

ATM401/CHEM601/ATM601 2. quiz

Read each question carefully before you answer. Cycle one answer only. Note that answers are in an arbitrary order. All students have to address all questions 1 to 16. All students can, but don't have to address the two questions for extra credit (17, 18). Graduate students have also to address the last question (19).

1. Clouds can contain all of the following
 - (a) air, cloud droplets, and ice crystals
 - (b) cloud droplets and ice crystals
 - (c) ice crystals, cloud droplets, raindrops, and snow
 - (d) moist air, cloud droplets, cloud ice, and hydrometeors of all kind
2. The Hallett-Mossop-mechanism refers to
 - (a) ice splinter production when super-cooled droplets with diameter $> 23\mu\text{m}$ collide with an ice surface at velocities $\geq 1.4\text{m/s}$ at temperatures between -8°C and -3°C .
 - (b) cloud droplets evaporate at the cost of ice crystal growth under conditions super-saturated with respect to ice, but sub-saturated with respect to water.
 - (c) aerosols can yield increased nucleation at higher temperatures than they will under other nucleation conditions, if they get into contact with super-cooled water droplets.
 - (d) ice nucleation activity of atmospheric aerosols that can increase by condensation or deposition nucleation, if the super-saturation of the ambient air exceeds 1% with respect to water.
3. Which of the following statements is wrong
 - (a) In saturated air masses with temperatures between -35°C and 0°C both ice and cloud water may coexist.
 - (b) In saturated air masses slightly warmer than 0°C , frozen hydrometeors may can exist.
 - (c) In saturated air masses with temperatures between -35°C and 0°C only ice and snow crystals can exists.
 - (d) In saturated air masses warmer than 0°C , only cloud-water and rainwater can exist.
4. Terminal velocity refers to
 - (a) the final non-accelerated velocity of any droplet that depends on the radius of the droplet.
 - (b) the fall speed of a drop.
 - (c) the mass-weighted velocity of the spectrum of droplets of different diameter.

- (d) the speed a drops has as it hits an object and bursts.
5. Absolute humidity depends on
- (a) water vapor
 - (b) both water vapor and temperature
 - (c) temperature
 - (d) water vapor saturation
6. How does condensation usually occur in clouds?
- (a) through fog formation
 - (b) water vapor diffusion onto embryo cloud droplets
 - (c) heterogeneous nucleation
 - (d) homogeneous nucleation
7. The saturated adiabatic lapse rate is less than the dry adiabatic lapse rate because
- (a) air is less dense with height
 - (b) the saturation vapor pressure of water rises non-linearly as the temperature increases
 - (c) saturated air is lighter than dry air
 - (d) latent heat released by condensing water vapor partially offsets cooling by expansion
8. What is the dew point?
- (a) The mass of water vapor divided by the mass of air.
 - (b) A variable temperature at which air becomes saturated.
 - (c) The part of the total atmospheric pressure that is due to water vapor.
 - (d) A ratio of the amount of moisture in the air to the amount of moisture possible in the air.
9. Which type of convection is driven by wind?
- (a) free convection
 - (b) forced convection
 - (c) conduction
 - (d) no convection
10. Suppose an air mass warms up as it moves over a land surface, but no water vapor is added or lost. What will the relative humidity and the specific humidity do? Mark the right combination (in the order relative humidity, specific humidity).
- (a) rise, not change

- (b) fall, rise
 - (c) fall, not change
 - (d) not change, fall
11. For ice crystals to form at temperatures near 0°C , which of the following is necessary?
- (a) condensation nuclei and super-saturation with respect to ice
 - (b) ice nuclei and super-saturation with respect to ice
 - (c) ice nuclei and sub-saturation with respect to water
 - (d) water vapor deposition and super-saturation with respect to ice
12. The displacement of one air mass over another is called the
- (a) convective lifting.
 - (b) buoyancy.
 - (c) frontal lifting.
 - (d) orographic lifting.
13. Why do some raindrops reach the ground?
- (a) Updrafts weaken during rain events.
 - (b) Wind currents in the clouds force them downward.
 - (c) Because they did not evaporate.
 - (d) Gravity effects overcome updrafts when drops get big enough, and the saturation and size conditions permit them not to totally evaporate.
14. How do cloud droplets usually grow to raindrops in water clouds?
- (a) Faster-moving heavy droplets sweep up lighter droplets as they fall.
 - (b) Cloud droplets grow through riming and accretion.
 - (c) Cloud droplets grow through water vapor diffusion.
 - (d) Cloud droplets are attracted to each other through electrostatic forces.
15. Why is sea level pressure used instead of surface air pressure on weather maps?
- (a) It is used mainly because of tradition.
 - (b) Sea level pressure is greater than surface air pressure.
 - (c) It is used to correct for the effect of altitude.
 - (d) This statement is wrong. Only the surface pressure is used on weather maps.

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16. Name the seven cloud microphysical processes.

For two extra credits:

17. Give the typical size of cloud droplets and raindrops.

18. Give the typical terminal velocities of raindrops, graupel, and snow, and comment on how they behave with size (formula is ok).

Graduate students:

19. In addition, develop the balance equations for conservation of water assuming a cloud that consists of water vapor, cloud-water, rainwater, and ice.