CHM1045 Practice Test 3 v.1 Name_____
Fall 2013 & 2011 (Ch. 5, 6, 7, & part 11) *Revised April 10, 2014*

Given: Speed of light in a vacuum = 3.00×10^{8} m/s
Planck's constant = 6.626×10^{-34} J•s

$$\Delta E = (-2.18 \times 10^{-18}\,J)\left(\frac{1}{n_{final}^{2}} - \frac{1}{n_{initial}^{2}}\right)$$

Part A. Multiple Choice – **Circle** the best answer, **FILL IN THE BLANK or ANSWER**.

1. The first law of thermodynamics is: (1 pts.)
   A) Mass is neither created nor destroyed.
   B) Energy is neither created nor destroyed.
   C) Pressure is constant.
   D) Gases obey the gas laws.

2. Standard Temperature and Pressure (STP) for gases is _____. (2 pts.)

   A) 25°C, 1 atm B) 0°C, 760 atm C) 0°C, 760 Torr D) 1°C, 0 atm

3. If the temperature of a gas decreases, what will happen to the volume if all other variables are held constant? (2 pts.)

   a) increase b) decrease c) stays the same

4. Question #3 above illustrates: (2 pts.)
   a) Charles' Law b) Avogadro's Law
   c) Boyle's Law d) Graham's Law
   e) Dalton's Law

5. What are the possible values of n and m_l for an electron in a 3d orbital? (2 pts.)
   a) $n = 3$ and $m_l = 2$
   b) $n = 3$ and $m_l = -1, 0,$ or $+1$
   c) $n = 2$ and $m_l = -2, -1, 0, +1,$ or $+2$
   d) $n = 3$ and $m_l = -2, -1, 0, +1,$ or $+2$
   e) $n = 3$ and $m_l = -3, -2, -1, 0, +1, +2,$ or $+3$

6. Which of the following set of quantum numbers are <u>not</u> allowed? (2 pts.)
   a) n=2, l=1, m_l= −1,0,+1
   b) n=3, l=2, m_l= −2, −1, 0, +1, +2
   c) n=3, l=3, m_l= −3, −2, −1, 0, +1, +2, or +3
   d) n=3, l=1, m_l= −1,0,+1

7. Kinetic Energy is defined as:
   (2 pts.)

8. The change of state from a gas to a solid is called _____. (1 pt.)

9. The name of the quantum number n is _____. (1 pt.)

10. Give a general description in words of the van der Waals equation (don't need to give the actual equation) and list at least one "thing" that this equation corrects for. (3 pts.)

11. The temperature of a 5.00 L container of N_2 gas is increased from 20ºC to 250ºC. If the volume is held constant, predict qualitatively how this change affects the following: (a) the average kinetic of the molecules; (b) the average speed of the molecules; (c) the total number of collisions of molecules with the walls per second; (d) the pressure in the container. (8 pts.)

Part B. Calculations. **<u>MUST SHOW ALL WORK</u>**. Give answer to correct significant figures and units.

12. (a) Is the following reaction exothermic or endothermic? Circle one. (2 pts.)
    (b) How much heat is absorbed or released when 7.55g of hydrogen are produced? (4 pts.)

$$2\ NH_3(s) \rightarrow N_2\ (g) + 3\ H_2\ (g) \qquad \Delta H = +92.38\ kJ$$

13. We obtain uranium-235 and U-238 by fluorinating the uranium to form UF_6 (which is a gas) and then taking advantage of the different rates of effusion and diffusion for compounds containing the two isotopes. Calculate the ratio of effusion rates for $^{238}UF_6$ and $^{235}UF_6$. The atomic mass of U-235 is 235.054 amu and that of U-238 is 238.051 amu (6 pts.)

14. (a) Convert 738 mmHg into Torr.
    (b) Convert 738 mmHg into atm.
    (c) Convert 738 mmHg into in.Hg. Show work. (8 pts. total)

15. Zinc metal reacts with hydrochloric acid according to the balanced equation:

$$Zn\ (s) + 2\ HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$$

When 0.103 g of Zn (s) is combined with enough HCl to make 50.0 mL of solution in a coffee-cup calorimeter, all of the zinc reacts, raising the temperature of the solution from 22.5°C to 23.7°C. Find ΔH for this reaction as written. (Use 50.0 g as the mass of the solution and 4.18 J/g·ºC as the specific heat.) (7 pts.)

16. A 248 mL gas sample has a mass of 0.433 g at a pressure of 745 Torr and a temperature of 28°C. What is the molar mass of the gas? (6 pts.)

17. A local radio station broadcasts and an energy of 7.82×10^{-26} J. What is this frequency in MHz? Show work. (4 pts.)

18. Green light has a wavelength of about 0.550 μm. What is the frequency in Hertz? (3 pts.)

19. A gas mixture contains 1.45 g N_2 and 0.65 g O_2 in a 1.75 L container at 19°C. Calculate the partial pressure of each component in the gas mixture and calculate the total pressure. (7 pts.)

20. How much energy is needed to heat 45.0 g of H_2O (s) from –25.0°C to 0.0°C? (4 pts.)

21. How much energy in kJ is needed to convert 115.0 g of H_2O from a liquid at 100ºC to a gas at 100ºC? (4 pts.)

22. CH_3OH can be synthesized by the reaction:

$$CO\ (g) + 2\ H_2\ (g) \rightarrow CH_3OH\ (g)$$

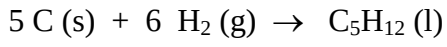
What volume of H_2 gas (in liters), at 85°C and 746 mmHg partial pressure of hydrogen gas, is required to synthesize 27.7 g of CH_3OH? MUST SHOW WORK. (7 pts.)

23. The volume of helium gas in a balloon is 5.0 L at 788 Torr. What is the volume of the balloon at 465 Torr if the temperature is constant? (6 pts.)

24. Use the change in enthalpy of formations to calculate ΔH of the following reaction. (7 pts.)

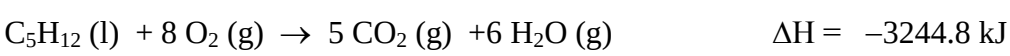
$$N_2O_4\,(g) + 4\,H_2(g) \rightarrow N_2\,(g) + 4\,H_2O\,(g)$$

25. Calculate ΔH for the following reaction: (8 pts) **MUST SHOW ALL WORK!**



$$5\ C\ (s) + 6\ H_2\ (g) \rightarrow C_5H_{12}\ (l)$$

Using the enthalpies of reactions:



$$C_5H_{12}\ (l) + 8\ O_2\ (g) \rightarrow 5\ CO_2\ (g) + 6\ H_2O\ (g) \qquad \Delta H = -3244.8\ kJ$$

$$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g) \qquad \Delta H = -393.5\ kJ$$

$$2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g) \qquad \Delta H = -483.5\ kJ$$

26. The oxygen gas formed in a chemical reaction is collected over water at 30.0ºC at a total pressure of 732 mmHg. What is the partial pressure of the oxygen gas collected in this way? If the total volume of gas collected is 722 mL, what mass of oxygen gas is collected? (8 pts.)

Given for Test 3

Gas constant = 0.08206 L·atm/mole·K = 8.314 J/mole·K

1 cal = 4.184 J

Properties of Water

Density = 0.99987 g/mL at 0°C
1.00000 g/mL at 4°C
0.99707 g/mL at 25°C
0.95838 g/mL at 100°C

Specific heat = ice, 2.092 J/gK
water, 4.184 J/gK
steam, 1.841 J/gK

Heat of fusion = 6.008 kJ/mol Heat of vaporization = 40.67 kJ/mol

Properties of Ethanol (C_2H_5OH)

Melting point = –117.3°C Boiling point = 78.5°C
Heat of fusion = 26.05 cal/g Heat of vaporization = 9,673.9 cal/mol
Specific heat = liquid, 27.0 cal/mol
gas, 15.7 cal/mol

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compound	ΔH_f (kJ/mole)	compound	ΔH_f (kJ/mole)
$CH_4(g)$	−74.8	C_3H_8 (g)	−103.85
CO (g)	−110.5	C_4H_{10} (g)	−124.73
CO_2 (g)	−393.5	C_4H_{10} (l)	−147.6
H_2O (g)	−241.82		
H_2O (l)	−285.83		
NO(g)	+90.37		
$NO_2(g)$	+33.84		
$N_2O(g)$	+81.6		
$N_2O_4(g)$	+9.66		
C_2H_4 (g)	+52.30		
C_2H_6 (g)	−84.68		

Vapor pressue of water (Torr):

Vapor Pressure (torr)							
T (°C)	P	T (°C)	P	T (°C)	P	T (°C)	P
0	4.58	21	18.65	35	42.2	92	567.0
5	6.54	22	19.83	40	55.3	94	610.9
10	9.21	23	21.07	45	71.9	96	657.6
12	10.52	24	22.38	50	92.5	98	707.3
14	11.99	25	23.76	55	118.0	100	760.0
16	13.63	26	25.21	60	149.4	102	815.9
17	14.53	27	26.74	65	187.5	104	875.1
18	15.48	28	28.35	70	233.7	106	937.9
19	16.48	29	30.04	80	355.1	108	1004.4
20	17.54	30	31.82	90	525.8	110	1074.6