

Please write your name on every page of your homework. Please use a word processor for all written answers. Show your work in any calculation; math work can be hand-written. Please write the day of the week and time that your discussion section meets on your homework.

Homework #1

ATM 10
Fall 2004

Due: 13 October 2004

1. (8 pts) Imagine that you were hiking in the Sierras. Your barometer read 832.3 mb when you finished the drink in your flexible plastic water bottle. Your thermometer showed $T=17\text{ }^{\circ}\text{C}$. You recapped the empty 1 liter bottle. When you return to Davis that evening, the temperature ($T = 17\text{ }^{\circ}\text{C}$) but your barometer reads 1000 mb. What is the volume (in liters, li) of the air inside the water bottle in Davis? Hint: use ideal gas law and assume that the T and P inside the bottle adjust to match T and P outside the bottle.

2. A large hailstone suspended at the base of a cloud begins to fall. The cloud base is 1 km above ground. Assume the stone was motionless before it began to fall. The stone weighs 200 gm ($= 1/5\text{ kg}$). Use gravitational acceleration, $g = 10\text{ m/s}^2$.

a. (3 pts) The hailstone's potential energy (PE) is zero on the ground. What was its potential energy (in $\text{kg m}^2/\text{s}^2 = \text{J}$) at the cloud base?

b. (4 pts) The hailstone reaches a fall speed of 67.1 mph when it slams into the hood of a car. What kinetic energy (KE, in $\text{kg m}^2/\text{s}^2 = \text{J}$) does it have when it hits the car? Hint: $1\text{ mph} = 0.447\text{ m/s}$

c. (1 pt extra credit) Potential energy was converted to kinetic energy when the hailstone fell. What is the primary reason why the KE in part b is much less than the PE in part a?

3. (8 pts) Rain is falling from a thunderstorm over a 10 km^2 area (10,000,000 square meters) of northern Arizona. Latent heat of condensation is $2.5 \times 10^6\text{ J/kg}$ (2,500,000 J/kg). The rain lasts for 4,000 seconds and the total amount of rain is 4 cm (0.04 m) deep. The density of water is 1000 kg/m^3 . Hint: combine things here to match the units in the final answers.

a. What is the total mass (in kg) of rain that fell?

b. What amount of latent heat (in J) was released?

c. What is the total amount of power (in mega-watts, MW) that was released? Hint: a mega watt is a million watts. One watt = one J/s. So, divide your answer to part b by the 4,000 seconds; then divide by a million.

d. How does the power of this thunderstorm compare with the 1,250 MW peak power of Glen Canyon Dam?

Multiple Choice questions (1 pt each):

4. In general, where in the troposphere is temperature the coldest?

- (a) near the ground
- (b) at the 700 mb level
- (c) at the 500 mb level
- (d) at the tropopause

5. Which of the following lists the layers of the atmosphere from lowest altitude to highest altitude?

- (a) troposphere, thermosphere, mesosphere, stratosphere
- (b) troposphere, mesosphere, stratosphere, thermosphere
- (c) troposphere, stratosphere, mesosphere, thermosphere
- (d) thermosphere, mesosphere, stratosphere, troposphere

6. Atmospheric pressure:

- (a) increases with height.
- (b) at sea level on average is approximately 1013 mb.
- (c) can be estimated by subtracting the dewpoint temperature from the air temperature.
- (d) Both (a) and (b) are true.

7. In a volume of air near the earth's surface, ____ occupies 78 % and ____ 21 %.

- (a) nitrogen, oxygen
- (b) hydrogen, oxygen
- (c) oxygen, hydrogen
- (d) nitrogen, water vapor
- (e) hydrogen, helium

8. True/false questions (1 pt each):

- a) Pressure is a measure of the weight of air above a unit area.
- b) Latent heat, the energy required for phase change, is released into the atmosphere when clouds form.
- c) A wind blowing from the south to the north is a "north wind."

Please write your name on every page of your homework. Please use a word processor for all written answers. Show your work in any calculation; math work can be hand-written. Please write the day of the week and time that your discussion section meets on your homework.