surface of the water.
   c. Make the fluid more viscous so as to mimic underwater pressure.
   d. The two blocks should be in contact with the basin or in the seafloor.

8. The island of Negros and Cebu are separated by the narrow Tanon strait. Rumors spread that a magnitude 6.4 earthquake will occur in the East Bohol Fault with its focus in Tagbilaran city. A Negrense was overheard saying “We might be hit by a tsunami!” How would you clarify or correct his idea?
   a. I will show him a map of the Philippines and indicate that before it hits Negros it will hit Cebu first thus its energy will be dissipated.
   b. I will show him a map of the Philippines and point out that Tagbilaran is on land and that tsunamis will be formed if the earthquake happened underwater. Moreover, the rumored earthquake does not have enough energy to generate an earthquake.
   c. I will tell him that the energy coming from the quake is not enough to generate a tsunami that will hit Negros. It would be possible though if the magnitude of the earthquake is higher.

d. I would explain to him that it is unlikely for a tsunami to occur because there is still a body of water between Negros and Cebu that can dissipate its energy. This body of water is not enough to contribute to the building up of a tsunami.

9. A house made of wood is located near a fault line which has been moving for the last decade. Which of the following should be a **foremost** consideration that the house owners should make in case an earthquake happens?
   a. access to highway
   b. location of an active fault
   c. road right of way
   d. type of building material

10. Which of the following would BEST explain the illustration below?



   a. Compressional forces acting on the block caused a rupture at A which created seismic waves traveling to the surface at B causing the footwall to rise.
   b. Shearing forces constantly acting on the block caused a rupture at point A which generated seismic waves traveling to the surface at point B thus the footwall slid sideways.
   c. Tensile forces pulled both sides of the block thus causing a rupture at A (focus) generating seismic waves traveling to the surface at B (epicenter). This activity caused the hanging wall to dip.
   d. A combination of vertically and horizontally acting forces created a rupture at A generating seismic waves traveling to the surface B. This made the footwall and hanging wall move in two directions – vertical and horizontal.

11. Which of the following statements are TRUE during an earthquake? Choose all that apply.
   a. The seafloor undergoes sudden horizontal slippage during an earthquake, causing the overlaying water to be accelerated or pushed laterally, initiating a tsunami.
   b. Tsunamis are only serious threats to coastal areas near an earthquake epicenter because the waves have lost most of their energy after moving across 100 miles of open water.
   c. Tsunamis lose little of their energy moving long distances through open water, so they can present serious threats to coastal areas hundreds of miles from the location of the initiating earthquake.

d. The seafloor suddenly moves upward or downward during an earthquake, displacing the sea surface into a mound or trough, initiating a tsunami.

12. Which of the following would be the LEAST IMPORTANT factor that would determine the degree of destruction during an earthquake?
    a. Distance to the epicenter
    b. Earthquake duration
    c. Magnitude of the earthquake
    d. Earthquake proximity to a populated area

13. In the year 2012, Cebu City was hit by a magnitude 6.8 quake with its focus in the neighboring town of Negros Oriental. If you were in the streets of the city a man is telling you that you should run or evacuate to safer grounds, how will you explain to him that his idea is correct?
    a. The earthquake occurred deep on land and does not have enough energy to move seawater to Cebu as a tsunami.
    b. Several structures in Negros would have dissipated the energy of the tsunami before it reaches Cebu.
    c. The earthquake did not occur underwater and does not have enough energy to generate a tsunami.
    d. It does not have enough energy and it occurred very deep on land. If it were shallow then it would have generated an earthquake.

14. A Boholano, reading a newspaper's headline "More than 2000 tremors recorded", immediately cried in front of you for fear that their house in Bohol must have been totally destroyed because of the quakes. How would you calm him down and explain to him scientifically?
    a. I will tell him that not all the quakes happened near the vicinity of their house.
    b. The foci of these earthquakes are located very deep on land and that it could not have reached the surface.
    c. Some of the earthquakes that were recorded are either deep or shallow but with lower intensities.
    d. Most of the earthquakes happened on a plain which was scarcely populated.

15. The Cebu City Medical Center (CCMC), a public hospital that caters to the residents of the City of Cebu was badly damaged by the magnitude 7.2 earthquake that hit the Visayas area last October 2013. Now the council is deciding whether to retrofit or build a new building. Which would be an appropriate suggestion to the council?
    a. Retrofitting the building would be a good idea as it will reinforce old structures that were not damaged by the earthquake. It is also not costly.

b. Retrofitting the building and constructing additional infrastructure would prepare it for possible re-occurrence of earthquakes.
c. Constructing a new building and making sure that this new structure is earthquake-proof is better in order to prevent further damage to property.
d. Neither of the two options would work as the area where the building will stand is near other structures that would cause damage.

16. With the recent quake that hit the Visayas, reports have come out about the extent of damage if a similar quake struck Metro Manila. You live in a 50-year old ***wooden*** ancestral house. Which part or component of your house would you have retrofitted first?
    a. Position of the appliances and small fixtures
    b. Position of breakable materials such as glass doors and panels
    c. Structure of the columns and beams that support the entire house
    d. Walls and ceilings of the house

17. Upon surveying your community, you found out that several homes are made of light materials and are near the river. Several alleys are also blocked by illegally set-up structures. You are asked to make an evacuation plan in case an earthquake occurs. What would be your first consideration?
    a. De-clogging of alleys and relocation of houses that are near the river.
    b. Electrical wirings and posts that may cause further damage when an earthquake strikes
    c. Exit routes to nearby open fields and areas
    d. Retrofitting of structures in order to withstand ground shaking

18. Your friends are having a heated argument as to which house will experience a greater damage if ever an earthquake of magnitude greater than 6 hits the area. One of them says that the house made of light and flexible material will experience the most damage while the other says otherwise. How would you explain yourself if you are asked for an opinion?
    a. A house made of light material will always crumble under the influence of seismic waves.
    b. A house that is made of light material but flexible enough to go with the motion of ground shaking will withstand an earthquake.
    c. Houses made of flexible materials will never withstand ground shaking and will eventually crumble.
    d. Nothing can ever replace the structural integrity of houses made of concrete and sturdy materials.

19. A coastal community in Mindanao facing the Pacific Ocean is planning to create an evacuation plan that will be useful in case an earthquake hits this area. What do you think would be a foremost consideration in making such a plan?
    a. Access to a nearby plain or wide area
    b. Location of electric posts and high rise buildings

c. Proximity to a nearby fault that will cause earthquakes
d. Structure of houses and other nearby buildings.

20. Atlas Mining Incorporated, the biggest copper mining firm in the Philippines, wants to expand its operation in Mindanao. What do you think would be considered by its geologic engineers when they start building the mining complex?
a. Area of coverage of the mining complex
b. Depth of digging that will done in order to extract copper ores
c. Proximity of the mining complex to a fault system or volcano
d. Soil composition and rock structure

EXPLORE

Let's start this module by doing an activity on the idea of building high-rise buildings in the Philippines. Remember to keep in mind these questions while doing the activity: Where should a build the condominium? What considerations should I make in building this condominium?

ACTIVITY No. 1: Build me a Condominium

A real estate development company is planning to build a 508-meter condominium in one of the places listed below. Your friend, an agent of the company, is asking for your opinion on which of the places should the company build the high-rise building. Choose the place from the list below and complete the box that follows then click submit. You may look at a political map for you to locate the place. You can also do an online research about the place.

Place Code	Location
A	Sagbayan, Bohol
B	Bayawan City, Negros Oriental
C	Sogod, Southern Leyte
D	Hinatuan, Surigao del Sur
E	Bonifacio Global City, Taguig

My chosen place is _____.

I chose this place because …

Process Questions:

1. What considerations did you make in choosing the place where the condominium should be built?
2. Which of the considerations you made weighed more than the others?
3. Would you build a condominium near a body of water? Or would you rather build it inland? Why or why not?
4. How do you determine the right place for building a high-rise condominium?
5. Should the movement of the Earth be considered when planning to build a high-rise condominium?

Now that you've decided on the place where a high-rise condominium should be built let's move on with the module. Before venturing deeply into the module, answer the "Initial" row of the table below.

ACTIVITY No. 2: Eliciting Prior Knowledge through IRF Chart

Fill-in the IRF Chart below. It will help you check your understanding of the lesson. Write the answers in your notebook.

Why are there Earthquakes?	
INITIAL	
REVISED	
FINAL	

As you proceed to the rest of the activities, always have these questions in your mind. What are faults? How are faults created? What is the relationship between a fault and an earthquake? What effect do earthquakes have? Why are there earthquakes?

End of EXPLORE:

You've just given your opinion on where a 508-meter condominium tower should be built based from a list. Keep in mind the reasons for you choice as you will encounter the same situation again later in this lesson. Remember to keep in mind the question on why earthquakes occur and what causes these. Your understanding of this natural phenomenon will allow you to determine the viability of building houses in a particular location and to create evaluation plans and kits that will be useful at home and in the community where you live.

Your understanding of faults and earthquakes will be increased as you study the lessons and perform the activities in the FIRM UP phase. Remember to take-down notes all the time using Evernote or your notebook.

FIRM-UP

You have shared you initial ideas on why earthquakes occur and you've also given your opinion on where a condominium should be built. Now it is time for you to do a simple investigatory on the effects of movement under the earth. Remember to observe closely everything that happens in the controlled environment as you try to manipulate the materials that you have.

ACTIVITY No. 3: When Stress is Applied…

Different materials react differently to stress. Stress is produced when force is applied to a particular area of any material. In this activity, you are going to do an investigation of the effects of the different kinds of stress that a material, in this case an analogy of the earth's surface, experiences and how it reacts to it.
MATERIALS: 6 slabs of Styrofoam (uniform rectangular shape), wooden table or any hard table, camera with high resolution for pictures

PROCEDURES:

TASK

1. In a wooden table, place two slabs of Styrofoam with its wider face on the table. Then push the 2 slabs toward each other until the two slabs experience a fracture. Take a close-up photo of the two slabs and observe carefully the edges that were fractured.
2. Take two different slabs of Styrofoam and place them beside each other on the table. Now slide the two slabs against each other and take pictures of the sides of the slabs that were initially in contact.
3. Now get one slab of Styrofoam and hold it on the sides. Pull each side simultaneously as hard as you can. You can also ask a friend of yours to pull one side while you pull the other side like a "tug-of-war" game. Observe the fractured part of the Styrofoam and take pictures.
4. Take the last Styrofoam slab and place it near the edge of the table such that half of it is no longer in contact with the table with the other half still rests on the table. Now push the hanging part of the slab until it gets deformed or fractured. Observe and take a picture of the fracture part.
5. Write down all your observations in your notebook and remember the action you did on the Styrofoam.

PROCESS QUESTIONS:

1. What happened to the Styrofoam when you compressed it?
2. What happened to the edges of the Styrofoam when they slipped past each other?
3. How about when you pulled one piece apart?
4. When you pushed a free end of the Styrofoam, what did you notice?
5. What effect did all your actions have on the Styrofoam?
6. Why are there earthquakes?

ACTIVITY No. 4: Stress under the Earth

What observations have you made from the previous activity? Could these observations be happening on a larger scale? What phenomenon does the previous activity mimic? Does that phenomenon contribute to geologic features that we see on the surface of the earth? Certain features of the Earth are brought about by several factors. One of these are the forces that are continually exerted by the different driving mechanisms of the earth. In this activity, you are going to read about the forces that would cause faulting.

The webpage posted in this activity will allow you to define what a fault is and its relationship to earthquakes. Furthermore, you will also be shown the different types of faults and some examples from data that have been collected from the United States.

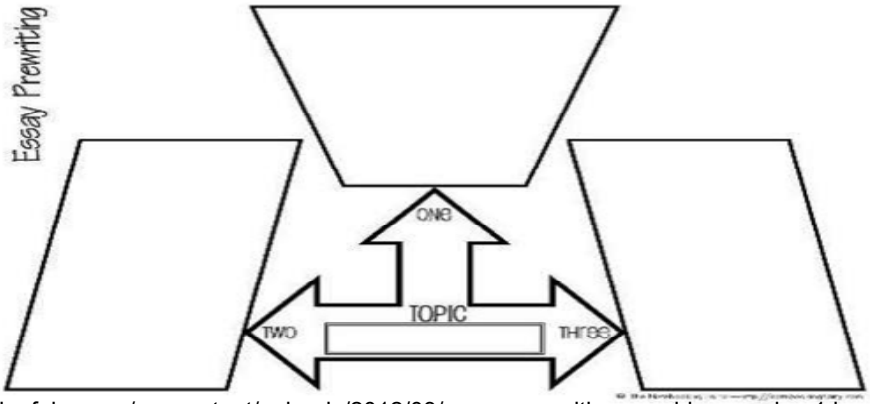
Browse through the webpage given below. Read and take note of the terminologies including the different kinds of faults. www.geo.umass.edu/courses/geo105/Lecture-10.**pdf**

PROCESS QUESTIONS:

1. What is a fault?
2. What are the different forces that create faults?
3. What are the different types of faults?
4. Why do these faults happen?
5. How do these faults differ from each other?
6. What effects do these faults have?

Part II: **Putting it all Together**

Now that you know the different forces that contribute to the formation of faults complete the graphic organizer below by listing down and describing each type of force that creates faults. Be sure to describe the different forces that affect the earth.



http://notebookingfairy.com/wp-content/uploads/2012/03/essay-prewriting-graphic-organizer1.jpg

PROCESS QUESTIONS:

1. What are the different forces that can act on any given landmass?
2. How does a compressional force affect a slab?
3. How about a tensile force, what effect does it have?
4. What effect does two slabs of landmass sliding past each other have on the adjacent landmasses?
5. Why does an earthquake occur when a fault system moves?

ACTIVITY NO.5: Let's Do A Quick Check!

Now that you've put everything in perspective, click this webpage on faults and do a self-check http://wps.pearsoncustom.com/pcp_80351_esm_tarbuck_earth_9/86/22073/5650878.cw/content/index.html. If on the first try you get a low score, you can repeat the test and then open this link for additional input on faults and folding http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Continents.shtml. Take the quiz again and see if you get a perfect score this time.

PROCESS QUESTIONS:

1. What are the driving mechanisms that create the different forces acting on landmasses?
2. How do these create faults?
3. Why are there earthquakes?

ACTIVITY No. 6: Whatever Happened to Land?

Faults, as you must have read, are of different types depending on which part of it has moved or has been lifted. These parts of a fault that must be considered are the hanging wall and the footwall. In this activity, you are going to analyze situations where fault lines have been created. Try to identify the kind of fault that is formed by clicking on the different links below. Observe carefully the formation of cracks and complete the table below.

1) http://cebudailynews.ph/news/story/21456/land-fissure-leads-to-discovery-of-fault-line
2) http://www.rci.rutgers.edu/~schlisch/structureslides/foldthrust_Pogue.jpg
3) http://geoscience.wisc.edu/~chuck/Classes/Mtn_and_Plates/Images/salv_faults.jpg
4) http://www.geolsoc.org.uk/ks3/webdav/site/GSL/shared/images/education_and_careers/RockCycle/RocksAroundBritain/Kilve%20NormalFault%20xtrawide.jpg
5) http://geology.csupomona.edu/janourse/Tectonics%20Photos/SplitMtnNormalFault.jpg
6) http://earthquake.usgs.gov/hazards/qfaults/images/sanandreas.jpg

Situation	Type of Force that Acted	Type of Fault	Observable Features
1			
2			
3			
4			
5			
6			

PROCESS QUESTIONS:

1. What happened to the landform that you observed in the websites?
2. How were you able to classify the fault?
3. What distinguishing characteristics made it easy for you to classify?
4. How do these faults lead to earthquakes?

ACTIVITY No. 7: ACTIVE OR INACTIVE?

Part I: Identifying whether a Fault is Active or Not

You have just identified the kind of fault that exists in a particular land mass. Whether the fault is active or not depends on certain prevalent conditions. It is therefore important to know whether a fault is active or not for you to be able to fully decide where the condominium should be built. In this activity, you are going to determine whether a fault line is active or inactive. If you live in Luzon, then you are going to determine the activity of the fault lines in Luzon. If you live in the Visayas, then the fault lines in the Visayas. Lastly, if you live in Mindanao, then the fault lines in Mindanao.

Browse through this website http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Earthquakes-and-Faults and then click on the menu “When is a Fault active?” Once you’ve read the contents of the site, go to http://www.phivolcs.dost.gov.ph and download the fault line maps of the island group where you belong. Once you’ve downloaded the maps, read the section in the website regarding the dates of recorded earthquakes in the Philippines and take note of the dates when earthquake was felt in the fault lines in your island group. Then classify the faults as active or inactive.

PROCESS QUESTIONS:

1. How do you know if a fault is active or not?
2. Which fault lines in your island group can be considered as active? Why?
3. Which ones are inactive? Why?
4. How do these fault lines shape the landscape of the Philippine islands?
5. Were you able to find fault lines near places of interest in your island group? If so, what are they and how do you think were they formed?

Part II: Going back to the Condominium Problem

Let's go back to the condominium problem. Do you still remember this activity?

ACTIVITY No. 1: **Build me a Condominium**

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Place Code	Location
A	Sagbayan, Bohol
B	Bayawan City, Negros Oriental
C	Sogod, Southern Leyte
D	Hinatuan, Surigao del Sur
E	Bonifacio Global City, Taguid

My chosen place is _____.

I chose this place because …

Now use the fault line maps that you've downloaded and your classification of active and inactive faults. Locate the places in the box and check if each of these is near an active fault line then answer the box below.

My chosen place is _____.

I chose this place because …

Part III: Filling-in New Knowledge

Now that you are able to identify faults and the mechanism behind it, let's go back to the IRF chart that you filled-in in one of the activities. Fill-up the revised part of the table that corresponds to your initial ideas on faults.

Why are there Earthquakes?	
INITIAL	
REVISED	
FINAL	

Process Questions:

1. Are there any changes to your initial ideas?
2. What are these changes? Discuss.

ACTIVITY No. 8: Video Analysis

Faults lying underneath an area can have severe effects on the people that live above it. One of the many effects that it has is the generation of earthquakes. Click on the website below and answer the questions that follow http://www.youtube.com/watch?v=iro9Kj5K4Es.

Process Questions:

1. What are the possible effects of a fault underneath an urban city?
2. How do earthquakes create damage in an urban city?

ACTIVITY No. 9: When the Earth Shakes

Earthquakes are caused by several factors, one of which is faults. Click on the webpage below and watch the video on earthquakes.
http://www.youtube.com/watch?v=-zNyVPsj8zc

Process Questions:

1. What role do earthquakes play in changing the landscape of the earth?
2. Why are earthquakes important?
3. Why are there earthquakes?

ACTIVITY NO.10: Terms…Terms…Terms

In order to understand fully the mechanism on how an earthquake works, one has to understand the different terminologies that we often read in news reports.

1.

2. Open and read this web page: *www.geo.umass.edu/courses/geo105/Lecture-10.**pdf***. This site provides you with all the terms that you need to know in order to understand earthquakes.

3.

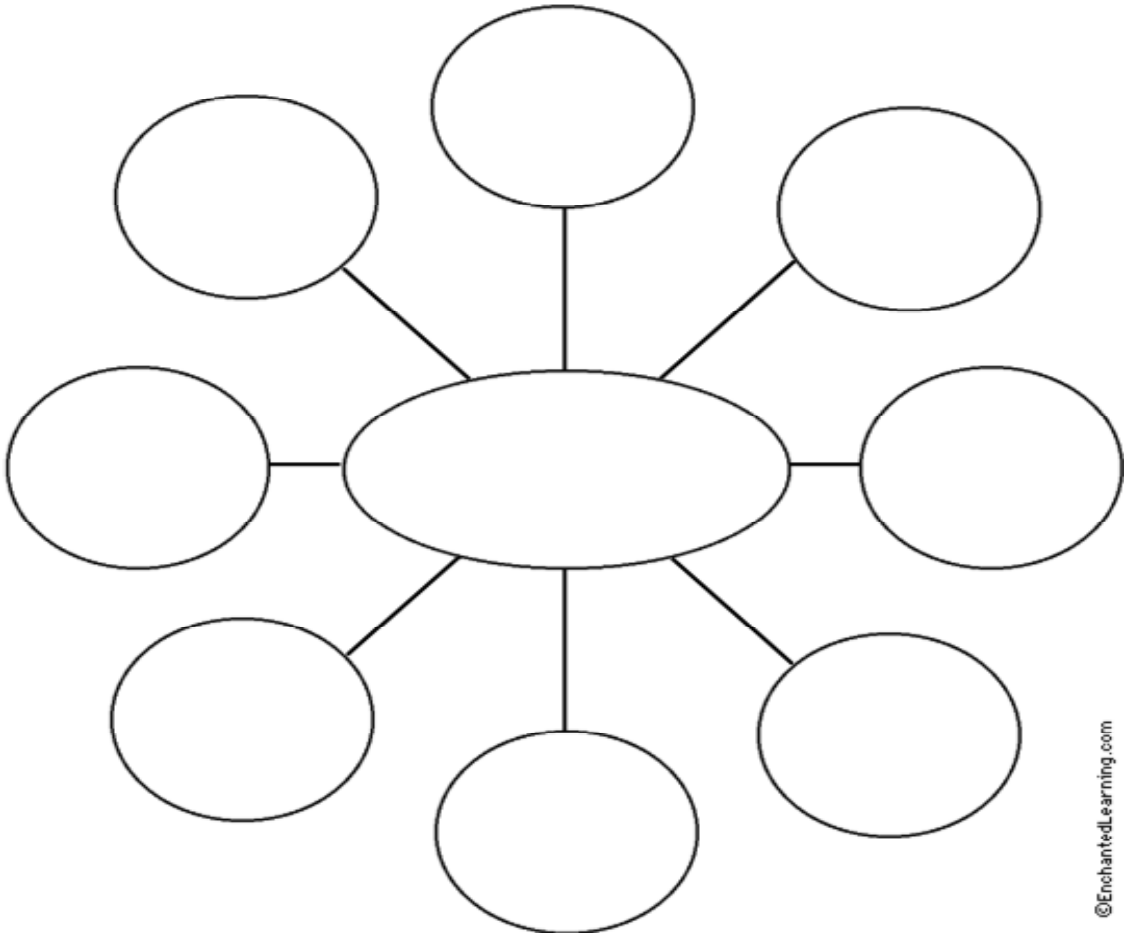
4. After opening the previous webpage, you can also click on this website for additional information http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Earthquakes-and-Faults. Click on the different menus that are found in

Process Questions:

1. How is a focus different from an epicenter?
2. When you read news reports, are given the intensity of the earthquake or the magnitude of the earthquake? How do you know?
3. What are the different scales that are used by geologists in order to ascertain the extent of damage caused by earthquakes?

***ACTIVITY No. 11:* Putting it Together**

After knowing the terms associated with earthquakes, you are now ready to complete the graphic organizer below. Remember to put the word Earthquake at the center of the organizer.



Process Questions:

1. What is an earthquake?
2. How is an earthquake different from faults?
3. What is the difference between an earthquake's focus and its epicenter?
4. What scales are used in determining the magnitude and the intensity of an earthquake?

1.

End of FIRM UP:

In this section, the discussion was about faults and earthquakes. You have read about how the different forces acting on the surface create faults and how these faults in turn generate earthquakes. How many forces can create faults? What effect does fault movement have? What is an earthquake? What are the different terms associated with earthquakes?

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? Please explain how faults are just one cause of earthquakes. How can your understanding of the relationship between faults and earthquakes be of good use to you? Can we benefit from the movements of the earth?

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

ACTIVITY No. 12: Earthquake Hazards

With each natural phenomenon come the hazards that accompany these. You are quite familiar with the hazards that a typhoon can bring whenever it enters our country. How about earthquakes? What do you think are the possible damages that this phenomenon can bring?

Click on these websites and see how an earthquake wrecks havoc in places where it happens.

1) http://www.youtube.com/watch?v=Sn4t13uxJFQ
2) http://www.youtube.com/watch?v=GFuSBc8Qvb0
3) http://www.youtube.com/watch?v=w3MhymxLS60
   - These websites show videos of the effects of earthquakes in different regions.

Process Questions:

1. Based from the videos that you've seen, enumerate all the possible effects of an earthquake.
2. While writing your answers in part 1, have you thought about your own home? What possible damage can your home suffer from an earthquake?
3. What effects do earthquakes have? Explain.

ACTIVITY No. 13: CONCEPT ALERT

Fill in the table: Provide answers in the first three columns on faults and earthquakes: Write your answers in your notebook and then click submit.

Statements about Changes of Matter	Agree or Disagree	Initial Explanation	Revised Explanation	Concluding Explanation
1. An earthquake always brings a lot of damage.				
2. Death is imminent when				

an earthquake strikes.				
3. Homes near the epicenter of an earthquake are most likely to have more damage.				
4. All earthquakes generate tsunamis.				
5. Tsunamis and storm surges are one and the same.				
6. A tsunami loses energy as it travels across the open sea.				

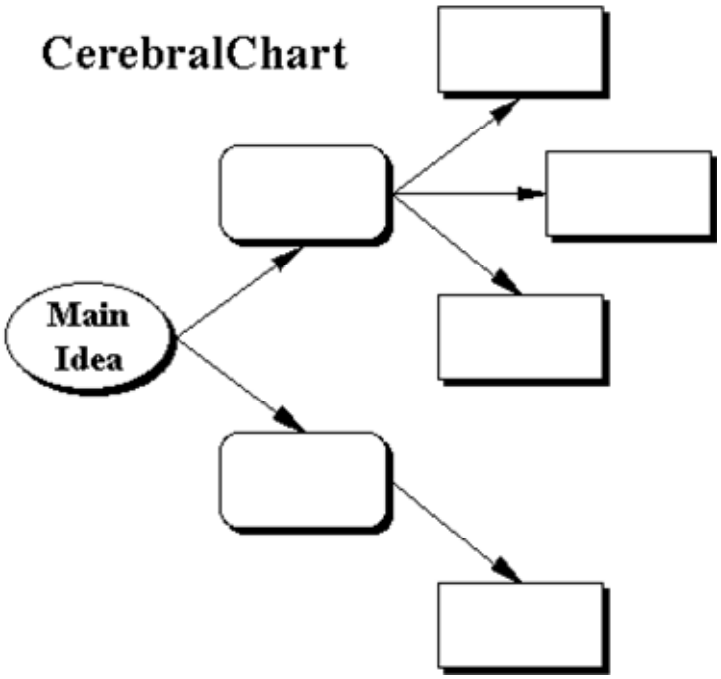
As you go on to the succeeding activities you will find out the answer of the above statements.

ACTIVITY No.14: Seismic Activity and Tsunamis

Whenever a part of the earth is moved, this creates movement in the adjacent land mass. Consider wiggling a whip in air, what happens to the air molecules that are hit by the whip? Now, if the whip hits an object, what happens to object? Is the object set in motion or will it remain at rest? Suppose the object is stationary, at the molecular level, what happens to the molecules hit by the whip? A slight movement in one part of the earth can have a dramatic effect on the other parts.

Click on these websites
ftp://ftpdata.dnr.sc.gov/geology/Education/PDF/Earthquakes.pdf (This website shows a pdf file of a powerpoint presentation focusing on earthquakes) ,
http://allshookup.org/quakes/wavetype.htm (This website shows the different type of seismic waves), and
http://www.nws.noaa.gov/om/brochures/tsunami2.htm (This website shows

what a tsunami is and how it is formed), and then fill-in the graphic organizer below.



The main idea here should be "earthquakes" followed by what you've read in the given sites.

Process Questions:

1. How are seismic waves generated?
2. What are the different seismic waves and how do they move?
3. Which of these waves do we feel and has the greatest effect on us?
4. How are seismic waves and tsunamis related?
5. Where should a seismic wave originate in order for it create a tsunami?
6. Do all earthquakes produce tsunamis? Why or why not?

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ACTIVITY No.15: Putting Life into Waves

In order to produce waves, you need to have energy that is carried by the wave all throughout its path. It is this energy that gives the wave its characteristic crest. It is also this energy that creates more harm as it hits land.

In this activity, you will need some of your friends in order to replicate what is done in the videos that you are about to see. Replicate what is done in the videos so that you will have a feel of how energy is transferred in a seismic wave.

Watch the videos by clicking on the following links
http://www.youtube.com/watch?v=gjRGIpP-Qfw and
http://www.youtube.com/watch?v=KZaI4MEWdc4
(These videos show how a seismic wave can be simulated using real world materials).

Process Questions:

1. Based on the video, how is energy carried by the wave?
2. What happens to the individual particles as it is hit by the wave?
3. If you think of your house as a particle, would it also behave in the same way as your friends did? Explain.

ACTIVITY No. 16: Quiz Time

It's now time to check your knowledge about the basic terms regarding faults and earthquakes. Click on this website http://ohhs.ohsd.net/~brick/ear/eara_eq_faults_vocabulary2.htm and answer the quiz without looking at other websites. Then check your work by browsing through the websites in this lesson.

Once you are done with the quiz, let's re-examine the concepts of the physical change of water for the concluding explanation column. Write your answers in your notebook. This will go through as your check up quiz.

Statements about Changes of Matter	Agree or Disagree	Initial Explanation	Revised Explanation	Concluding Explanation
1. An earthquake always brings a lot of damage.				
2. Death is imminent when an earthquake strikes.				
3. Homes near the epicenter of an earthquake are most likely to have more damage.				
4. All earthquakes generate tsunamis.				
5. Tsunamis and storm surges are one and the same.				
6. A tsunami loses energy as it travels across the open sea.				

ACTIVITY No. 17: Understanding it More

Read the situations below and come-up with a generalization on earthquake safety.

Situation 1:
Maria lives in the province of Ilocos Sur. Their house is made-up of wood and is slightly elevated from the ground by means of bamboo poles. It is a 50-year old house that has seen her grow and have her own family. When a magnitude 4 earthquake hit the province of Ilocos Norte, their house was completely destroyed.

Process Questions:

1. According to the correlating intensity of a magnitude 4 earthquake, what should have been a very observable effect? Support your answer.
2. Why do you think did their house crumble with a magnitude 4 quake?
3. What precautionary measure should they undertake?

Situation 2

Your friend's house is near the West Valley Fault. His house is made of concrete with wider columns and beams. These columns and beams are reinforced by steel beams that are of greater diameter than what is required. Moreover, the house is not full of lighting fixtures and glass panels.

Process Questions:

1. If ever the fault line near your friend's house move, would his house be damaged?
2. What advantage does having wide columns and beams have when an earthquake strikes?
3. What best practice can be learned from your friend's house design?

Process Questions:

1. What danger does the occurrence of an earthquake pose to the people living in Olivia's community?
2. Should the residents in this community be evacuated? Why or why not?
3. If they will not be evacuated, how should the residents prepare in case of emergency?

GENERALIZATION:

Why are there earthquakes and what considerations should be made in preparing for them?

Let's go back to the IRF Chart. Now fill in the last row. Write the answers in you notebook

Why are there Earthquakes?	
INITIAL	
REVISED	
FINAL	

End of DEEPEN:

In this section, the discussion was about the hazards that earthquakes pose, seismic waves and earth's interior, and tsunamis. What new realizations do you have about the topic? What new connections have you made for yourself?

In your notebook, write a brief reflection on your experience about the implication of earthquake occurrence and what we should think about them. Why are there faults and earthquakes? How are these two related to each other? Do you think understanding the relationship between these two is beneficial in human and in an environment? Why or why not?

Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is apply your learning to real life situations. You will make a Powerpoint presentation that will explain the viability of building houses or buildings in a particular area. From this presentation, you are going to make emergency plans and kits that shall be used by the community that will be built. Be sure to do all the tasks and apply what you've learned from the previous activities.

ACTIVITY No.18: Learning from the Videos

Watch the video in the URL below and answer the following questions carefully. Remember to take down notes before answering the questions. You may pause and play the video to clarify some items in the questions.
http://youtube.com/watch?v=LCJtvtUlhPk

Process Questions:

1. In the first frame of the video, what do you notice about the things in the shelf?
2. How about the shelf itself and the appliances?
3. Do you think the house was not damaged after the earthquake? Why or why not?
4. In the second frame of the video, you can see people running of their homes or offices, is it safe to do this? Why or why not?

After viewing the video, click the URL http://www.phivolcs.com.ph and check on hazard preparedness.

Process Questions:

1. What key elements are there?
2. How would this be implemented in your community?

ACTIVITY No.19: Webpage Reading

After viewing a sample video and taking-note of what has to be considered in the evacuation plan and kit, click on the webpage below and read on what things should be considered in retrofitting.

http://www.saundersseismic.com/assets/pdf/What-Is-Seismic-Retrofitting.pdf

- This website shows a pdf file on how retrofitting is done.

Process Questions:

1. Which parts of the house or a building should be considered first when retrofitting? Explain.
2. What benefit will retrofitting a house have?

ACTIVITY No.20: Pictorial View!

Take pictures of the different places in the area where the community will be built. Complete the table below and make a Prezi presentation.

TASK

Picture Taken	Structure to be Built	Precautions	Reason

Process Questions:

1. Which picture showed a spot on the area to be built that can be problematic in the creation of an evacuation plan and kit?
2. Why should access to the area as well as identification of faults be made prior to the construction of the housing project?
3. Why should the probability of earth shaking be considered in the building process?
4. How will the area be affected by earthquakes?

ACTIVITY No.21: The Making

TASK

You are now going to make the following items: (a) powerpoint or Prezi presentation that shall be presented to the officials and builders of habitat for humanity, and (b) evacuation plans and kits. Be sure to consider the following items:

a. Area where the houses will be built,
b. Nearby geologic structure,
c. Terrain, and
d. Materials that shall be used in building the houses.

Process Questions:

1. How should the houses be arranged?
2. How should the houses look like?
3. Which structure on the ground should be considered seriously?
4. Where should the drainage structure be placed?
5. What type of materials should the houses be made?

ACTIVITY No.22: **PERFORMANCE TASK**(presentation):

TASK

To help the victims of the magnitude 7.2 earthquake in Bohol, Habitat for Humanity is planning to build houses for these victims in a lot that is 10 kilometers away from the epicenter of the earthquake.

In response to this, you prepared a Powerpoint presentation that will explain to them the viability of building houses in the proposed lot. You also created emergency and safety plans and kits to be used in this new community. The acceptance of your suggestion and emergency plans and kits will be based on the accuracy of the information, clarity of presentation, practicality of recommendations and creativity.

Rubrics for the Performance Task:

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1	RATING
Accuracy of Information	The information presented is accurate, detailed and informative. Contains a detailed picture of all the parts of the house with complete retrofitting suggestions .	The information presented is accurate and informative. Contains a detailed picture of all the parts of the house with sufficient retrofitting suggestions .	The information is inaccurate but informative. Does not contain pictures of all parts of the house for comparison but with retrofitting suggestions .	The information presented is inaccurate and non-informative. Does not contain any picture of a part of the house and without any suggestion for earthquake retrofitting.	
Clarity of Presentation	The presentation and the emergency map are striking and understand able. A translation to the local	The presentation and the emergency map are clear and understand able.	The presentation and the emergency map are inconsistent in some.	The presentation and emergency map are confusing and difficult to read.	

	dialect is provided.				
Creativity	The presentation and the emergency map are creative and original with appropriate colors used together with illustrative and eye-captivating pictures or diagrams.	The presentation and the emergency map are creative with appropriate colors used and appealing pictures or diagrams.	The presentation and the emergency map are limited but with confusing pictures or diagrams.	The presentation and emergency map are copied. Both do not contain pictures or diagrams.	
Practicality of Recommendations	The recommendations are practical, innovative and can be immediately implemented.	The recommendations are practical and can be implemented after a few months.	The recommendations are practical but its implementation involves a lot of expenses.	The recommendations are not practical and cannot be implemented.	
				OVERALL RATING	

Before you go to the post-assessment, write a reflection in your synthesis journal about your experiences in the entire lessons. You may choose to answer one, or all of these guide questions:

1. What have you learned about the entire lesson? Is it challenging to see the world you live in?
2. What would our life be if earthquakes did not exist?
3. What other tasks would you like to work on in the future that could be beneficial to humans and the environment?

End of TRANSFER:

In this section, your task was to create a powerpoint presentation on the viability of building structures near a fault line. You also created emergency plans and kits that will be used in the community to be built.

How did you find the performance task? How did the task help you see beyond the damage that a natural phenomenon brings?

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

Read, analyze and answer each of the questions below by choosing the letter of the MOST APPROPRIATE answer.

1. What is the focus of an earthquake? The focus is ____.
   a. a seismic wave that travels along the surface of the earth
   b. the last place that motion in an earthquake is detected
   c. the point on the earth's surface directly above the earthquake's focus
   d. the location along a fault where the first motion of an earthquake occurs

2. The intensity of an earthquake is determined from the _____.
   a. damage done by the earthquake
   b. duration of an earthquake
   c. arrival of P waves and S waves
   d. measurement of the amplitude of the largest seismic waves

3. Which of the following is evidence that the Earth is made-up of different boundaries?
   a. Refraction of seismic waves as they encounter different mediums.
   b. The wave shadow effect of P- and S- waves as they encounter the solid and liquid core.
   c. The wave shadow effect of P- and S- waves and the increase in velocity of P-waves as they encounter the solid inner core.
   d. The reflection of waves as they hit the boundaries, its refraction as they pass through different boundaries, and its diffraction around obstacles.

4. While walking towards school, a student of Inabanga National High School in Inabanga, Bohol saw cracks on the road with one side of the road going over

the other running for about 1 kilometer. What would be the best explanation for the presence of this crack?

a. The road experienced tensional stress causing it to rupture.
b. A shearing stress was applied to the land mass causing it to rupture.
c. Reverse faulting happened as a result of compressional stress
d. Normal faulting happened as a result of shearing stress.

5. A road in Marikina City has a 10-meter long crack with no uplift at all. A motorist noticed that as years passed by, a once straight line crossing the road is no longer aligned but are far from each other. What do you think is happening to the road?
   a. The road is experiencing tensile stress causing the two blocks to move away from each other.
   b. Compressional stress is acting underneath the two blocks thus moving them away from each other.
   c. The amount of shearing force applied to the two blocks is so great that these blocks become separated from each other.
   d. A combination of vertical and horizontal forces causes the two blocks to move away from each other.

6. As you jog through a stretch of the national highway, you noticed that the land mass on the side of the road has moved down and that the road is now a little bit higher than the sides. Which of the processes could have caused this rock to be in that position?
   a. Tension underneath the road surface has caused one block to move up on top of the other.
   b. Right under the road blocks is a shearing force that causes one block to move below the other.
   c. One block is less dense than the other causing it to subduct below the other.
   d. Compressional forces caused this horst to form pushing the middle part to be lifted.

7. Your classmate was able to read about the Elastic Rebound Theory as an explanation of how the rupture or breaking of crustal material releases energy that we feel on the ground as an earthquake. Although he has read about it, he still cannot understand how it happens. How would you explain this to him?
   a. I will get two blocks and place each side by side. I will push both blocks up until part of it breaks.
   b. I will get a Styrofoam board and then slowly bend it until it breaks. Then I will ask him to look at the broken edges.
   c. I will get an aluminum wire and then bend it slowly. As I bend it, I will ask him to look at the portion that is about to break.

d. I will get a piece of plastic, slightly bendable ruler. I will slowly bend it and place a Styrofoam board on top. I will ask him to look at the bent portion and listen to the sound as the ruler breaks.

8. Look at the map of the Philippines below and answer the questions that follow.

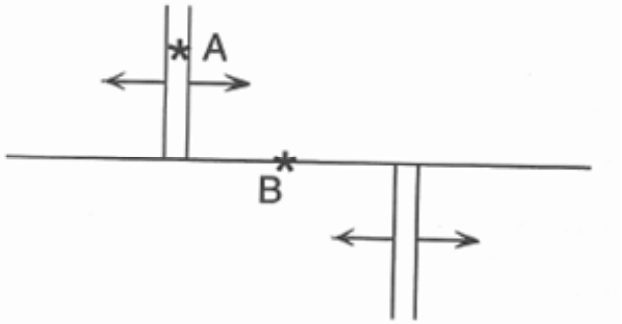
Suppose an underwater earthquake of magnitude 6 occurred in the Sulu sea and generated a tsunami. Will there be a possibility for the island of Bohol to be hit by the tsunami?

a. Yes, because the earthquake occurred underwater.
b. Yes, because the earthquake occurred underwater and releases a considerable amount of energy enough to create a tsunami.
c. No, even if the earthquake occurred underwater the energy carried by the waves will only be dissipated as it travels at sea.

d. Cannot be determined because Bohol is very far from the source of the earthquake.

9. A house made of old bricks is located near a fault line which has been moving for the last decade. Which of the following should be a **foremost** consideration that the house owners should make in case an earthquake happens?
   a. access to highway
   b. location of an active fault
   c. road right of way
   d. type of building material

10. Given the picture below. What type of earthquakes would most likely occur at point B?



   a. Deep-focus earthquakes caused by thrust faulting.
   b. Shallow-focus earthquakes caused by thrust faulting.
   c. Shallow-focus earthquakes caused by normal faulting.
   d. Shallow-focus earthquakes caused by strike-slip faulting.

11. In the year 2012, Cebu City was hit by a shallow-focus magnitude 6.8 quake with its focus in the neighboring town of Bohol. If you look at the map in question no. 8, you will see that Cebu and Bohol are neighboring provinces separated only by a body of water that has a small area. How would you explain the probability of a tsunami created by the earthquake?
   a. The probability of the earthquake creating a tsunami is close to zero because the magnitude of the quake is not that high. Moreover, the earthquake occurred on land and the energy will be dissipated as it moves through several media.
   b. The probability of the earthquake creating a tsunami is high because the magnitude of the quake is also high. Furthermore, since the quake occurred where a body of water is then it is likely to create a tsunami.
   c. The earthquake will definitely create a tsunami given the fact that there is a body of water in between the two provinces. Moreover, it carries with it enough energy that can be transferred to the surrounding body of water.

d. Whether the quake will create a tsunami or not cannot be determined from the given data.

12. Which of the following statements is FALSE?
    a. Most earthquakes occur at plate boundaries.
    b. P waves travel faster than both S waves and Surface waves.
    c. Earthquakes can be caused by normal, reverse, and strike-slip faulting.
    d. The time and location of most major earthquakes can be predicted several days in advance.

13. After the Bohol earthquake, panic-stricken Cebuanos started to evacuate from downtown Cebu to upland barangays and municipalities both in the Northern and Southern part of Cebu for fear of a tsunami hitting the city. You happen to ride with one of them in a jeepney. How would you calm him down and explain to him scientifically?
    a. I will tell him that Bohol is too far from Cebu City and that the energy of the tsunami would have dissipated already.
    b. The foci of these earthquakes are located very deep on land and that it could not have reached the surface.
    c. The earthquake happened very deep and that tsunamis are only caused by strong, shallow earthquakes.
    d. Most of the earthquakes happened on a plain which was scarcely populated.

14. Several structures were damaged by the magnitude 7.2 earthquake that hit the Visayas area last October 2013. Some of these structures are built on ground that is made-up of limestone. Would it be a good idea to build the structures on the same ground?
    a. Yes, because they own the property and they can easily procure the materials needed for re-building.
    b. Yes, because limestone is a relatively stable kind of stone thus it would support the same structures again.
    c. No, because limestone will easily crumble with just a few tremors hitting it thus these structures would easily be destroyed.
    d. The owners need to conduct further soil study in order to avoid the possibility of liquefaction in case another earthquake occurs.

15. With the recent quake that hit the Visayas, reports have come out about the extent of damage if a similar quake struck Metro Manila. Similarly, Climate change experts are voicing out the eminent sinking of some parts of the metropolitan. These warnings have stirred urban planners to create evacuation plans and kits that will combine the preparation for the two catastrophes. Which of the following CAN BE done as a precautionary measure?
    a. Ask residents to retrofit their houses to prepare for both
    b. Construct dikes on the shoreline to serve as shield

c. Evacuate all residents of the metropolis to higher ground
d. Put early warning devices to aide during the evacuation process

16. You belong to a community that lives right beside a river with a known fault line. You are asked to make an evacuation plan in case an earthquake occurs. Which of the following would be a likely solution?
    a. Following the 2-meters easement zone and then removing the structures that block the alleys.
    b. Constructing a dike so as to prevent water from the river from spilling over.
    c. Putting communication systems within the community in order to give warning in cases of emergency.
    d. Putting up signages that warn people about the location of the fault.

17. A school building has a gym located in the topmost floor and is commonly used as a venue for student activities as well as other school-wide events. An interview with the engineer, who built the building, revealed that the original intention of the school was to use it for sports activities although the gym can also serve other purposes. When a 7.2 magnitude earthquake hit the city, school officials are now feeling that the gym's floor shakes whenever students' run across the gym. Which solution would be very feasible to address this problem?
    a. Close down the gym and build a separate one on the ground floor.
    b. The gym should be wrecked and a new one should be constructed.
    c. New columns should be constructed to support the weight of the gym with or without occupants.
    d. The beams of the gym can be retrofitted with thick solid steel plates that are mounted using steel bolts and nuts.

18. A community living near the Mayon Volcano is planning to create an evacuation plan that will be useful in case a volcanic earthquake hits this area. What do you think would be a foremost consideration in making such a plan?
    a. Access to a nearby plain or wide area
    b. Location of electric posts and high rise buildings
    c. Proximity of houses to the volcano and radius of volcanic eruption.
    d. Structure of houses and other nearby buildings.

19. One of Cebu Province's famous landmarks, found in the municipality of Boljoon, is the Ili Rock (picture shown below). On the side of the rock is the national highway where buses and other motorists going towards the southern part of Cebu and in the neighboring island of Negros pass by. When the 7.2 magnitude earthquake struck, part of this limestone rock crumbled.

http://boljoon.myguide.ph/about.html

What do you think would be considered by engineers from the DPWH when they visit the place?

a. Building of a dike to control the erosion
b. Landscaping of the remaining part of the rock
c. Construction of an alternate route just beside the existing highway
d. Soil composition and rock structure of the nearby coastal area

20. The City of Manila is planning to approve the proposal of one company to extend the reclamation area in Roxas Blvd. From a geologic perspective, how will you explain to the mayor of Manila the viability of such a project?

a. Any reclamation project in the city of Manila would be beneficial to its residents as it would generate more jobs for its constituents.
b. A reclamation project in the city of Manila would kill all the aquatic resources in the bay and would therefore lessen the benefits to the city.
c. Reclaiming part of the sea would involve dumping of soil into it. This would put into question the stability of the area especially that the West Valley Fault is in the city.
d. Reclamation projects in Manila would only cause much traffic as buses who ply that route will have to be rerouted in order to accommodate the machines that will be used.

GLOSSARY OF TERMS USED IN THIS LESSON:

Body waves – seismic waves that travel inside or through the earth

Compressional force – a force that pushes two land masses toward each other

Earthquake – the shaking of the earth's surface that results from a rupture of a land mass

Epicenter – the point on the earth's surface that is directly above the focus

Fault – a crack in the earth's surface

Focus – the point underneath the earth where the rupture or fault started

Footwall – part of the land mass where one can step on in a fault

Hanging wall – in mining terms, this is the part of the land mass where one can hang a lamp for lighting

Hazard – is anything that can cause or inflict harm on another

Intensity – the extent of damage that an earthquake causes

Magnitude – a measure used to quantify the energy that an earthquake carries with it

Normal fault – a fault that is created when the footwall is lifted up

P-wave – back and forth movement of rock and can travel through any medium in the earth's crust

Retrofitting – the process of putting necessary corrections or reinforcements to certain structures in order for it to withstand a particular phenomenon that can cause damage to it

Reverse fault – a fault that is created when the hanging wall is lifted up exposing part of it

Seismic wave – a wave that is produced by the release of energy as the earth ruptures

Shear force – a force that acts perpendicularly to the surface of a landmass

Strike-slip fault – fault that is created when two masses of land slide past each other

Surface waves – seismic waves that travel on the surface of the earth and cause more damage

S-wave – a body wave that moves rocks sideways and can travel through solids only

Tensile force – a force that pulls or stretches a land mass away from each other

Tsunami – a series of water waves caused by the displacement of a large volume of water

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

1) www.geo.umass.edu/courses/geo105/Lecture-10.**pdf** - This webpage presents a lecture on earthquakes and faults.

2) http://wps.pearsoncustom.com/pcp_80351_esm_tarbuck_earth_9/86/22073/5650878.cw/content/index.html - This webpage is a knowledge quiz on faults.

3) http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Continents.shtml - This webpage presents the plate tectonics theory and the effect that it has on the continents.

4) http://cebudailynews.ph/news/story/21456/land-fissure-leads-to-discovery-of-fault-line
http://www.rci.rutgers.edu/~schlisch/structureslides/foldthrust_Pogue.jpg
http://geoscience.wisc.edu/~chuck/Classes/Mtn_and_Plates/Images/salv_faults.jpg
http://www.geolsoc.org.uk/ks3/webdav/site/GSL/shared/images/education_and_careers/RockCycle/RocksAroundBritain/Kilve%20NormalFault%20xtrawide.jpg
http://geology.csupomona.edu/janourse/Tectonics%20Photos/SplitMtnNormalFault.jpg
http://earthquake.usgs.gov/hazards/qfaults/images/sanandreas.jpg - These websites show pictures of rock formation that have undergone faulting. The pictures in these sites are for analysis.

5) http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Earthquakes-and-Faults - This website provides additional information about earthquakes and faults.

6) http://www.youtube.com/watch?v=iro9Kj5K4Es – This website shows a video of an existing fault system located underneath one of the United States biggest state.

7) http://www.youtube.com/watch?v=-zNyVPsj8zc – This website shows a video documentary by the National Geographic Channel on earthquakes and its importance.

8) http://www.youtube.com/watch?v=Sn4t13uxJFQ
http://www.youtube.com/watch?v=GFuSBc8Qvb0
http://www.youtube.com/watch?v=w3MhymxLS60 – These websites show videos of the effects of earthquakes in different regions.

9) ftp://ftpdata.dnr.sc.gov/geology/Education/PDF/Earthquakes.pdf - This website shows a pdf file of a powerpoint presentation focusing on earthquakes.

10) http://allshookup.org/quakes/wavetype.htm - This website shows the different type of seismic waves.

11) http://www.nws.noaa.gov/om/brochures/tsunami2.htm - This website shows what a tsunami is and how it is formed.

12) http://www.youtube.com/watch?v=gjRGIpP-Qfw – This website shows a video of how a seismic wave can be simulated.

13) http://www.youtube.com/watch?v=KZaI4MEWdc4 – This website shows a video of how a seismic wave can be simulated.

14) http://ohhs.ohsd.net/~brick/ear/eara_eq_faults_vocabulary2.htm - This is quiz on vocabulary.

15) http://youtube.com/watch?v=LCJtvtUlhPk – This website shows a video shows the interior of house during an earthquake.

16) http://www.phivolcs.com.ph – This is the official website of the Philippine Institute of Volcanology and Seismology where information regarding earthquakes that happened in the Philippines.

17) http://www.saundersseismic.com/assets/pdf/What-Is-Seismic-Retrofitting.pdf - This website shows a pdf file on how retrofitting is done.

Lesson 2: Understanding Typhoons

Introduction and Focus Questions

Ondoy, Milenyo, Sendong. How do these names make you feel? What are the personal experiences you associate with them? Over the past years, typhoons that enter the Philippine Area of Responsibility become more frequent and violent, causing great damage and loss to many lives and properties.

How do typhoons develop? How can we manage its potential risks and hazards? These are some of the important questions that you will seek to answer in this module.

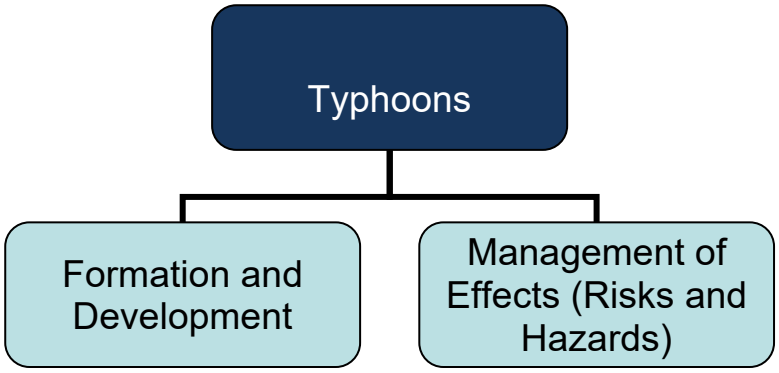
LESSON COVERAGE:

In this lesson, you will go through the following topics:

Lesson No.	Title	You'll learn to…	Estimated Time
Lesson 2.1	Formation and Development of Typhoons	• Explain how typhoons develop • Explain how landforms and bodies of water affect typhoons	4 hrs.
Lesson 2.2	Managing the Effects of Typhoons	• Infer why the Philippines is prone to typhoons • Trace the path of typhoons that enter the Philippine Area of Responsibility	10 hrs.

Concept Map of the Lesson

Here is a simple map of the topics you will cover in this lesson:



Expected Skills

To do well in this module, you need to remember and do the following:

1. Read the instructions carefully before starting anything.
2. Complete all the activities and worksheets. Follow instructions on how to submit them.
3. Look up the meaning of words that you do not know.
4. You will frequently come across process questions as you go through different lessons. Keep a notebook (or use the Notepad) where you can write (and revise) your answers to these questions. Use also the notebook to jot down short notes, draw diagrams, and summarize what you have just read.
5. For worksheets and reports that need to be submitted, use the provided checklist and rubric to evaluate your work before submission.
6. Allow time for relaxation and recreation when you are mentally tired. Make a time table to schedule your study and recreation.

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

(A) 1. Which of the following best describes a typhoon?
   A. A low pressure area
   B. Heavy rains and flood
   C. Hurricane
   D. Mature tropical cyclone

(A) 2. Which of the following is **not** involved in the formation of typhoons?
   A. Intertropical Convergence Zone
   B. Low Pressure Areas
   C. Strong Vertical Wind Shear
   D. Warm Sea Surface Temperature

(A) 3. What causes the formation of low pressure area that can lead to the development of a typhoon?
   A. Cold and dry air
   B. Cold waters surrounded by warm conditions
   C. Warm waters surrounded by cold conditions
   D. Very low moisture or humidity

(A) 4. Lolita noticed that when typhoons came from the west, they barely get affected by such weather systems. But when typhoons originate from the east, they would almost always be dealing with strong winds and sometimes floods. Their village in General Santos City is sandwiched by a mountain range 2 kilometers from the west and by the sea which is about a kilometer away. What can explain her observations?
   A. Cold air produced by trees from the mountains weakens the incoming typhoons headed towards the village.
   B. Lolita is mistaken as typhoons in tropical countries would always follow a west to east route.
   C. Mountains have the ability to deflect bodies of air, thus, Lolita's village is not affected by typhoons from the west.
   D. Typhoons cannot possibly originate west of their village as there is no body of water from that direction.

(A) 5. Most of the tropical cyclones that affect the Philippines develop east of the country, usually between 125°E and 170°E over the Pacific Ocean. These cyclones generally move towards the northwest direction. Given this case, which areas can be most frequently hit by these typhoons?

A. Central and Southern Mindanao
B. Eastern and Southern Visayas
C. Eastern and Northern Luzon
D. Western Visayas and Northern Palawan

(A) 6. The Philippines is one of the countries near the equator, and, just like the other countries in this region, it is regularly visited by typhoons. The reason for this is that

A. Equatorial countries are those that are usually in the route of typhoons that move from east to west.
B. Equatorial countries are those that are usually in the route of typhoons that move from west to east.
C. Our country is an archipelago, typhoons are likely to form in the waters in between the lands.
D. The temperature is conducive to forming typhoons as water from the surrounding seas get evaporated.

(A) 7. Refer to the following figure to infer why the Philippines is prone to typhoons that originate from the Northwestern Pacific Ocean:

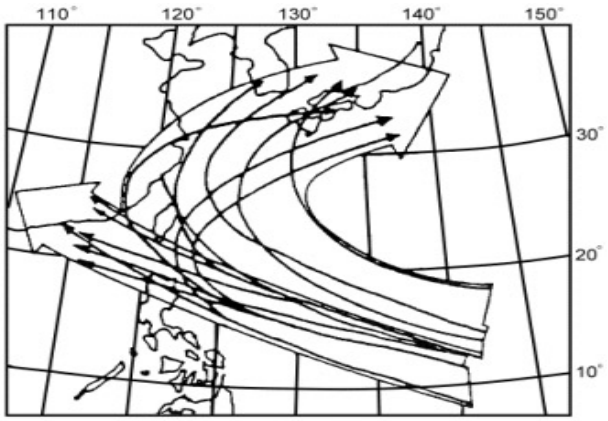
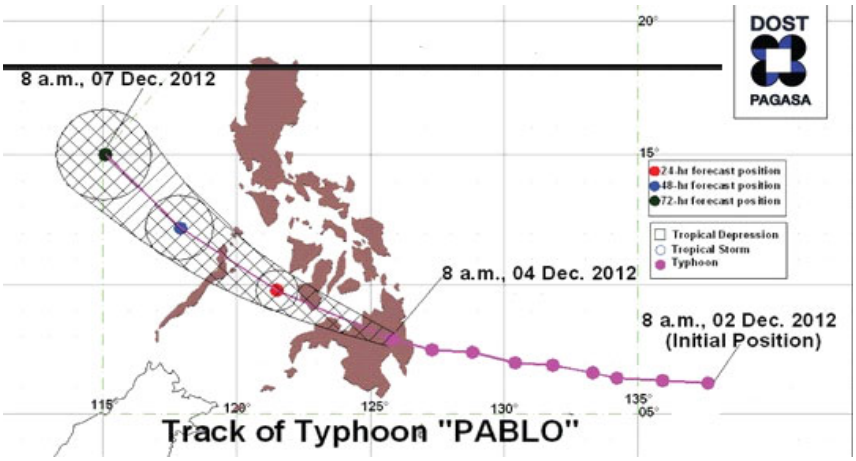


Fig 3 Typhoon paths in the Northwestern Pacific Ocean

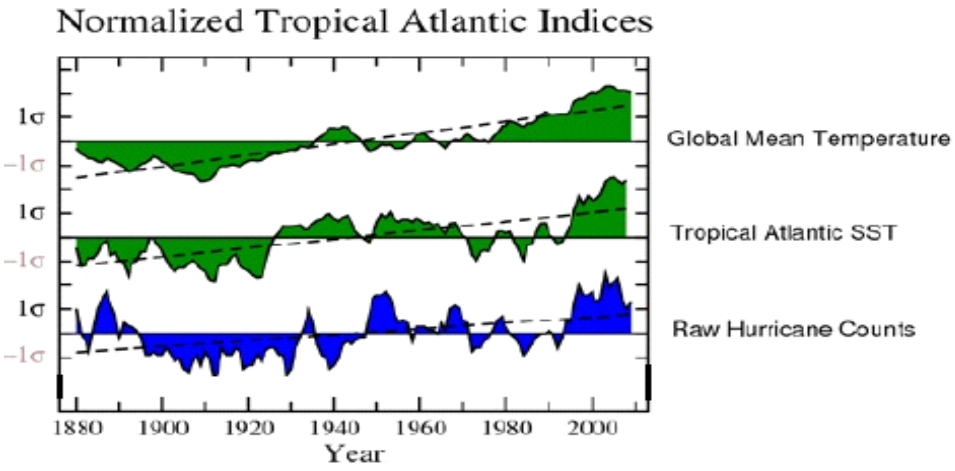
A. Airflow steers the typhoon towards the Northeast direction.
B. Large scale airflow directs westbound movement of the typhoon.
C. Typhoons rotate counterclockwise due to the Coriolis force.
D. Trade winds cause these typhoons to move towards the east.

(A) 8. Based on the given tracking data of Typhoon Pablo, in what areas will the typhoon be expected to move?



A. Batanes, Cagayan, Isabela
B. Davao, Cagayan de Oro, Bohol, Negros Oriental
C. Eastern Samar, Masbate, Quezon, Laguna
D. Southern Leyte, Cebu, Iloilo

For nos. 9-11, refer to the graph.
The graph below shows the global mean temperature, tropical atlantic sea surface temperature (SST), and raw hurricane counts over the past century:



(M) 9. Which of the following is the best interpretation of the data?
A. Global mean temperature, tropical atlantic SST, and number of hurricanes changed from 1900 to 2000.
B. Much of the increase in hurricane counts came in the 1990's along with the steady increase in global temperature and tropical atlantic SST.
C. The global mean temperature, tropical atlantic SST, and number of hurricanes have decreased at different periods over the past century.

D. The number of hurricanes generally increased since the 1970's.

(M) 10. What do the data tell us about the formation of tropical cyclones like hurricanes and typhoons?
A. Increasing global temperature and warm SST influence the formation of tropical cyclones.
B. Much of the tropical cyclones like hurricane and typhoon formed and developed during the 20th century.
C. The formation of hurricanes and typhoons is affecting the condition of the atmosphere and the oceans.
D. Tropical cyclones like hurricanes and temperatures form and develop in the ocean surface.

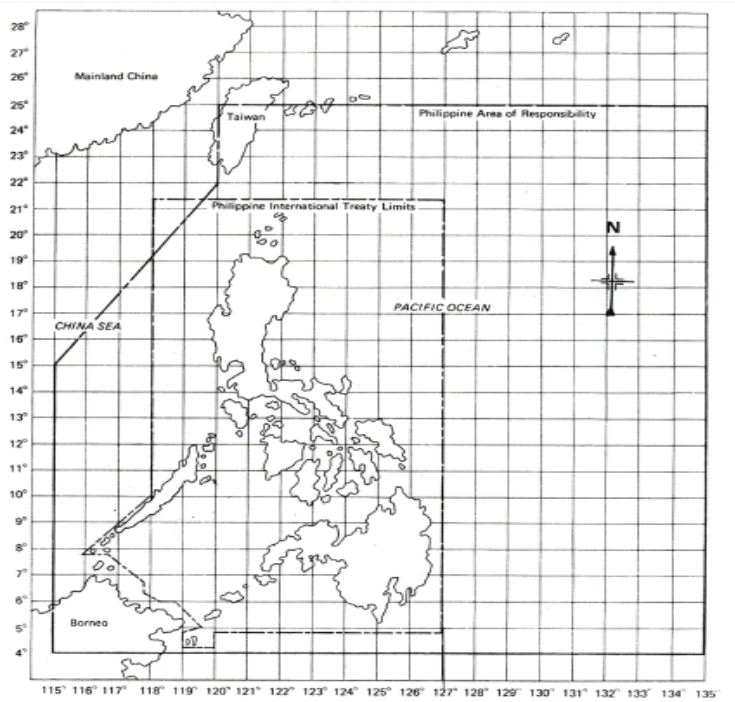
(M) 11. Given this data, what is the likely effect of global warming to the formation of typhoons and hurricanes?
A. Less typhoons and hurricanes
B. Less typhoons and hurricanes and increased drought
C. Longer rainy and wet season and shorter dry season
D. More frequent and more violent typhoons and hurricanes

(M) 12. The Philippines has a total coastline of 36,289 kilometers, and 70% of the cities/municipalities depend on coastline and marine ecosystems as a source of livelihood. Using information from the 2003 official statistics, about 14.9 million homes are vulnerable to the impacts of strong typhoons and storm surges as they have structures with roofs and/or walls that are either make-shift or made of substandard materials.
The rise in sea level increases the risk of many more people to flooding. In urban areas flooding is aggravated by clogged drainages, and ground subsidence due to over-extraction of groundwater for domestic and industrial use.

These are only some of the main considerations why national estimates show that 82.5% of the entire population of the Philippines are at risk to typhoons.

Which of the following sets of factors **best** determine an area's vulnerability to impacts of typhoons?
A. The area's geographical location and topographic characteristics
B. The area's geographical location and people's preparedness and capacity
C. The area's proximity to bodies of water and their use of groundwater
D. The area's topographic characteristics and the degree of environmental pollution

(M) 13. Refer to the figure below which shows the boundaries of the Philippine International Treaty Limits (PITL) and the Philippine Area of Responsibility (PAR).



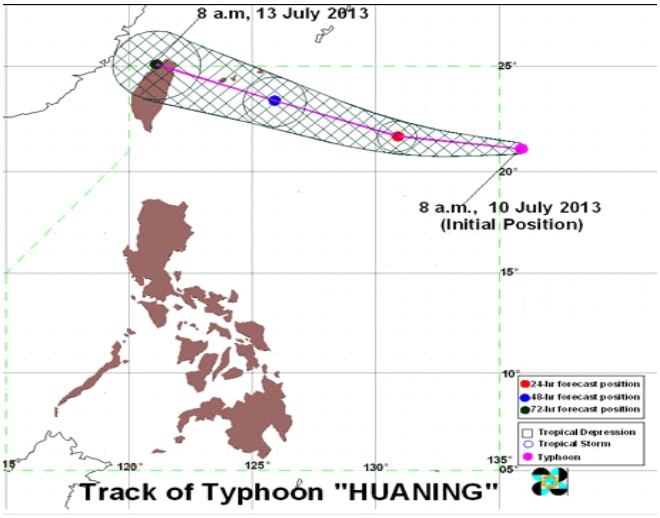
What is the advantage of having an area of responsibility wider than the national territory?

A. Incoming weather disturbances can be predicted in advance hence precautions can be taken.
B. It will boost the country's tourism as tourists will be interested in the many rich natural resources found in the country.
C. There will be less natural disasters that will hit the country.
D. Wider area of study increases the possibility for meteorologists to change the path of an incoming typhoon.

(M) 14. A lot of factors are needed for a tropical cyclone to form, develop, and maintain its strength. Although typhoons can develop throughout the year, which of the following seasons provides the best condition for these weather disturbances to form?

A. During the cold, dry season from December to February
B. During the hot, dry season or summer from March to May*
C. During the rainy season from June to November
D. During the rainy season and cold, dry season from June to February

(T) 15. You and your family will fly to Cebu on July 11, 2013 to visit your relatives. However, a day before the flight you heard from the news that Typhoon “Huaning” has entered the Philippine Area of Responsibility. You decided to check the PAGASA track of the typhoon to be sure:



What is the appropriate action?

A. Make other plans for tomorrow; you’re sure that the flights to Cebu will get cancelled anyway.
B. Pursue the earlier plan because it is apparent that the typhoon will not make a landfall anywhere in the country.
C. Pursue the earlier plan but make sure to pack umbrella and raincoats because rain showers are expected.
D. Re-book the flights as it is definitely not safe to fly when there is a typhoon threat.

(T) 16. PAGASA has just issued Public Storm Warning Signal (PSWS) # 2 in your locality. Who among the following residents took the correct precautionary measure?

A. Anna risked her flight to the North because of a very important conference she needs to attend.
B. Carlos decided to go to work because there was no suspension of work for the day. The place where he works is not prone to flood but their locality is.
C. Jose continued his fishing job for the day and boarded his seacraft.
D. Maria postponed the scheduled class field trip and disseminated the information as early as possible.

(T) 17. The damages left by the typhoon create even bigger problems to the community and further weakens their adaptive capacity. All of the following are measures that should be taken after a typhoon **except**:
A. Assist the physical and psychological rehabilitation of those who suffered the effects of the disaster.
B. Improve the skills of staff in search, rescue, and retrieval operations.
C. Mobilize funding sources to restore people's means of livelihood.
D. Reconstruct damaged infrastructure and other public utilities.

(T) 18. If you are a weather forecaster, which of the following is the best way to deliver a rain forecast?
A. "About half an inch of rain can be expected."
B. "It will most likely rain in the afternoon."
C. "The rain will be heavy at times."
D. "There is a 30% chance of rain."

(T) 19. Through the National Disaster Risk Reduction Management Plan (NDRRMP), it is hoped that the country will have *"safer, adaptive and disaster-resilient Filipino communities towards sustainable development."* Which of the following activities does **not** support this vision?
A. A forestry society strengthened their fight against illegal logging.
B. Many homeless families found relatively more decent residences along river pathways.
C. News stations make use of social media to disseminate up-to-date and accurate weather information and forecast quickly.
D. The local government conducted series of trainings to improve skills in search, rescue and retrieval operations.

(T) 20. As a researcher for the Local Disaster Risk Reduction and Management Office of your locality, you are tasked to assess the risk of typhoons in your area and recommend plans of action. You will develop a risk assessment plan and present it to the barangay officials. What should you take into consideration when presenting the plan to the barangay officials?
A. Presentation is based on data gathered from experiences and success stories from other countries.
B. Presentation is concise and convincing, based on accurate data, and includes practical recommendations.
C. Presentation is concise, visually appealing, and makes use of appropriate graphics.
D. Presentation is elaborate and highly technical, and based on accurate interpretation of data.

Lesson 2.1: Formation and Development of Typhoons

EXPLORE

With its frequency and degree, the damages it can bring, and the many problems it has caused our country, "typhoon" is definitely something to think about seriously. In what way do you think about typhoons? How closely have you paid attention to their formation and development? the risks and hazards they can bring to you and your family? Have you ever thought of finding a way to solve these problems?

Let's start this module by gathering your thoughts about typhoons.

Activity 1.1: Article Analysis

Read the article entitled *Unusual Typhoon Leaves Southern Philippines Reeling* by clicking on the link provided below. The article presents an interesting foreign perspective about a recent destructive typhoon that hit the Philippines.

Typhoon victims stand outside their destroyed house and toppled banana trees swept at the height of Typhoon Bopha, in New Bataan town. (Photo: REUTERS/Erik De Castro)

Unusual Typhoon Leaves Southern Philippines Reeling
By Peter Thomson
December 7, 2012

http://www.theworld.org/2012/12/unusual-typhoon-leaves-southern-philippines-reeling/

Go back to the following statements from the article:

"But now forecasters are warning that Bopha (local name: Pablo) might take a turn back toward land and hit the country again, farther to the north."

"But typhoon Bopha seemed to come almost out of nowhere. It came outside of the usual typhoon season and hit a part of the country that's off the usual storm track."

1. In what ways is Typhoon Pablo (international name Bopha), which hit the Southern part of our country on December 2012, ***unusual*?**
2. What is your "usual" idea of a typhoon? ***How do they form and develop?***

Again, go back to the article and pay closer attention to the following statements:

"It was the country's strongest storm of the year when it hit earlier this week. Combine that with a hilly landscape ravaged by mining and a population unprepared for a storm, and the awful result is more than 400 dead, nearly as many missing, and more than 300-thousand homeless."

"The country's interior minister pointed to allegations of illegal mining and haphazard building on dangerous terrain, both of which are common in the region."

3. What do you think are the author's reasons for saying that our population is *"unprepared for a storm?"*

4. ***Why is our country very much exposed to the risks and hazards of typhoons?***

Pay close attention to this statement again taken from the article:

"Philippines president Benigno Aquino III visited the region on Friday and promised to find ways to avoid a similar disaster in the future."

5. Based from what you often hear or experience, ***how do we cope with disasters like this? How can we prepare for such calamities?***

<u>Activity 1.2</u>: Eliciting Prior Knowledge through K-W-L Chart

What were your initial answers to the questions posed in the previous activity?

Summarize your answers to the questions, and your thoughts and ideas regarding typhoons in the first column (*What I Know*) of the given K-W-L chart. Then in the second column (*What I Want to Know*), write the questions you have about typhoons that you want to find answers to as you go through this module. Leave the third column (*What I Learned*) blank for now. Click on "Save" to save your response.

TYPHOONS		
What I **K**now	What I **W**ant to Know	What I **L**earned

End of Explore

You gave your initial ideas on typhoons – formation and development, damaging effects, and ways of managing and coping. You started to explore the answers to the following questions:

- How do typhoons develop?
- Why are some areas more exposed to the risks and hazards of typhoons?

Let's now find out what the answers are by doing the next part.

FIRM-UP

Your goal in this section is to learn and understand the formation and development of typhoons. You will determine and relate the different factors that are at work during its formation.

Activity 1.3: Getting to Know Important Terms about Typhoons

Part 1. Using *Tag Galaxy*

Get to know *typhoon* by looking at tags and photos related to it. Go to this site: http://taggalaxy.de/

Enter as Initial Tag the word **TYPHOON.**

Select the "planets" which bear the words / terms that you think are relevant to your study of typhoons.

Exercise 1.1

Write all the terms and words that you gathered in a *vocabulary journal*:

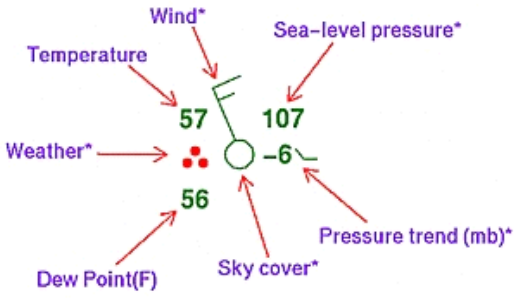
VOCABULARY JOURNAL: *TYPHOONS*	
Term / Word / Concept	**Definition / Meaning / Importance**

Process Question:

From all the terms/words/concepts you gathered, what is your own definition of a *typhoon*?

Part 2: Using Station Models and Weather Updates

Add more terms to your vocabulary journal on typhoons by looking at station models and severe weather updates. The terms used in weather forecasts are very important in understanding typhoons.



Go to this website:
http://www.hpc.ncep.noaa.gov/html/stationplot_printer.html

Sample Station Model

Go to this website:
http://weather.com.ph/weathertv/mr-typhoons-special-coverage-on-typhoon-soulik-huaning-fri-july-12-2013

Severe Weather Update
Weather Forecast

Add to your *vocabulary journal* the new terms and words that you gathered from the two websites:

VOCABULARY JOURNAL: *TYPHOONS*	
Term / Word / Concept	**Definition / Meaning / Importance**

Before you move on to the next activity, you may want to check your vocabulary journal and see if these terms are already clear to you:

• Weather • Wind • Wind Speed (in km per hour or kph) • Pressure • Rain • Thunderstorm • Storm Surge • Sky Cover / Cloud Cover • Landfall	• Monsoon • "Developing System" in the Western Pacific Ocean • Ocean Heat Content (OHC) • ITCZ (Intertropical Convergence Zone) • LPA (Low Pressure Area) • Typhoon Track

Activity 1.4: Net Exploration – *Learning How Typhoons Form*

Part 1. Basics of Typhoon and Typhoon Formation

Try to answer the questions on your own, then click on the provided links to get the correct answers and to learn more:

1. What is a hurricane, a typhoon, or a tropical cyclone?
   http://www.aoml.noaa.gov/hrd/tcfaq/A1.html
   http://factsanddetails.com/world.php?itemid=1317&catid=52&subcatid=327

2. What is a tropical disturbance, a tropical depression, or a tropical storm?
   http://www.aoml.noaa.gov/hrd/tcfaq/A5.html

3. What are the conditions for a tropical cyclone to form?
   http://www.aoml.noaa.gov/hrd/tcfaq/A15.html
   http://factsanddetails.com/world.php?itemid=1317&catid=52&subcatid=327

4. What is the eye? How is it formed and maintained?
   http://www.aoml.noaa.gov/hrd/tcfaq/A11.html

5. Can a tropical cyclone weaken and "die?" How?
   http://weather.com.ph/index.php?url=typhoon/climatology

Part 2. Animated Guide to the Formation of Typhoons

Watch the interactive animation found in the link below. Answer the questions that follow:

http://news.bbc.co.uk/2/hi/science/nature/4183344.stm - animated guide: typhoon

Process questions:

1. What creates a low pressure area (LPA)? Why is LPA associated with the formation of typhoons?
2. Once a tropical cyclone forms, ***how does it develop into a typhoon*?**
3. If a typhoon hits land, what are the effects?
4. How do landforms and bodies of water affect the formation of typhoons?

Activity 1.5: Self-Assessment – 3-2-1 Chart

It's now time for you to do an assessment of your progress in this module. Accomplish this 3-2-1 chart then send to your teacher through the OHSP portal.

3 Things You Learned	
2 Things That Need to be Clarified	
1 Thing You Want to Explore More	

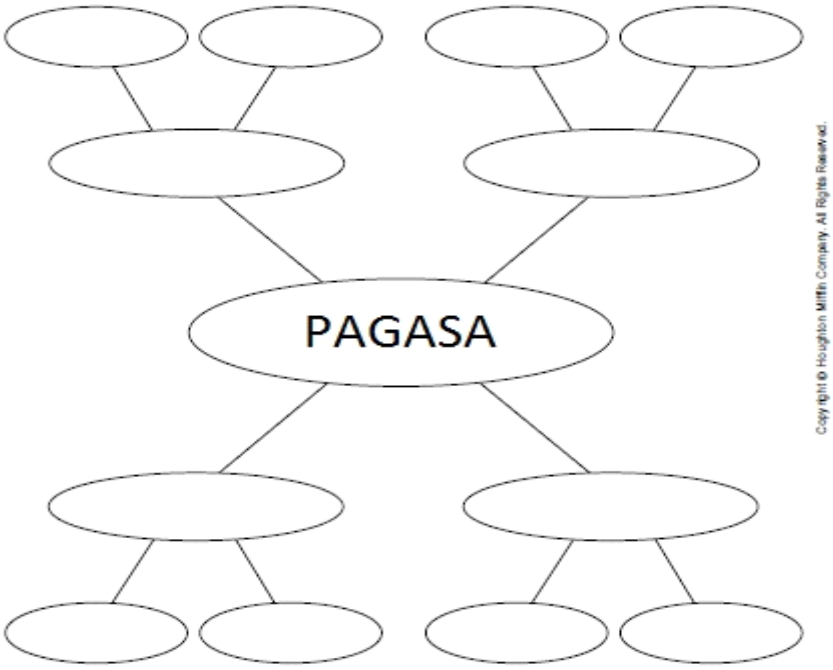
Activity 1.6: Getting Updated: PAGASA and its Activities

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is a national institution tasked by the government to monitor and provide typhoon warnings, public weather forecasts and advisories, meteorological, astronomical, climatological, and other specialized information and services primarily for the protection of life and property and in support of economic, productivity, and sustainable development.

Click on the PAGASA website to learn more about their activities: http://www.pagasa.dost.gov.ph/

Exercise 1.2

Complete the cluster web below to create a visual picture of the activities and services of PAGASA:



Focused Listing:

How can we as Filipino citizens maximize the use of the services provided by PAGASA? Make a listing of the different ways.

End of Firm-Up

In this section, the discussion was all about the formation and development of typhoons.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision?

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

Let's deal with these questions more deeply in the next section.

DEEPEN

Now that you understand the basic requirements in the formation of typhoons, your goal in this next section is to look at various factors that affect this formation and development. You'll also try to focus more on the typhoons that hit the Philippines.

Activity 1.7: Situation Analysis

Read carefully the situations given below. Then answer the questions that follow.

Situation 1:

Below is a *Weather Advisory for Low Pressure Area* issued by the National Disaster Risk Reduction and Management Council (NDRRMC) on August 8, 2013:
Source: http://www.ndrrmc.gov.ph/attachments/article/1064/04081202.PDF

REPUBLIC OF THE PHILIPPINES
NATIONAL DISASTER RISK REDUCTION AND MANAGEMENT COUNCIL
National Disaster Risk Reduction and Management Center, Camp Aguinaldo, Quezon City, Philippines

NDRRMC UPDATE

Weather Advisory No. 01 for Low Pressure Area (LPA)

Releasing Officer:

USEC EDUARDO D. DEL ROSARIO
Executive Director

DATE : 08 August 2013 11:00AM
Source: PAGASA-DOST

I. OVERVIEW

- At 10:00AM today, the Low Pressure Area (LPA) was 110 km East of Hinatuan, Surigao del Sur (8.2°N, 127.4°E) and is embedded along the Intertropical Convergence Zone (ITCZ). These weather systems are expected to bring moderate to occasionally heavy rains and thunderstorms over Palawan, Visayas, and Mindanao which may trigger flashfloods and landslides.
- Residents are advised to take all the necessary precautionary measures

Process Questions:

1. Describe the situation 110 km East of Hinatuan, Surigao del Sur.
2. Explain why heavy rains and thunderstorm can be expected over Palawan, Visayas, and Mindanao.
3. Can this weather system possibly develop into a tropical cyclone? a typhoon? Justify your answer.

Situation 2:

Meteorological History of Typhoon Pepeng (International name: Parma)

On September 26, 2009, the Joint Typhoon Warning Center (JTWC) started to monitor an area of convection that was located about 445 km (275 mi), to the southeast of Guam. The system had an elongated low-level circulation center with convection developing around the center. Analysis showed that the system was located in an area of low vertical wind shear and had a good poleward outflow into a tropical upper tropospheric trough. During the next day, convection started to consolidate before both the Japan Meteorological Agency (JMA) and the JTWC initiated advisories on the system, with the JTWC designating it as Tropical Depression. After being classified, the depression remained weak and poorly organized. On September 28 however, the

JTWC reported that the depression had intensified into a tropical storm despite it remaining poorly organized, and acquired the name *Parma*. During its landfall in the Philippines, *Parma* began to travel northwest towards China. It suddenly slowed down (due to interactions with Typhoon Melor) rendering it stationary. Surprisingly, it began to retreat back to mainland Philippines making a second landfall. After regaining some strength, it began to travel westward towards Vietnam.

Process Questions:

1. Describe the conditions that led to the development of Typhoon Parma (Pepeng).
2. What were the unusual (and surprising) conditions experienced during the onslaught of Pepeng? Why are these possible?

Situation 3:
Forecast for Typhoon Utor (Local name: Labuyo)

Utor has accelerated and weakened slightly as the northwestern periphery of the system began to interact with Luzon Island, causing a disruption of the surface circulation. After weakening over the Philippines, Utor is expected to re-strengthen in the South China Sea before making landfall in southern China. These areas were hit hard by Mangkhut and Jebi.

The system will weaken considerably over the next 12 hours as it tracks over the terrain of Luzon, before emerging into the South China Sea. Favorable environmental conditions will allow steady intensification after the next 36 hours. The cyclone is expected to make landfall west-southwest of Hong Kong, and begin a rapid dissipation.
Source: http://thewatchers.adorraeli.com/2013/08/11/red-alert-issued-as-super-typhoon-utor-made-landfall-in-philippines/

Process Question:

1. Evaluate the forecast given. Why is it possible for a typhoon to weaken, then re-strengthen?

Go back to your analysis of the three situations. What can you generalize about the formation of typhoons? ***How do typhoons develop?***

Activity 1.8: **Learning How Landforms and Bodies of Water Affect the Formation of Typhoons**

The Philippines has a tropical marine climate dominated by a rainy season and a dry season. Northeast monsoon (Amihan) is experienced from November to April and southwest monsoon (Habagat) from May to October. Monsoon rains, although hard and drenching, are not normally associated with high winds and waves. But the Philippines does sit astride the typhoon belt, and it suffers an annual onslaught of dangerous storms from July through October.

The existing weather conditions in the Philippines are not only affected by its latitudinal location, but also by landmasses and bodies of water that surround its groups of islands.

Given below is a map of the Philippine islands. Locate each of the regions that will be discussed.

1. Mindoro, Negros, Palawan, and the western part of Luzon are regions bounded inland by mountain ranges while located on their western side is the Indian Ocean.

How do you think this affects rainfall and typhoon in the area?

The blowing Northeast Monsoon is blocked by the mountain ranges. However, the Southwest Monsoon blows freely over them, and this can give them plenty of rainfall. From November to April, these areas experience dry season. From May to October, it is rainy season, and they are also open to hurricanes that will form over the Atlantic Ocean.

2. Places located at the Eastern Coast of the Philippines like the eastern part of Cagayan, Isabela, Aurora, Quezon, Catanduanes, Sorsogon, Eastern Albay; eastern and northern part of Camarines Norte and Camarines Sur; northern and Eastern Samar, southern Leyte; and eastern Mindanao are all exposed to the Philippine Sea.

How do you think this affects rainfall and typhoon in the area?

The Northeast Monsoon freely blows over them, bringing them cold winds and some rains. The air masses that blow over this region are wet as they collect moisture when they pass over the neighboring seas.

3. Western Cagayan, western Isabela, Nueva Viscaya, eastern Mountain Province, Southern Luzon, Masbate, and Mindanao are regions trapped in the middle of mountain ranges. They are situated on the west of the mountain ranges in the eastern part of the country. They are also situated at the east of the mountain ranges in the western part of the country.

How do you think this affects rainfall and typhoon in the area?

The air masses that reach them are dry. The mountain ranges scrape off much of the moisture in the wind or totally block the wind, and the moisture from the air masses has already been precipitated over the eastern and western coastlines.

4. Batanes, Northeastern Luzon, the western part of Camarines Norte, and Camarines Sur, western Albay, eastern Mindoro, Marinduque, western Leyte, northern Cebu, northern Negros, and most of the southern, central, and northern Mindanao are areas located in the inner middle part of the archipelago, but are open to inland bodies of water (big open seas). Forested mountain ranges are found within the boundaries of these places.

How do you think this affects rainfall and typhoon in the area?

There is no dry season in these places and no heavy rainfall. The trees in the forest give off a lot of water vapor in the atmosphere when they transpire adding a lot of moisture. The forests block off the moisture-laden air masses that have passed over the big open seas scraping much of their moisture.

(Source: http://www.mongabay.com/reference/country_studies/philippines/GEOGRAPHY.html; Science Links Grade 8, Rex Book Store Inc.)

Activity 1.9: Data Analysis

You are now familiar with the climate and weather systems in different parts of the Philippines. However, do they still hold true today? Are they still the weather systems and climate experienced by the areas? Or irregularities exist? Why do you think so?

Why does rain fall more frequently nowadays? Why are typhoons more frequent and violent? Why do typhoons hit areas that are not normally hit?

To start finding answers to that, examine the following data:

Data # 1:

Table 1
Change in the number and percentage of typhoons in categories 4 and 5 for the 15-year periods 1975–1989 and 1990–2004 for the different ocean basins.

Basin	Period			
	1975-1989		1990-2004	
	Number	Percentage	Number	Percentage
East Pacific Ocean	36	25	49	35
West Pacific Ocean	85	25	116	41
North Atlantic	16	20	25	25
Southwestern Pacific	10	12	22	28
North Indian	1	8	7	25
South Indian	23	18	50	34

Source: Webster et al, 2005, http://www.sciencemag.org/content/309/5742/1844.full

Questions: What do you notice? What is the trend?

Data # 2:

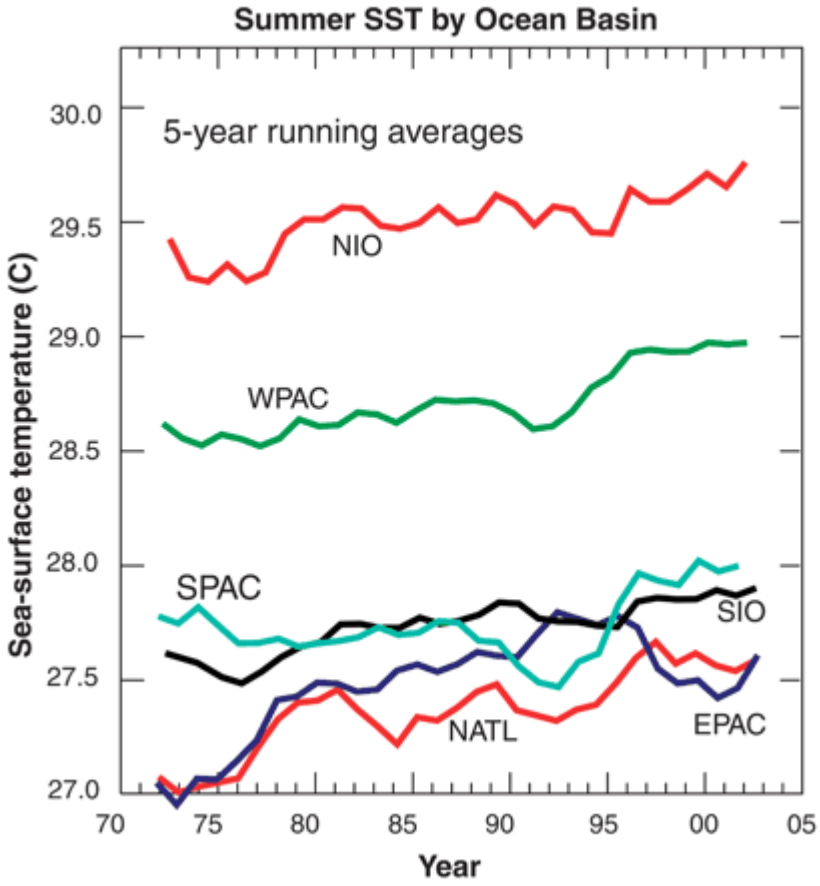


Fig 1. Running 5-year mean of SST in the principal ocean basins: the North Atlantic Ocean (NATL), the Western Pacific Ocean (WPAC), the East Pacific Ocean (EPAC), the Southwest Pacific Ocean (SPAC), the North Indian Ocean (NIO), and the South Indian Ocean (SIO) (Source: Webster et al, 2005, http://www.sciencemag.org/content/309/5742/1844.full)

Questions:
Is the average sea surface temperature (SST) of the different ocean basins increasing or decreasing?

In which years did it show continuous or steady increase?

How can you relate this to data # 1?

Data # 3:

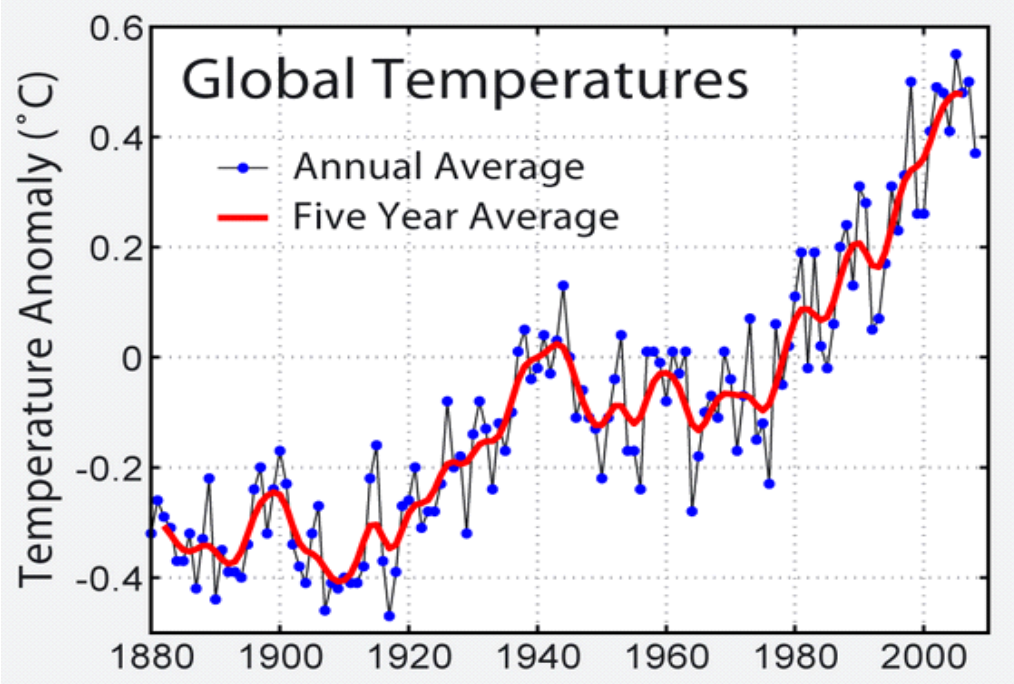


Fig 2. The record of global average temperatures compiled by NASA's Goddard Institute for Space Studies. The "zero" on this graph corresponds to the mean temperature from 1961-1990, as directed by the Intergovernmental Panel of Climate Change (IPCC).
(Source: http://ete.cet.edu/gcc/?/resourcecenter/slideshow/3/1)

Questions:
What is the trend in global average temperatures?

How can you relate this to Data #2 and #3?

Read also the article found in this link:
http://news.nationalgeographic.com/news/2005/08/0804_050804_hurricanewarming.html - Is Global Warming Making Hurricanes Worse?

Exercise 1.3

After going through the data and the article, accomplish this worksheet. Submit to your teacher through the OHSP system.

Situation/Problem:
Analysis of Data:

Conclusion/Generalization:

End of Deepen

In this section, the discussion was about the different factors that affect the formation and development of tropical cyclones and typhoons. The activities should give you new insights to answer the question: **How do typhoons develop?**

What new realizations do you have about the topic? What new connections have you made for yourself?

Now that you have a deeper understanding of the topic, you are ready to move on to the next lesson.

Lesson 2.2: Managing the Effects of Typhoons

EXPLORE

Now that you have gone through series of activities to better understand how typhoons form and develop, you are ready to answer more questions about typhoons. Important questions such as: **Why are some areas more exposed to the risks and hazards of typhoons? How can our understanding of typhoons help us prepare for such calamities?** These are what you are going to answer as you go through this lesson.

Let's start this lesson by looking at the damaging effects brought by typhoons and how prepared (or unprepared) we are to face them.

Activity 2.1: News Clip Analysis (Discussion Forum)

Read the news article found in this link:


Residents were fast asleep in their homes, with no orders to evacuate, when Sendong roared through Iligan City. **Irish Lungay**

'Sendong' among deadliest cyclones to enter PHL in 12 years
By Andreo Calonzo, GMA News
December 18, 2011

http://www.gmanetwork.com/news/story/242058/news/nation/sendong-among-deadliest-cyclones-to-enter-phl-in-12-years

After reading, answer the following questions:

1. What were the damaging effects of Typhoon Sendong to Cagayan de Oro and Iligan cities?
2. What were identified as reasons for the high death toll?
3. Do you think the great loss of lives and properties during and after Typhoon Sendong could have been prevented? How?
4. ***How can we make ourselves prepared for typhoons?***

Summarize your answers to these questions and post them in the discussion board of the OHSP system.

Read your classmates' answers and make comments too.

End of Explore

You just tried finding out the risks and hazards associated with typhoons and how we can be better prepared for such.
Let's now learn more about managing the effects of typhoons in the next part.

FIRM-UP

Your goal in this section is to infer why the Philippines is prone to typhoons. You will also learn some skills in tracking a typhoon. The information you will learn and the skills you will acquire should enable you to be more prepared for typhoons, and eventually contribute to a more "disaster-resilient" country.

Activity 2.2: Profiling Major Typhoons that Hit the Philippine Area of Responsibility

Make a profile of what you think are the Top Five Worst Typhoons that hit our country.

This is a suggested format. You can add more information to enrich the profile:

Typhoon Name (Local and International)	
Date	
Location	
Strength	
Death Toll	
Damage	
Comments/Remarks	

Refer to the following websites for information:
http://kidlat.pagasa.dost.gov.ph/cab/tc_frame.htm - important data about the typhoons that hit the Philippines

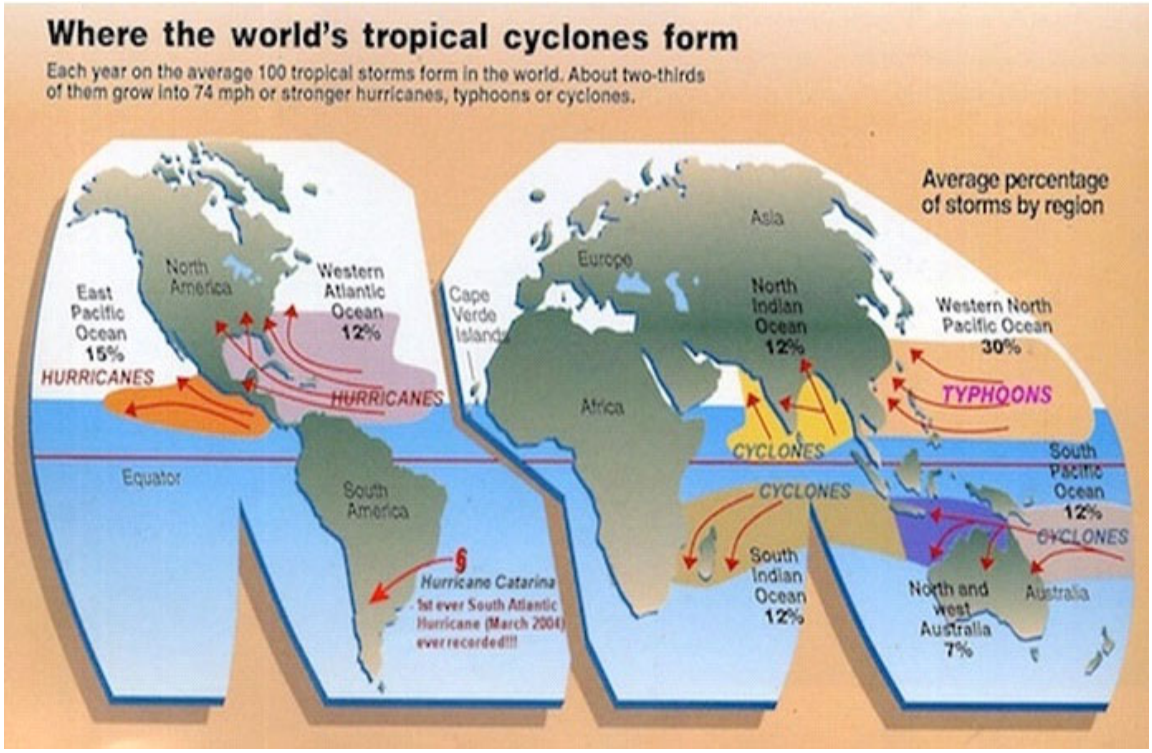
http://typhoon2000.ph/archives.htm - archive of typhoon records

Questions for Reflection:
What can we learn from our bad experiences from typhoons in the past?

How can our understanding of typhoons help us prepare for such calamities?

Activity 2.3: Inferring Why the Philippines is Prone to Typhoons

Review your previous lesson about where tropical cyclones form. Refer to this diagram that illustrates the origin of many tropical cyclones (most of which grow into typhoons) in the world:



http://weather.com.ph/index.php?url=typhoon/climatology

Guide Questions:
1. The highest percentage of tropical cyclones form over what area?
2. If the cyclone that forms over this area grows into a typhoon, what

is the direction of the movement?

3. Based from the direction of its movement, what countries will often be hit?
4. Why do you think the Philippines is very prone to typhoons?

Aside from our geographical location, what else are the factors that you think contributes to our increased risk and hazards to typhoons? ***Why are some areas more exposed to the risks and hazards brought by typhoons?***

Read this excerpt to confirm your thoughts. This is an excerpt from the Climate Change Assessment for Sorsogon, Philippines done by United Nations Human Settlements Programme (UN-HABITAT). Though the excerpt mainly talks about climate change, many insights about our country's risks to typhoons and floods can be gathered.
If you wish to read the full article, you can download the file from this website: http://www.scribd.com/doc/44375263/SORSOGON-CLIMATE-CHANGE-ASSESSMENT

The Impacts Of Climate Change In The Philippines

The physiographic and geophysical characteristics of the Philippines make the country highly vulnerable to climate change. With a total coastline of 36,289 kilometers, 70% of the cities/municipalities depend on coastline and marine ecosystems as a source of livelihood. National estimates show that 82.5% of the entire population of the Philippines are at risk to tropical cyclones, flooding and storm surge.

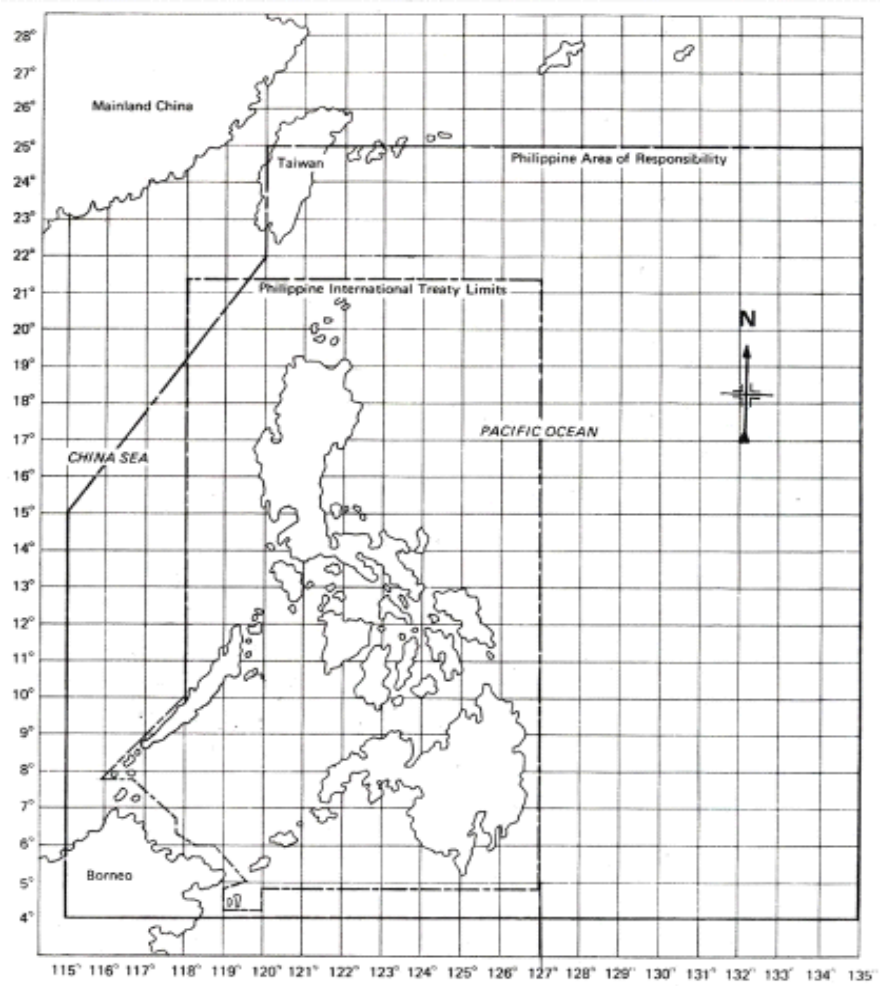
Using information from the 2003 official statistics, about 14.9 million homes are vulnerable to the impacts of climate change as they have structures with roofs and/or walls that are either make-shift or made of substandard materials, and are also non-engineered. These homes are unlikely to withstand the impacts of stronger typhoons or storm surges. In 1992 the National Mapping and Resource Information Authority of the Philippines estimated that a sea level rise (SLR) of 100 cm will inundate a total area of 129,114 ha affecting approximately two million people. This was projected using topography as the sole basis for evaluation. Given that sea level rise would also increase the level of storm surges, it is predicted to increase risk of many more people to flooding. Changes in tides as well as salt water intrusion into surface and ground water may affect the amount and quality of water supply. In urban centres, the impacts of sea level rise are compounded by ground subsidence due to over-extraction of ground-water for domestic and industrial use (Rodolfo and Siringan, 2006).

The agriculture sector of the Philippines is projected to be greatly vulnerable to climate change especially due to the increased occurrences of El Nino Southern Oscillation (ENSO) and La Nina events, bringing drought and extreme rainfalls respectively. The 1997-1998 El Nino caused a drop in

GDP by 6.6% in agricultural production and in construction and construction-related manufacturing by 9.5%. The 2008 Labour Force Survey estimated 11.8 million workers along with their families and dependents, in agriculture, forestry and fisheries were affected by extreme weather events. Twenty percent (20.6%) of fishponds dried out in the 1998 El Nino. These impacts on agriculture create more pressure to the urban areas not only in food security but also in accommodating alterations in livelihood/income source and settlement patterns. The rural to urban migration pattern is predicted to increase considering the latter. Higher population densities spell higher vulnerability to climate change. As it is now, 60% of the Philippine population is concentrated in cities and the national urbanization rate is 3.4%. Climate change impacts are expected to bring added pressure for the urban environment with respect to sustainable land use, infrastructure, access to potable water and health services, and waste management, among others.

Activity 2.4: Determining the Boundaries: Philippine Area of Responsibility

Study the figure below which shows the boundaries of the Philippine Area of Responsibility (PAR) and the Philippine International Treaty Limits (PITL). The PITL defines the national territory – the islands, the waters, and the submarine areas that make up the Philippine archipelago. Answer the questions that follow:



Questions:

1. Which has a larger area – the PAR or the PITL?
2. By how many degrees is it wider at the eastern boundary?
3. What is the advantage of having an area of responsibility wider than the national territory?
4. What would be the disadvantage if the boundary of the area of responsibility were only as wide as or were less wide than the international treaty limits?

To know more about PAR, click on the following:
http://kidlat.pagasa.dost.gov.ph/cab/tc_frame.htm

The PAGASA starts tracking a tropical cyclone the moment it enters the PAR. Once a tropical cyclone is located, PAGASA can tell which areas are likely to be affected by it in the next 24 hours. The agency is also responsible for issuing warning signals to these areas.

What is the importance of knowing the storm warning signals?

The system of warning signals used by PAGASA, as well as the precautionary measures that need to be taken are found in this link:

http://kidlat.pagasa.dost.gov.ph/genmet/psws.html - the Modified Philippine Public Storm Warning Signals

Activity 2.5: How to "Plot" Typhoons

You will now learn how to track tropical cyclones. This will help you know and understand where a tropical storm or a typhoon is going to strike.

The step-by-step procedure on how to do it is provided in the link below:
http://www.typhoon2000.ph/TCGuide.htm

Summary of steps:

1. Download and print the blank Philippine Tropical Cyclone Chart (in Adobe Acrobat file):
   http://www.typhoon2000.ph/plotting/Ty2000Chartnew.pdf

2. Get the latest tropical cyclone information from your chosen agency (e.g. PAGASA, JTWC, JMA) thru websites, radio, TV, print or other sources.

3. Start plotting the present storm. For this exercise, you will track: *Super Typhoon Rosing (Angela) of November 02, 1995.* Click on the link to get sample data information:
   http://www.typhoon2000.ph/plotting/exerplot.gif
4. Plot the coordinates, and then pinpoint the precise location of the typhoon. For tutorial, click on the following flash animation:
   http://www.typhoon2000.ph/plotting/howtotrak.html

5. After plotting the exact position of the storm, you must also plot the forecast positions as well as the past positions of the storm - for you to know where and when the storm will strike. Don't forget to add the date, wind speed and the line connecting the points.
6. Check your work by comparing it to the finished tracking chart for Typhoon Rosing found in this link:
   http://www.typhoon2000.ph/plotting/sampleplot.html

Activity 2.6: Tracking a Tropical Cyclone
(learning activity developed by UP NISMED)

What to do:

1. Read the following news excerpt, reproduced from the Manila Bulletin, May 13, 2006 issue. (Any news clipping that contains similar information may be used.)

Caloy to bring more rains, winds to Greater Luzon

"Caloy" (International codename: Chanchu) is maintaining direction and strength, threatening to bring heavy rains and gusty winds to the the Greater Luzon area, including Metro Manila, in the next few hours, the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) yesterday said.

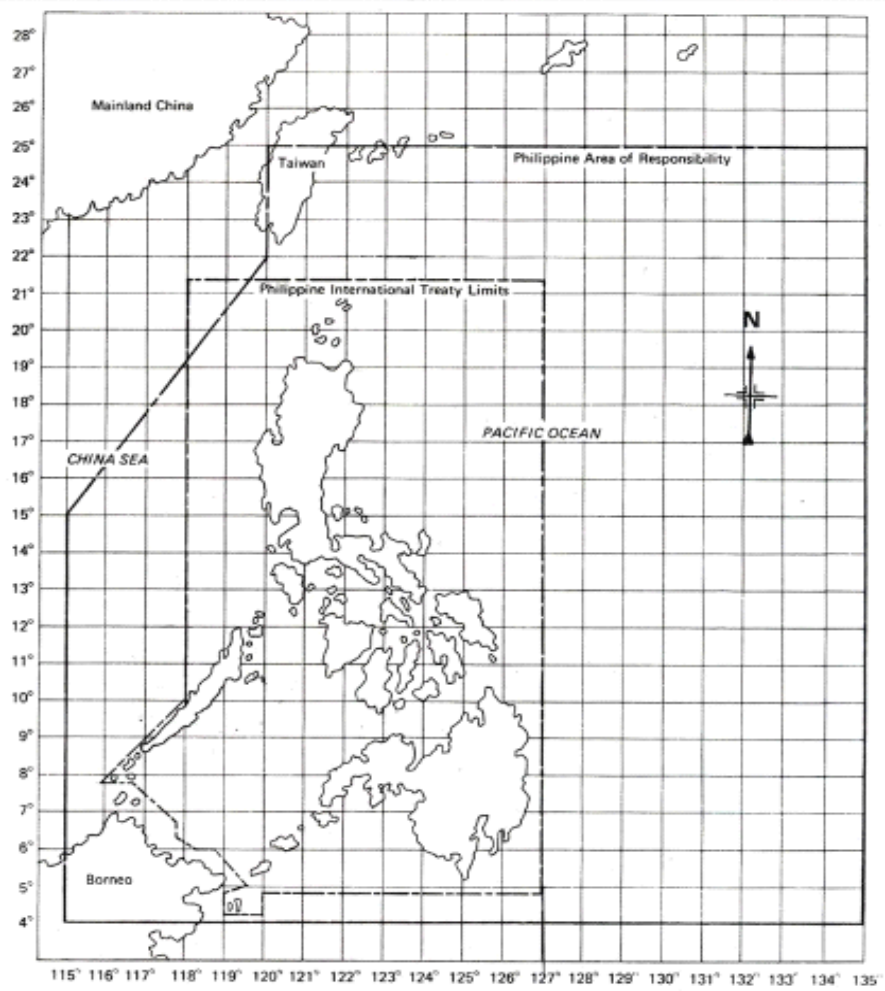
According to PAGASA bulletin issued at 4 p.m. yesterday, "Caloy" was located at 60 kilometers (km) northeast of Romblon. It maintained winds of 95 kilometers per hour (kph) with gusts reaching 120 kph. It is expected to be at 150 km southwest of Iba, Zambales by this afternoon. By tomorrow afternoon, "Caloy" is expected to be at 550 km west of Dagupan. Signal No. 2 has been raised over Southern Quezon, Batangas, Marinduque, Mindoro provinces, Romblon, and Burias island.

"Caloy", the third tropical cyclone to enter the Philippine Area of Responsibility (PAR) for this year, was initially detected as a low pressure area on the east of northern Mindanao but intensified two days after it was spotted by the weather bureau.

2. Based on the news item, trace the path of "Caloy" across the country. In what direction was it moving?

3. Plot the day-to-day location of "Caloy" on the map of the Philippine Area of Responsibility using the given data (tracking information).

Day	Time (UT)	Latitude (°)	Longitude (°)
May 8, 2006	18:00	8.6 N	135.2 E
9	00:00	8.1 N	133.3 E
9	06:00	8.1 N	132.5 E
9	12:00	8.4 N	131.9 E
9	18:00	8.6 N	131.4 E
10	00:00	9.1 N	130.7 E
10	06:00	9.6 N	129.6 E
10	12:00	9.8 N	129.1 E
10	18:00	10.3 N	128.8 E
11	00:00	10.9 N	128.1 E
11	06:00	11.4 N	126.8 E
11	12:00	12.2 N	125.9 E
11	18:00	12.4 N	124.6 E
12	00:00	12.8 N	123.7 E
12	06:00	13.0 N	122.6 E
12	12:00	12.9 N	121.8 E
12	18:00	12.7 N	121.2 E
13	00:00	13.4 N	120.6 E
13	06:00	13.8 N	119.4 E
13	12:00	13.9 N	118.9 E
13	18:00	13.9 N	118.3 E
14	00:00	13.7 N	117.5 E
14	06:00	13.9 N	116.5 E
14	12:00	13.9 N	115.9 E
14	18:00	13.8 N	115.4 E
15	00:00	14.1 N	115.3 E
15	06:00	14.8 N	115.2 E
15	12:00	15.4 N	115.2 E
15	18:00	16.2 N	115.1 E
16	00:00	16.9 N	114.8 E
16	06:00	17.7 N	114.8 E
16	12:00	18.8 N	115.1 E
16	18:00	19.5 N	115.4 E
17	00:00	20.4 N	115.6 E
17	06:00	21.3 N	116.0 E
17	12:00	22.5 N	116.5 E
17	18:00	23.4 N	117.0 E
18	00:00	24.5 N	118.1 E
18	12:00	26.9 N	120.5 E



4. Study the plot that you made and answer the following questions:
   a. Where did “Caloy” start to form?
   b. Which province was first hit by “Caloy”? (In weather forecasts, the term “landfall” refers to the place where the tropical cyclone first hits land.)
   c. After its formation, in what direction did “Caloy” move? Did it keep on moving in the same direction?
   d. Where did it end up?

How can our understanding of typhoons help us prepare for such calamities?

End of Firm Up:
In this section, the discussion helped you determine why the Philippines is prone to typhoons and how we can track a typhoon.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision?

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

Now that you have acquired the necessary knowledge and skills, you are ready to make an assessment of the vulnerability of an area to typhoons. Be guided by these questions: **Why are some areas more exposed to the risks and hazards of typhoons? How can our understanding of typhoons help us prepare for such calamities?**

Activity 2.7: Risk and Hazard Assessment

Part 1. National Disaster Risk Reduction and Management

The enactment of Republic Act 10121 otherwise known as the Philippine Disaster Risk Reduction and Management Act of 2010 has led to a paradigm shift from just disaster preparedness and response to disaster risk reduction and management (DRRM).

A National Disaster Risk Reduction and Management Plan (NDRRMP) for 2011-2028 specified various activities that are aimed at "strengthening the capacity of the national government and the local government units (LGUs) together with partner stakeholders, to build the disaster resilience of communities and to institutionalize arrangements and measures for reducing disaster risks, including

projected climate risks and enhancing disaster preparedness and response capabilities at all levels."

Through the NDRRMP, it is hoped that the country will have ***"Safer, adaptive and disaster resilient Filipino communities towards sustainable development."***

This will be achieved through the four distinct priority areas, namely:
(a) Disaster Prevention and Mitigation;
(b) Disaster Preparedness;
(c) Disaster Response; and
(d) Disaster Recovery and Rehabilitation.

Click the following link and find the different projects and activities outlined in the NDRRMP: http://www.dilg.gov.ph/PDF_File/resources/DILG-Resources-2012116-420ac59e31.pdf

Exercise 2.1:

Enumerate the activities related to the ***hazards of typhoons*** in the following priority areas:

Disaster Prevention and Mitigation
Disaster Preparedness
Disaster Response
Disaster Recovery and Rehabilitation

Part 2. Your Turn to Assess Risks and Hazards

In this activity, you are challenged to identify an area's risk and hazards to typhoons. You will determine the impact of these hazards and propose actions to prevent dangers.

Procedure:

- Review your understanding of risk, hazard, exposure, vulnerability, and disaster management.
- Choose an area that you would like to assess.
- Visit the area and observe the surroundings. Identify at least 5 hazards related to typhoon in that area.
- Determine who and what will be affected by each hazard.
- Identify ways to eliminate the hazard, control the hazard, and protect the community from the hazard.
- Make a simple sketch of the area you chose, indicating the location of the hazards you have identified.

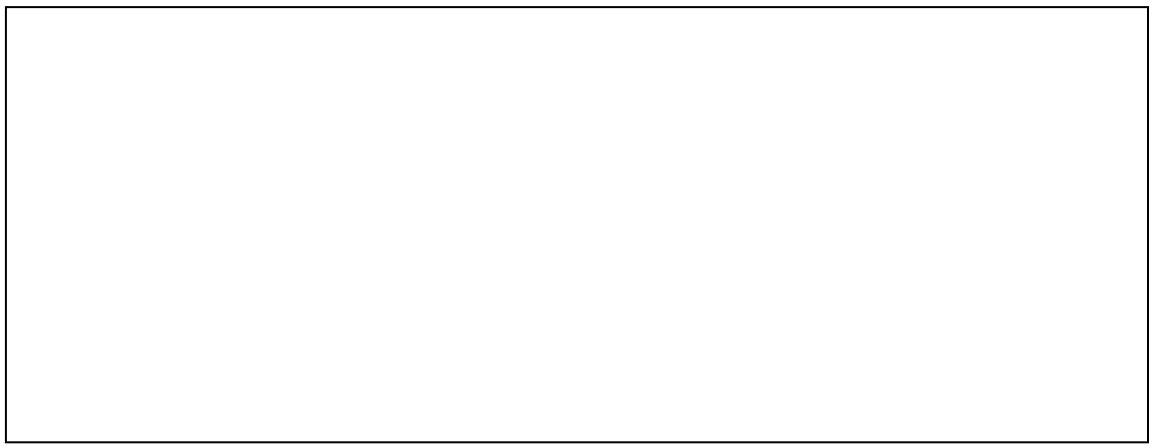
Exercise 2.2:

Complete the worksheet and map:

Hazard Assessment Worksheet

Identified Hazard	Possible Cause	Effect		Strategy
		People	Property	
Ex. landslide	*Slope instability, heavy rainfall*	*Residents near the area*	*Houses and other structures at the bottom of the slope*	*Reinforce the slope Plant trees to prevent erosion*

Map of Assigned Area:



Activity 2.8: Forecasting a Typhoon

Now, it's time for you to create your very own typhoon forecast.

Given is the track of the recent typhoon Ofel (International name: Son-Tihn). Click on the following links:

http://weather.unisys.com/hurricane/w_pacific/2012/SON_TINH/track.gif - track of typhoon Ofel

http://www.typhoon2000.ph/24W12_log.htm - storm log for typhoon Ofel

Based on the given information, prepare a comprehensive forecast for the typhoon using appropriate charts and diagrams.

Then, recommend **safety measures** for those who may possibly be affected by the typhoon.

Activity 2.9: Affirming New Knowledge through K-W-L Chart

You are almost done with this module. What have you learned so far about typhoons? How would you answer the following questions: ***How do typhoons develop? Why are some areas more exposed to the risks and hazards of typhoons? How can our understanding of typhoons help us prepare for such calamities?***

Summarize your answers in the **last column** (What I Learned) of this K-W-L chart. Click on "Save" to save your response.

TYPHOONS		
What I Know	**What I Want to Know**	**What I Learned**

End of Deepen

In this section, the discussion was about the risks and hazards associated with typhoons. The activities should give you new insights to answer the following questions: **Why are some areas more exposed to the risks and hazards of typhoons? How can our understanding of typhoons help us prepare for such calamities?**

What new realizations do you have about the topic? What new connections have you made for yourself?

TRANSFER

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

Activity 2.10: Transfer Task: Assessing the Risk and Hazards of Typhoon

TASK

For years, disaster risk reduction in the Philippines has placed more emphasis on disaster preparedness and response, and not so much in identifying the hazard-prone areas and other factors that contribute to people's exposure to disasters. Now, the focus shifts to enhancing the **capacity** of the community to cope with the threats and hazards of typhoons.

As a researcher for the Local Disaster Risk Reduction and Management Office of your locality, you are tasked to assess the risk of typhoons in your area and recommend plans of action. You will develop

a PowerPoint presentation for your risk assessment plan and present it to the barangay officials.

Your presentation will be evaluated based on quality of data gathered and interpreted, practicality of recommendations, and effectiveness of presentation.

RUBRIC: Presentation

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1
Use of scientific data	Convincingly discusses, based on rich and elaborate scientific data, the risks and hazards of typhoons in the area	Adequately discusses, based on accurate scientific data, the risks and hazards of typhoons in the area	Discusses the risks and hazards of typhoons in the area, but with minimal use and reference to scientific data	Superficial discussion of the risks and hazards of typhoons in the area, and with very few or almost no reference to scientific data
Practicality of recommendations	Recommended plans of action are based on careful and in-depth analysis of the area's risks; recommendations are original, highly practical, and innovative	Recommended plans of action are based on correct analysis of the area's risks; recommendations are realistic and practical	Recommended plans of action reflect some flawed and incomplete understanding of the area's risks; recommendations are not very realistic and practical	Recommended plans of action reflect lack of understanding of the area's risks; recommendations are not realistic and not practical
Effectiveness of Presentation	Information are presented clearly, concisely, and in an interesting sequence, with a balanced mix of texts and	Information are presented clearly, in a logical sequence, using both texts and illustrations; Background, graphics,	Some information are not presented clearly; some ideas appear "hanging" and irrelevant because sequence is not logical;	Information are not presented clearly; lack of logical organization of ideas presented; Background, graphics, animations

	illustrations; Background, graphics, animations used are highly appropriate and enhance the presentation	animations used are appropriate and support the content of the presentation	Background and some graphics and animations used are inappropriate; some do not support the content and may lead to confusion and distraction.	used are inadequate, inappropriate, and distracting, making the presentation difficult to understand

Activity 2.11: Sharing your Story (Typhoon Blogs)

Everybody loves stories. You not only get entertained, you learn so much as well.

Take this opportunity to share your own story about typhoons.

For this activity, you need to accomplish **three** things:
First, write an account of your unforgettable experience about typhoons and the things you learned from it.

Second, upload your story to the OHSP portal.

Third, wait for your other classmates to upload theirs. Read at least two other stories and leave a comment for each.

End of TRANSFER:

In this section, your task was to assess the risk and hazards of a typhoon in your area.

How did you find the performance task? How did the task help you see the real world use of the topic?

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment questions.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. A typhoon has the following characteristics, except_____.
   A. a lot of rain
   B. forms in cold waters
   C. high winds
   D. low pressure centers

(A) 2. Intertropical Convergence Zone (ITCZ), low pressure areas, and warm sea surface temperature all contribute to the formation of
   A. dry spells
   B. typhoons
   C. monsoon rains
   D. tornadoes

(A) 3. How can warm waters surrounded by cold conditions lead to the formation of a typhoon?
   A. It leads to the formation of a low pressure area which is needed in forming typhoons.
   B. It leads to the formation of a high pressure area which is needed in forming typhoons.
   C. It leads to the formation of two areas with equal pressure.
   D. It leads to the formation of two areas with equal pressure that prevents movement of typhoons.

(A) 4. The area where Thor lives is sandwiched by a mountain range 2 kilometers from the west, and the sea which is about a kilometer away. When typhoons originate from the west, they barely get affected, but if the weather disturbance came from the east, they almost always deal with strong winds and floods. Why is this so?
   A. Cold air produced by trees from the mountains weakens the incoming typhoons headed towards the village.
   B. Typhoons in tropical countries would always follow a west to east route.
   C. Mountains have the ability to deflect bodies of air; thus, the area is not affected by typhoons from the west.

D. Typhoons cannot possibly originate west of their area as there is no body of water from that direction.

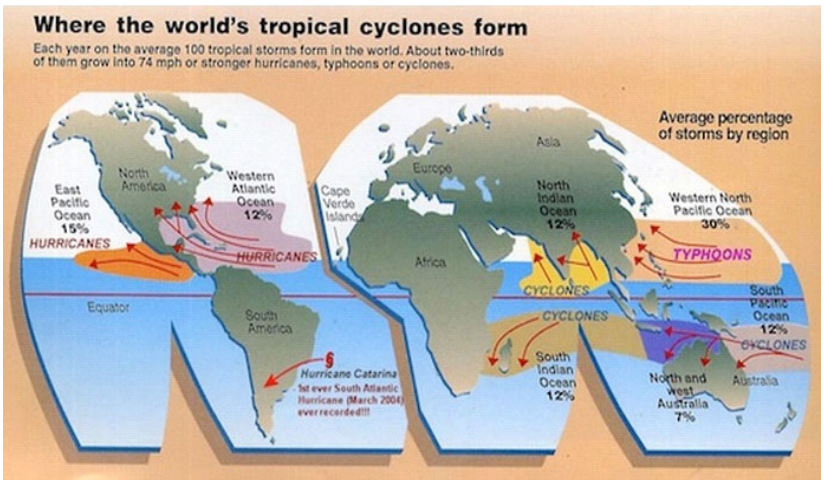
(A) 5. On October 18, 2010, Typhoon Juan made landfall over Isabela. By noon of the same day, it passed through the Sierra Madre Mountain Range. Later during the day, the typhoon hit the South China Sea. If you are to predict what will happen to the typhoon given these situations, what will be the most likely prediction?

A. Typhoon Juan is expected to gain intensity as it approaches the Sierra Madre Mountains. It will eventually weaken and dissipate over the South China Sea.
B. Typhoon Juan is expected to weaken as it passes the Sierra Madre Mountains. When it hits the South China Sea, it is expected to gain intensity.
C. Typhoon Juan will continue to gain strength as it passes through different areas within the Philippine Area of Responsibility.
D. Typhoon Juan will weaken and eventually dissipate as it goes out of the Philippine Area of Responsibility.

(A) 6. Typhoon Maring is the thirteenth typhoon to hit the country this 2013. You learned from your teacher that countries near the equator – like the Philippines – would usually have around twenty typhoons during the rainy season. The best reason for this is that

A. Equatorial countries are those that are usually in the route of typhoons that move from east to west.
B. Equatorial countries are those that are usually in the route of typhoons that move from west to east.
C. Our country is an archipelago, typhoons are likely to form in the waters in between the lands.
D. The temperature is conducive to forming typhoons as water from the surrounding seas get evaporated.

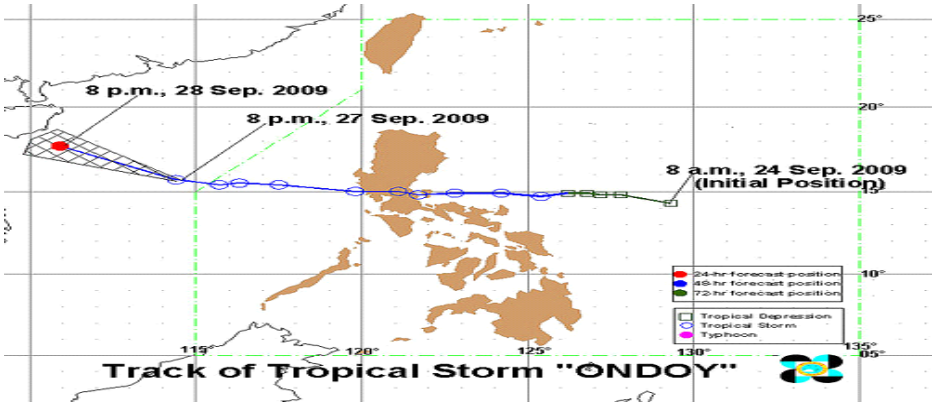
(A) 7. The figure below shows where all the tropical cyclones in the world form. Locate the Philippines and use the given information to infer why the country is prone to typhoons.



Which of the following best explains why the Philippines is prone to typhoons?

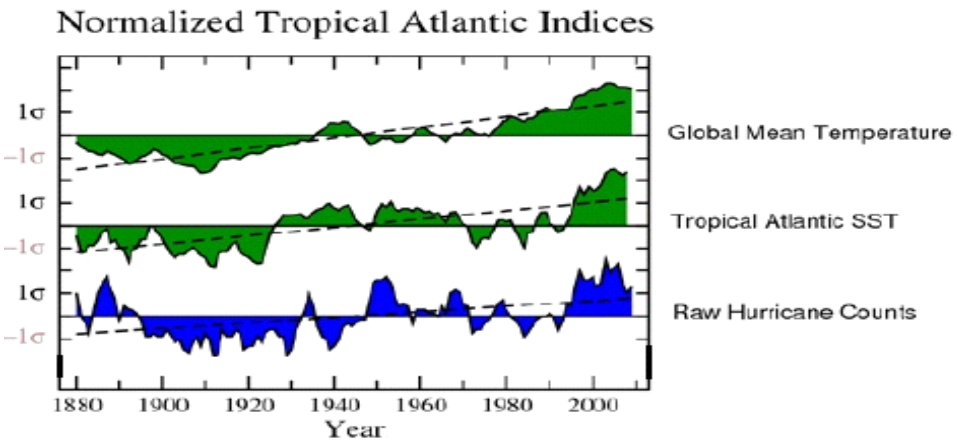
A. The highest percentage of tropical cyclones form over the Philippine Sea and Western Pacific Ocean.
B. The Philippines is located near the equator and sits astride the typhoon belt.
C. The Philippines is located near the Pacific Ocean where all tropical cyclones form.
D. Typhoons originating from the South Pacific Ocean directly hit the Philippines.

(A) 8. Based on the given tracking data of Typhoon Ondoy, in what areas will the typhoon be expected to move?



A. Aurora, Quezon, Manila
B. Batanes, Cagayan, Isabela
C. Davao, Negros Oriental, Palawan
D. Eastern Samar, Masbate, Laguna

(M) 9. The graph below shows the global mean temperature, tropical Atlantic Sea surface temperature (SST), and raw hurricane counts over the past century:



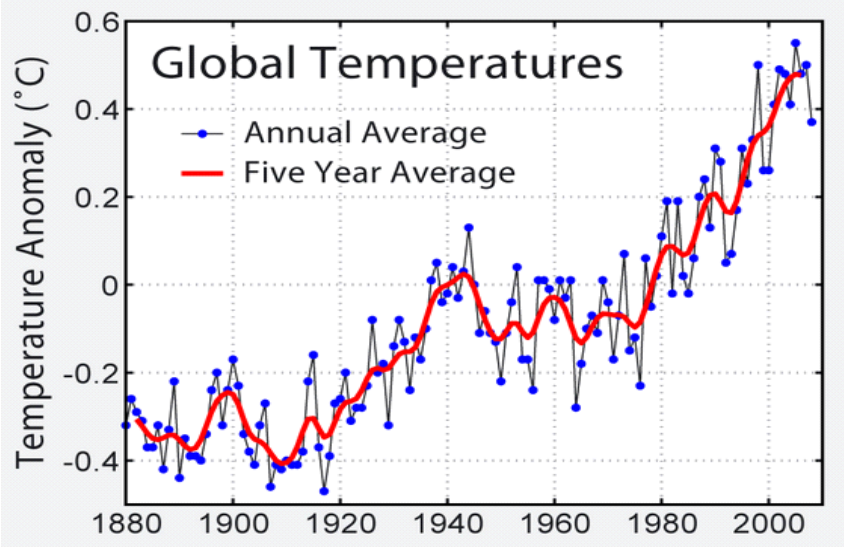
Based on the data, what can be generalized about the relationship of global mean temperature and SST to the formation of tropical cyclones that can later develop into hurricanes or typhoons?

A. Increasing global temperature and warm SST influence the formation of tropical cyclones.
B. Much of the tropical cyclones like hurricane and typhoon formed and developed during the 20th century.
C. The formation of hurricanes and typhoons is affecting the condition of the atmosphere and the oceans.
D. Tropical cyclones like hurricanes and temperatures form and develop in the ocean surface.

(M) 10. The table below shows the change in the number and percentage of typhoons in categories 4 and 5 for the 15-year periods 1975–1989 and 1990–2004 for the different ocean basins:

Basin	Period			
	1975-1989		1990-2004	
	Number	Percentage	Number	Percentage
East Pacific Ocean	36	25	49	35
West Pacific Ocean	85	25	116	41
North Atlantic	16	20	25	25
Southwestern Pacific	10	12	22	28
North Indian	1	8	7	25
South Indian	23	18	50	34

Below is a record of global average temperatures from 1880 to 2000.



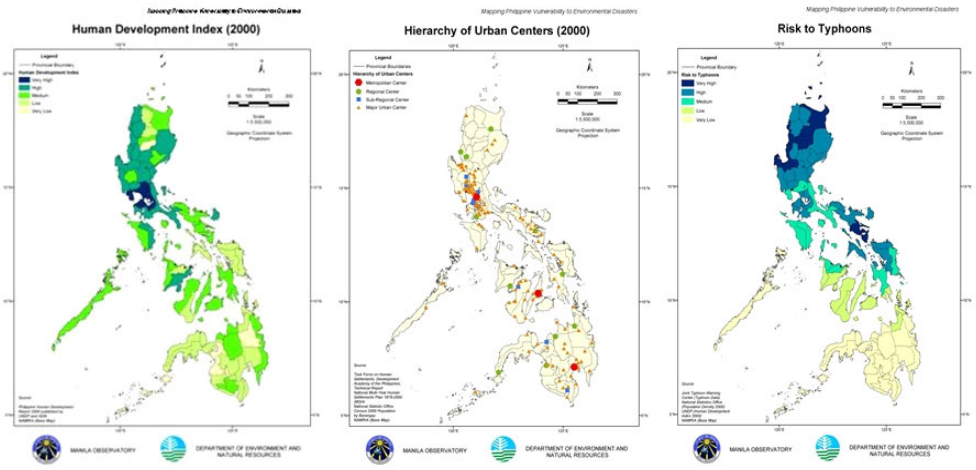
How can the two given data best interpreted?

A. Global average temperature and number of typhoons changed from 1900 to 2000.
B. Much of the increase in typhoon count came in the 1990's along with the steady increase in global temperature.
C. The global average temperature and number and intensity of typhoons have decreased at different periods over the past century.
D. The number of typhoons generally increased since the 1970's.

(M) 11. Given this data, what is the likely effect of global warming to the formation of typhoons and hurricanes?

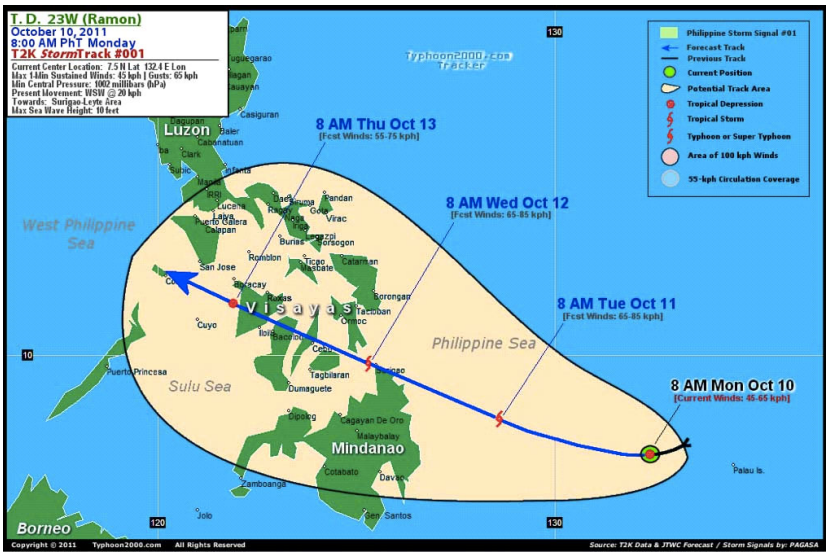
A. Less typhoons and hurricanes
B. Less typhoons and hurricanes and increased drought
C. Longer rainy and wet season and shorter dry season
D. More frequent and more violent typhoons and hurricanes

(M) 12. When assessing the vulnerability of an area to typhoons, why do you think the following risk maps are used?



A. An area's vulnerability to typhoon can be determined by its geographical location, human activities, and residents' preparedness and capacities.
B. An area's vulnerability to typhoon depends on its location on the map, the human development index, and the number of urban centers.
C. An area's vulnerability to typhoon depends on its proximity to the ocean, its temperature, and the presence of landmasses in the area.
D. An area's vulnerability to typhoon is determined by the temperature in the area and its geographical location and features.

(M 13) .



The image above taken from the website Typhoon2000.com tracks the movement of a typhoon. Such images are also shown in the news. The following can be derived from the image except

A. determine areas that are on the path of the typhoon.
B. predict the path that the next typhoon will take.
C. prepare areas that might be hit hard by the typhoon.
D. warn fishermen in coastal towns that should refrain from heading out to sea.

(M) 14. In the Philippines, typhoons can be expected to form at any time of the year. Although this may be true, it is from March to May that most typhoons form because of the following except

A. elevated temperatures.
B. ocean surface is warmest during this period.
C. equatorial waters are very warm during these months.
D. cold winds during the Christmas season are crossing the equator.

(T) 15. You and your family reside in Manila and plan to fly to Isabela on August 11, 2013 to visit your relatives. However, days before the flight you heard from the news that Typhoon “Labuyo” has entered the Philippine Area of Responsibility. You decided to check the PAGASA track of the typhoon to be sure:

What is the appropriate action?

A. Ask your relatives to come over to your residence in Manila instead because the weather is better.
B. Pursue the earlier plan because it is apparent that the typhoon will not make a landfall anywhere in the country.
C. Pursue the earlier plan but make sure to pack umbrella and raincoats because rain showers are expected.

D. Re-book the flight because it is dangerous to travel to that part of Luzon due to typhoon threat.

(T) 16. PAGASA has just issued Public Storm Warning Signal (PSWS) # 3 in your locality. Who among the following residents did not take the correct precautionary measure?
A. Melanie cancelled her flight to the North despite a very important conference she needs to attend there.
B. Omar decided not to go to work even when there is no suspension of work in the place where he is working.
C. Precy postponed the scheduled class field trip and disseminated the information as early as possible.
D. Zoren fixed many parts of his house, so he did not have to evacuate despite their local government's call for evacuation.

(T) 17. Typhoon damages create even bigger problems to the community and further weaken their adaptive capacity. All of the following are measures that should be taken **before** a typhoon except:
A. Assist the physical and psychological rehabilitation of those who suffered the effects of the disaster.
B. Equip the staff with necessary skills in search, rescue, and retrieval operations.
C. Prepare funding sources in the event that people's means of livelihood get negatively affected.
D. Regularly check the integrity of infrastructure and other public utilities.

(T) 18. The heavy downpour brought about by typhoon *Kulas* steadily elevated the water level of the Marikina River at 1 meter/hour. The water level is now at fourteen meters and the critical level when they will have forced evacuation is nineteen meters. The latest weather bulletin mentioned that there was no indication that there will be any change for the next 6 hours. As one of the barangay officials near the Marikina River, you will
A. advise people to keep calm and wait for updates the following day.
B. encourage people to put sandbags around their houses to stop the floods.
C. take only what they need and cooperate as they begin evacuation.
D. stay inside their homes to stop looters during the forced evacuation.

(T) 19. Through the National Disaster Risk Reduction Management Plan (NDRRMP), it is hoped that the country will have *"safer, adaptive*

and disaster-resilient Filipino communities towards sustainable development." Which of the following activities does **not** support this vision?

A. A school's ecology club continued its thrust to plant trees in the vacant lots within their community.
B. Many homeless families found relatively more decent residences along river pathways.*
C. The local government provided trainings in schools on how to act before, during, and after a typhoon.
D. You and your friends have made it a habit to use apps from your mobile phones to disseminate up-to-date and accurate weather information and forecast quickly.

(T) 20. As a weather forecaster from PAGASA, you volunteered to help prepare your neighbors in the coastal town where you live in as a super typhoon is expected to land in 3 days. What might be the best means to inform them of the possible effects of a super typhoon that hits a coastal town?

A. gather residents and show photos of *Yolanda*-hit towns in Eastern Visayas
B. gather residents and show satellite photos of the typhoon's path
C. distribute brochures that show typhoon classifications
D. distribute statistics of typhoon damages in the last decade

GLOSSARY OF TERMS USED IN THIS MODULE:
http://www.nw-weathernet.com/wx_terms.htm

Air - the mixture of gases that make-up the earth's atmosphere.

Air Mass - a large body of air that has similar temperature and moisture characteristics.

Angular Momentum - the energy of motion of a spinning body or mass of air or water.

Anticyclone - a body of air in which the atmospheric pressure is higher than the pressure in the surrounding air; a high or high pressure area.

Atmosphere - the mass of air surrounding the earth and bound to it more or less permanently by the earth's gravitational attraction.

Calm - the absence of apparent motion in the air.

Clear - the appearance of the sky when it is without clouds, or less than 1/10th of the sky is covered by clouds.

Climatology - the scientific study of climate.

Cloudy - the state of the sky when 7/10ths or more of the sky is covered by clouds.

Coastal Flooding - the submersion of land areas along the ocean coast and other inland waters caused by sea water over and above normal tide action.

Coastal Waters - include the area from a line approximating the mean high water along the mainland or island as far out as sixty nautical miles including the bays, harbors and sounds.

Cold Front - the leading edge of a cold air mass as it moves toward warmer air; its movement is characterized by a drop in temperature and humidity after the front passes.

Cyclone - a body of air in which the pressure is lower than that of the surrounding air; a low or low pressure area.

Depression - a region of low atmospheric pressure that is usually accompanied by low clouds and precipitation.

Disturbance - a disruption of the atmosphere that usually refers to a low pressure area, cool air and inclement weather.

El Niño - a great warming of the equatorial waters in the eastern Pacific Ocean; El Nino events occur every three to seven years and are related to shifts in global weather patterns.

Fair - describes weather in which there is less than 4/10ths of opaque cloud cover and no precipitation; and there is no extreme visibility, wind or temperature conditions.

Flood - a condition that occurs when water overflows the natural or artificial confines of a stream or river; the water also may accumulate by drainage over low-lying areas.

Front - the boundary or transition zone of two air masses; if cold air advances and replaces warmer air the front is a cold front, and if warm air advances and replaces cooler air the front is a warm front.

High or High Pressure Area - an area of high pressure that is usually characterized by clear skies and fair weather carried by sinking air; winds rotate clockwise around and outward from the center of the high.

Humidity - the amount of water vapor present in the air.

Hurricane - a tropical cyclone with sustained winds over seventy-four mph.

Knot - the unit used to measure wind speed, equal to 1.15 statute miles per hour.

Low or Low Pressure Area - an area of low pressure usually characterized by clouds of precipitation caused by rising air; often related to inclement weather such as winds flowing counter clockwise and into the center of the low.

Monsoon - a seasonal change in wind direction bringing dry air or heavy rain.

Overcast - when more than 9/10ths of the sky is covered with clouds.

Precipitation - all forms of water that fall from the sky and reach the ground.

Pressure - a measure of the weight of the air, that is usually measured with a barometer in meteorology.

Storm Surge - a rise above the usual water level along the shore that is the result of strong onshore winds and/or reduced atmospheric pressure; the actual surge height is the difference of the observed water level minus the predicted tide.

Storm Track - the path that a low pressure area follows.

Temperature - a measure of the warmth or coldness of an object or substance with reference to a standard value.

Trade Winds - easterly-blowing winds that are found on either side of the equator and blow northeasterly in the Northern Hemisphere and southeasterly in the Southern Hemisphere.

Tropical Air - an air mass that has warm temperatures and high humidities and develops over tropical or sub-tropical areas.

Trough - an elongated relatively low pressure area between two high pressure areas.

Typhoon - a tropical cyclone that occurs in eastern Asia.

Warning - is used when severe weather conditions are occurring, imminent or are expected within the following twelve to twenty-four hours.

Wind Shear - the change in wind direction; vertical wind shear is the change in wind speed with height.

WEBSITE RESOURCES AND LINKS IN THIS MODULE:

Aquino, M., Valdoz, M., Mariano, J.J.M., Bascana, M. "Science Links Grade 8." Quezon City: Rex Book Store, Inc, 2013.

Cortes, L. "Earth Science: The Philippines in Focus." UPSEC, 2003.

http://www.theworld.org/2012/12/unusual-typhoon-leaves-southern-philippines-reeling/ - article by Peter Thomson: *Unusual Typhoon Leaves Southern Philippines Reeling*

http://taggalaxy.de/ - Tag Galaxy

http://www.hpc.ncep.noaa.gov/html/stationplot_printer.html – sample station plot

http://weather.com.ph/weathertv/mr-typhoons-special-coverage-on-typhoon-soulik-huaning-fri-july-12-2013 - Mr. Typhoon's Special Coverage on Typhoon Soulik (Huaning) on July 12, 2013

http://www.aoml.noaa.gov/hrd/tcfaq/A1.html - What is a hurricane, typhoon, or tropical cyclone?

http://www.aoml.noaa.gov/hrd/tcfaq/A5.html - What is a tropical disturbance, a tropical depression, or a tropical storm?

http://www.aoml.noaa.gov/hrd/tcfaq/A15.html - What are the conditions for a tropical cyclone to form?

http://factsanddetails.com/world.php?itemid=1317&catid=52&subcatid=327 – Hurricanes and Typhoons: Their Physics, Formation Dynamics, and Tracking and Studying Them

http://www.aoml.noaa.gov/hrd/tcfaq/A11.html - What is the eye? How is it formed and maintained?

http://news.bbc.co.uk/2/hi/science/nature/4183344.stm – animation of typhoon formation

http://weather.com.ph/index.php?url=typhoon/climatology - Typhoon Climatology
http://www.mongabay.com/reference/country_studies/philippines/GEOGRAPHY.html – Philippine Geography

http://www.sciencemag.org/content/309/5742/1844.full - Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment

http://news.nationalgeographic.com/news/2005/08/0804_050804_hurricanewarming.html - Is Global Warming Making Hurricanes Worse?

http://www.gmanetwork.com/news/story/242058/news/nation/sendong-among-deadliest-cyclones-to-enter-phl-in-12-years - 'Sendong' among deadliest cyclones to enter PHL in 12 years

http://kidlat.pagasa.dost.gov.ph/cab/tc_frame.htm - Philippine Area of Responsibility

http://kidlat.pagasa.dost.gov.ph/genmet/psws.html - the Modified Philippine Public Storm Warning Signals

http://www.typhoon2000.ph/TCGuide.htm - How to plot a typhoon

http://weather.unisys.com/hurricane/w_pacific/2012/SON_TINH/track.gif - track of typhoon Ofel

http://www.typhoon2000.ph/24W12_log.htm - storm log for typhoon Ofel

http://www.typhoon2000.ph/plotting/Ty2000Chartnew.pdf – Philippine Typhoon Tracking Chart

http://www.typhoon2000.ph/plotting/exerplot.gif – sample data information for Typhoon Rosing

http://www.typhoon2000.ph/plotting/howtotrak.html – how to plot typhoons (flash animation)

http://www.typhoon2000.ph/plotting/sampleplot.html – finished tracking chart for Typhoon Rosing

http://www.scribd.com/doc/44375263/SORSOGON-CLIMATE-CHANGE-ASSESSMENT_ - Climate Change Assessment for Sorsogon, Philippines: A Summary

http://www.dilg.gov.ph/PDF_File/resources/DILG-Resources-2012116-420ac59e31.pdf - The National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028

http://www.ndrrmc.gov.ph/attachments/article/1064/04081202.PDF - Weather Advisory for Low Pressure Area on August 8, 2013 by NDRRMC

http://thewatchers.adorraeli.com/2013/08/11/red-alert-issued-as-super-typhoon-utor-made-landfall-in-philippines/ - Forecast for typhoon Utor

Image Credits:
http://www.theworld.org/2012/12/unusual-typhoon-leaves-southern-philippines-reeling/ - damages of typhoon Bopha in New Bataan town

http://weather.com.ph/weathertv – Weather TV

http://www.hpc.ncep.noaa.gov/html/stationplot_printer.html – sample station plot

http://www.eduplace.com/graphicorganizer/pdf/cluster.pdf - cluster web

http://www.mapsofworld.com/philippines/philippines-political-map.html# - political map of the Philippines

http://ete.cet.edu/gcc/?/resourcecenter/slideshow/3/1 - Global average temperatures

http://weather.com.ph/index.php?url=typhoon/climatology - Where most of the tropical cyclones form

Lesson 3: Other Members of the Solar System

INTRODUCTION AND FOCUS QUESTION:

Have you ever seen a shooting in the night sky? Have you heard of this game before? "When you see a meteor in the sky, make a quick wish. If you finish making your wish before the streak of light disappears, your wish will come true." Have you ever wondered how the meteor showers are related to granting the wishes? Have you asked whether this belief on meteor shower have a scientific basis?

In this module, you will find out how the characteristics of the other members of the solar system explain the superstitious beliefs and practices. Remember to search for the answer to the following question: **How true are folk beliefs about comets and meteors?**

LESSON AND COVERAGE:

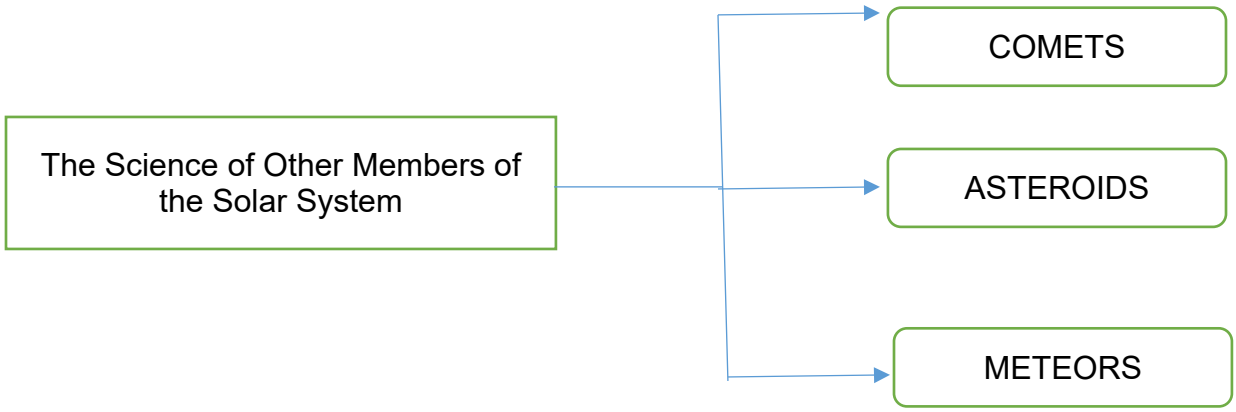
In this module, you will examine the question when you take the following lesson:
Lesson 1 – The Science of Other Members of the Solar System

In this lesson, you will learn the following:

Lesson 1: The Science of Other Members of the Solar System	• Compare and contrast comets, meteors, and asteroids. • Predict the appearance of comets based on recorded data of previous appearances. • Explain the regular occurrence of meteor showers.

MODULE MAP:

Here is a simple map of the above lesson you will cover:



EXPECTED SKILLS:

To do well in this module, you need to remember and do the following:

1. Read and follow the instructions carefully and thoroughly.
2. Read each lesson and do activities that are provided you.
3. Perform all the activities diligently to help and guide you in understanding the topic.
4. Open the indicated interactive simulations. Explore further and deeper as time allow.
5. Review questions as many times as needed, as you answer the discussion questions related to them.
6. Gather the materials for the experiments and demonstrations and actually do them yourself. The actual experiments give you richer learning experience than just reading the texts and even watching related videos.
7. Use the rubric to guide you in the preparation and evaluation of the expected outputs.
8. Consult your teacher if you need to clarify or verify something about an activity.
9. Follow schedule of the activities, remind yourself of deadline. Read advance when necessary
10. Find time to relax and take a break. Have fun learning.

PRE-ASSESSMENT:

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

(A) 1. Asteroids are located in a:

A. spherical cloud-like region surrounding our solar system.
B. disk-like layer found a little beyond Neptune's orbit.
C. wide belt found within the gaps of the rings of Saturn.
D. region of space between the orbits of Mars and Jupiter.

(A) 2. A meteor shower is produced when:

A. A large number of sporadic meteors are observed.
B. The Earth passes through the asteroid belt.
C. The Earth passes through the orbital path of a comet.
D. Massive particles are carried outward from the sun by the solar wind and enter Earth's atmosphere

(A) 3. Which of the following do not have their own supply of light?
A. Asteroids
B. Comets
C. Shooting star
D. All of the above

(A) 4. Why do asteroids and comets differ in composition?
A. Asteroids formed inside the frost line, while comets formed outside.
B. Asteroids and comets formed at different times.
C. Comets formed from the Jovian nebula, while asteroids did not.
D. Comets are much larger than asteroids.

(A) 5. What causes the bright of streak of light that you see when a meteor enters Earth's atmosphere?
A. The sunlight reflects the body of the meteor
B. The meteor triggers Earth's magnetic field
C. There is a frictional heating as the meteor enters Earth's atmosphere.
D. The meteor disturbs the atmosphere, making the sunlight refract toward unusual directions.

(A) 6. Halley's Comet appeared in the sky in 1910 and then again in 1986. When will it appear again?
A. 2061-2062
B. 2067-2068
C. 2056-2057
D. 2042-2043

(A) 7. Which of the following best describes a meteorite?
A. A meteorite is a meteor that makes it through the earth's atmosphere
B. A meteorite is any celestial object that has fallen on the earth's surface
C. A meteorite is a piece of rock of metal that is traveling through space
D. A meteorite is a piece of icy rock and dust that has its own orbit

(A) 8. Katie and Robbie look up into the night sky and see a fiery streak falling towards the Earth. They just saw a:
A. Meteor
B. Meteorite
C. Comet
D. Asteroid

(M) 9. Since the particles of comets are constantly blown away as they travel around the solar system, what can be predicted about the comet's existence?
A. Comets can lose mass, become smaller, and eventually break up.
B. Comets can gain mass because gases and dust particles can build up their nucleus.

C. The nucleus of comets can become larger particles from the tail can build up.
D. Comets melt and freeze as they travel around the solar system.

(M) 10. Which of the following statements about comets and asteroids is *true*?
A. Only asteroids collide with Earth.
B. Comets are balls of ice and dust.
C. Most of the trillions of comets in our solar system have tails.
D. All asteroids lie in the asteroid belt between Mars and Jupiter.

(M) 11. Why does the plasma tail of a comet always point away from the Sun?
A. Radiation pressure from the Sun's light pushes the ions away.
B. The conservation of the angular momentum of the tail keeps it always pointing away from the Sun.
C. Gases from the comet, heated by the Sun, push the tail away from the Sun.
D. The solar wind electromagnetically "blows" the ions directly away from the Sun.

(M) 12. Meteor showers such as the Perseids in August are caused by:
A. the breakup of asteroids that hit our atmosphere at predictable times.
B. the Earth passing through the debris left behind by a comet as it moves through the inner Solar System.
C. passing asteroids triggering auroral displays.
D. nuclear reactions in the upper atmosphere triggered by an abnormally large meteoritic particle entering the upper atmosphere.

(M) 13. Astronomers think that most comets come from:
A. interstellar space
B. material ejected by volcanic eruptions on the moons of the outer planets
C. condensation of gas in the Sun’s hot outer atmosphere
D. small icy bodies in the extreme outer parts of the Solar System that are disturbed into orbits that bring them closer to the sun

(M) 14. Which of the following is true about the majority of the space debris that enters the earth’s surface?
A. Majority of the space debris impact on the earth’s surface
B. Majority of the space debris burns up in the atmosphere
C. Majority of the space debris all melts on the earth’s surface
D. Majority of the space debris explodes in the earth’s atmosphere

(T) 15. You are hiking in the Arctic Circle and find a piece of rock. After testing it, you discover that it is from Mars. What is the most likely explanation for how this rock got there?

A. The rock broke off from the Mars awhile ago and came to Earth as a meteor.
B. A meteoroid came to Earth on a comet
C. An alien came and left it on Earth
D. Mars and Earth crashed into each other awhile ago, and Mars left some debris behind.

(T) 16. Scientists believe that most of the asteroids, meteors, and comets come from:
A. debris from planets in other galaxies.
B. leftover materials from the solar system when it was still forming.
C. pieces of older planets in the solar system that exploded.
D. materials that have evaporated from the surface of the planets of the solar system.

(T) 17. Some scientists believe that these could be responsible for some of the water found on Earth:
A. meteor B. comet C. asteroid D. satellite

(T) 18. In the asteroid impact theory of the extinction of the dinosaurs some 65 million years ago, the dinosaurs (and over half of all the other species on Earth at that time) died off largely because:
A. of injuries suffered from direct hits of pieces of the asteroid or comet.
B. dust injected into the stratosphere from the impact absorbed visible light from the Sun, causing global temperatures to plummet.
C. radiation from iridium in the asteroid caused the dinosaurs to die of cancer.
D. the impact caused massive earthquakes and volcanic activity worldwide.

(T) 19. Why would global temperature drop if the Earth were struck by an asteroid several km in diameter or larger?
A. The impact would move the Earth farther from the sun.
B. The resulting dust cloud would block out sunlight.
C. The ices in the asteroid would increase the Earth's albedo
D. The low temperature of the asteroid would chill the oceans

(T) 20. Scientists believe that most of the asteroids, meteors, and comets come from:
A. debris from planets in other galaxies.
B. leftover materials from the solar system when it was still forming.
C. pieces of older planets in the solar system that exploded.
D. materials that have evaporated from the surface of the planets of the solar system

EXPLORE

Have you heard the news about an asteroid that will hit Earth on September 24, 2015? If not, a previously unknown asteroid belt has just been located in space and is now heading towards our part of the solar system. Killer asteroids could collide with Earth as soon as 2015, wiping out life as we know it and changing the climate for millennia. The news trigger doomsday prophecies. But does the phenomena has scientific basis? **How true are folk beliefs about comets and meteors?**

ACTIVITY 1: VIDEO VIEWING- DOOMSDAY PROPHECY

Let us watch a documentary film about an doomsday asteroid impact. Click on the link to watch "Doomsday Prophecy Doomsday Asteroid Impact". You do have the option to download it first. It would help if you take down notes as well.

https://www.youtube.com/watch?v=WrXbbfm5Ky4 Doomsday Prophecy Doomsday Asteroid Impact

After watching the video, write your arguments on the THESIS column and write your proof/s or evidence/s on the PROOF column to support your arguments.

THESIS	PROOF

PROCESS QUESTIONS:

2. 1. What ideas on asteroid did you learn after watching this video?
3. 2. What is the prediction that will happen in 2016? Does it trigger doomsday prophecies?
4. 3. How did the scientists prove the world's largest environmental disaster in 2016?
5. **4. What is the scientific explanation for an asteroid hitting the Earth in 2016?**

ACTIVITY 2: VIDEO ANALYSIS

After watching the documentary film, try to imagine how the asteroid will hit the Earth. In the video that you are about to watch, pay close attention to the collision of large asteroid and Earth. Click on the link below to view the video:

https://www.youtube.com/watch?v=bU1QPtOZQZU Discovery Channel- Large Asteroid Impact Simulation

PROCESS QUESTIONS:

1. How will you describe the impact of large asteroid to the Earth? How will it affect the life on Earth?
2. Can the collision of asteroid to the Earth be avoided? Explain your answer.

ACTIVITY 3: ELICITING PRIOR KNOWLEDGE THROUGH I-R-F CHART

What were your initial answers to the questions posed in the previous activity, **How true are folk beliefs about comets and meteors?**
Summarize your answers to the question, and your thoughts and ideas in the first column IRF Chart.

How true are folk beliefs about comets and meteors?		
Initial	**R**evised	**F**inal

End of EXPLORE

You just wrote about how the belief on asteroids is proved and explained scientifically.

Let's find out how your other classmates answered the first column of the IRF chart. You can make use of the Discussion Forum to communicate with your classmates. Compare their ideas with your own.

What you learn in the next sections will also enable you to do the final project which involves the scientific basis that will help in explaining the beliefs and practices regarding other members of the solar system.

Let's start gathering information by proceeding to the next part.

FIRM-UP

Your goal in this section is to learn and understand key concepts about comets, meteors and asteroids. The competencies that you should be able to accomplish are listed below. Monitor your progress in this module using this checklist competencies.

CHECKLIST OF COMPETENCIES

Competencies	Crystal Clear	Partially Clear	Not Fully Understood
1. Compare and contrast comets, meteors, and asteroids.			
2. Predict the appearance of comets based on recorded data of previous appearances.			
3. Explain the regular occurrence of meteor showers.			

ACTIVITY 4: ANTICIPATION-REACTION GUIDE

Are you certain with your ideas on the characteristics of comets, meteors and asteroids? You will answer the Anticipation-Reaction Guide below to examine these ideas.

Read the statements in the middle column. Then under the column Before, write Agree or Disagree. Answer only this column first.

Before	Statements	After
	1. Shooting stars are really meteors that have entered Earth's atmosphere	
	2. When comets reach the Earth's surface, they are called meteorites.	
	3. Meteoroids consist of ice, rocks and dust particles.	
	4. Craters on Earth's surface were caused by comets crashing into its surface.	
	5. You can always see a comet's tail.	
	6. Meteoroids are formed from comets and asteroids.	
	7. Asteroids, comets and meteoroids revolve around the sun in their perspective orbits.	
	8. Asteroids, comets and meteors have light of their own.	

What can you say about your answers in the ARG? Do you have the right ideas on the characteristics of comets, meteors and asteroids? Let us try to check your ideas by performing the next activity.

ACTIVITY 5: SURF THE NET

You are now about to learn more about the other members of the solar system. As you explore this concept, do remember the various study skills and strategies that were mentioned initially in this module such as downloading videos, exporting a

web, page to PDF, taking screen shots, screen recording, taking down notes, posting stickies, using a dictionary and many more.

Part 1: Draw and Tell

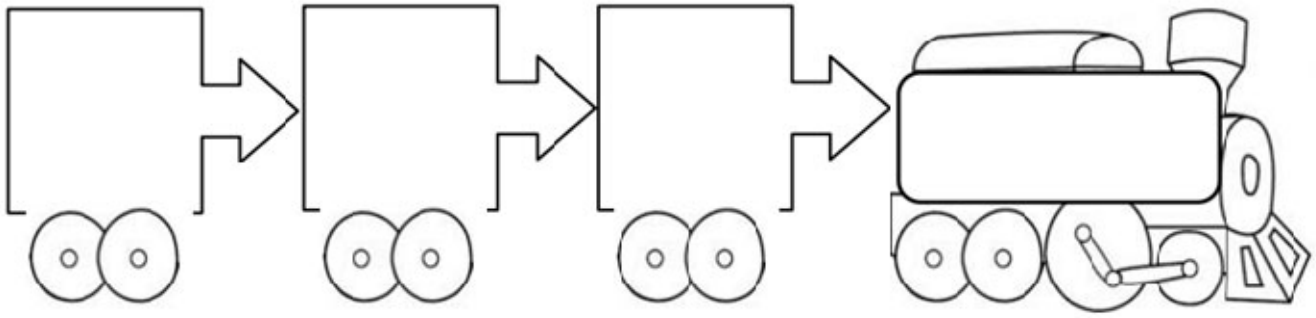
Before you start learning about comets, meteors and asteroids, answer the questions in the worksheet below and draw what is required. Write and draw your response in the second column or “My Response Before Surfing the Net”. You may use Paint or Photoshop to make your drawing and save a JPEG file of the image. Alternatively, you can replicate the Draw & Tell worksheet in a paper, then scan or take a photo of your output and upload it in the submission bin. Make sure to keep both the hard and soft copies. File name should be Last Name_Draw&Tell.

DRAW AND TELL WORKSHEET		
Questions	My Response Before Surfing the Net	My Response After Surfing the Net
How are comets, asteroids and meteors formed?		
How does comet and meteor appear in the sky?		

How did you come up with your drawing? Let’s see how others would answer those questions and find out if you have the same illustration by moving on to the next section.

Part 2: A QUICK TOUR TO THE SOLAR SYSTEM
For an introduction of other members of the solar system, click on this link to watch the video.
https://www.youtube.com/watch?v=evWeRHMwSu0 A Tour through our Solar System

Summarize the video by listing down facts about the members of the solar system. Use the “Travel Tour” sheet to accomplish this task then submit your work.



Process Questions:
1. What are the members of the solar system? What are the other members of the solar system?
2. How the solar system works?
3. What do you think will happen to the planets without the Sun?

Part 3: SURFING THE NET

After a quick tour to the solar system, you will be guided to the other members of the solar system. In this section, you will learn the characteristics of comets, meteors and asteroids.

Do take down notes and be prepared to answer three worksheets after exploring the websites.

Explore the characteristics of other member of the solar system by reading these articles. Click on the link.

http://richardloosemore.com/docs/PHYS106/PHYS106-16-MeteorsCometsAsteroids.pdf Comets, Meteors and Asteroids

http://www.asc-csa.gc.ca/eng/educators/resources/astronomy/module5/lesson2.asp The difference between comets, meteors and asteroids

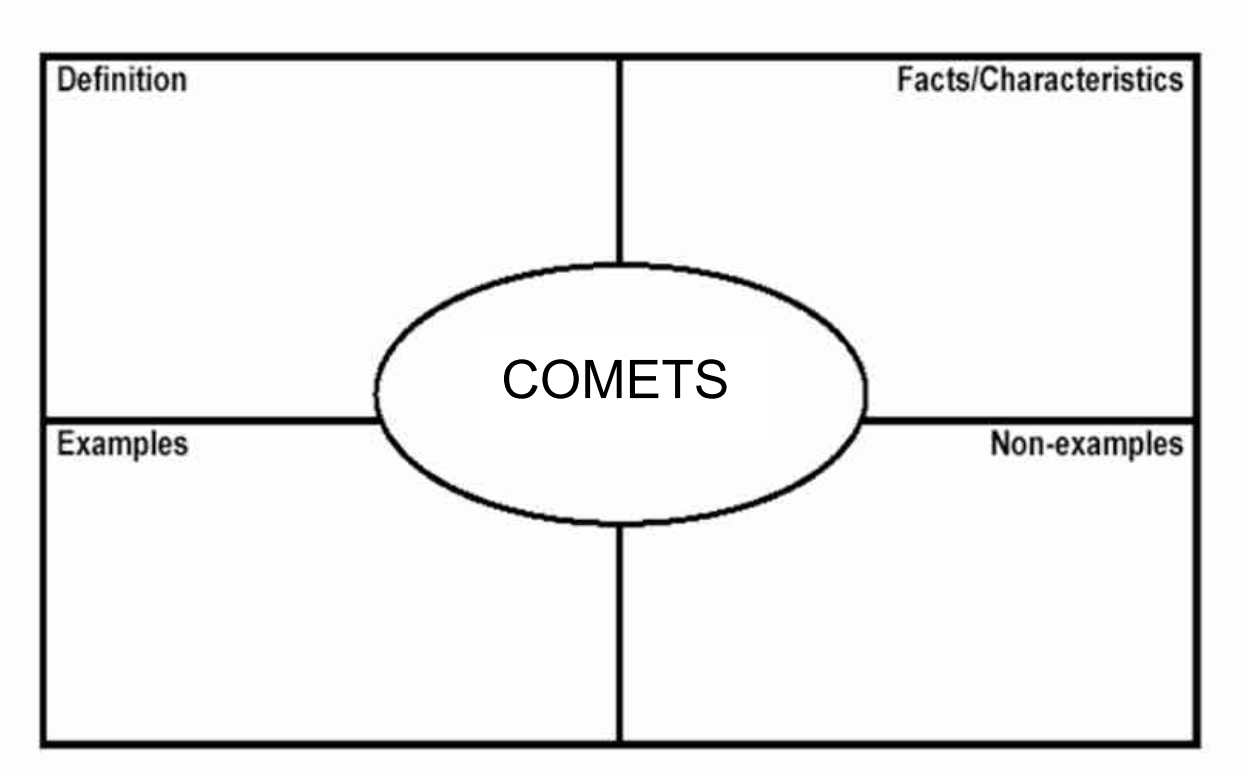
http://www.carolinacurriculum.com/premium_content/eBooks/Earth+Space/pdfs/Lesson_17.pdf Asteroids, Comets and Meteoroids

Process Questions:
1. What is an asteroid? A comet? A meteor?
2. How are asteroids similar to or different from comets and meteoroids?
3. How and when do scientists think asteroids, comets and meteors may have formed?

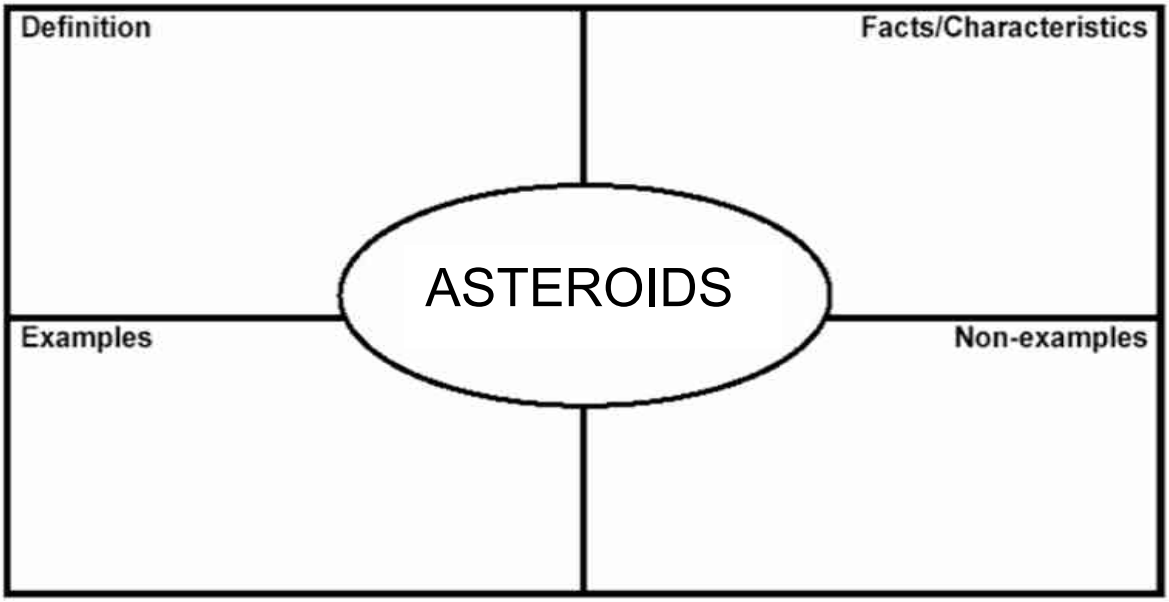
Now, complete the three Frayer Model graphic organizers.

- Identify the other members of the solar system and write the name of each member inside the oval at the middle of each Frayer Model organizer.
- Fill in the required information in each window/box for each of the three Frayer Model organizers.

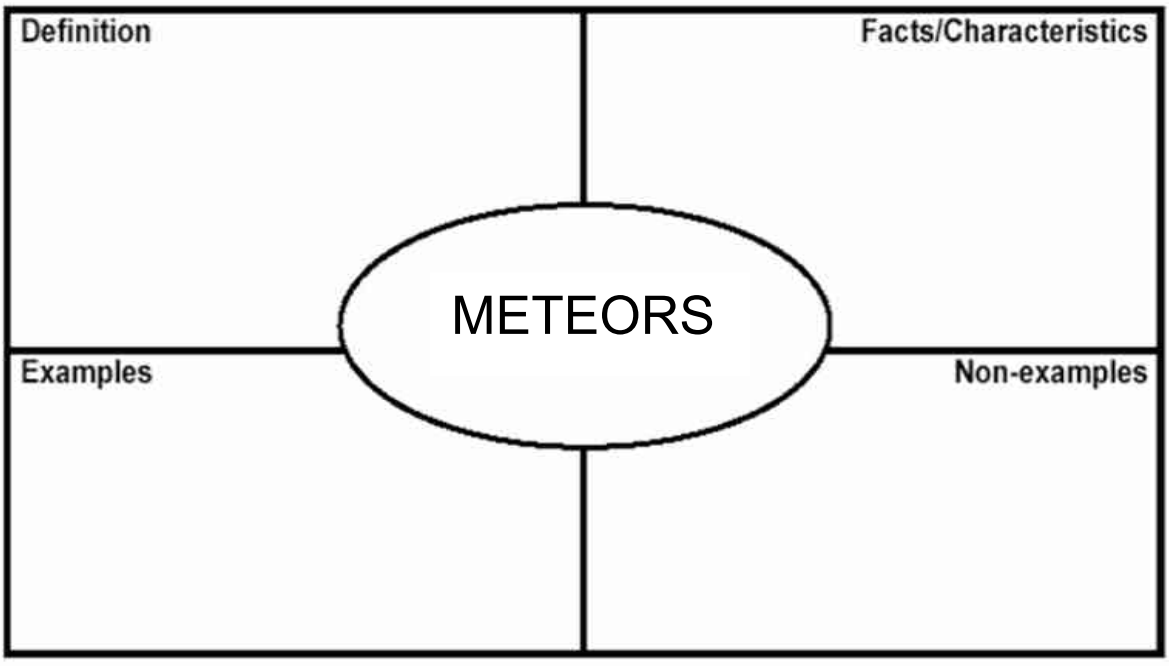
Member of the Solar System No.



Member of the Solar System No. 2



Member of the Solar System No. 3



Part 6: DRAW AND TELL ME AGAIN

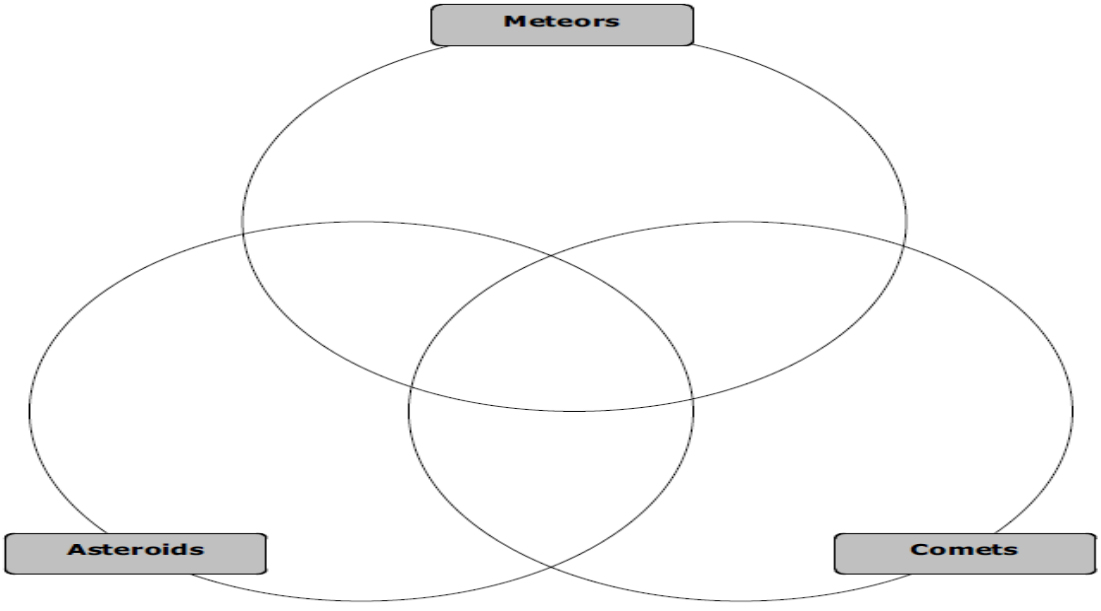
Retrieve the Draw & Tell Worksheet you initially accomplished in Part 1. Alternatively, you may go back to the hard copy if you used one. Fill in the third

column or “My Response After Surfing the Net” column. Then submit your final worksheet showing both your response before and after.

DRAW AND TELL WORKSHEET		
Questions	My Response Before Surfing the Net	My Response After Surfing the Net
How are comets, asteroids and meteors formed?		
How does comet and meteor appear in the sky?		

ACTIVITY 6: VENN DIAGRAM

From Activity No. 5: Surfing the Net, analyze the similarities and differences on the characteristics of other members of the solar system. Fill the Venn Diagram with the similar and different characteristics of each member of the solar system.



What can you say about your answers in the Venn diagram? Do you have the right ideas on the characteristics of each member of the solar system? What are your insights and realizations when you compare the other members of the solar system? You will now do a journal writing activity to express your ideas,

realizations and insights on the characteristics of the other members of the solar system.

_____
_____
_____
_____
_____
_____
_____
_____

ACTIVITY 7: Prediction of Appearance of Comets

You will now take a closer look at some aspects of comets.

Comets have been studied by the astronomers. The astronomers used to wait the appearance of comets in the sky periodically. Let us try to find out on how the astronomers predict the appearance of comets.

Click on this link to read the some famous comets appeared. You can take down notes by completing the table below.
http://burro.astr.cwru.edu/stu/comets.html Comets

Comet Name	Orbital Period	Year Found	Type of Comet

PROCESS QUESTIONS:
1. How do the astronomers classify comets?
2. How do they predict the appearance of comets? What are their bases?

SELF-CHECK:
Let's do comprehensive check in predicting the appearance of some comets. You will complete the table by filling in the predicted next appearance of the following comets on the space provided.

Comet Name	Orbital Period	Year Found	Next Approach of the Sun
Brorsen-Metcalf	70.6	1847	(a)_____
Temple 1	5.51	July 7, 2005	(b)_____
Ikeya-Seki	800	1965	(c)_____

ACTIVITY 8: METEOR GARDEN

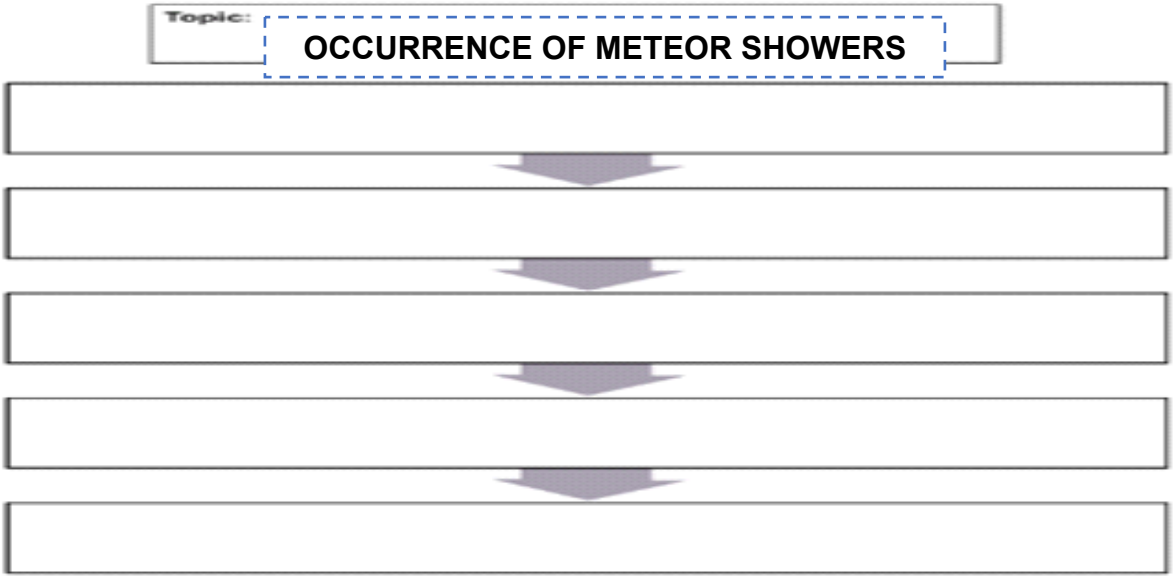
Now you will take a look to some aspects of meteors.

Try to imagine how many times the meteor showers occur. Click on the link below to view the video: The video explains about the meteor shower.

http://www.space.com/15353-meteor-showers-facts-shooting-stars-skywatching-sdcmp.html Meteor showers and Shooting Stars: Formations, Facts and Discovery

Process Questions:
1. How are meteor showers formed?
2. What are some examples of meteor showers? What are their characteristics?
3. What is the impact of meteor showers to the Earth?
4. Why do meteor showers occur about the same time every year?

Complete the graphic organizer below to summarize the regular occurrence of meteor showers.



ACTIVITY 9: SELF-ASSESSMENT QUIZ

Let's check your knowledge of other members of the solar system. Take Asteroids, Meteors and Comets online quiz by clicking on this link: http://www.astro.umass.edu/~arny/jquiz10.html 10-item online quiz about asteroids, meteors and comets

How did you perform in the quiz? Look at the items you missed. Go back to your notes and review the terms and concepts you missed.
6.

ACTIVITY 10: REVISING PRIOR KNOWLEDGE THROUGH I-R-F CHART

Go back to the question: **How true are folk beliefs about comets and meteors?**

This time, write your answers the question posted at the beginning of this module by accomplishing the REVISED column of the IRF Chart. When you are finished, click on "Submit."

How true are folk beliefs about comets and meteors?		
Initial	**R**evised	**F**inal

7.
Moreover, go back to your checklist of competencies and see how much you've accomplished.

CHECKLIST OF COMPETENCIES			
Competencies	**Crystal Clear**	**Partially Clear**	**Not Fully Understood**
1. Compare and contrast comets, meteors, and asteroids.			
2. Predict the appearance of comets based on recorded data of previous appearances.			
3. Explain the regular occurrence of meteor showers.			

End of FIRM UP:

In this section, the discussion was about the key concepts of comets, meteors and asteroids. Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which of your ideas need revision? What new learning goal should you now try to achieve? Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

Your goal in this section is to take a closer look at some aspects of the topic.

ACTIVITY 11: ARTICLE READING AND ANALYSIS

In this activity, you will read 3 articles related to stories of comets, asteroids and meteors and how they triggered beliefs and practices. You will be asked to summarize each article.

Article 1: Big asteroid buzzes past Earth and will again in 19 years

http://edition.cnn.com/2013/10/18/tech/asteroid-near-pass/

One of the most dangerous asteroids on record zipped close by Earth last month.

It made headlines on Thursday, when reports said that there's a chance it could strike our planet in less than 20 years. Such a collision could unleash a force as powerful as a couple of thousand atomic bombs.

But NASA was quick to calm nerves and point out some very good news. The most dangerous known asteroids don't really pose much of a threat. And there are very few of them.

Also, the chances that this one, which the Ukrainian astronomers who discovered it named 2013 TV135, will collide with Earth are extremely slim, NASA said in a statement it called "a reality check."

The space agency is 99.998% certain that when it whooshes back around the planet in 2032, it will simply sail past us again.

The probability of it striking Earth currently stands at 1:63,000, and even those odds are fading fast, as scientists find out more about the asteroid.

"This is a relatively new discovery," said Don Yeomans, manager of NASA's NEO Program. "With more observations, I fully expect we will be able to significantly reduce, or rule out entirely, any impact probability for the foreseeable future."

2013 TV135 was discovered on October 8, while NASA was closed during the government shutdown. And already it looks to soon be joining the ranks of the more than 10,000 known near-Earth objects that are virtually certain to cause us no harm.

But until then, it has the distinction of having a danger rating of 1 out of a possible 10 on the Torino Impact Hazard Scale, the system that gauges the danger of impact destruction by asteroids.

The 1 rating means that it poses "no unusual level of danger." There is "no cause for public attention or concern."

Almost all other asteroids that scientists have discovered rank a 0 on the scale. There is another asteroid with a danger rating of 1. And it, too, is no cause for alarm, NASA says.

September's close pass

The close pass 2013 TV135 made on September 16 was not a near miss. At a distance of 4.2 million miles as it flew by, it was more than 15 times as far away from Earth as the moon.

That pales by compare to the closest shave the Earth got from an asteroid of considerable size in recorded history.

On February 15 this year, asteroid 2012 DA14, which measured 150 feet wide, slipped in below the moon's orbit and squeaked by our planet just 17,200 miles from its surface.

The one that passed by in September is big, with a diameter of 1,300 feet. That's the size of four football fields, but it does not quite make it an Earth crusher.

An asteroid needs to be at least twice as large to advance into that league.

"We believe anything larger than one to two kilometers (about 0.6 to 1.2 miles) could have worldwide effects," NASA said in a statement.

Russian divers find huge suspected meteorite chunk

Near passes daily

Two behemoths in that size range will pass by planet Earth in the next three months at similar distances as 2013 TV135. NASA says that neither will hit us.

Near asteroid passes are common. They pretty much occur daily, if not two or three times a day, NASA says.

They come, and they go, and they leave the Earth in peace.

In addition, particles from space bombard our planet every minute -- at a rate of 100 tons a day, NASA says.

You eat them; you drink them; you breathe them. Much of you and everything else on Earth contains them.

Distant catastrophe

Though it seems Earth is safe for now, there is such a thing as a doomsday asteroid.

Scientists say it is likely that the impact of an asteroid over six miles wide wiped out dinosaurs along with much of the life on Earth 65 million years ago.

More like it will come, NASA says.

But they only turn up once every "few million years."

That may give humanity some time to find a way of dealing with it.

Sum It Up Instructions:

- Read the article and, as you read, list the main idea words on the “Sum It Up” sheet.
- Write a summary of the article using as many words of the main idea words as possible. Put one word in each box under the “Text Summary”. Imagine that you have only $2.00 and that each word you use is worth 10 cents.
- Finally, you’ll sum it up in 20 words.

Sum It Up!				
Name:			Date:	
Title of the Article:				
Main Idea Word Bank				
Text Summary (10 cents per word)				
Sum it up for $2.00				

PROCESS QUESTIONS:

1. How the astronomer did discovered the 2013 TV135?
2. What are their propositions that 2013 TV135 collides to the Earth?
3. **What are the scientific explanations about an asteroid that will hit Earth after 19 years?**
8.

Article 2: Comet ISON Offers Doomsday Déjà vu

Click this link to read the second article.
http://news.discovery.com/space/asteroids-meteors-meteorites/comet-ison-offers-doomsday-deja-vu-130909.htm Comet ISON Offers Doomsday Déjà vu

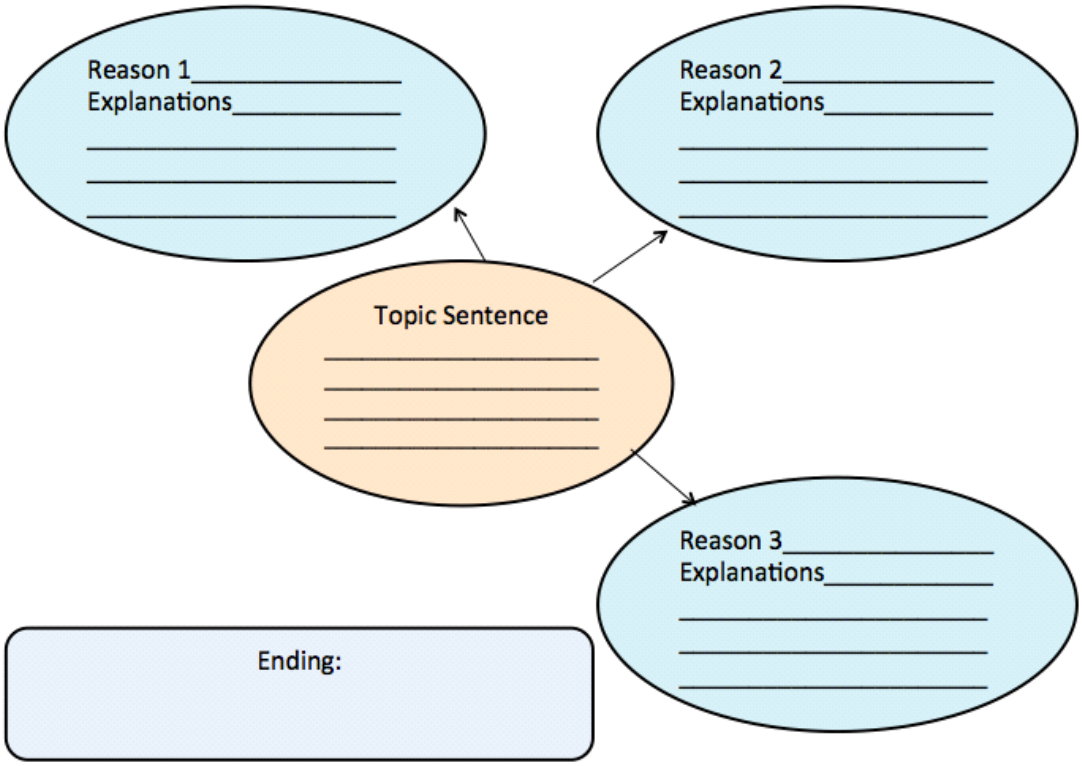
After reading the article, answer this question: Should it be true that COMET ISON offer doomsday?

To guide you in answering that question, do the POW + TREE Activity.

Strategy		Activity
Pick an idea or opinion.		Formulate an opinion and state that opinion clearly.
Organize and generate notes and ideas for each part of the TREE.		Organize notes by completing a graphic organizer:
	**T**opic Sentence	Formulate a topic sentence expressing an opinion.
	Reason	Give at least three reasons to support the topic sentence.
	Explanation	Explain your reasons.
	Ending	Formulate a statement to summarize the topic sentence.
Write and say more.		Write a complete paragraph. Follow the plan developed using the TREE strategy.

Source: http://iris.peabody.vanderbilt.edu/module/pow/cresource/how-might-ms-price-provide-help-to-meet-the-individual-needs-of-all-her-students-including-those-with-disabilities/pow_04/

Accomplish the TREE graphic organizer shown below.



Now write your paragraph inside the box below based on the TREE graphic organizer that you have completed.

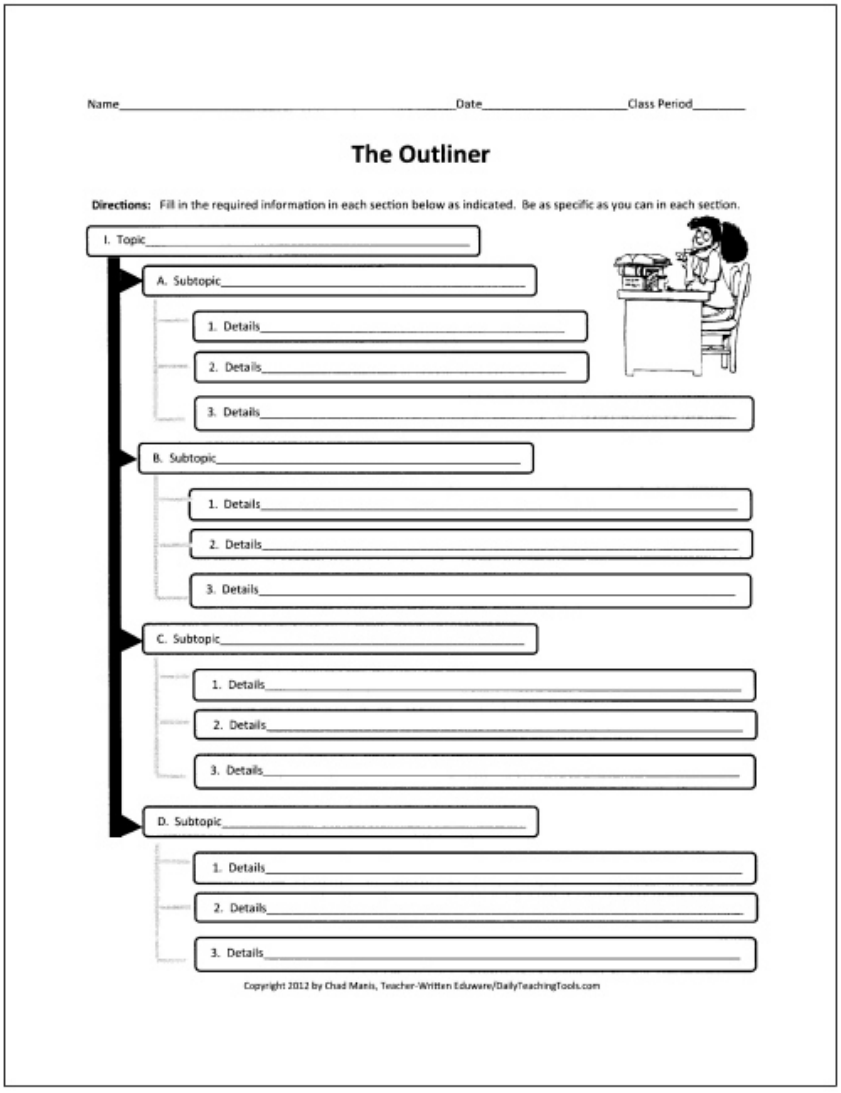
Submit your work when you're done.

Article 3: Meteorites, Asteroids and Comets: Damages, Disasters, Injuries, Deaths and Very Close Calls

Click this link to read the third article.

http://www.sott.net/article/151954Meteorites-Asteroids-and-Comets-Damages-Disasters-Injuries-Deaths-and-Very-Close-Calls

Summarize the article by listing down evidences of catastrophes related to meteorites, asteroids and comets. Use the "Outliner" sheet to accomplish this task then submit your work.



Name_____ Date_____ Class Period_____

The Outliner

Directions: Fill in the required information in each section below as indicated. Be as specific as you can in each section.

I. Topic_____

A. Subtopic_____

1. Details_____
2. Details_____
3. Details_____

B. Subtopic_____

1. Details_____
2. Details_____
3. Details_____

C. Subtopic_____

1. Details_____
2. Details_____
3. Details_____

D. Subtopic_____

1. Details_____
2. Details_____
3. Details_____

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Compare the different catastrophes related to the other members of the solar system. **How the catastrophes related to the other members of the solar system are be explained scientifically?**

ACTIVITY 12: SITUATION ANALYSIS

In this activity, you will examine three beliefs and practices that are related to other members of the solar system. Make sure to read thoroughly or listen carefully to the situations that will be presented. Take down notes, highlight key concepts and

use the dictionary to find the meaning of unfamiliar words. Be prepared to answer questions after each situation and make a synthesis after examining all the given situations.

Part 1: Beliefs and Real Stories About Comets and Asteroids

Click this link to read about the beliefs and stories about comets and asteroids.
http://mysteries24.com/n4-40295
Beliefs_and_Real_Stories_About_Comets_and_Asteroids

PROCESS QUESTIONS:

1. What are the beliefs about comets and asteroids?
2. How these beliefs triggered cataclysm on Earth?
3. **How true are beliefs about comets and asteroids?**

Part 2: Meteors: Native American Folklore

Click this link to read about the Native American folklore on meteors.
http://www.crystalinks.com/meteor.folklore.html Meteors: Native American Folklore

PROCESS QUESTIONS:

1. What are the beliefs of Native American about meteors?
2. How these beliefs on meteors created? What are their bases for these?
3. **How true are beliefs about meteors?**

Part 3: Meteorites, Asteroids and Comets: Damages, Disasters, Injuries, Deaths and Very Close Falls

Click this link to read about the catastrophes connecting to meteorites, asteroids and comets.
http://www.sott.net/article/151954-Meteorites-Asteroids-and-Comets-Damages-Disasters-Injuries-Deaths-and-Very-Close-Calls

PROCESS QUESTIONS:

1. What are the catastrophes happened brought about by meteors, asteroids, comets?
2. How do the scientists relate the catastrophes happened to the other members of the solar systems?
3. Do they create beliefs on steroids, comets and meteors? What are their bases for these?
4. **How true are beliefs about comets, asteroids and meteors?**

Be guided by the rubric shown below.

RUBRIC FOR UNDERSTANDING

SCORE	DESCRIPTION
3	Generalization is valid, logical, insightful, and makes accurate references to the data presented. Justification is comprehensive, clearly stated, and based on careful analysis of cases given. The way the student defends his/her answer is reflective of strategic thinking and a deep understanding of the topic.
2	Generalization is valid. Justification is correct and shows some analysis of cases given. The way the student defends his/her answer is reflective of an adequate understanding of the topic.
1	Generalization shows little relationship to the data presented. Some statements are correct, but most are inaccurate due to incomplete analysis of cases given. The way the student defends his/her answer is reflective of a superficial understanding of the topic.
0	Generalization is invalid. Justification is incorrect and has no relationship or no reference to the cases given. The student clearly does not understand the topics. The way the student defends his/her answer is coming out from memorization.

Synthesis

In the previous section, we looked at different beliefs and practices about other members of the solar system. Let's put together in the table below our answers to the essential questions that we asked for each article.

	VIDEO 1	VIDEO 2	VIDEO 3
ESSENTIAL QUESTION: How true are folk beliefs about comets and meteors?	We should explain the beliefs and practices by……	We should explain the beliefs and practices by……	We should explain the beliefs and practices by……

PROCESS QUESTIONS:

1. Look at your answers to the essential questions in the above table. What do all the answers have in common?
2. Are all the strategies the same? How do the answers differ?
3. Complete the following statement and support your answer with examples from the above articles.

The ways by which belief and practices about the members of the solar system can be explained are …

_____
_____
_____
_____

Supporting reasons and examples from the above articles:

_____
_____
_____
_____

Organize and present your answers to the essential questions in the table above by creating your own blog using www.edublogs.org. Sign up for a free account. Create your blog, publish it and submit by sharing the URL in the portal.

ACTIVITY 13: I AM STRONG AND COMPLETE!

After doing the tasks in the previous activities, you should now be able to strengthen your new knowledge and understanding of plate tectonics.
It's time for you to complete the IRF Chart by filling out the FINAL column.

How true are folk beliefs about comets and meteors?		
Initial	**R**evised	**F**inal

End of DEEPEN:

In this section, the discussion was about the different situations involving beliefs and practices related to comets, meteors and asteroids.

What new realizations do you have about the topic? What new connections have you made for yourself?

Now that you have deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is to apply your learning to real life situations. You will be given a practical task which demonstrate your understanding.

ACTIVITY 14: DIFFRERENTIATED PERFORMANCE TASK

You're now ready to make the project for this module. You will be given three options for your final product. You only need to choose and make one.

Over the past few years, there are fireballs and meteorites that entered the Earth and issue from the media regarding these incursions. The news triggers doomsday prophecies.

In response to the news issued, you are to discuss scientifically the nature of comets and meteors for the common citizens.
Your product will be evaluated based on:

- Content
- Organization
- Justification
- Impact

OPTION 1: PAG-ASA SCIENCE RESEARCH SPECIALIST
You are the Science Research Specialist of PAG-ASA, and you are to present on a forum on the scientific explanations behind the beliefs and practices about comets and meteors.
You will prepare any of the following as your visual aid that will be shown to the viewers during the forum.

- PowerPoint Presentation (Web 2.o like www.prezi.com)
- Animated Video (e.g., Flash, Shockwave or Web 2.0 Tools like www.powtoon.com)
- Flyers illustrating the scientific explanations on beliefs and practices of comets and meteors

OPTION 2: SCIENCE EDITOR

One of the specialists of PAG-ASA announced that there will be a meteor shower this year during the aired-interview. The Filipinos are so excited to the meteor shower because they believed that wishing upon a shooting star make their wishes come true.
You are a Science Writer of a newspaper and asked to write an article explaining on the superstitious belief about meteor shower scientifically among public and private schools in the city.

You are to create any of the following that will be used to educate the readers in characteristics of comets and meteors in relation to the beliefs and practices.

- Publisher presentation
- Web 2.0 applications like wattpad and blogger

OPTION 3: ASTRONOMER

A rumor is spreading fast across the country that there will be asteroid hit the Earth this year. As a renowned astronomer of the country, you are invited by media men to clarify the matter. The public expects your point to be presented in any medium they are commonly exposed to.

The presentation may be created using any of the following format.

- Infographic in PDF using Canva (www.canva.com)
- Script for a scientific cartoon
- Comic Booklet of Digital Cartoon (e.g. Web 2.0 Tools like www.toondoo.com)

9.

Scoring Rubric

Criteria	4 Outstanding	3 Satisfactory	2 Developing	1 Beginning
Content	Presents detailed and advanced scientific reasoning with detailed elaboration.	Presents a good number of scientific reasons with sufficient elaboration.	Presents insufficient and inconsistent scientific evidences in some parts with little elaboration.	No scientific reasoning was presented.

Organization	Order of ideas is apparent and has an interesting progression.	Order of ideas is apparent. Sufficient details are geared to the central idea.	Order of ideas is confusing in some parts Some details are not specific to one central idea.	Order of ideas is not present. No supporting details were given.
Justification	Evidences gathered from the data and relevant and updated information are presented clearly and concisely making the work reasonable and compelling.	Evidences gathered from the data and relevant information is presented clearly and concisely making the work reasonable.	Few evidences are presented and with very few references to the data; some information is not presented clearly making the work unconvincing in certain parts.	Almost no evidences are presented and made no references to the data;
Impact	Material is highly stimulating and immediately mobilizes the reader or audience to initiate action. Impact is high.	Material provides reader or audience with substantial reason to take action. Impact is sufficient.	Some parts of the material are confusing thus weakening the impact of the message on the reader.	Material is vague about the proper course of action to take. Impact is low.

ACTIVITY 15: MY REFLECTION JOURNAL

Now that you have accomplished your performance task, let's look back and review your learning process in this lesson.

Write your personal reflections in the journal log below by answering the questions.

My Reflection Journal
How did I get started? What were my first thoughts?

Which activity helped me understand the topic better?
Which part of the lesson did I find most challenging? Did I try anything that didn't work? How did I feel about it?
How did I prove my ideas?
How well did I do? Did I get the results I expected?
What could I have done differently?
What were my remarkable accomplishments? How did it make me feel?

End of TRANSFER:

In this section, your task was to discuss scientifically the different beliefs about comets, meteors and asteroid. How did you find the performance task? How did the task help you see the real world use of the topic? You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

(A) 1. Which of the following statements describing comets and asteroids is accurate?
A. Comets and asteroids are similar to each other in that both develop tails in the portion of their orbit nearest to the sun.
B. After comets have burned off all their ices and gases, the leftover rocky debris migrates to a new orbit within the asteroid belt.
C. Each revolves around the sun, but the orbital period of comets is far greater than is the orbital period of asteroids.
D. Asteroids are the seed from which comets form as vapors from the solar wind are deposited in icy layers around the rock.

(A) 2. What do asteroids and comets have in common?
A. Most have been unchanged since their formation in the solar nebula.
B. They have similar densities.
C. They have similar orbital radii.
D. They have a similar range of orbital inclinations.

(A) 3. The tail of a comet
A. is gas and dust pulled off the comet by the Sun's gravity
B. always points away from the sun
C. trails behind the comet, pointing away from the sun as the comet approaches it, and toward the sun as the comet moves out of the inner Solar System
D. is gas and dust expelled from the comet's nucleus and blown outward by radiation pressure and the solar wind.

(A) 4. Comets are one of the sources of meteorites which strike the Earth. The other source is:
A. stars.
B. solar flares.
C. asteroids.
D. small moons.

(A) 5. Short period comets originate in the:
A. asteroid belt B. Oort Cloud C. the Milky Way D. the Kuiper Belt

(A) 6. Halley's comet is named after the English scientist Edmund Halley because he
A. discovered it.

B. was the first to see it in 1682.
C. calculated its orbit and predicted that it would return in 1758.
D. was the most famous astronomer in England during its appearance.

(A) 7. A meteor shower is produced when
A. a large number of sporadic meteors are observed.
B. the Earth passes through the asteroid belt.
C. massive particles are carried outward from the sun by the solar wind and enter Earth's atmosphere.
D. the Earth passes through the orbital path of a comet.

(A) 8. The gas tail of a comet always
A. trails behind the head along the orbital path.
B. extends ahead of the head along the orbital path.
C. points toward the sun.
D. points away from the sun.

(M) 9. Why do we sometimes observe asteroids at the distances of the gaps in the asteroid belt?
A. A gap is located at an average orbital distance, and asteroid orbits often have large eccentricities.
B. Jupiter's gravitational tugs keep them there.
C. They are held in place by resonances with other asteroids.
D. They are kept in place by shepherding asteroids.

10.

(M) 10. When do comets generally begin to form a tail?
A. inside Mercury's orbit
B. between Mercury and Earth's orbit
C. beyond Jupiter's orbit
D. inside of Jupiter's orbit

(M) 11. Why does the plasma tail of a comet always point away from the Sun?
A. The solar wind electromagnetically "blows" the ions directly away from the Sun.
B. Radiation pressure from the Sun's light pushes the ions away.
C. The conservation of the angular momentum of the tail keeps it always pointing away from the Sun.
D. Gases from the comet, heated by the Sun, push the tail away from the Sun.

(M) 12. Which of the following statements about comets and asteroids is *true*?
A. Only asteroids collide with Earth.
B. Comets are balls of ice and dust.
C. Most of the trillions of comets in our solar system have tails.
D. All asteroids lie in the asteroid belt between Mars and Jupiter.

(M) 13. What evidence exists that some of the asteroids were geologically active?
A. A few of the larger asteroids show small volcanic mountains.
B. The moons of Mars, which are thought to be captured asteroids, show evidence of flooding by lava.
C. The meteorites that are breccias could only have formed in a molten mantle.
D. Spectroscopically, Vesta appears to have regions of small lava flows.

(M) 14. Which of the following is true about the majority of the space debris that enters the earth's surface?
A. Majority of the space debris impact on the earth's surface
B. Majority of the space debris burns up in the atmosphere
C. Majority of the space debris all melts on the earth's surface
D. Majority of the space debris explodes in the earth's atmosphere

(T) 15. You are hiking in the Arctic Circle and find a piece of rock. After testing it, you discover that it is from Mars. What is the most likely explanation for how this rock got there?
A. The rock broke off from the Mars awhile ago and came to Earth as a meteor.
B. A meteoroid came to Earth on a comet
C. Mars and Earth crashed into each other awhile ago, and Mars left some debris behind.

(T) 16. Scientists believe that most of the asteroids, meteors, and comets come from:
A. debris from planets in other galaxies.
B. leftover materials from the solar system when it was still forming.
C. pieces of older planets in the solar system that exploded.
D. materials that have evaporated from the surface of the planets of the solar system.

(T) 17. Some scientists believe that these could be responsible for some of the water found on Earth:
A. meteor B. comet C. asteroid D. satellite

(T) 18. In the asteroid impact theory of the extinction of the dinosaurs some 65 million years ago, the dinosaurs (and over half of all the other species on Earth at that time) died off largely because:
A. of injuries suffered from direct hits of pieces of the asteroid or comet.
B. dust injected into the stratosphere from the impact absorbed visible light from the Sun, causing global temperatures to plummet.
C. radiation from iridium in the asteroid caused the dinosaurs to die of cancer.

D. the impact caused massive earthquakes and volcanic activity worldwide.

(T) 19. Why would global temperature drop is the Earth were struck by an asteroid several km in diameter or larger?
A. The impact would move the Earth farther from the sun.
B. The resulting dust cloud would block out sunlight.
C. The ices in the asteroid would increase the Earth's albedo
D. The low temperature of the asteroid would chill the oceans

(T) 20. Scientists believe that most of the asteroids, meteors, and comets come from:
A. debris from planets in other galaxies.
B. leftover materials from the solar system when it was still forming.
C. pieces of older planets in the solar system that exploded.
11. D. materials that have evaporated from the surface of the planets of the solar system

GLOSSARY OF TERMS USED IN THIS LESSON:

Comets- are cosmic snowballs of frozen gases, rock and dust roughly the size of a small town.

Asteroids- are small chunks of irregularly shaped objects that occupy space between Mars and Jupiter

Meteors-are stray pieces of stony or metallic rocks that pass through the earth's atmosphere

Meteorites- meteors that are able to land on the surface

Long-period comet- have orbits that take more than 200 years

Short-period comet- have orbits that take less than 200 years

Meteor shower- usually burn up, leaving a glowing trail

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

https://www.youtube.com/watch?v=0pF9ilPFBzs Asteroid Will Hit in the Near Future 2015

https://www.youtube.com/watch?v=bU1QPtOZQZU Discovery Channel- Large Asteroid Impact Simulation

https://www.youtube.com/watch?v=evWeRHMwSu0 A Tour through our Solar System
http://richardloosemore.com/docs/PHYS106/PHYS106-16-MeteorsCometsAsteroids.pdf Comets, Meteors and Asteroids

http://www.asc-csa.gc.ca/eng/educators/resources/astronomy/module5/lesson2.asp The difference between comets, meteors and asteroids

http://www.carolinacurriculum.com/premium_content/eBooks/Earth+Space/pdfs/Lesson_17.pdf Asteroids, Comets and Meteoroids

http://burro.astr.cwru.edu/stu/comets.html Comets

http://www.space.com/15353-meteor-showers-facts-shooting-stars-skywatching-sdcmp.html Meteor showers and Shooting Stars: Formations, Facts and Discovery

http://www.astro.umass.edu/~arny/jquiz10.html 10-item online quiz about asteroids, meteors and comets

http://edition.cnn.com/2013/10/18/tech/asteroid-near-pass/ Big asteroid buzzes past Earth and will again in 19 years

http://news.discovery.com/space/asteroids-meteors-meteorites/comet-ison-offers-doomsday-deja-vu-130909.htm Comet ISON Offers Doomsday Déjà vu

http://www.sott.net/article/151954Meteorites-Asteroids-and-Comets-Damages-Disasters-Injuries-Deaths-and-Very-Close-Calls
http://mysteries24.com/n4-40295
Beliefs_and_Real_Stories_About_Comets_and_Asteroids

http://www.crystalinks.com/meteor.folklore.html Meteors: Native American Folklore

http://www.sott.net/article/151954-Meteorites-Asteroids-and-Comets-Damages-Disasters-Injuries-Deaths-and-Very-Close-Calls

www.blabberize.com - a fun, free web 2.0 tool that allows you to quickly and painlessly create talking photos. Simply upload a photo of your choice, select the photo's mouth or jaw, and record your audio.

www.edublogs.org a free Web 2.0 tool that lets you easily create and manage student and teacher blogs

www.canva.com a free Web 2.0 tool used to create designs for Web or print. Canva makes design simple for everyone.

www.emaze.com a free online presentation platform built on html5 technology. Users can create, manage and share their presentations through their cloud-based SaaS system.

www.prezi.com a free cloud-based (SaaS) presentation software and storytelling tool for presenting ideas on a virtual canvas

www.powtoon.com an online business presentation software tool that allows you to create free, cool, and awesome animated video explainers

www.toondoo.com a cool, comic-creating tool. Toondoo lets you create comic strips and cartoons easily with just a few clicks, drags and drops.