

Name: \_\_\_\_\_

Atmosphere

Time Allotted: 30 minutes

Key: (\*) = none, one, or more than one answer possible (e.g. Answer: A, D, and E)

1. An inversion layer consists of a layer of warm air overlying a colder region, often forming due to prolific radiative cooling. In theory, when would one expect a nocturnal inversion to be most strongly exhibited?

- a) 5:00 PM
- b) 8:00 PM
- c) 11:00 PM
- d) 2:00 AM
- e) 5:00 AM
- f) 8:00 AM

2. Which of the following is/are false regarding the forces that influence wind? (\*)

- a) The wind-generating pressure-gradient force (PGF) is mathematically defined as change in pressure over change in altitude.
- b) The Coriolis effect only influences winds that blow over long distances.
- c) Counter-clockwise flow around a low is caused by a PGF that strengthens the Coriolis effect on the air parcels in motion.
- d) Pressure gradients are tighter around stormy lows.
- e) In the Northern Hemisphere, geostrophic winds are propelled by lows on the left and highs on the right.

3. It starts precipitating and you posit the collision-coalescence process is responsible for the formation of the precipitation you're experiencing. Which of the following observations would support your hypothesis? (\*)

- a) Clouds above freezing temperature
- b) A high ice crystal to water droplet ratio
- c) The precipitation being snow or hail
- d) Strong updrafts
- e) Lofty cirrus clouds above the storm clouds

4. In an area of rapid urbanization, you start to notice increased traffic and thus increased car exhaust being emitted into the air. Which of the following sets of chemical reactions would most likely occur in the stratosphere above the hypothetical urbanizing area with the stated observation as the cause?

- a)  $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$   
 $\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{ClO}_2$
- b)  $\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$   
 $\text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2$
- c)  $\text{O}_3 + \text{O}_3 \rightarrow 3\text{O}_2$   
 $\text{O}_3 + \text{UV} \rightarrow \text{O}_2 + \text{O}$   
 $\text{O} + \text{O}_3 \rightarrow 2\text{O}_2$
- d)  $\text{NO}_2 + \text{ClO} \rightarrow \text{ClONO}_2$   
 $\text{CH}_4 + \text{Cl} \rightarrow \text{HCl} + \text{CH}_3$
- e)  $\text{O}_3 + \text{NO} \rightarrow \text{O}_2 + \text{NO}_2$   
 $\text{NO}_2 \rightarrow \text{O} + \text{NO}$   
 $\text{O} + \text{O}_2 \rightarrow \text{O}_3$

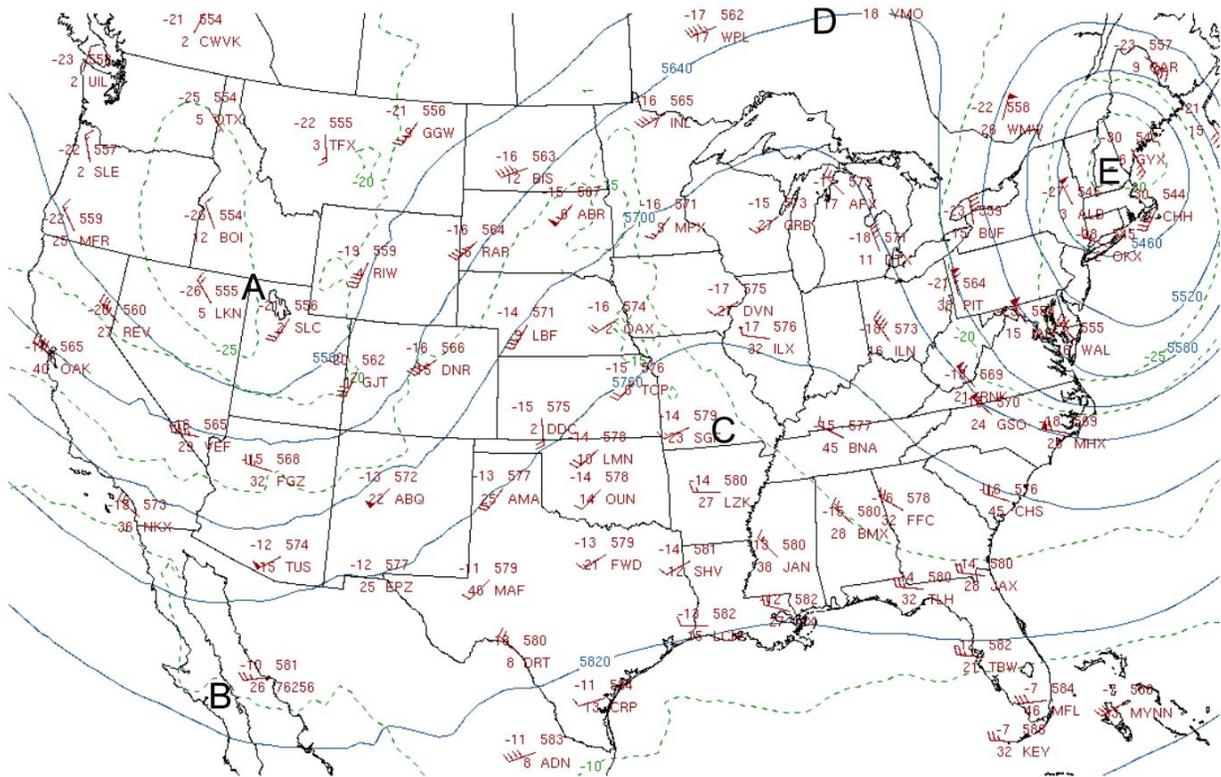
Consider the image below.



5. Which of the following is the most likely explanation for the phenomenon shown?

- a) Strong temperature inversions  
 b) Refraction by ice crystal in the atmosphere  
 c) Lensing by airborne dew droplets  
 d) Reflection off of fog droplets

Consider the isobaric chart below.



12Z 30 Apr 2018 500 hPa

Identify the most likely candidate for a region that could expect an intensifying a surface low.

- a) To the west of A
- b) To the east of A
- c) Directly below A
- d) To the west of E
- e) To the east of E
- f) Directly below E

6. If one were to create a surface map corresponding to the same isobaric chart, around which letter would you most likely expect to see  ?

- a) A
- b) B
- c) C
- d) D
- e) E

7. Researchers observe two greenhouse spaces, A and B. The dry and wet bulb temperature measurements for space A are 22.5 °C and 15 °C, while the dry and wet bulb temperature measurements for space B are 23.0 °C and 20 °C. The researchers want to adjust the spaces so that their dew points will be the same. Which of the following changes can the researchers make?

- a) The researchers should add water vapor to space A and increase the temperature of space A.
- b) The researchers should add water vapor to space B and increase the temperature of space B.
- c) The researchers should add water vapor to space A and increase the temperature of space B.
- d) The researchers should add water vapor to space B and increase the temperature of space A.

8. In the following problems, DALR refers to the dry adiabatic lapse rate, SALR refers to the saturated adiabatic lapse rate, and the ELR refers to the environmental lapse rate.

In Denver, CO, the surface air temperature is 32 °C and the dew point temperature is 15 °C. Assume the DALR is 10 °C/km, the SALR is 8.5 °C/km, and the ELR is 6.5 °C/km. Which of the following altitudes is closest to the height at which a cloud base will begin to form?

- a) 1700 m
- b) 1900 m
- c) 2100 m
- d) 2300 m

9. A polluted air parcel rises above Beijing on a hot summer day. If we hope to contain the pollution as much as possible (prevent it from rising), which of the following scenarios would be most ideal?

- a) The ELR should be less than the SALR.
- b) The ELR should be greater than the SALR.
- c) The ELR should be less than the DALR.
- d) The ELR should be greater than the DALR.
- e) The ELR should be greater than the SALR, but less than the DALR.
- f) The ELR should be less than the SALR, but greater than the DALR.

10. How would an air parcel behave in conditions where environmental lapse rate is between dry and wet adiabatic rate?

- a) The air parcel is stable and tends to sink both above and below the condensation level.
- b) The air parcel is unstable and tends to rise both above and below the condensation level.
- c) The air parcel is stable and tends to sink below the condensation level. It is unstable and tends to rise above the condensation level.

- d) The air parcel is unstable and tends to rise below the condensation level. It is stable and tends to sink above the condensation level.
- e) It is impossible for environmental lapse rate to be between the dry and wet adiabatic rate.

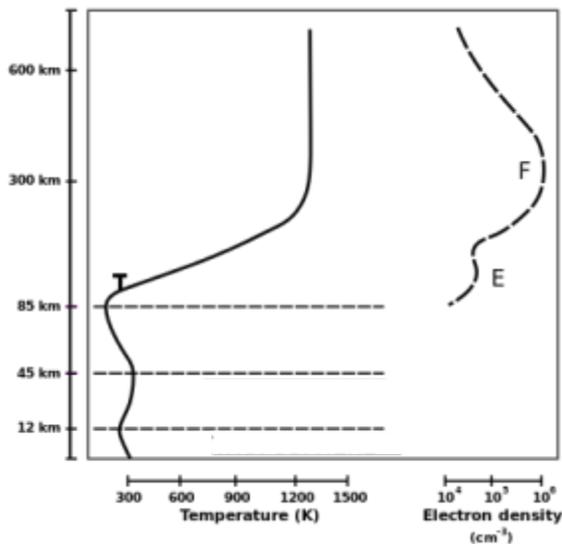
11. A sharp drop in dew point, shifting winds, and towering cumulus clouds would most likely indicate which of the following?

- a) An approaching cold front
- b) An ongoing cold front
- c) A cold front after passing
- d) An approaching warm front
- e) An ongoing warm front
- f) A warm front after passing

12. Each of the following statements are components of feedback mechanisms that operate in our atmosphere in conjunction with the other spheres on Earth. Which of the following statements are both correct and a part of a positive feedback mechanism? (\*)

- a) A warmer planet causes more carbonic acid to weather silicates.
- b) Melting of ice lowers surface albedo.
- c) Higher temperatures cause more water vapor to enter the atmosphere.
- d) Tectonic activity leads to increased outgassing.
- e) A warmer planet emits more infrared radiation.

Answer Q13-14 using the figure below.



13. Which of the following could account for observations of temperature seen above 85 km? (\*)

- a) Atmospheric mixing
- b) Environmental lapse rate
- c) Friction from incoming particles
- d) Absorption of Sun radiation
- e) Lower density of gas particles

14. Which of the following is/are true concerning the dotted line to the right? (\*)

- a) It depicts daytime ionosphere layers.
- b) During the daytime, the Sun's UV and X-ray radiation intensifies the ionosphere layers.
- c) The ionosphere is unionized in the night.
- d) It produces lightning.
- e) It is responsible for aurorae.

15. The Urban Heat Island (UHI) effect describes the relative warmth of urban areas compared to surrounding rural areas. The UHI would likely be most noticeable in which of the following conditions? (\*)

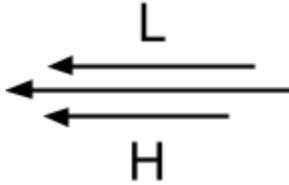
- a) in the morning
- b) at night
- c) in the summer
- d) in the winter
- e) in a region with moist air
- f) in a region with dry air
- g) in a region below a low aloft
- h) in a region below a high aloft

16. The intertropical convergence zone (ITCZ) is located where the Hadley cells of both Hemisphere converge; given this information and your knowledge of the global atmospheric system, infer all that is false concerning the ITCZ. (\*)

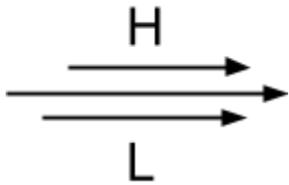
- a) The ITCZ is located at 0 N latitude year-round.
- b) Due to its rising air, the ITCZ produces thunderstorm clouds.
- c) The ITCZ is more active over oceans than over land masses.
- d) The region below the ITCZ is characterized by a strong pressure-gradient.
- e) The Sun is the ultimate source of the ITCZ.

17. Which of the following images best depicts a polar jet stream? Note that the letters are meant to show aloft pressure systems.

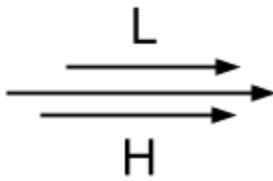
a)



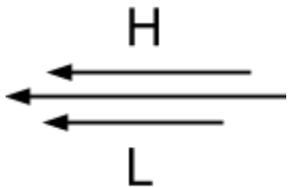
b)



c)



d)



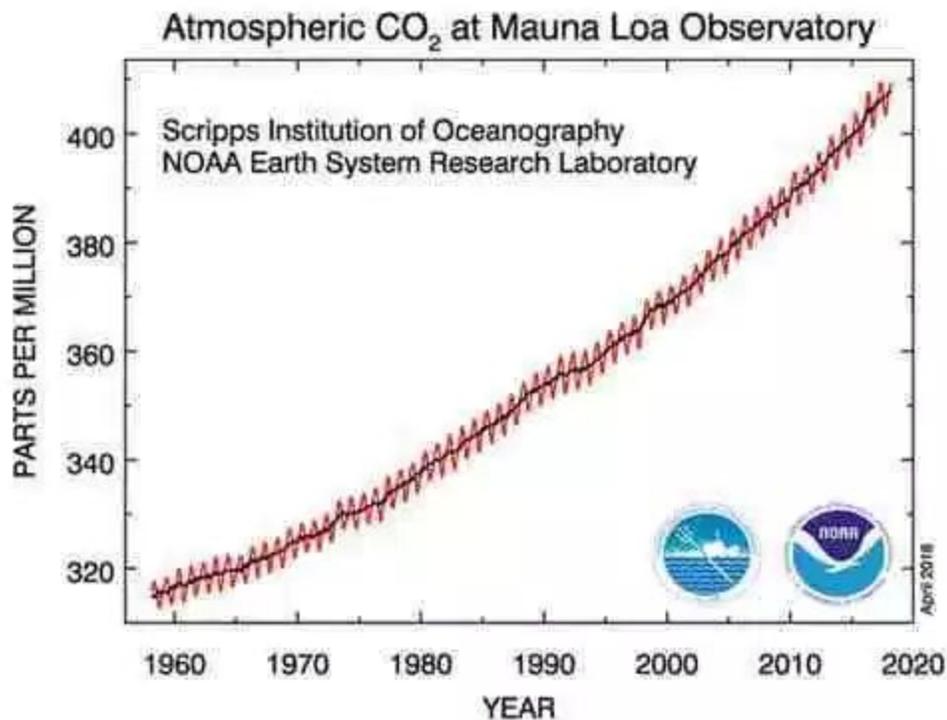
18. A highly productive fishing village in the northern hemisphere exists along a coastline that runs North-South, with the ocean to the West. What is likely to be the dominant wind direction?

- a) To the north
- b) To the south
- c) To the east
- d) To the west

19. The fishing village in Q18 occasionally suffers (roughly every 4-7 years) from a collapse in its fish populations. This can probably be attributed to which of the following? (\*)

- a) Weakening of trade winds
- b) Migration of warm water towards the West
- c) Decreased salinity near the fishing village coastline
- d) High pressure systems near the fishing village coastline

Consider the Keeling curve below.



20. Based on the above figure, indicate all of the following statements that are true. (\*)

- a) Lunar cycles are responsible for the periodic intra-annual fluctuation.
- b) If identical measurements were made in the southern hemisphere, intra-annual fluctuations would likely be more pronounced.
- c) The measured gas is a major constituent of the Earth's atmosphere by volume.
- d) The measured concentrations have never been reached in the history of Earth's atmosphere.