9. Electrical Conductivity

If you place a light bulb containing two electrodes in a sugar solution, the light fails to illuminate. What happens if you dip the same gadget into a NaCl solution?

A Definitions

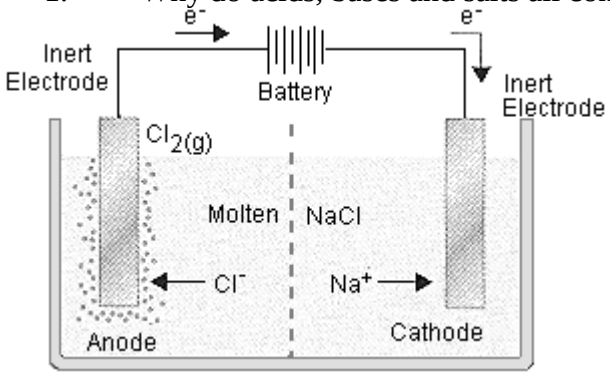
Electrolyte: _____

Acids, bases and salts in solution are all examples of electrolytes.

Non-electrolyte: _____

Examples:

1. Why do acids, bases and salts all conduct electricity?



Here we are explaining why molten NaCl conducts. Explaining why aqueous NaCl conducts is complicated by the fact that water is a better electron acceptor than

2. From the point of view of physical properties, what do electrolytes have in common? Non-electrolytes?

3. What chemical properties do electrolytes share? Non-electrolytes?

4. Write two chemical equations showing the difference between electrolytes and nonelectrolytes.

Exercises

1. Which of the following properties is **common** to acids, bases, and salts?

   A) They all react with metals to produce hydrogen gas.

   B) They all turn litmus paper red.

   C) They all conduct electricity.

   D) They all are slippery to the touch.

2. Compare (list similarities) and contrast (list differences) the physical and chemical properties of electrolytes and non-electrolytes.

3. Is it a good idea to go swimming in the sea with an approaching storm, even if the water remains calm?

4. How do electrolytes and non-electrolytes help us survive driving in wintry conditions?

5. Draw a diagram explaining how a molten solution of KBr conducts electricity. Also show two equations.

6. Wood alcohol (CH_4O) is a non electrolyte. Write an equation to represent what happens when it dissolves in water.

7. Potassium chloride (KCl) is a salt. Write an equation to represent what happens when it dissolves in water.

10. Acids and Bases

A. Definitions and Examples:

Acids	Bases
Operational Definitions: If you recall, operational definitions are based on what you can actually observe in the lab. • Acids taste sour. • They conduct electricity. • They destroy the properties of bases. • They turn blue litmus red. • Red litmus remains red. • Phenolphthalein indicator remains clear when added to acids. • They release H_2 gas when added to some metals.	**Operational Definitions**: If you recall, operational definitions are based on what you can actually observe in the lab. • Bases taste bitter. • They conduct electricity. • They destroy the properties of acids. • They turn red litmus blue. • Blue litmus remains blue • Phenolphthalein indicator turns deep pink when added to bases. • They feel slippery. • They turn fats into soaps.
Conceptual Definitions: The Arrhenius definition of an acid: a substance that releases H^{+1}. Example: $HCl_{(aq)} \rightarrow H^{+1}_{(aq)} + Cl^{-1}_{(aq)}$ Very important: Always remember that when considering acids , the H^{+1} ion is aqueous, in other words, it is dissolved in *water*.	**Conceptual Definitions**: The Arrhenius definition of a base: a substance that releases OH^{-1}. Example: $NaOH_{(aq)} \rightarrow Na^{+1}_{(aq)} + OH^{-1}_{(aq)}$. Very important: Always remember that when considering bases, the OH^{-1} ion is aqueous, in other words, it is dissolved in *water*.
Everyday substances that are acidic (pH <7) include fruits (contain citric and/or malic and/or tartaric acids) soda drinks(carbonic acid and/or phosphoric acid), toilet bowl cleaner (HCl), muriatic acid brick cleaner (HCl).	**Everyday substances that are alkaline (basic) (pH >7) include baking soda ($NaHCO_3$), soap, milk of magnesia ($Mg(OH)_2$),ashes (contain KOH) and household ammonia (NH_4OH).**

Examples

1. Classify as acid or base

a. vinegar_____

b. drano_____

c. NaOH _____

d. HCl_____

e. pH = 3_____

f. pH = 5_____

g. pH = 8 _____

h. A solution which turns blue litmus red_____

i. An electrolyte that is corrosive but which will not react with Mg to release hydrogen gas_____

j. A bitter-tasting substance_____

2. Complete the following ionic equations:

a. HBr →

b. KOH →

B. Neutralization

This is a reaction in which a base and an acid destroy each other, leaving behind an ionic compound(salt) and water:

Examples

a. $NaOH + HCl \rightarrow$???

b. $2\ KOH + H_2SO_4 \rightarrow$????

Exercises

1. How do you tell acids from bases using litmus?
2. How can taste be used to distinguish between non-poisonous acids and bases?
3. How can a blind person tell a poisonous acid from a poisonous base?
4. What popular beverage turns colour in the presence of acid?
5. What kind of substance produces OH^- in solution?
6. Complete the following ionic equations:

a. $HCl \rightarrow$

b. $NaOH \rightarrow$

c. $Ca(OH)_2 \rightarrow$

d. $H_2C_2O_4 \rightarrow$

7. The table shows a number of chemical substances. Name them and identify the acids, bases and salts by placing an 'X' in the appropriate box.

FORMULAS	NAME of SUBSTANCES	ACID	BASE	SALT
NaOH				
H_2SO_4				
HNO_3				
CuBr				
$Ca(OH)_2$				
HCl				
NaCl				
$Al(OH)_3$				
	Windex window cleaner			
	The content of citrus foods			
	Potassium iodide			

8. Give three everyday examples of neutralization reactions.

9. Fill in the blank: NaOH + HF --> _____ + _____

C. The pH Scale

The pH scale is used to classify aqueous substances. If you leave out very concentrated acids or bases, it runs from 0 to 14. Distilled water is in the middle of the scale at 7. Distilled water is neutral. It only has a very small amount of acidic ions (H^{+1}) but an equally small amount of basic ions (OH^{-1}). For each unit above 7, a substance ends up with 10 times more OH^{-1} and so becomes increasingly alkaline or basic. For each unit below 7, a solution ends up with 10 times more H^{+1} and so becomes increasingly acidic. The small amount of OH^{-1} from water also becomes even smaller by that same factor.

Example 1: Draw the pH scale

Example 2: How much more acidic is a pH 4 solution compared to a pH = 6 solution?

Other examples

pH	3	5	7	9	11
amount of H^{+1}	10^4 X more than water	100 X more than water	10^{-7} moles/L	100 X less than water	10^4 X less than water
amount of OH^{-1}	10^4 X less than water	100 X less than water	10^{-7} moles/L	100 X more than water	10^4 X more than water

Exercises

1. a) List three everyday solutions or substances with a pH < 7.
   b) Do the same for pH > 7.

2. List three substances that can have a pH of exactly 7. What do these substances have in common?

3. How much more acidic is a pH 4 solution compared to a pH = 6 solution?

4. How much more basic is a pH 11 solution compared to a pH = 9 solution?

5. What could you do to lower the pH of soil?

6. What could you do to raise the pH of an acidified lake?

11. Energy

A. **What is energy?**

Energy is the capacity to do work.

- According to this definition, light is energy because, for example, it can make the molecules in your black sweater "work". It makes them vibrate faster as they absorb light, and you feel the effect of all that work in the form of heat.
- Wind or rushing water also have energy: they can be made to turn turbines. Moving turbines have energy because they can be made to spin the magnets of a generator. That work, in turn (no pun intended), gets electrons to move, and the electricity is delivered to your home. Electricity is also a form of energy because it can make motors spin, heat tungsten filaments in ordinary light bulbs or excite mercury vapour in fluorescent lights.

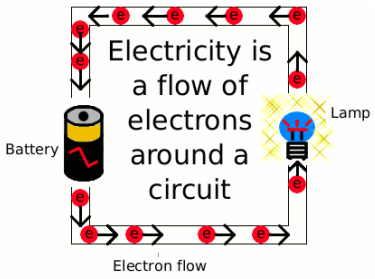
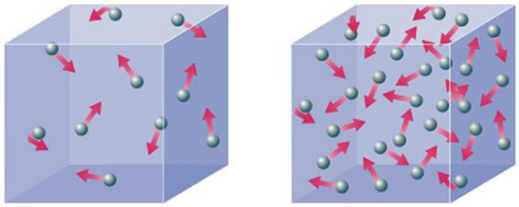
Example How is heat a form of energy according to this definition?

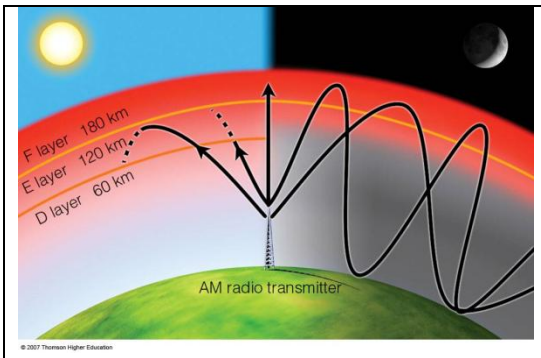
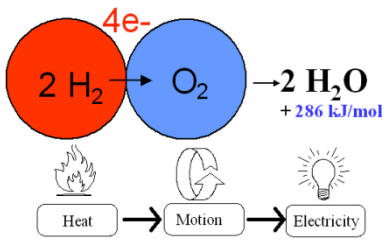
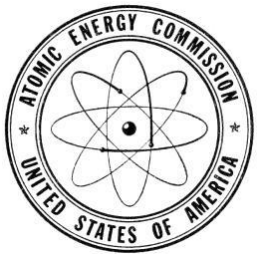
B. The Joule

The amount of energy it takes to raise the temperature of 1 gram of water by just 1^{o} C is defined as a calorie. But in SI (systeme internationale) the accepted unit of energy is the joule (J).

1 calorie = 4.19 J.

C. **Forms of Energy**

Form	Description	Examples	How is work being done?
Electrical 	Movement of electrons	Battery, power plant , generator	Electrons through magnetism can move mechanical parts or generate heat, light
Thermal 	Motion of atom and molecules releases heat		
Radiation energy	Propagation(movement) of electromagnetic waves		

			
Chemical energy 	Stored in bonds		
Wind energy 	Results from the movement of air		
Nuclear energy 	Stored in the nucleus of atoms		

D- Conservation of Energy

Energy can be transformed from one form to another but cannot be destroyed or created.

Example 1: If a certain amount of water contains 150 kJ of energy, and it splits up into oxygen and hydrogen, which contain a total of 250 kJ, how much energy is required to electrolyze that same quantity of water?

D- Energy Efficiency

$$\%\ efficiency = \frac{useful\ energy}{total\ energy\ consumed}$$

Example 1 A certain amount of gasoline with a total energy content of 1000 kJ is burnt, but only 120 kJ of it goes towards moving the car's wheels. 330 kJ are wasted through heat and pollution. What is the % efficiency of an automobile burning gasoline?

Example 2 A certain clock is 75% efficient. If it is provided with 0.10 kWh of energy, how much energy goes towards keeping time? How much energy is wasted? Where does the rest of the energy go?

E- The Difference between Heat and Temperature

Heat is a form of energy that depends on temperature and the total number of molecules at that temperature.

Temperature is related to how fast molecules are moving but does **not** depend on the number of molecules.

Example: Give an example of something with lots of heat but with a mild temperature. Also give an example of a high temperature object with a low heat content.

Exercises

1. Give examples for each of the following:
   a) radiation energy
   b) wind energy
   c) solar energy

2. How do microwaves do work on the food?

3. If a cake contains 1000 kJ of energy, and 150kJ end up stored as fat in your body and 400 kJ ended up as heat, how much of the cake's energy went into movement and thinking etc.?

4. A certain bike is 65% efficient. If it is provided with 600 kJ of energy, how much energy goes towards moving the wheels? How much energy is wasted? Where does the rest of the energy go?

5. Calculate the % efficiency of a solar cell if it absorbs 2000 kJ of light energy and converts into 400 kJ of electrical energy.

6. Near Jupiter, the temperature of the thin gases from the planet Io's volcanoes is extremely high and yet the space probes that pass through the gases do not get damaged. Why is that?

12. TIDES

To see a colored and clearer version of the printed paper you have along with extra pics needed for #6 onwards, go to http://www.emsb.qc.ca/laurenhill/science/tidesEasy.pdf

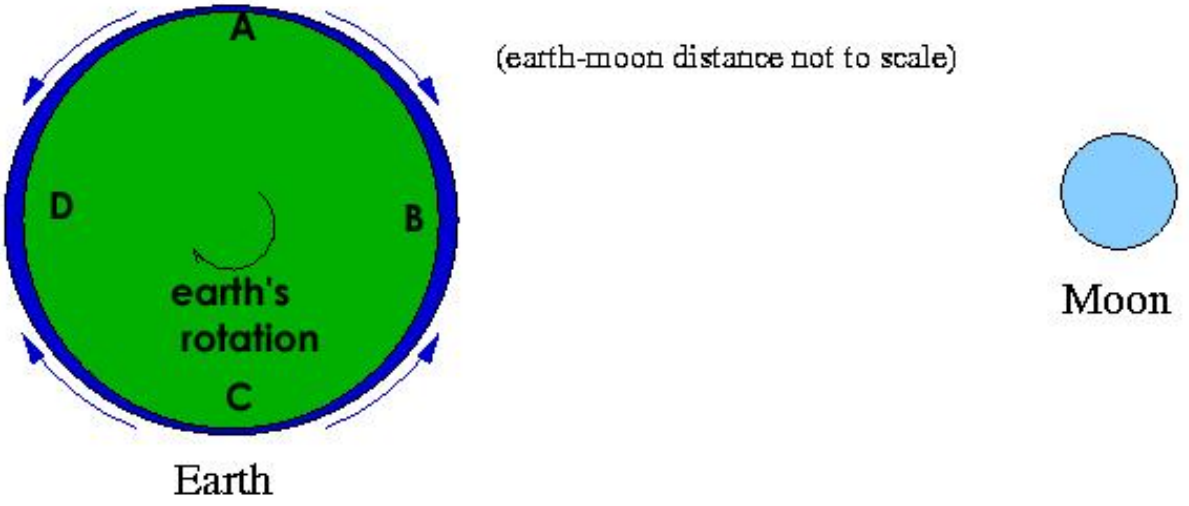
Read the following and answer the questions that follow.

Large masses have a strong pulling effect on nearby objects. It's the reason you don't fly off the earth and the reason you'll find something you drop on the floor.

The tug of war between the earth and especially the moon's gravity (and the sun to a smaller degree) cause tidal bulges to appear. That means ocean levels are not at the same level everywhere on earth, at a given time.

The open oceans on each side of the earth facing the moon are about 1 m higher than those at 90^{o} from it.

1. People seeing water at higher positions witness **high tide**. What letters on the diagram show the location of high tide?_____ and _____

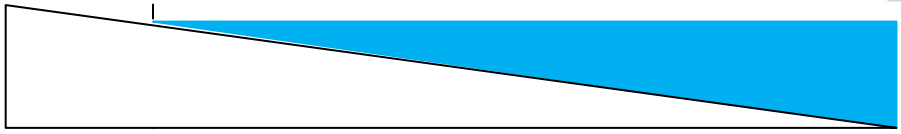


2. People seeing water at lower positions witness **low tide**. What letters on the diagram show the location of low tide?_____ and _____

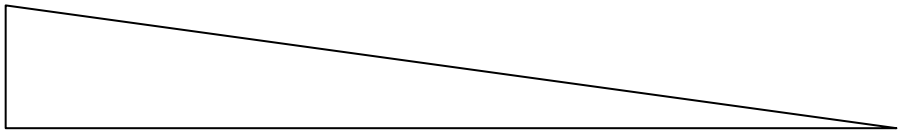
3. If the coastline (beach) where you're standing has a very shallow slope, the differences between low and high tide, will be very dramatic.

B

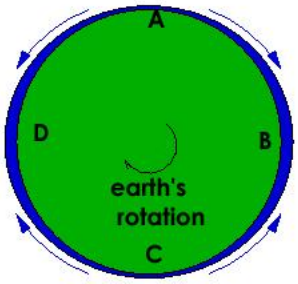
A



a) Which diagram reveals the coastline at high tide?_____
b) If you were standing on the beach at the position along the dotted line, how deep would the water be at high tide?_____
c) Let's say that diagram A wasn't low tide just yet. Redraw the coastline with an even lower level of water.



4. As the earth rotates, obviously, you and the water turn with it. But the water facing the moon keeps bulging at the opposite ends, so it's as if the bulges don't move with you.



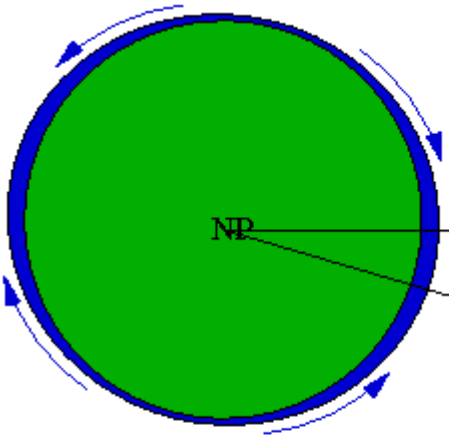
Earth

(earth-moon distance not to scale)

Moon

a) You would expect to move from position A to B in about 6 hours. In other words if it was low tide at 12 PM, it might be high tide at 6 PM. Why 6 hours? Show calculation._____

b) In reality, you would probably have to wait not six hours but 6.25 hours. Study the diagram below and explain why._____
_____
_____
_____



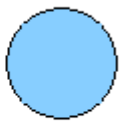
Earth

(earth-moon distance not to scale)

NP

One extra hour of rotation

Moon's position yesterday



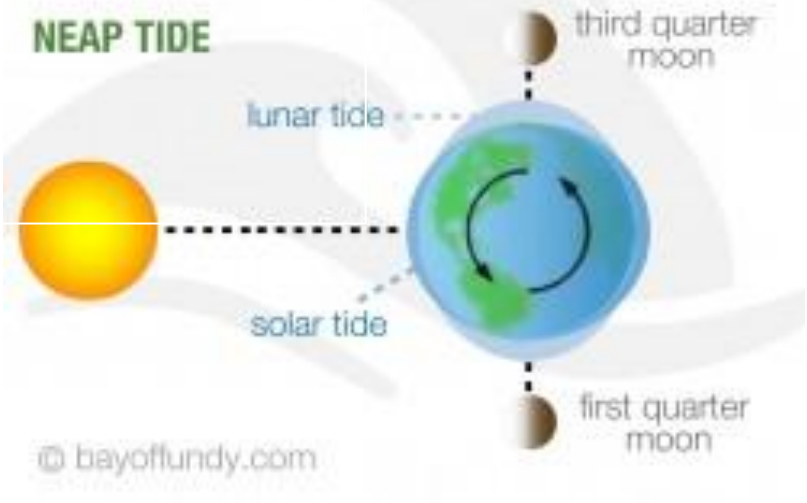
Moon today

5. The following diagram shows how the sun can make high tides higher and low tides even lower.

a) In which situation(A or B) do you think we experience the highest high tides?_____

A

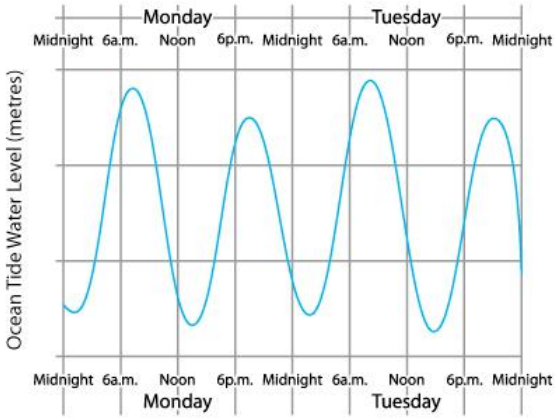
B

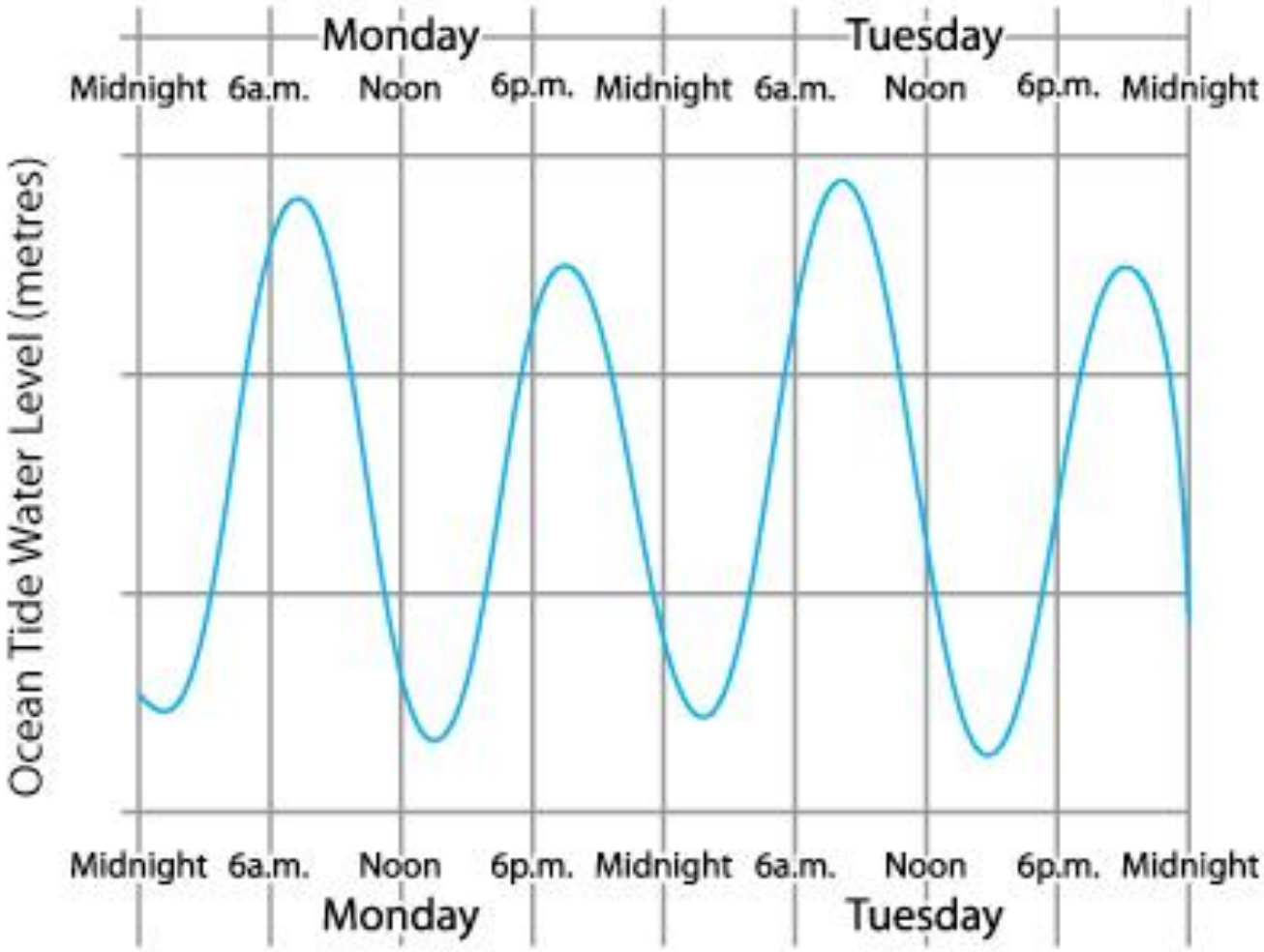


6. A) Examine picture 1 from the computerized version of this file. Explain the difference between

them._____
_____
B) If it's 10:15 AM right now and your boat is in the sand as shown on the left, at what time will the water look like the pic on the right? Show
work._____

7. Give the times of the low tides on Monday.
(see next page for bigger graph)




Monday
Tuesday
Midnight 6a.m. Noon 6p.m. Midnight 6a.m. Noon 6p.m. Midnight
Ocean Tide Water Level (metres)
Midnight 6a.m. Noon 6p.m. Midnight 6a.m. Noon 6p.m. Midnight
Monday
Tuesday

Tides Homework

1. How many low tides are there in a day?
2. How many high tides are there in half a day?
3. Why is the tide cycle a little longer than 24 hours? Think of what the moon is doing while the earth spins on its axis.
4. Draw what the tidal bulges would look like if the moon's gravity was the only factor involved in tides.
5. Draw the actual bulges.
6. Why are tides more pronounced in certain areas of the planet than others?
7. a)Why is it not completely accurate to say that the moon revolves around the earth? What is the earth also doing aside from spinning on its axis and revolving around the earth-sun center of mass?
   b) Where is the earth-moon center of mass?

8. Why do you think the center of mass for the Jupiter-sun system is outside of the sun, whereas that of the earth-sun system is inside of the sun?