IESO 2012 Written TEST Atmosphere

Name_____   Nationality _____

1) . Look at this picture below and indicate the correct answer: (1 pts)

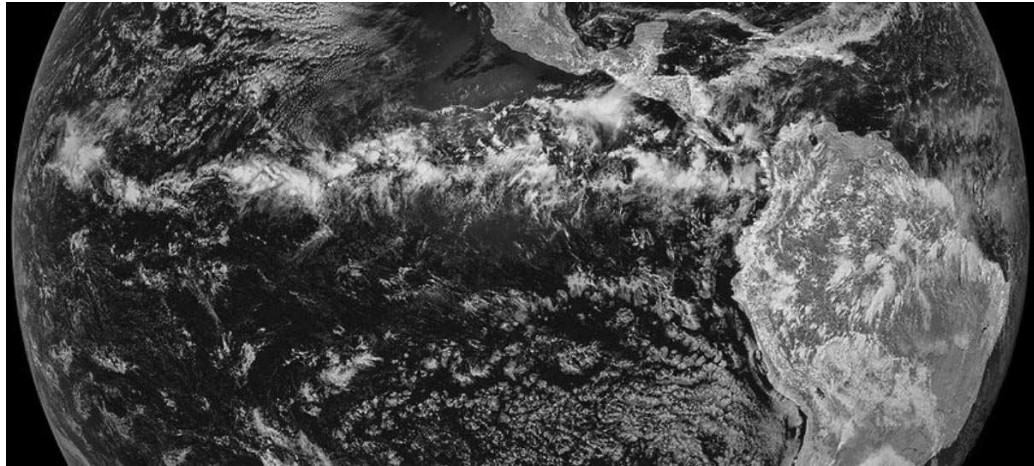Figure 1. Satellite image of Tropics area

This belt of clouds forms on the equator, where cold air from the northern hemisphere meets warm air from the southern hemisphere.	**A**
During the summer of the northern hemisphere, the mean position of this belt of clouds is north of the equator.	**B**
This belt of clouds is associated with high pressures.	**C**
This belt of clouds forms at the confluence of winds named "westerlies".	**D**
This belt of clouds forms where cold air from the upper atmosphere comes down.	**E**

|		
2). What is the <u>INCORRECT</u> statement about the jet stream? (1 pt)	A sharp variation of the height of the tropopause gives information about the position of the jet stream	A
	The presence of dark stripes visable in a water vapour image gives information about the position of the jet stream	B
	The jet stream has a maximum velocity called the jet stream core	C
	On a 300 hPa chart the position of the jet stream is not able to be identified	D
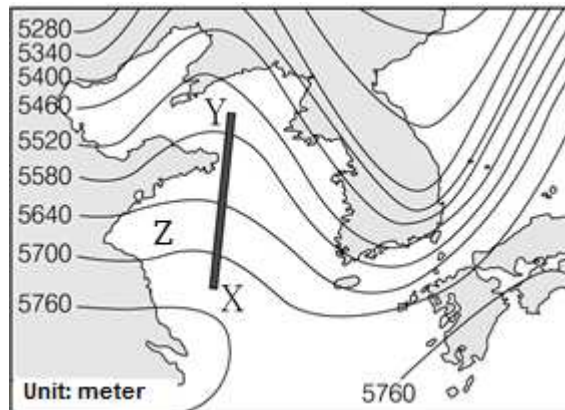
Figure 2. Geopotential contours

.3). Figure 2 above illustrates the distribution of the geopotential contour of the 500 hPa isobaric surface over Korea. (1 pt)

Select the best answer among the statements that describes the upper air corectly

1. Pressure gradient forces act from point X towards point Y.
2. At point Z the wind blows from the west to the east.
3. The steeper the slope of the 500hPa isobaric surface the greater the pressure gradient force

1	A
2	B
3	C
2 and 3	D
1 and 2	E
1 and 3	F
1,2, and 3	G
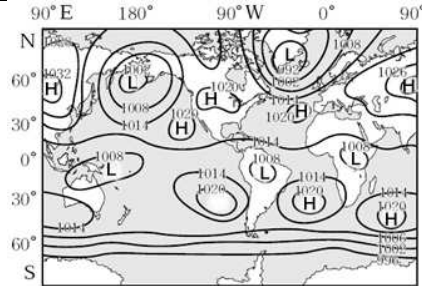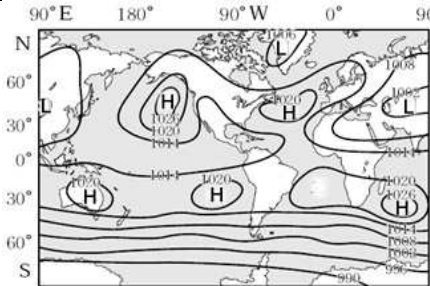
| 4). The western coast of the southernmost part of South America, to the west of the Andes, is characterized by the presence of a rain forest. As opposed to the area to the east of the mountain chain which is a desert (the Patagonia). Taking into account that winds in the area blow most of the time from west to east, how you could explain this difference in vegetation? (1 pt) | In the Andes there are many volcanoes that produce a lot of ash that facilitates precipitation. | A |
	The rainfall mainly resulted from mountain effect – "orographic uplift"	B
	Seasonal Monsoonal rainfall	C
	Increased in water flow due to the melting of glaciers	D

5). Choose the correct statement about the atmosphere near the equator (1 pt) :
 	
    (A) Cold and warm fronts are the dominant source of rainfall
    (B) Diurnal variation is not important
    (C) Typhoons often develop in this area
    (D) The Tropopause temperature is colder than that of midlatitude regions
    (E) The pressure gradient is important for weather analysis
	A

	B
	C
	D
	E

Figure 3a
January

Figure 3b
July

1	A
2	B
3	C
2 and 3	D

6). Figures 3a and 3b above illustrates the distribution of annual average atmospheric pressure on the ground in January and July. Select the best response from the following statements to describe the given weather charts correctly. (1 pt) 1. In the northern hemisphere Winter, high pressure develops over the land area. 2. In January, high pressure develops over the land area in the southern hemisphere. 3. There is less average variation in atmospheric pressure between winter and summer in the northern hemisphere, compared with the southern hemisphere.	1 and 2	E
	1 and 3	F
	1,2, and 3	G

7). Match the following statements with the right choices (1pt)	Put the letter of your choice below	
1. Which gas has the biggest variation in space and time, and has strong influence on the local weather?		A. CO_2
2. Which gas has the highest concentration in the Earth's atmosphere?		B. CO
3. Which gas makes the largest contribution to the greenhouse effect?		C. H_2O D. He
4. Which gas's anthropogenic concentration change is contributing most to climate change?		E. N_2

8). Clouds are classified according to height and form. Which response best describes Altocumulus lenticularis? (1 pt)	High cloud	A
	Middle cloud	B
	Low cloud	C
	Stratiform cloud	D
	Cirriform cloud	E

Figure 4
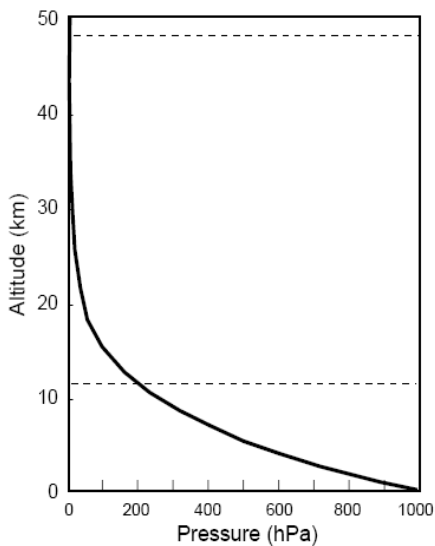
Question number 9 and 10 refers to Figure 4 to the left.

Figure 4 shows the vertical profile of mean global air pressure starting from mean sea level and going up to 50 km in altitude. Use the information from Figure 4 to answer the following questions:

9). The term "Pressure" at the horizontal axis is equivalent to .... (1 pt)	Weight divided by Volume	A
	Mass divided by Area	B
	Density multiplied by Temperature	C
	Mass multiplied by Temperature	D
	Force divided by Area	E

10). According to Figure 4, The thickest layer is .... (1 pt)	101-110 hPa	A
	501-510 hPa	B
	701-710 hPa	C
	1001-1010 hPa	D

11). Choose the correct answer (1 pt)

1. Wind above the 1 km elevation generally blows parallel to the pressure contour lines. 2. It always rains when a warm front is approaching. 3. Behind the cold front a northwest wind will blow. A southeast winds will blow behind a warm front. 4. The fronts are expected to move towards the north. 5. The speed of the cold front is nearly the same as the wind speed just behind front.	1 and 2 are true	A
	2 and 4 are true	B
	1 and 3 are true	C
	1 and 4 are true	D
	1 and 5 are true	E
	3 and 5 are true	F
	4 and 5 are true	G
	3 and 4 are true	H

12). The center of mass of the Earth's atmosphere is (1pt):

    A) a little less than halfway between the Earth's surface and the outer boundary of the atmosphere.
    B) near the surface of the Earth.
    C) near the outer boundary of the atmosphere.
    D) **near the center of Earth**.
    E) none of the above.

13). Look at the picture of the clouds in Figure 5 below

Figure 5

Which statement is correct ? (1pt)
The clouds are:
(A) associated with a vertical wind shear
(B) formed due to a passage of a jet plane (jet contrail)
(C) thunderstorm clouds
(D) a precursor of an earthquake
(E) cloud street

Calculation Problems

14).		The vapor pressure of water decreases as the temperature decreases. If the amount of water vapor in the air is kept constant as the air is cooled, then the temperature would reach the *dew point*, at which the partial pressure and vapor pressure coincide and the vapor is saturated.

Temperature (^{0}C)	Vapor Pressure (X 10^3Pa)
10,0	1,23
12,0	1,40
14,0	1,60
16,0	1,81
18,0	2,06
20,0	2,34
22,0	2,65
24,0	2,99
26,0	3,36
28,0	3,78
30,0	4,24

The vapor pressure of water decreases as the temperature decreases. If the amount of water vapor in the air is kept constant as the air is cooled, then the temperature would reach the *dew point*, at which the partial pressure and vapor pressure coincide and the vapor is saturated.

If the air is cooled further, vapor condenses to liquid until the partial pressure again equals the vapor pressure at that temperature.

In the meteorological laboratory with the room temperature 26.0 ^{o}C, a meteorologist cools a metal can by gradually adding cold water. When the can temperature reaches 16.0^{o}C, water droplets form on the can's outside surface.

What is the relative humidity of the 26.0^{o}C air in the room?
(show all your calculations) (3 pts)

Answer.

$$\text{Relative humidity} = \frac{partial\ pressure\ of\ water\ vapor\ at\ temperature\ T}{saturated\ vapor\ pressure\ of\ water\ at\ temperature\ T} \times 100\ \%$$

The experiment shows that the dew point is 16.0^{o}C, so the partial pressure of water vapor at 26.0^{o}C is equal to the vapor pressure at 16.0^{o}C, which is 1.81×10^3 Pa.

$$\text{Thus the relative humidity} = \frac{1.81 \times 10^3\ Pa}{3.36 \times 10^3\ Pa} \times 100\% = 0.539 \times 100\% = 53.9\%$$

15). In a static atmosphere, the pressure change with height is governed by the hydrostatic equation $\Delta p = \rho g \Delta z$.

In this equation:
g is the gravitational acceleration in m/s^2 (g = 9.81 m/s^2)
ρ is the air density in kg/m^3
Δp is pressure difference in Pa (pascal)
Δz *is* the thickness of different height

When the mean air density between 1000 hPa to 500 hPa layer is 0.910 kg/m^3, calculate the height of 500 hPa level with the assumption that mean sea level pressure is 1000 hPa
(show your calculations). (3 pts)
Answer: 1 hPa = 100 Pa = 100 kg/m/s^2

$\Delta p = 1000$ hPa – 500 hPa = 500 hPa = 50000 Pa

$\Delta p = \rho g \Delta z \rightarrow \Delta z = \Delta p/(\rho g)$
$$= 50000 \text{ Pa} / (0.910 \text{ kg/m}^3 \text{ x } 9.81 \text{ m/s}^2)$$
$$= 50000 \text{ Pa}/(8.9271 \text{ kg/m}^2/\text{s}^2)$$
$$= 5600{,}9 \text{ m}$$

Thus the hight of 500 hPa level is ≈ 5601 m
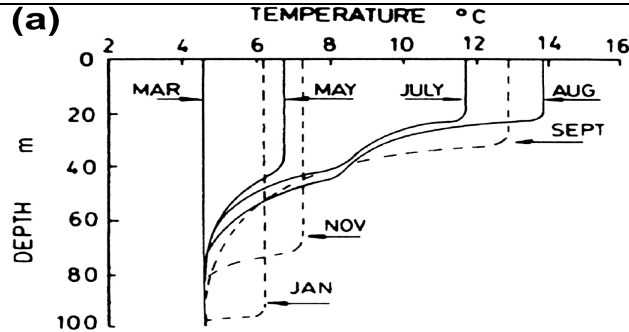
Name_____   Nationality _____

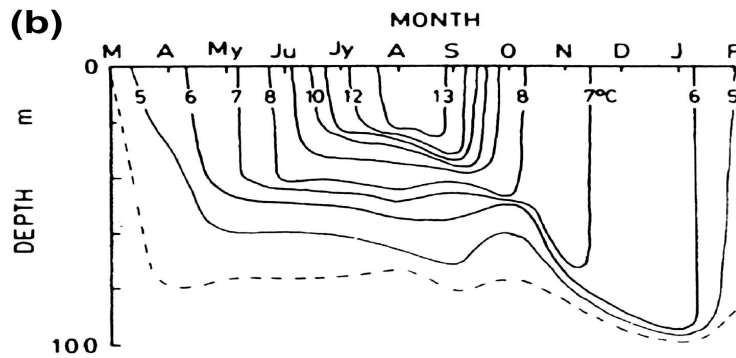Figure 1(a) vertical temperature profiles

Figure 1(b) time series of isothermal contours.

1). Figures 1(a) and 1(b) show growth and decay of the seasonal thermocline at 50°N, 145°W in the eastern North Pacific. The upper mixed layer, as seen in the upper part of Figure 1(a) is a vertically mixed layer with nearly homogeneous water temperature.
   Referring the above figures 1(a) and 1(b), choose two right answers (2pts).

|	
A.	Variation of the mixed layer depth depends on the strength of the warm and cold water currents.
B.	Decreasing of the mixed layer thickness from winter to summer is due to the heat increase from solar radiation and the decrease of mixing by weakening winds.
C.	The main processes that cause the highest water temperature to occur in August are due to the cold water runoff from the land and the decrease of mixed layer thickness.
D.	The depth of the mixed layer in November is deeper than in May. One of the factors causing an increase in depth of the mixed layer in November is thermal convection due to the surface cooling by heat loss.
All the right answers are: B, D	

2). Methane hydrates, also called *fire ice*, trap methane molecules, and are found in enormous quantities in the near subsurface of marine sediments in many places. If the warming of water melts the *fire ice*, and liberates the methane molecules into the ocean water and eventually into the atmosphere, what will the effect on the global weather be: (2 pts)	Decreasing the global warming	A
	Increasing the global warming	B
	It will not affect the global warming	C
	Increasing only the local warming	D

3). Tide is the most periodic phenomena in the sea but the tidal range varies every day. Choose the two __INCORRECT__ answers describing the tidal phenomena (2 pts).	Lunar tide is generated by the difference of forces between the gravitational attraction force of the Moon and the centrifugal force by the Earth's rotation.	A
	Tide generating forces (TGF) by the Sun is about 46% of TGF by the Moon.	B
	Tidal range is greater in the new and full moon phases than in quarter moon phases.	C
	Spring and neap tides are produced by the superposition of diurnal and semi-diurnal tides.	D
	High and low tides occur once or twice a day depending on the geographical locations on the Earth.	E

4). Figure 2 below indicates the general pattern of ocean currents in the Pacific Ocean.
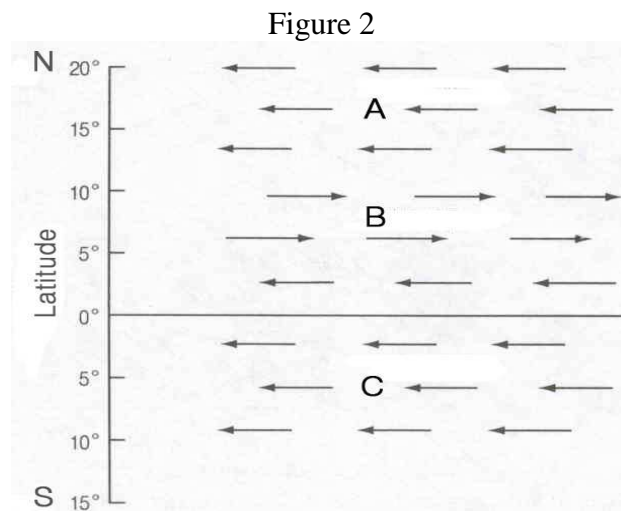
Figure 2

4.1) From Figure 2, what wind is responsible for the current at location A? (2pts)
   (A) Polar Westerly Wind
   (B) Southeasterly Trade Wind
   (C) Westerly Wind
   (D) Northeasterly Trade Wind

4.2) From Figure 2, what is the name of current at location B? (2pts)
- (A) South Equatorial Current
- (B) Equatorial Counter Current
- (C) North Equatorial Current
- (D) North Pacific Current

4.3) Currents at locations A, B, C all belong to the geostrophic current. What are the two major opposing forces that create the geostrophic currents? (2 pts)
- (A) Wind stress
- (B) Coriolis force
- (C) Pressure gradient force
- (D) Bottom friction

5) . (3 pts) Figure 3
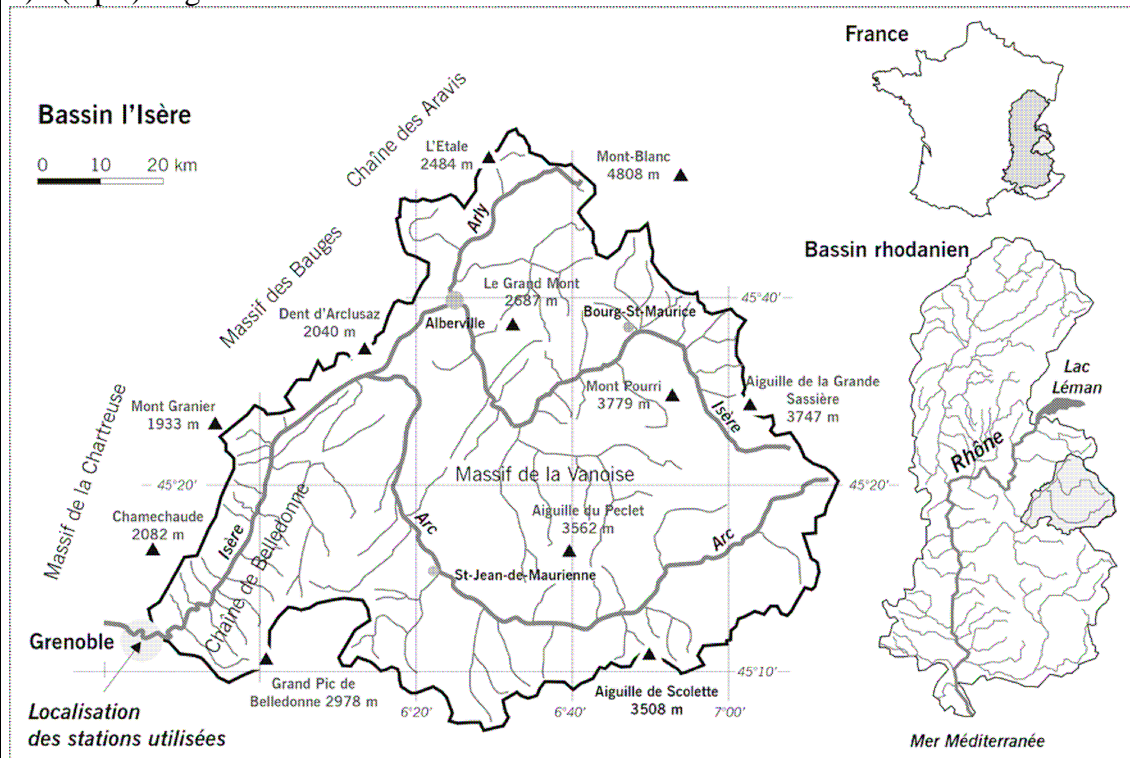
The alpine river Isère, in France flows through the city of Grenoble. Its drainage basin, as measured at this location, has an area of 6×10^9 m^2. The mean density of the rocks in this drainage basin is 2.5g/cm^3. During the year 2004, the Isère at Grenoble removed 3×10^9 kg of material (dissolved and solid). For the drainage basin, calculate the mean rate of erosion in depth per year for 2004. Choose the correct answer.	2 meters per year	A
	1 meter per year	B
	20 millimeters per year	C
	2 millimeters per year	D
	0.2 millimeter per year	E