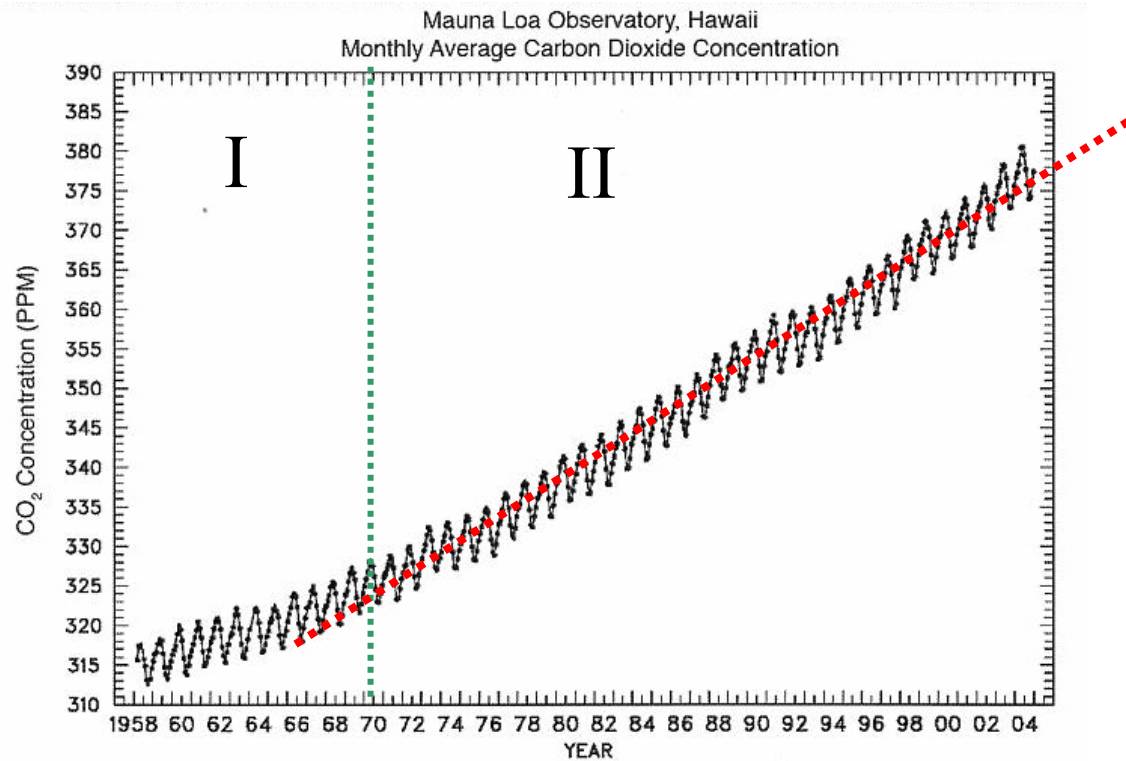1. Use the following figure to answer the questions below (1.8 pts total, 0.6 pt each).
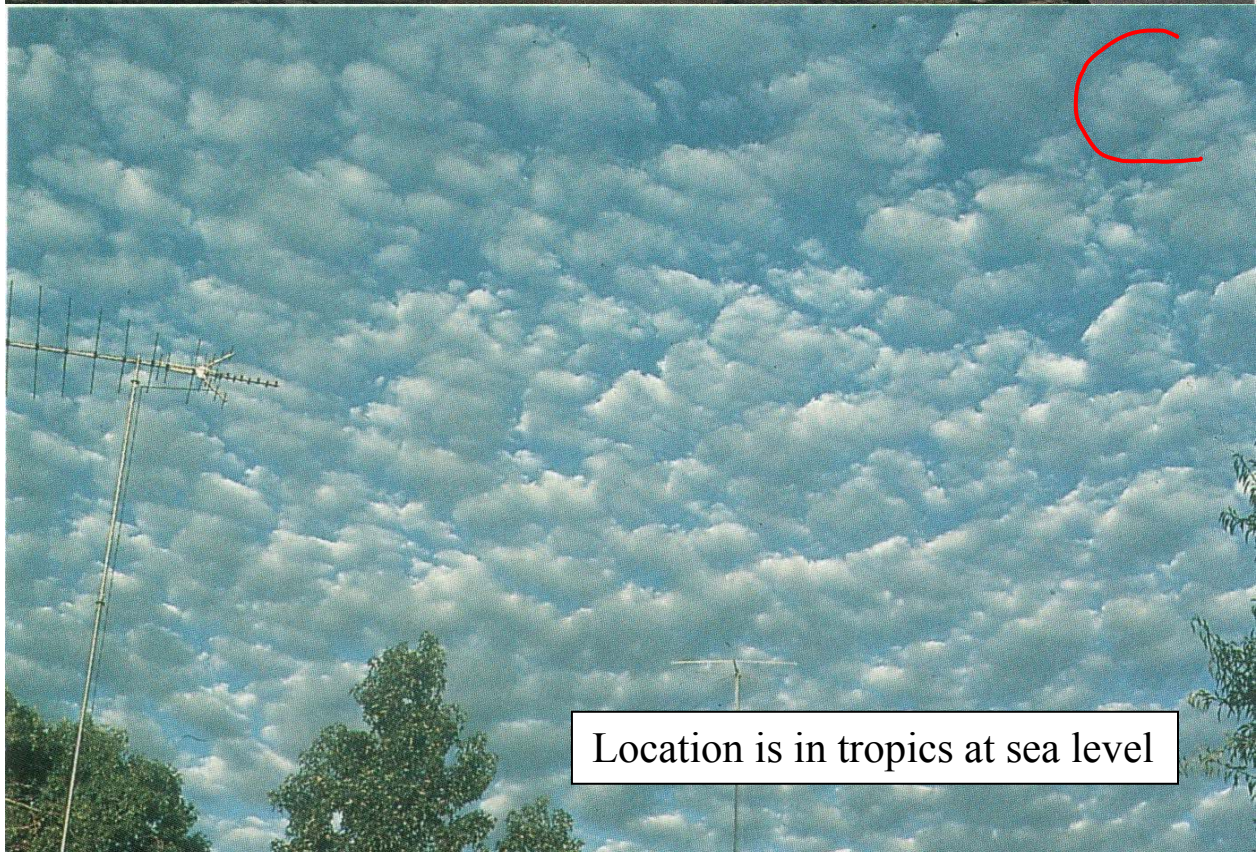

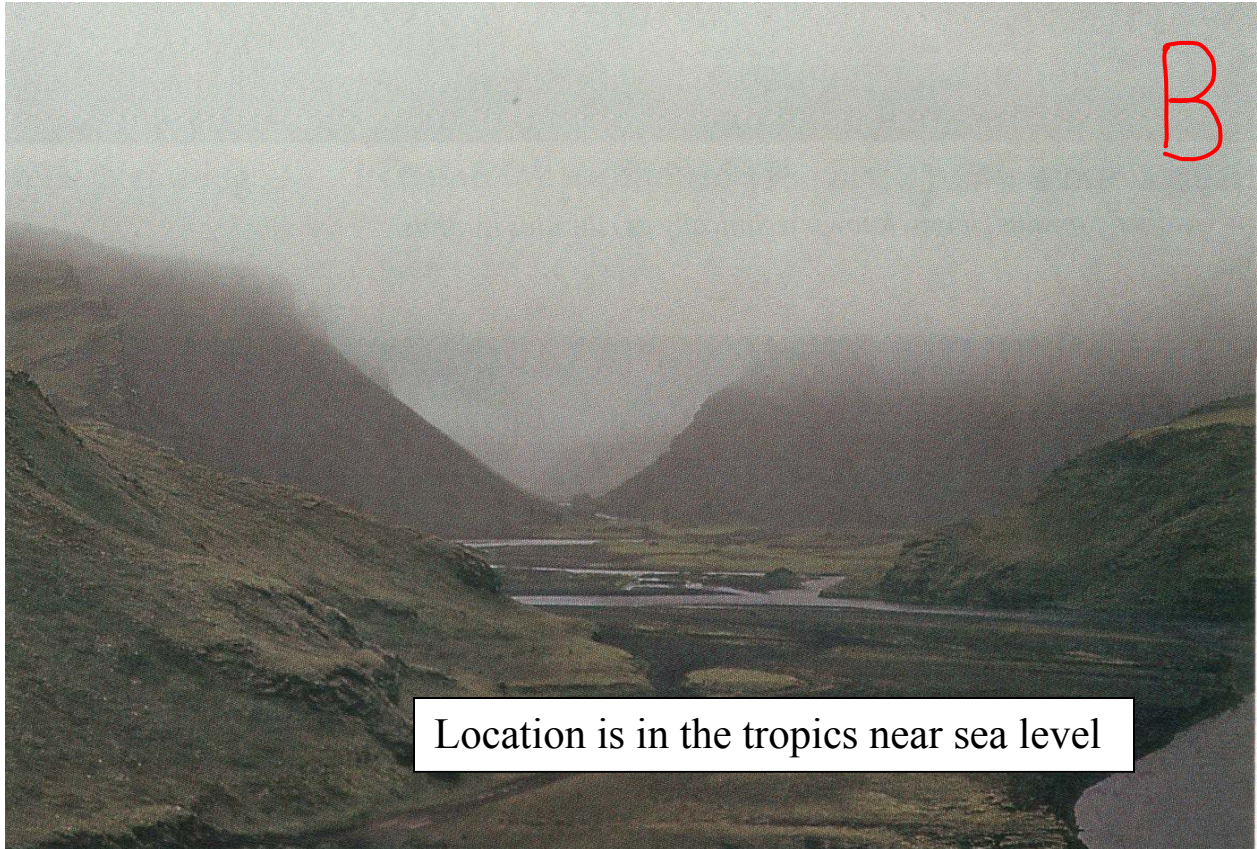Mauna Loa Observatory, Hawaii
Monthly Average Carbon Dioxide Concentration

(a) Calculate the percent increase in CO_2 from 1970 to 2004. (0.6 pt)

(b) Estimate in ppm the annual range of CO_2 variation. (0.6 pt)

(c) In addition to CO_2, list two other greenhouse gases produced by human activities. (0.6 pt)

2. Use the three images of clouds to complete the chart below (2.7 pts total, 0.3 pt each).

	A	B	C
Name of cloud type			
H$_2$O form (liquid, ice, vapor)			
Altitude of cloud (low, medium, high)			

Location is in high elevation mountain range

B

Location is in the tropics near sea level

C

Location is in tropics at sea level
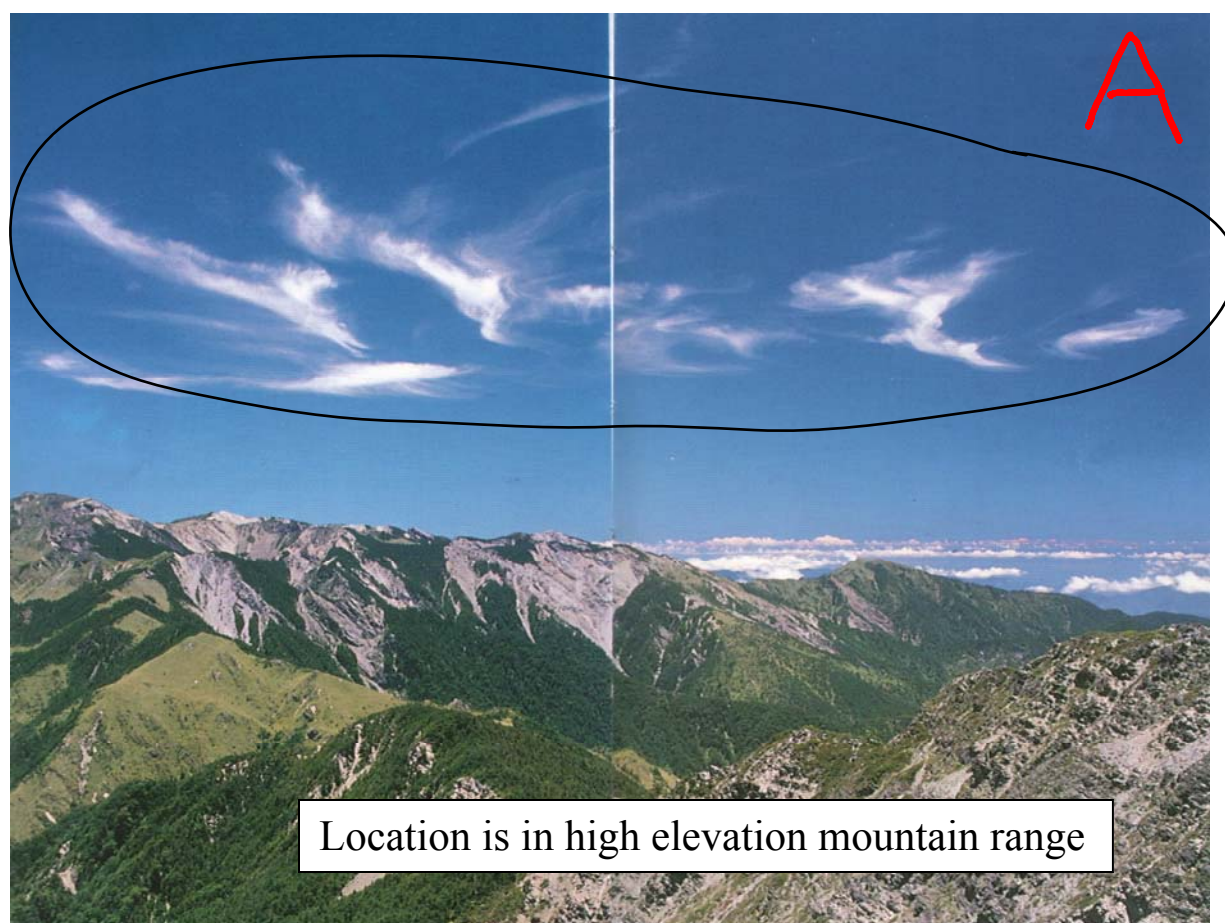
3. The position marked A is used in answering the following question (2.5 pts total):
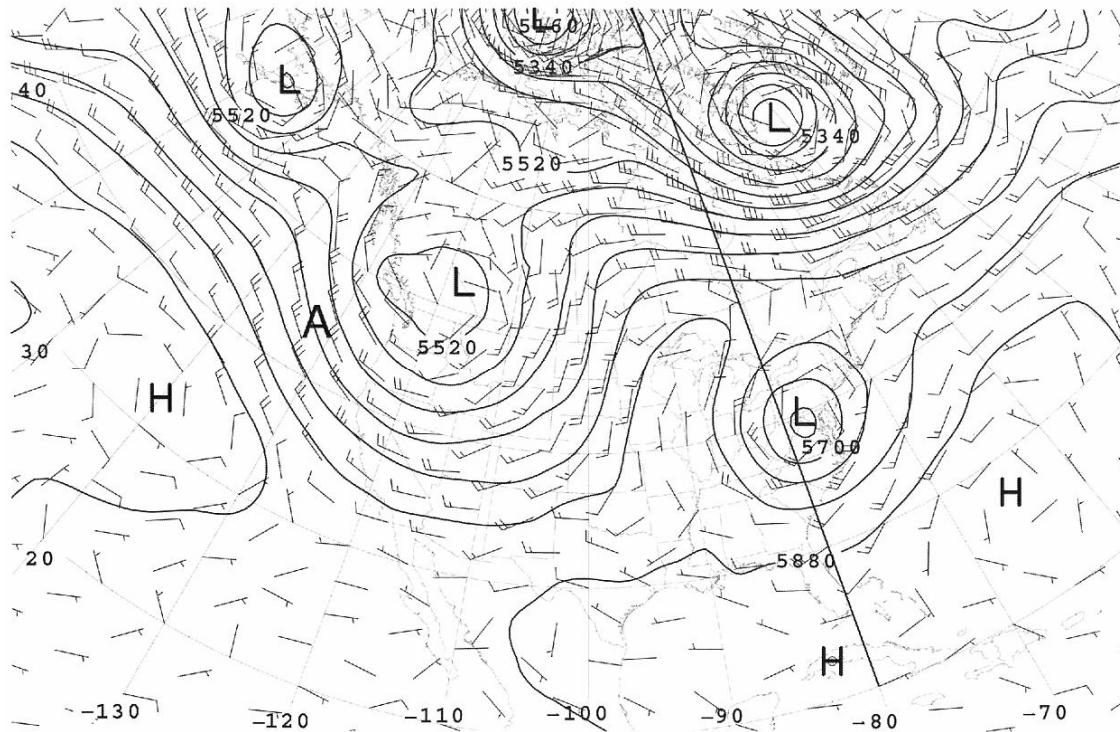
The equation below describes the balanced flow at location **A** in this 500 hPa chart:

$$\frac{V^2}{R} + fV = -\frac{1}{\rho}\frac{\Delta P}{\Delta n}$$
$$(1.)\quad (2.)\qquad (3.)$$

Where V is the wind speed, f is the Coriolis parameter, ΔP is the pressure difference in a distance Δn, n is normal to the horizontal velocity vector and pointing to left hand side of the wind direction, and R is the radius of curvature of trajectory.

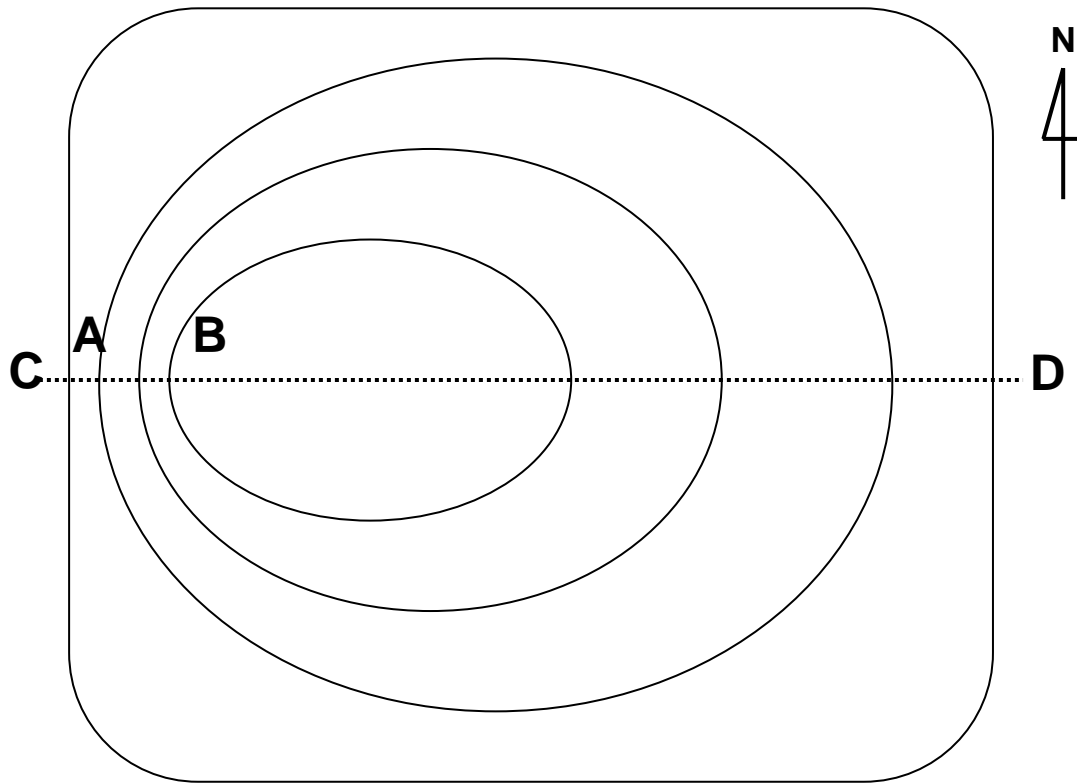a) Explain the physical meaning of each term in the equation.

   (1.)_____(0.5 pt)

   (2.) _____(0.5 pt)

   (3.) _____(0.5 pt)

b) On the figure above, show the direction of term(2) and term(3) at the position **A**.   (1 pt)

4. The following figure shows a schematic diagram of sea surface height in the North Pacific
   Ocean. [9 pts/3 →3 pts total]

(a) Which station shows higher sea surface height between A and B? [1 pt]

(b) Show sea surface current vectors corresponding to the above sea surface height pattern. Draw the
    vectors on the figure above. [3 pts]

(c) Continued from question (b), what are the two dominant forces responsible for the currents? [1 pt]

(d) Also continued from question (b), explain the main cause of the asymmetrical circulation [2 pts]

(e) Draw temperature contours for the vertical section across the line CD in the blank figure below [2 pts]

N

C   A   B   D

Depth
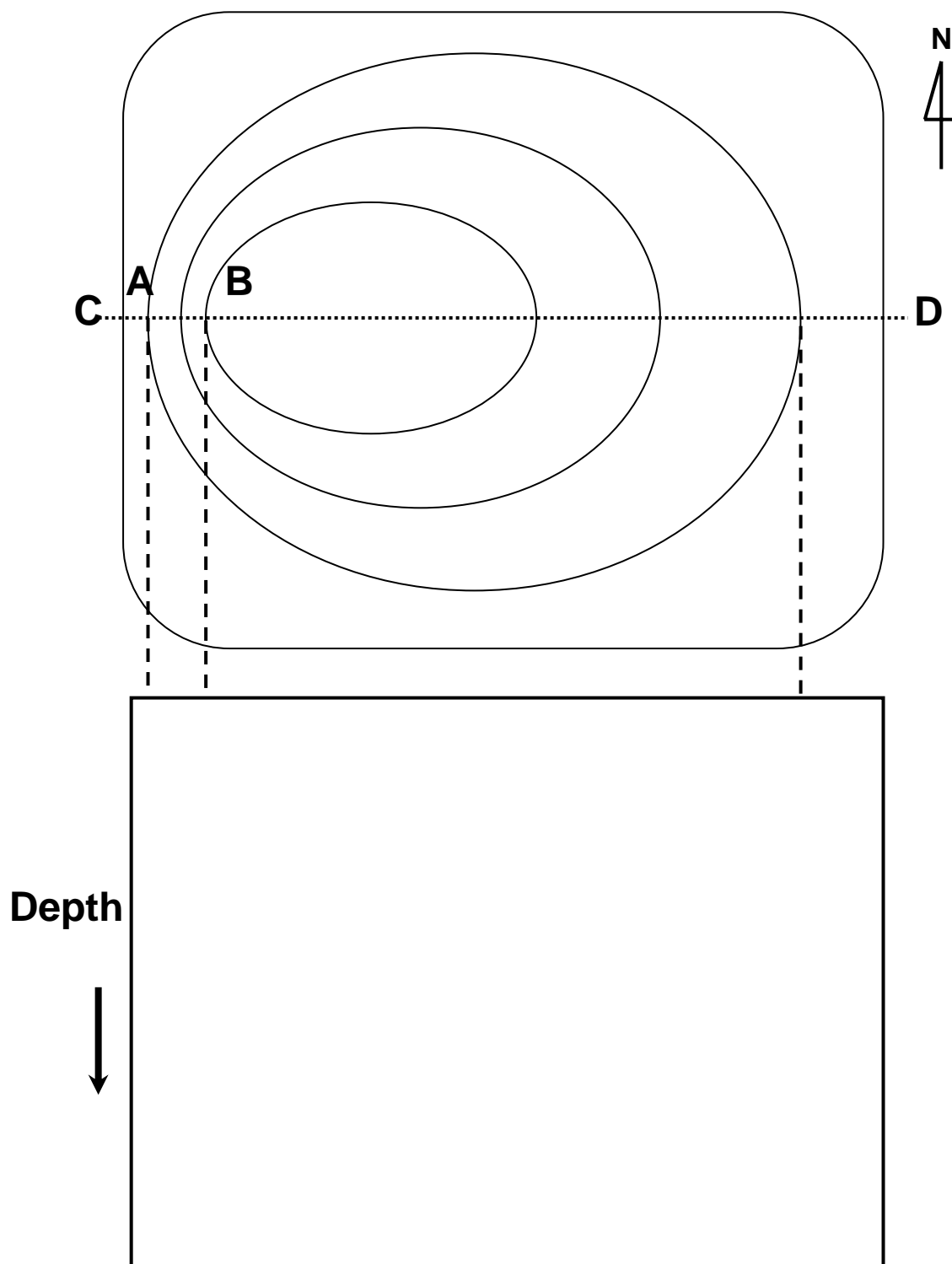
5. This set of questions tries to show the Kepler's third law using the images of Uranus and its moons. Figure (1) shows the images of Uranus taken by Hubble Space Telescope in 1997, and the time interval between left and right images was 90 minutes. There are 8 moons revolving around Uranus as seen in the images.
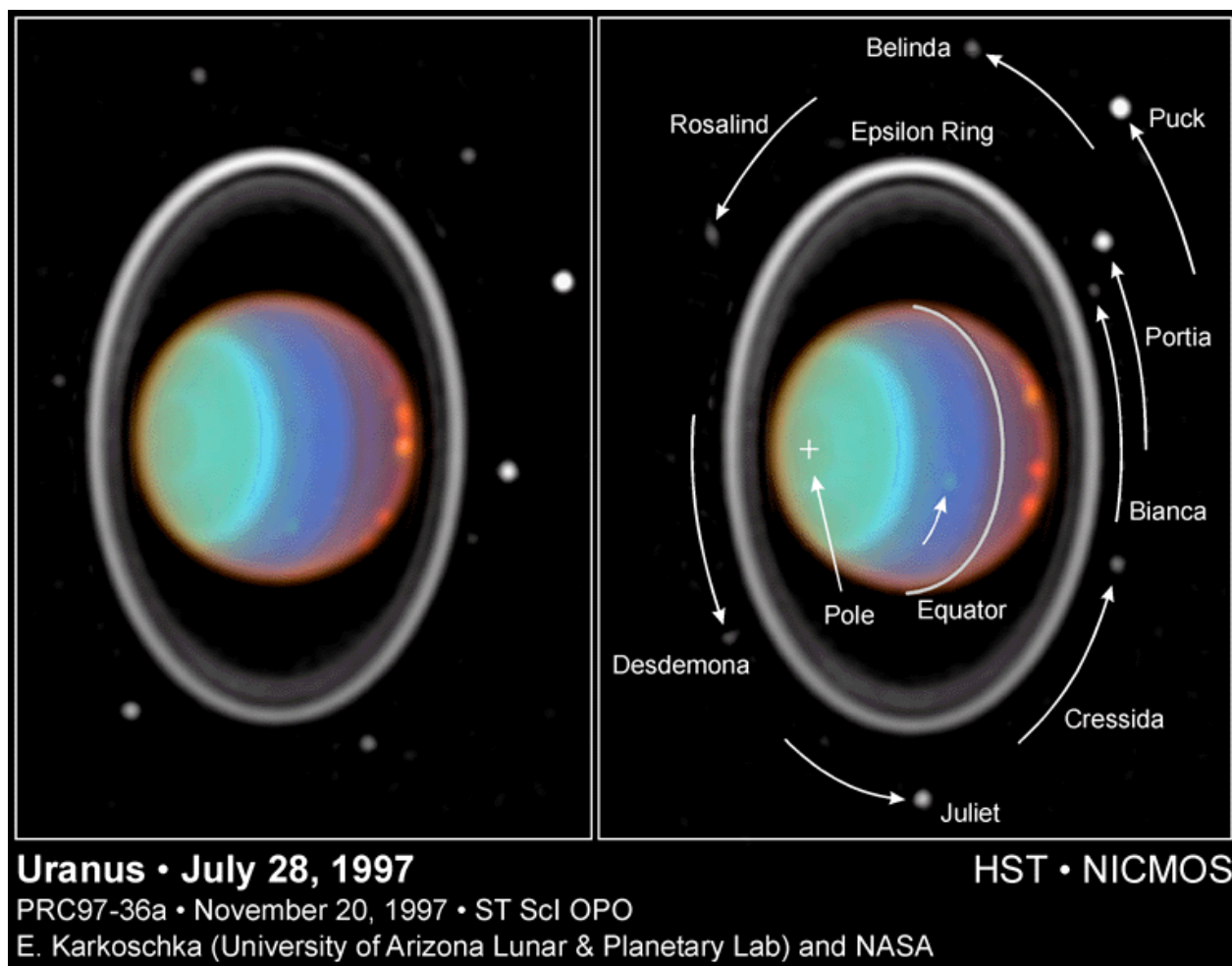

Figure (1) The images of Uranus

In order to figure out the motion of these 8 moons, the two images in Figure (1) were overlapped and combined to form a single image shown in Figure (2). Assume that the orbits of the 8 moons are circular and lying on the same plane with the same inclination angle. (Note: you are observing the plane of the circular orbits from an angle so that they appear as ellipses.) Using a ruler, a protractor and a compass, measure the radius of each orbit (R) in mm and estimate the period of revolution (T) of each orbit in hours. Note that the periods of all 8 moons are less than 24 hours. The procedure below described by steps a) to g) on the next page was used to find the information that is in Table 1. Use the same procedure to complete Table 1. (3 pts total)
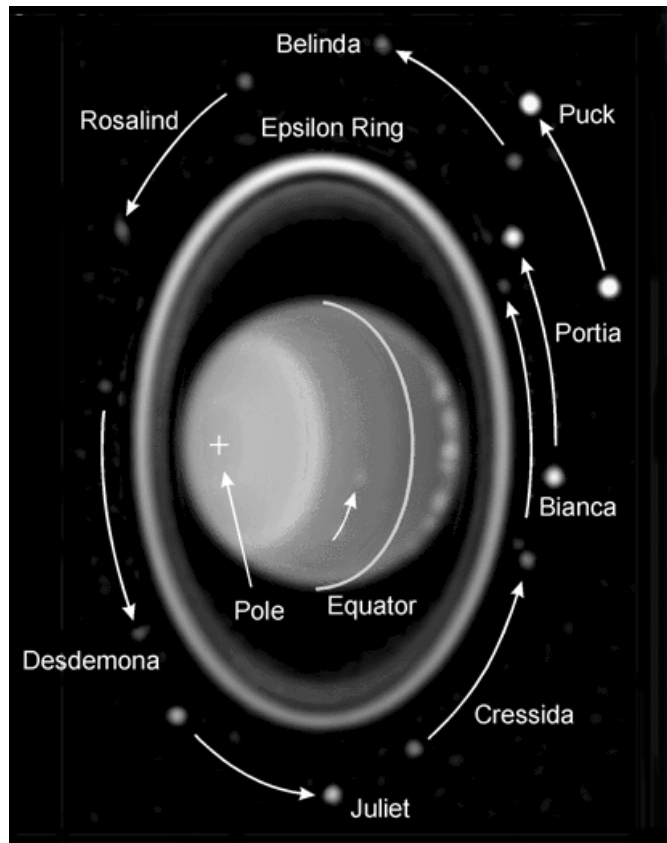
Figure (2) The motion of Uranus' moons

a) Find the center of Uranus and mark it as the origin of an x and y axis.

b) Find the observed elliptical orbit of Portia using its track in figure (2).

c) Draw the approximate elliptical orbit on figure (2).

   Note: Keep the center of ellipse at origin.

d) Draw the circular orbit from the observed ellipse orbit found in steps b) and c).

   Note: Keep the length of the semi major axis in the ellipse to be the same as the radius of the circular orbit.

e) Find the first and the second positions (90 minutes apart) of Portia at the circular orbit you drew.

   Note: Draw perpendicular lines from the y axis, passing through Portia's two images in figure (2). Find two points on the circular orbit by intersecting these two perpendicular lines with the circular orbits.

f) Find the angular difference between the two points in the circular orbit.

   Note: Draw two lines from the origin to the two points you found in step e).

g) Calculate the orbital period in hours.

   Note: The two images were taken 90 minutes apart.

1) Complete the table below for both Portia and Puck (2 pts)

Table 1					
Moons	R(mm) radius of circular orbit	Angular difference(º) in 90 minutes	T(hour) Period of orbit	R^3	T^2
Belinda	54	34º	15.88	157464	252.2
Bianca	41				
Cressida	44.5	44.2	12.22	88121	149.3
Desdemona	45	43	12.56	91125	157.7
Juliet	46.5	41	13.17	100545	173.5
Portia					
Puck					
Rosalind	50	38	14.21	125000	201.9

2) Plot a graph to show Kepler's third law. On the graph paper, plot the data points on Table 1 showing the relationship of R^3 and T^2 of the 7 moons. Draw the best straight line that fits Kepler's third law in your graph. (0.5 pt)

3) Estimate the period of Bianca using graph made in question 2). [The radius of Bianca's circular orbit is 41 mm.] (0.5 pt)

6. Telescope Practical Section

1) Operation (3 pts)

    Please go to the station where parts of telescopes can be found. Take one set of telescope parts and set it up as following steps.

** <u>A proctor will evaluate how you set up the telescope.</u>

a) Mount the telescope to the tripod firmly. (0.5 pt)

b) Adjust the tripod, set the equatorial mount oriented to the north. (0.5 pt)

   [See the direction mark on the ground]

c) Adjust the tripod using the bubble level on it. (0.5 pt)

d) Adjust the angle of the equatorial mount based on the latitude of Manila, 14° 36′.(0.5 pt)

e) Balance the main telescope with the weight. (0.5 pt)

f) Balance the telescope parts which consist of the main telescope, the finder, and the eyepiece. (0.5 pt)

2) Find the the diameter and focal length of the main telescope and complete Table 2 (2 pts)

    Diameter of main telescope = (   ) cm

    Focal length of main telescope = (   ) mm

         Table 2.

eyepiece	magnification
Or 6 mm	
Or 12 mm	
K 25 mm	

    When you finish questions above, please raise your hand and the proctor will let you go back to your seat.

3) Usually, the pupil of human eye will enlarge to 8 mm in a dark place for about 15-20 minutes. If a person observes a faint star with magnitude 6.0, what magnitude of a heavenly object can he/she observe with this telescope? (1 pt)

4) In observing Saturn, which eyepiece in Table 2 would be the best choice if you want to see more detail? (1 pt)
.

There are 8 stations for the geology practical section
Please spend only **5 minutes** for each station.

Station 1   [1.6 pts]

Identify the following rock specimens:

Rock Specimen Number	Answer
2	
19	
30	
32	

Station 2   [1.6 pts]

Identify the following rock minerals:

Rock Mineral Number	Answer
3	
23	
39	
40	

Station 3 [1.6 pts]

Identify the following rock specimens:

Rock Specimen Number	Answer
21	
27	
39	
82	

Station 4 [1.6 pts]

Identify the following rock specimens:

Rock Specimen Number	Answer
43	
46	
49	
60	

Station 5   [0.9 pt]

* Please do not touch the block model

Examine the given geologic cross-section and choose the correct event sequence from the oldest to the youngest.

1. faulting
2. uplift and erosion
3. deposition of sedimentary beds below the solid horizontal line (labelled 92)
4. subsidence
5. deposition of sedimentary beds above the solid horizontal line (labelled 92)
6. folding

Choose the correct answer
   a. 3-2-5-1-4-6
   b. 6-3-2-4-5-1
   c. 3-4-6-2-5-1
   d. 3-6-4-2-5-1
   e. 3-6-2-4-5-1

Answer : _____

Station 6   [0.9 pt]

Write down the number of the rock specimen that matches the thin section.

Answer : _____

Station 7   [0.9 pt]

Write down the number of the rock specimen that matches the thin section.

Answer : _____

Station 8   [0.9 pt]

Write down the number of the rock specimen that matches the thin section.

Answer : _____

1. Label each contour line in the topographic map below with the correct elevation using a contour interval of 50 meters. (6 pts)
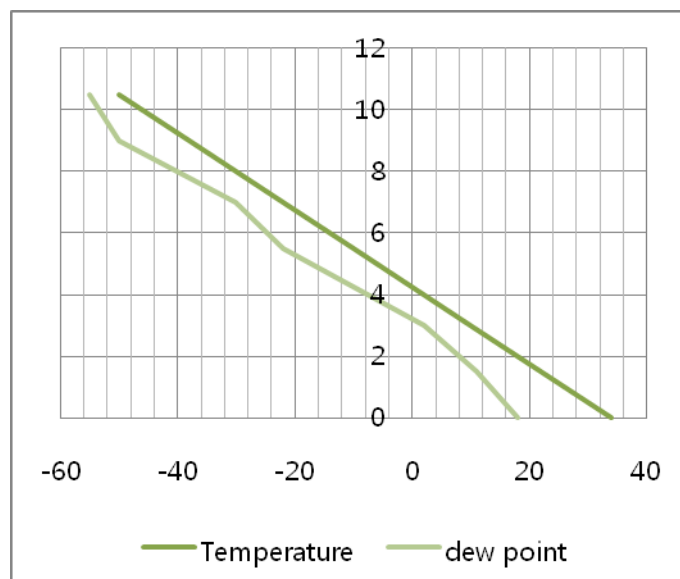

Answer questions 2-4 in the table below. Based on the features of rocks described in the right column of the table, answer the questions in the left column.

Questions	Features
2. By which process was the rock formed? (5 pts) Ans:	Sizes of crystals from 1 to 5 mm; less than 10 % of dark minerals; mainly composed of quartz, feldspar, and muscovite.
3. By which type of metamorphism was the rock formed? (5 pts) Ans:	Grains larger than 1 mm; alternating layers of light and dark minerals; light minerals are plagioclase, feldspar, and quartz, and dark minerals are biotite and hornblende.
4. Name the specific rock. (5 pts) Ans:	Individual grains are too small to be identified without magnification; composed predominantly of Ca-rich plagioclase and pyroxene with small amounts of olivine; black, dense and massive.

5. Describe three different ways in which minerals are formed. (9 pts)

6. The following figure and table show a vertical profile of air temperature and dew point measured by radiosonde. The air parcel is lifted mechanically from the ground and a cloud forms.

   When unsaturated air rises adiabatically, the temperature of air parcel decreases at a rate of 10 °C/km and the dew point of air parcel decreases at a rate of 2 °C/km. Assume that the saturated lapse rate is 6 °C/km. During the rising process, there is no exchange of heat between the air parcel and the environment.

| Height (km)	Temperature (°C)	Dew point (°C)
0	34	18
1.5	22	11
3	10	2
5.5	-10	-22
7	-22	-30
9	-38	-50
10.5	-50	-55

Answer the following questions (12 pts in total).
a) Before the air parcel begins to rise, is it saturated or unsaturated? (2 pts)

b) Calculate the height of cloud base. (3 pts)

c) Calculate the height where the air parcel starts to rise on its own. (3 pts)

d) Is the air parcel in question c) stable or unstable? (1 pt)

e) Calculate the dew point of the rising air parcel at 5 km (3 pts)?

7. Which of the following processes ABSORBS the greatest amount of latent heat?
    Circle the letter of the correct answer. (2 pts)

    a. Freezing
    b. Evaporation
    c. Condensation
    d. Melting

8. Which of the following statements is FALSE? Circle the letter of the correct answer.
    (2 pts).

    a. Salt particles make good condensation nuclei.
    b. The vapor pressure is higher over water than over ice.
    c. The typical raindrop is about 2 millimeters in diameter.
    d. Cloud droplets freeze once the temperature drops below 0^oC.

9. Where are many of the world's desert regions located? Circle the letter of the correct
    answer. (2 pts)

    a. On the east coast of most continents
    b. Just north or south of the equator
    c. In the west coast regions along the Tropics of Capricorn and Cancer
    d. At 60° North and 60° South

10. Which of the following reasons explains why ice crystals develop much faster than liquid water drops in the upper and middle levels of thunderstorms? Circle the letter of the correct answer (2 pts)

    a. Electrical currents within thunderstorm allow the building of water vapor on ice crystals more rapidly than on liquid water drops.
    b. When temperatures drop below freezing, condensation of water vapor into liquid water does not take place.   The water vapor can, however, build on ice crystals due to deposition.
    c. It is because the vapor pressure of ice is less than that over water.   This produces a vapor pressure gradient between liquid and frozen water that causes water vapor to move from liquid water drops towards ice crystals.
    d. This is due to the turbulent motion of the air. Condensation rates in liquid water slow with increasing wind speed.

11. Which combination of conditions characterizes the Coriolis effect on moving particles? Circle the letter of the correct answer (2 pts)

    a. zero effect along the equator, increasing effect away from the equator
    b. highest effect along the equator, decreasing effect away from the equator
    c. latitudinal position has no influence on Coriolis effect

12. Name three major factors that cause cloud dispersal. (3 pts)

13. The following figure shows satellite-observed near-sea surface wind vectors over a cloud image in the Northwest Pacific Ocean during a typhoon as shown in Figure (a). The colors of the arrows show the magnitude of wind field from 2 to 20 m/s. Instruments called ARGO floats, shown in Figure (b), automatically measure vertical profiles of temperature and salinity at the stations A, B, and C. The large black arrow stands for the direction of the typhoon's movement. [7 pts in total]
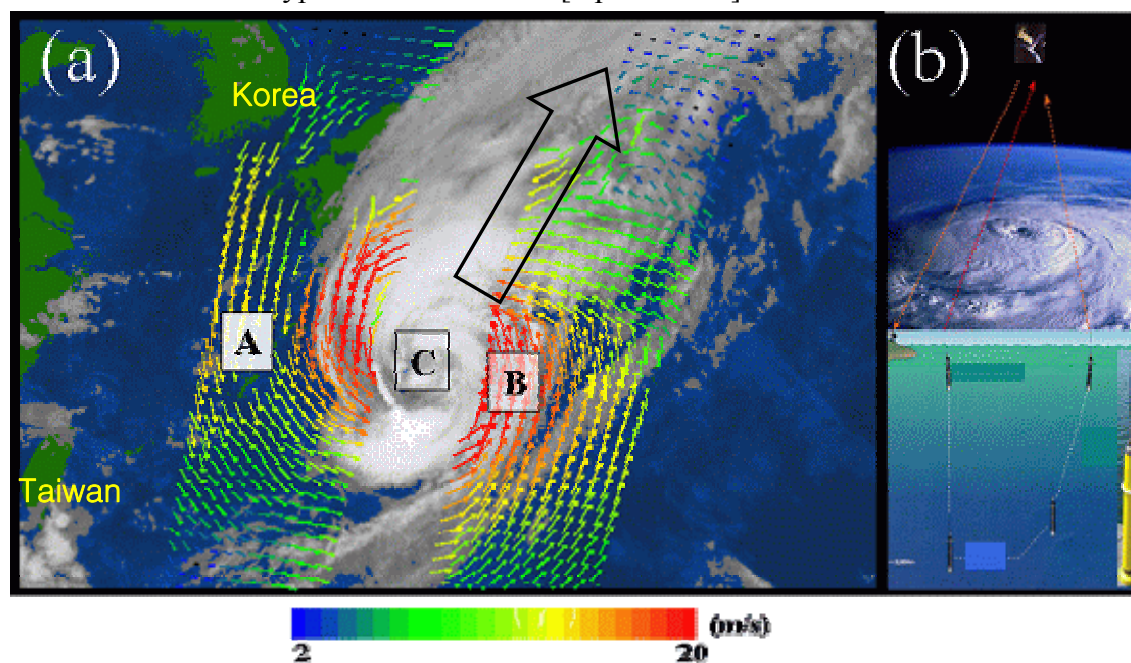
(a) At which location is the wind stronger?   A or B?   [1 pt]

(b) Explain your answer for question (a). [2 pts]

(c)   If the following profile shows the temperature at Station C near the typhoon center, draw
       a new temperature profile once the typhoon passes Station C. [2 pts]
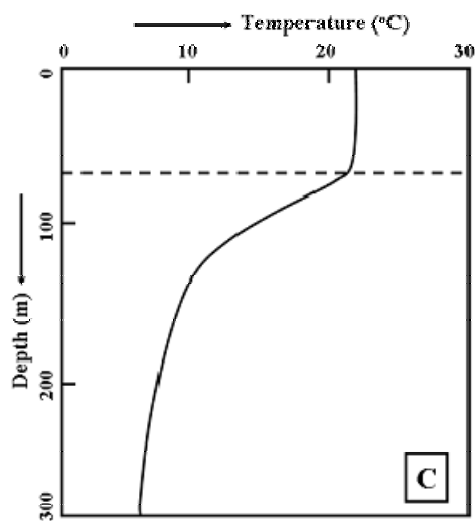
(d)   Describe a process that is responsible for your answer in question (c). [2 pts]

14. The following figure shows oceanic topography. An earthquake occurs at Station B (15.25°N, 140°E) at 1:50 A.M. Estimate the arrival time of the tsunami at Station A (15.25°N, 122°E). [3 pts in total]

   To avoid difficulty in the calculation, the bathymetry between stations A and B is shown by red dashed lines in the second figure. (sin15.25°=0.26, cos15.25°=0.96, gravitational acceleration g ≈ 10 m/s^2, the earth radius R = 6400 km). Assume Station A and Station B are in the same time zone.
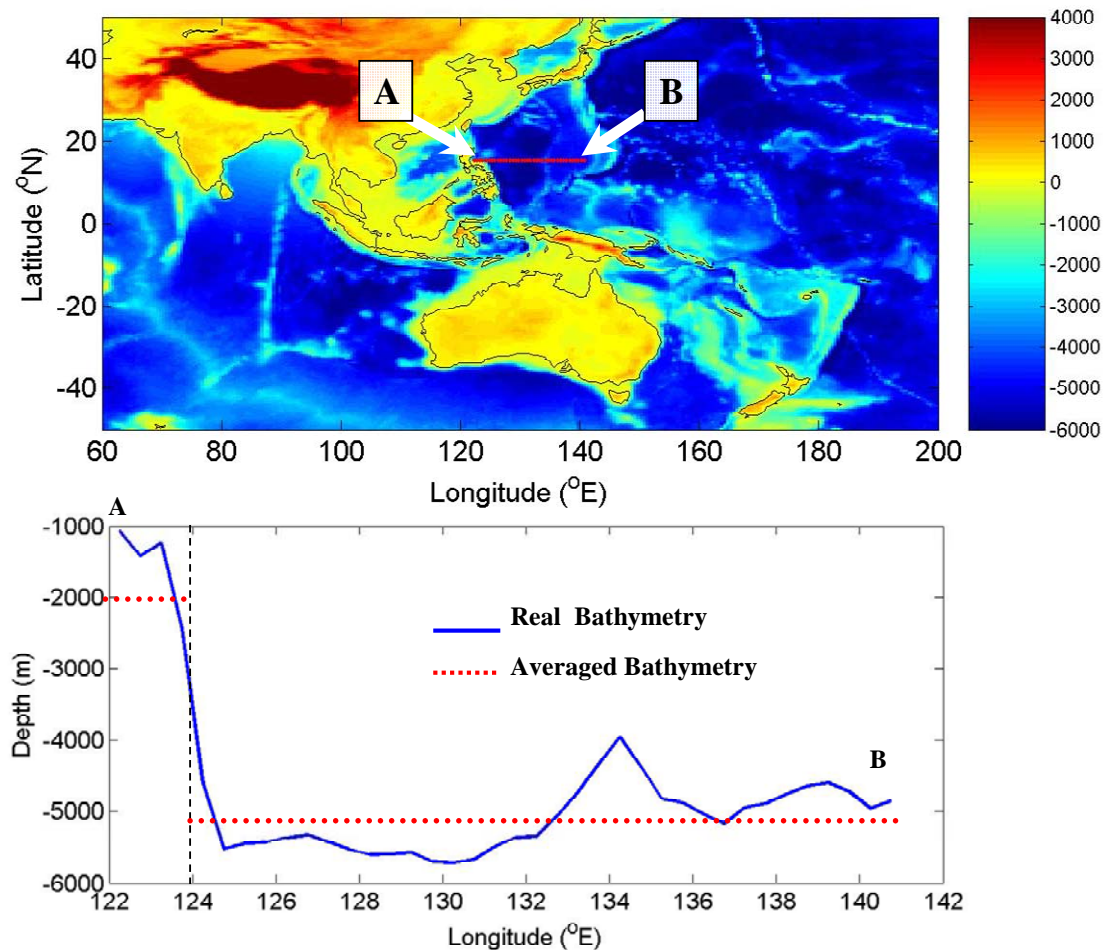
15. A recent partial lunar eclipse was observed during the night of August 16th, 2008. The composite images were recorded during the eclipse from Athens, Greece, showing a large part of the umbra (dark part of the earth's shadow). An angular diameter of the lunar image is 31′. You may need a ruler, a compass, and a calculator to answer the questions below. (5 pts in total)


a) Using this picture, calculate an approximate angular diameter of the umbra. Show how you obtained your answer by drawing on the figure above.
(2 pts)

b) Using the sidereal period of the Moon (about 27.5 days) and the distance between the Earth and the Moon (about 380,000 km), calculate the approximate duration time of this lunar eclipse. (3 pts)

16. An icy body in an elliptical orbit around the sun is observed from Earth. At perihelion it has a distance to the sun of 40 AU, an albedo of 0.6 and a magnitude of 20. At aphelion it has a distance to the sun of 60 AU and an albedo of 0.7. What magnitude do you expect the icy body to have at aphelion?   Draw a diagram and show all calculations.
    (4 pts)

17. Sean is in Manila and driving his car to the north at noon. He has trouble seeing the car moving in front of him because the sun's rays are reflected from the back window glass and the glare is in his eyes. The back window glass of the car A forms an angle with the ground of 52° 18′as shown in the picture below. The arrow AB is parallel to the ground. .
    (6 pts in total)
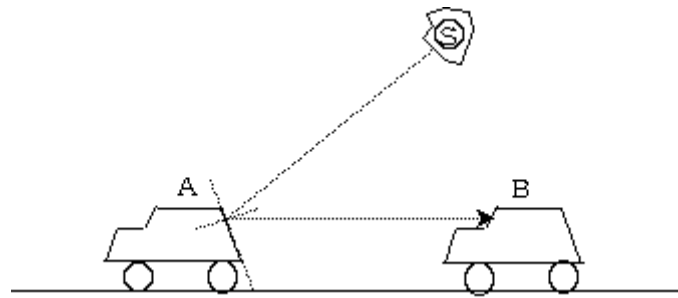
a) In this situation, what is the altitude of the sun? (2 pts)

b) The latitude of Manila is 14° 36′ N. What is the declination of the sun on this date. (2 pts)

c) Estimate the dates when this situation occurs. (2 pts)

18. The Orionid meteor shower radiant can be found in RA $6^h 20^m$ and Dec $+16°$ as indicated in the map below: (5 pts in total)
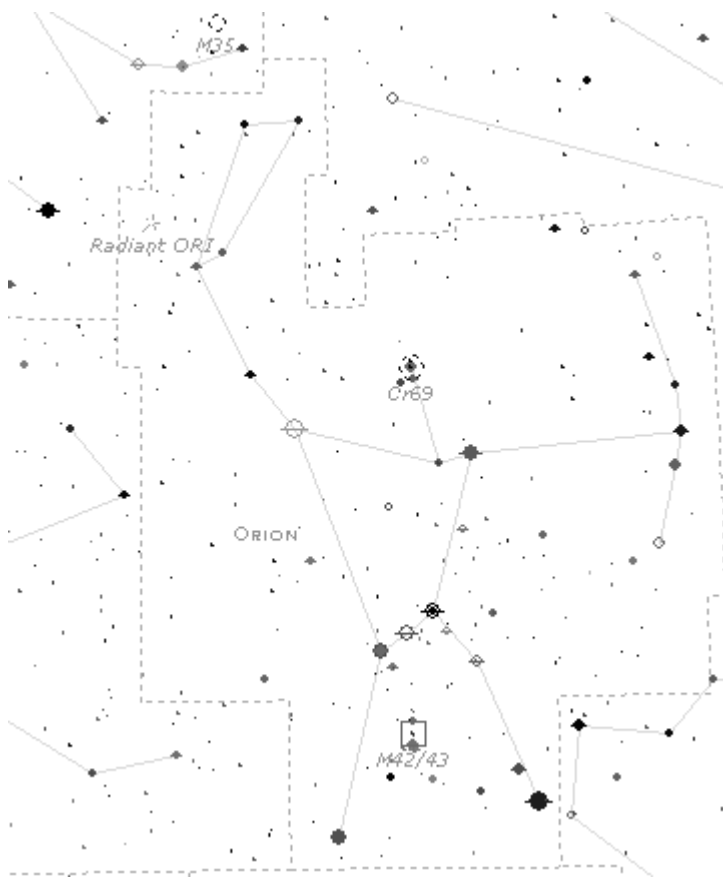
a) If the sun is at RA $13^h 45^m$ and Dec $-10° 45'$, at what time will the radiant transit? Assume that both the equation of time and the standard correction due to latitude are equal to zero. (3 pts)

b) At what latitude should an observer be for the radiant to pass exactly at his/her zenith? (2 pts)

Questions 19-21 are a set of questions. Consider a hypothetical earth that has the same volume and mass as our real earth, but has a spherical shape with an interior made of homogeneous material.

19. Which of the following statements about the estimated gravity and the radius at the poles of the two earths is correct ? (2 pts)

   a. The gravity and radius are larger on the real earth.
   b. The gravity and radius are larger on the hypothetical earth.
   c. The gravity is larger on the real earth, and the radius is larger on the hypothetical earth.
   d. The gravity is smaller on the real earth, and the radius is larger on the hypothetical earth.
   e. The gravity is larger on the real earth, and the radius is smaller on the hypothetical earth.

20. Which of the following statements about the densities of surface rocks of the two earths is correct ? (2 pts)
   a. Surface rocks of the real earth have the larger density.
   b. Surface rocks of the real earth have the smaller density.
   c. Surface rocks of the real earth have the same density as that of the hypothetical earth.

21. Sketch the directions of gravity and magnetic fields at the northern pole and equator of the real earth.   (3 pts)

22. The figure below is the vertical component of waveform recorded at one seismic station. The arrival times of several waves are indicated by arrows. (6 pts in total)
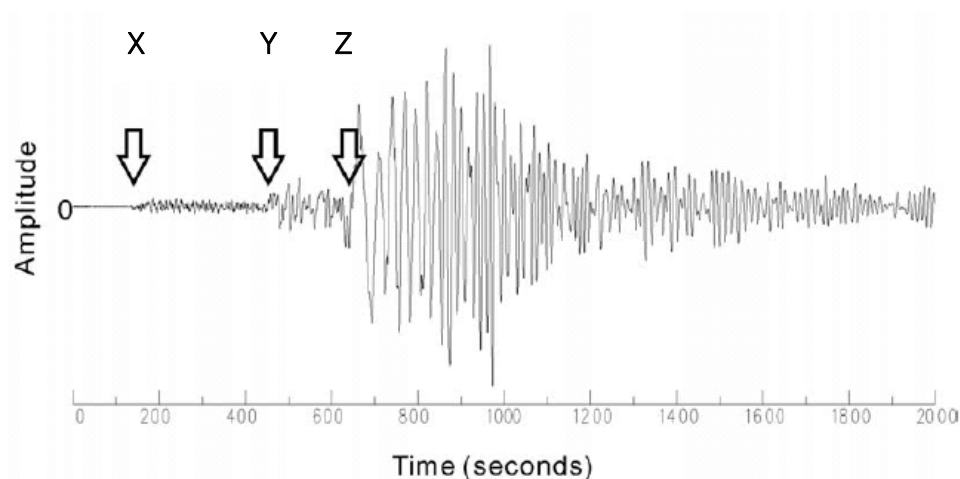
(a) Which letter above most likely respresents the S wave,   X, Y or Z?   (1 pt)

(b) According to the Z onset time and the later waveform, which graph represents the relationship between the period and velocity?   (2 pts)

(A)

(B)

(C)

(D)

(E)
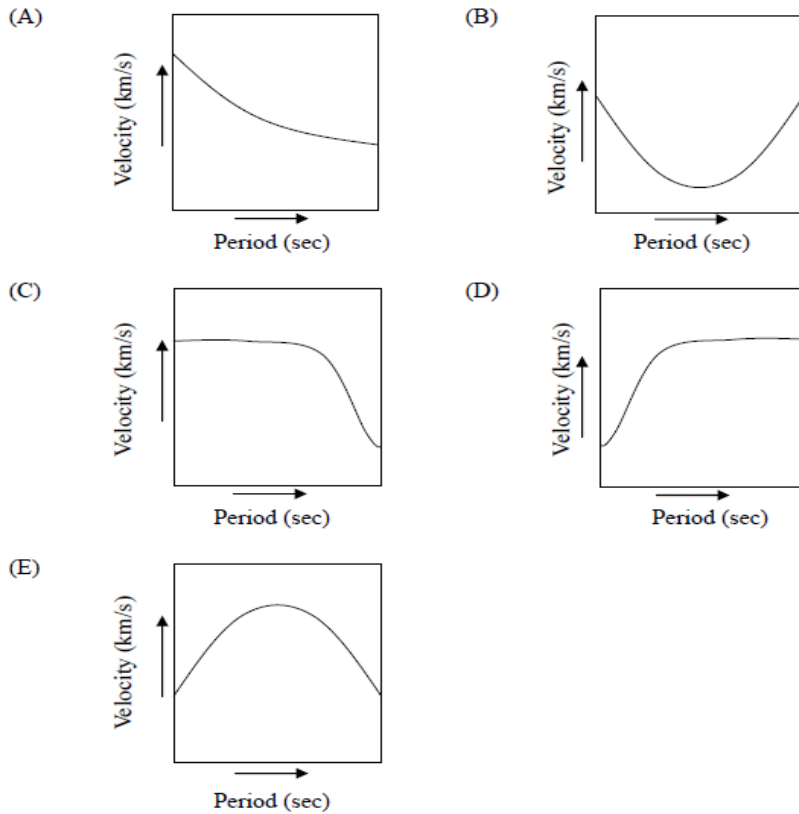
(c) List three different possible causes of earthquakes.   (3 pts)

23. Using your knowledge of plate tectonic theory and the map below, briefly describe the movement of tectonic plates that may have caused the Sichuan earthquake in China on May 12, 2008. (The white star indicates the epicenter and arrows show the direction and relative speed of ground movement)   (2 pts)