Chem 101A Study Questions, Chapters 5 & 6 Name: _____
Review Tues 10/23/18
Due 10/25/18 (Exam 3 date)
This is a homework assignment. Please show your work for full credit. If you do work on separate paper, attach the work to these.

Useful Information to be provided on the exam:

1 atm = 760 mm Hg = 760 torr = 14.69 lb/in^2
= 101,325 Pa = 101.325 kPa

$q = m \cdot C \cdot \Delta T$

$w = -P\Delta V$

$PV = nRT$

$MP = dRT$

$$\left(P_{obs} + a\frac{n^2}{V^2}\right)(V - nb) = nRT$$

(VDW Equation)

$R = 0.082057\ L \cdot atm/K \cdot mol$

$R = 8.314\ J/K \cdot mol$

1 cal = 4.184 J

$1\ L \cdot atm = 101.325\ J$

$$1\ J = 1\ \frac{kg \cdot m^2}{s^2}$$

$$KE_{avg} = \frac{3}{2}RT$$

$$\chi_a = \frac{n_a}{n_{tot}} = \frac{P_a}{P_{tot}}$$

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

Table 5.3 Values of the van der Waals Constants for Some Common Gases

Gas	$a\left(\frac{atm \cdot L^2}{mol^2}\right)$	$b\left(\frac{L}{mol}\right)$
He	0.0341	0.0237
Ne	0.211	0.0171
Ar	1.35	0.0322
Kr	2.32	0.0398
Xe	4.19	0.0511
H_2	0.244	0.0266
N_2	1.39	0.0391
O_2	1.36	0.0318
Cl_2	6.49	0.0562
CO_2	3.59	0.0427
CH_4	2.25	0.0428
NH_3	4.17	0.0371
H_2O	5.46	0.0305

1. Gases generally have
   A) low density
   B) high density
   C) closely packed particles
   D) no increase in volume when temperature is increased
   E) no decrease in volume when pressure is increased

2. Which of the following is **true** about the kinetic molecular theory?
   A) The volume of a gas particle is considered to be small – about 0.10 mL.
   B) Pressure is due to the collisions of the gas particles with the walls of the container.
   C) Gas particles repel each other, but do not attract one another.
   D) Adding an ideal gas to a closed container will cause an increase in temperature.
   E) At least two of the above statements are correct.

3. Which conditions of *P*, *T*, and *n*, respectively, are most ideal?
   A) high *P*, high *T*, high *n*
   B) low *P*, low *T*, low *n*
   C) high *P*, low *T*, high *n*
   D) low *P*, high *T*, high *n*
   E) low *P*, high *T*, low *n*

Use the following to answer questions 4-5:

Four identical 1.0-L flasks contain the gases He, Cl_2, CH_4, and NH_3, each at 0°C and 1 atm pressure.

4. For which gas do the molecules have the highest average velocity?
   A) He
   B) Cl_2
   C) CH_4
   D) NH_3
   E) all gases the same

5. For which gas are the molecules diatomic?
   A) He
   B) Cl_2
   C) CH_4
   D) NH_3
   E) all gases the same

6. Which of the following statements correctly describes the signs of q and w for the following exothermic process at $P = 1$ atm and $T = 370$ K?

$$H_2O(g) \rightarrow H_2O(l)$$

A) q and w are negative.
B) q is positive, w is negative.
C) q is negative, w is positive.
D) q and w are both positive.
E) q and w are both zero.

7. Which of the following statements is correct?
A) The internal energy of a system increases when more work is done by the system than heat was flowing into the system.
B) The internal energy of a system decreases when work is done on the system and heat is flowing into the system.
C) The system does work on the surroundings when an ideal gas expands against a constant external pressure.
D) All statements are true.
E) All statements are false.

8. Calculate the work associated with the expansion of a gas from 42.0 L to 79.0 L at a constant pressure of 16.0 atm.
A) 592 L·atm
B) –592 L·atm
C) -1.26×10^3 L·atm
D) 672 L·atm
E) 1.26×10^3 L·atm

9. *True or False?* A state function does not depend on the system's past or future.
A) True
B) False

10. Consider the reaction:

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l);\ \Delta H = -1370\ \text{kJ}$$

Consider the following propositions:

I. The reaction is endothermic

II. The reaction is exothermic.

III. The enthalpy term would be different if the water formed was gaseous.

Which of these propositions is (are) true?

A) I
B) II
C) III
D) I, II
E) II, III

11. Two metals of equal mass with different heat capacities are subjected to the same amount of heat. Which undergoes the smallest change in temperature?
    A) The metal with the higher heat capacity.
    B) The metal with the lower heat capacity.
    C) Both undergo the same change in temperature.
    D) You need to know the initial temperatures of the metals.
    E) You need to know which metals you have.

12. Which of the following does *not* have a standard enthalpy of formation equal to zero at 25°C and 1.0 atm?
    A) $F_2(g)$
    B) $Al(s)$
    C) $H_2O(l)$
    D) $H_2(g)$
    E) They all have a standard enthalpy equal to zero.

13. A gas sample is held at constant pressure. The gas occupies 3.62 L of volume when the temperature is 21.6°C. Determine the temperature at which the volume of the gas is 3.39 L.

14. A gas sample is heated from -20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.149 atm, what is the final pressure?

15. A 4.53-L sample of carbon monoxide is collected at 55°C and 0.824 atm. What volume will the gas occupy at 1.05 atm and 25°C?

16. What volume is occupied by 17.6 g of methane (CH_4) at 27°C and 2.56 atm?

17. Calculate the density of nitrogen at STP.

18. A 3.31-g sample of lead nitrate, $Pb(NO_3)_2$, molar mass = 331 g/mol, is heated in an evacuated cylinder with a volume of 1.56 L. The salt decomposes when heated, according to the equation:

$$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$$

Assuming complete decomposition, what is the pressure in the cylinder after decomposition and cooling to a temperature of 300. K? Assume the PbO(s) takes up negligible volume.

19. At 1000°C and 10. torr, the density of a certain element in the gaseous state is 1.14×10^{-3} g/L. Identify the element (note: also consider some elements are diatomic)

20. Given the equation:

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

A 3.00-g sample of $KClO_3$ is decomposed and the oxygen at 24.0°C and 0.628 atm is collected. What volume of oxygen gas will be collected assuming 100% yield?

21. A vessel with a volume of 31.1 L contains 2.80 g of nitrogen gas, 0.807 g of hydrogen gas, and 79.9 g of argon gas. At 25°C, what is the pressure in the vessel?

22. A gaseous mixture containing 1.5 mol Ar and 3.5 mol CO_2 has a total pressure of 8.8 atm. What is the partial pressure of CO_2?

23. The partial pressures of CH_4, N_2, and O_2 in a sample of gas were found to be 175 mmHg, 514 mmHg, and 563 mmHg, respectively. Calculate the mole fraction of oxygen.

24. The _____ of a system is the sum of the kinetic and potential energies of all the particles in the system.

25. A fuel-air mixture is placed in a cylinder fitted with a piston. The original volume is 0.220-L. When the mixture is ignited, gases are produced and 885 J of energy is released. To what volume will the gases expand against a constant pressure of 635 mmHg, if all the energy released is converted to work to push the piston? Make sure your units agree.

26. The enthalpy of fusion of ice is 6.020 kJ/mol. The specific heat capacity of liquid water is 4.184 J/g·°C. What is the minimum number of ice cubes at 0°C, each containing one mole of water, necessary to cool 500. g of liquid water initially at 20°C to 0°C?

27. What is the specific heat capacity of a metal if it requires 179.4 J to change the temperature of 15.0 g of the metal from 25.00°C to 33.00°C?

28. Consider the reaction:

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l),\ \Delta H = -1370 \text{ kJ}$$

When a 28.3-g sample of ethyl alcohol (molar mass = 46.07 g/mol) is burned, how much energy is released as heat?

29. The heat of formation of $Fe_2O_3(s)$ is -826.0 kJ/mol. Calculate the heat of the reaction $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ when a 31.57-g sample of iron is reacted.

30. The total volume of hydrogen gas needed to fill the Hindenburg was 2.11×10^8 L at 1.00 atm and 25.3°C. How much heat was evolved when it burned?

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l),\ \Delta H = -572 \text{ kJ}$$

31. What is the enthalpy change when 32.0 mL of 0.510 *M* sulfuric acid reacts with 24.6 mL of 0.167 *M* potassium hydroxide?

$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$ $\quad \Delta H° = -111.6$ kJ/mol

32. Given the heats of the following reactions:

		$\Delta H°$(kJ)
I.	$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(g)$	–1225.6
II.	$P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$	–2967.3
III.	$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$	–84.2
IV.	$PCl_3(g) + \frac{1}{2} O_2(g) \rightarrow Cl_3PO(g)$	–285.7

Calculate the value of $\Delta H°$ for the reaction below:

$$P_4O_{10}(s) + 6PCl_5(g) \rightarrow 10Cl_3PO(g)$$

33. Using the following thermochemical data, calculate $\Delta H_f°$ of $Nd_2O_3(s)$.

$2NdCl_3(s) + 3H_2O(l) \rightarrow Nd_2O_3(s) + 6HCl(g)$ $\quad \Delta H° = 577.7$ kJ/mol

$2Nd(s) + 3Cl_2(g) \rightarrow 2NdCl_3(s)$ $\quad \Delta H° = -2082.0$ kJ/mol

$4HCl(g) + O_2(g) \rightarrow 2Cl_2(g) + 2H_2O(l)$ $\quad \Delta H° = -202.4$ kJ/mol

Hint: First write the equation for the formation of Nd_2O_3.

34. Consider the following standard heats of formation:

$P_4O_{10}(s) = -3110$ kJ/mol

$H_2O(l) = -286$ kJ/mol

$H_3PO_4(s) = -1279$ kJ/mol

Calculate the change in enthalpy for the following process:

$P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(s)$

Answer Key

1.	A
	Chapter/Section: 5.1
2.	B
	Chapter/Section: 5.6
3.	E
	Chapter/Section: 5.3
4.	A
	Chapter/Section: 5.6
5.	B
	Chapter/Section: 5.3
6.	C
	Chapter/Section: 6.1
7.	C
	Chapter/Section: 6.1
8.	B
	Chapter/Section: 6.1
9.	A
	Chapter/Section: 6.1
10.	E
	Chapter/Section: 6.2
11.	A
	Chapter/Section: 6.2
12.	C
	Chapter/Section: 6.4
13.	276 K
	Chapter/Section: 5.2
14.	0.0864 atm
	Chapter/Section: 5.3
15.	3.23 L
	Chapter/Section: 5.3
16.	10.6 L
	Chapter/Section: 5.3
17.	1.25 g/L
	Chapter/Section: 5.4
18.	0.395 atm
	Chapter/Section: 5.4
19.	Be
	Chapter/Section: 5.4
20.	1.43×10^3 mL
	Chapter/Section: 5.4
21.	1.97 atm
	Chapter/Section: 5.5
22.	6.2 atm

	Chapter/Section: 5.5
23.	0.450
	Chapter/Section: 5.5
24.	internal energy
	Chapter/Section: 6.1
25.	10.7 L
	Chapter/Section: 6.1
26.	7
	Chapter/Section: 6.2
27.	1.49 J/g°C
	Chapter/Section: 6.2
28.	8.42×10^2 kJ
	Chapter/Section: 6.2
29.	–233.5 kJ
	Chapter/Section: 6.4
30.	2.47×10^9 kJ
	Chapter/Section: 6.2
31.	–0.229 kJ
	Chapter/Section: 6.2
32.	–610.1 kJ
	Chapter/Section: 6.3
33.	–1807.9 kJ/mol
	Chapter/Section: 6.3
34.	–290 kJ See Sec. 6.4 of Zumdahl *Chemistry*. 4(-1279) - [-3110 + 6(-286)] = -5116 + 3110 + 1716 = -290
	Chapter/Section: 6.4