 Name: ______________________________

Chem 111 *9:05a section* *Final Exam v1*

This exam is composed of **50** questions. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations.

$PV = nRT$ $N_o = 6.022x10^{23}\ mol^{-1}$ $1\ mL = 1\ cm^3$ $h = 6.626x10^{-34}\ J\ s$

$E = h\nu = \frac{hc}{\lambda}$ $\overline{u^2} = \frac{3RT}{M}$ $\overline{K.E.} = \frac{1}{2}m\overline{u^2}$ $1\ atm = 760\ mm\ Hg$ $c = 2.998x10^8\ m\ s^{-1}$

$\Delta H_{vap}(H_2O) = 40.65\ kJ\ mol^{-1}$ $R = 0.0820\ L\ atm\ K^{-1}\ mol^{-1}$

$E_n^{H-atom} = -\frac{R_H hc}{n^2}$ $R_H hc = 1312\ kJ\ mol^{-1}$ $\Delta H_{fus}(H_2O) = 6.00\ kJ\ mol^{-1}$ $R = 8.314\ J\ K^{-1}\ mol^{-1}$

$\Delta E = q + w = \Delta H - P\Delta V$ $J = kg\ m^2\ s^{-2}$

PERIODIC TABLE OF THE ELEMENTS

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.939	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (99)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 181.0	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.0	89 **Ac** 227.0	104 **Unq** (261)	105 **Unp** (262)	106 **Unh** (263)	107 **Uns** (262)	108 **Uno** (265)	109 **Une** (266)									

Solubility Rules for some ionic compounds in water

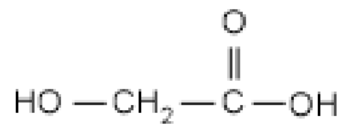
Soluble Ionic Compounds

1. All sodium (Na^+), potassium (K^+), and ammonium (NH_4^+) salts are SOLUBLE.
2. All nitrate (NO_3^-), acetate ($CH_3CO_2^-$), chlorate (ClO_3^-), and perchlorate (ClO_4^-) salts are SOLUBLE.
3. All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) (Pb^{2+},Ag^+, Hg_2^{2+}) which are NOT soluble.
4. All sulfate (SO_4^{2-}) salts are SOLUBLE - - EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead (Ca^{2+}, Ag^+, Hg_2^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}) which are NOT soluble.

Not Soluble Ionic Compounds

5. Hydroxide (OH^-) and oxide (O^{2-}) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium (Na^+, K^+, Ba^{2+}) which are soluble.
6. Sulfide (S^{2-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium (Na^+, K^+, NH4$^+$, Ba^{2+}) which are soluble.
7. Carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium (Na^+, K^+, NH_4^+), which are soluble.

1. Surgeons use biodegradable polymers for sutures. One commonly used polymer, poly(glycolic acid), degrades to the small molecule glycolic acid, shown at right. 0.5 moles of glycolic acid corresponds to what mass of glycolic acid?



1) 23.5 g 2) 90.1 g 3) 111 g 4) 38.0 g 5) 45.0 g

(4) $C_2H_4O_3$ $M = [2(12.01) + 4(1.008) + 3(16.00)]g\ mol^{-1} = 76.05 g\ mol^{-1}$ **(Chapt 3)**

$m = n\,M = (0.5 mol)(76.05 g\ mol^{-1}) = 38.0 g$

2. Direct reaction of iodine (I_2) and chlorine (Cl_2) produces an iodine chloride, I_xCl_y, a bright yellow solid. If you completely use up 0.678 g of iodine and produced 1.246 g of I_xCl_y, what is the empirical formula of the compound?

1) I_2Cl_3 2) ICl_3 3) I_3Cl_2 4) I_3Cl 5) I_3Cl_3

(2) ICl_3

Mass I_2 incorporated $= 0.678 g$

$\text{moles I incorporated} = \dfrac{0.678 g}{126.91 g\ mol^{-1}} = 0.00534 mol$

Mass Cl_2 incorporated $= 1.246 g - 0.678 g = 0.568 g$

$\text{moles Cl incorporated} = \dfrac{0.568 g}{35.45 g\ mol^{-1}} = 0.0160 mol$

$$\frac{y}{x} = \frac{0.0160 mol}{0.00534 mol} = 3.00$$

3. What is the formula of the ionic compound expected to form between the ions $\mathbf{Fe^{3+}}$ and $\mathbf{SO_4^{2-}}$?

1) $Fe_2(SO_4)_3$ 2) Fe_2SO_4 3) $Fe(SO_4)_2$ 4) $FeSO_4$ 5) Fe_2SO_2

(1) **$Fe_2(SO_4)_3$** **(OWL, Chapt 3)**

4. A sample of aspirin, $\mathbf{C_9H_8O_4}$, contains 0.104 mol of the compound. What is the mass of this sample, in grams?

1) 20.1 g 2) 12.5 g 3) 37.3 g 4) 0.0730 g 5) 18.7 g

First we need the molar mass of $C_9H_8O_4$:

$$9(\text{molar mass of C}) + 8(\text{molar mass of H}) + 4(\text{molar mass of O}) =$$

$$9\left(12.011\frac{\text{g}}{\text{mol}}\right) + 8\left(1.0079\frac{\text{g}}{\text{mol}}\right) + 4\left(15.9994\frac{\text{g}}{\text{mol}}\right) = 180.2\frac{\text{g}}{\text{mol}}$$

Use that to calculate the mass:

(5) $(0.104 mol)\left(\dfrac{108.10 g}{mol}\right) = 18.74 g$ **(OWL, Chapt 3)**

5. What is the wavelength of light with frequency $6.01 x 10^{14}$ Hz?

1) 209 nm 2) 420 nm 3) 501 nm 4) 162 nm 5) 250 nm

(3)

$$\lambda = \left(\frac{2.9998x10^{8}\,m}{s}\right)\left(\frac{1}{5.99x10^{14}\,Hz}\right)\left(\frac{Hz}{1}\,\frac{s}{1}\right) = 5.01x10^{-7}\,m$$

(OWL, Chapt 7)

$$= 5.01x10^{-7}\,m\left(\frac{10^{9}\,nm}{m}\right) = 501nm$$

6. What is the wavelength of the photon emitted from or absorbed by a hydrogen atom when the electron goes from n=7 to n=2?

1) 0.023 nm 2) 397 nm 3) 434 nm 4) 923 nm 5) 22 nm

$$E = E_f - E_i = \left(-\frac{Rhc}{n_f^2}\right) - \left(-\frac{Rhc}{n_i^2}\right) = -Rhc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) = -1312\ kJ\ mol^{-1}\left(\frac{1}{2^2} - \frac{1}{7^2}\right) = 301\ kJ\ mol^{-1}$$

$$\lambda = \frac{hc}{E} = \frac{hc}{-Rhc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)} = \frac{1}{-(1.097x10^{7}\,m^{-1})\left(\frac{1}{2^2} - \frac{1}{7^2}\right)}$$

$$= \frac{1}{-(1.097x10^{7}\,m^{-1})\left(\frac{1}{4} - \frac{1}{49}\right)} = \frac{1}{-(1.097x10^{7}\,m^{-1})(0.2296)} = -3.97x10^{-7}\,m = 397nm$$

(2) What happened to the negative sign? A negative wavelength makes no sense. This reflects that E is negative. That is, that energy is *emitted* in this transition. Had we done the longer calculation (solved for E first), we would have dropped the negative sign at that point. **(Chapt 7)**

7. In the above question, does the energy of the H atom increase or decrease?

1) increase 2) decrease 3) doesn't change 4) can't tell

(2) If you note that higher "n" values are at higher energy, then this is clearly a transition from higher to lower energy – energy must be given off (emitted as a photon to the environment). The energy of the H atom must therefore decrease

(Chapt 7, with a Chapter 6 twist)

8. A local AM radio station broadcasts at an energy of **$3.33x10^{-7}$ kJ/mol.** Calculate the frequency at which it is broadcasting.

1) 1.39 MHz 2) 0.835 MHz 3) 1.39 KHz 4) 2.23 Mhz 5) Cant' tell

(2) $$\nu = \frac{E}{h} = \frac{3.33x10^{-7}\,kJ\,mol^{-1}}{6.626x10^{-34}\,J\,s}\,\frac{10^{3}\,J}{kJ}\,\frac{1}{6.02x10^{23}\,mol^{-1}} = 8.35x10^{5}\,s^{-1} = 0.835\,MHz$$

(OWL, Unit 7-2c and 7-3c)

 Name: ______________________________

9. The angular momentum quantum number *l* specifies:

1) subshell orbital shape 2) orbital orientation
3) transition probability 4) orbital karma
5) energy and distance from nucleus

(1) **(OWL, Unit 7-7b)**

10. The name of the element represented by the symbol C is:

1) carbon 2) nitrogen 3) oxygen 4) neon 5) aluminum

(1) A freebie!

11. Which list below is in order of increasing ionization energy (low to high)?

1) Cl < S < P < Si 2) Ne < F < O < N
3) F < Cl < Br < I 4) Rb < K < Na < Li
5) none of the above

(4) **(Chapt 8)**

12. Which of the following correctly compares atomic sizes (small to large)?

1) Ne < Li < B < C < N 2) Ne < N < C < O < Be
3) N < C < B < Be < Li 4) Ar < Cl < S < P < Si
5) none of the above

(3 or 4) **(OWL, Unit 8-8c)**

13. Which of the following correctly compares ionic/atomic sizes (small to large)?

1) Ne < O < C < Mg^{2+} < Na^{+} 2) Ca^{2+} < K^{+} < Ar < Cl^{-} < S^{2-}
3) C < O < Ne < Na^{+} < Mg^{2+} 4) Ne < Mg^{2+} < Na^{+} < O < C
5) none of the above

(2) **(OWL, Unit 8-9c)**

14. The correct spectroscopic notation for the sulfur ion Si^{-} is:

1) $1s^2 2s^2 2p^6 3s^2 3p^2$ 2) $1s^2 2s^2 2p^6 3s^2 3p^3$
3) $1s^2 2s^2 2p^6 3s^2 3p^4$ 4) $1s^2 2s^2 2p^6 3s^2 3p^5$
5) $1s^2 2s^2 2p^6 3s^2 3p^6$

(2) **(OWL, Unit 8-7c)**

 Name: ______________________________

15. What is the **maximum number of electrons** that can be accomodated by the orbitals that can be identified by the set of quantum numbers $n=+3$ $l=+2$?

1) 3 2) 6 3) 4 4) 10 5) 12

(4) for *l* = 2, one can have m_l = -2, -1, 0, +1, +2 (5 orbitals, with 10 electrons) (Chapt 7)

16. Draw the Lewis structure for $\mathbf{NO_2^-}$

Your resulting molecule has a total of:

1) Two single bonds
2) Two double bonds
3) One single and one double bond
4) One double and one triple bond
5) Two triple bonds

(3) From OWL units 9-1d and 9-2b. See Study Questions 13-14, Chapter 9 of K&T

<u>Bond Dissociation Energies</u> (kJ mol^{-1}) (gas phase)

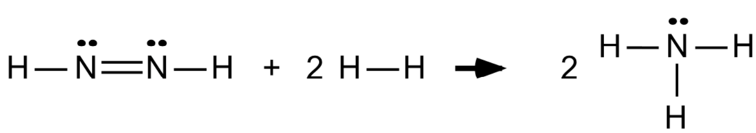
Bond	D	Bond	D	Bond	D
H-H	436	C-C	346	N-N	163
C-H	413	C=C	610	N=N	418
N-H	391	O-O	146	C-O	358
O-H	463	O=O	498	C=O	745

17. Consider the reaction: HNNH (g) + H_2 (g) → 2 NH_3 (g)

What is the energy ($\Delta H°$, in kJ mol^{-1}) for this reaction?

1) –183 2) +183 3) –274 4) +463 5) +274

5) –1 for one O and 0 for the other O

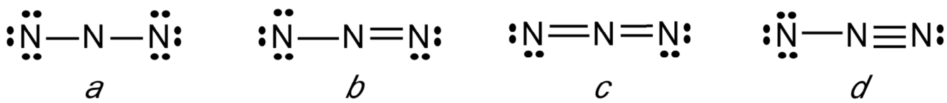


(3)

$\Delta H°$ = (Bonds Broken) – (Bonds Formed)

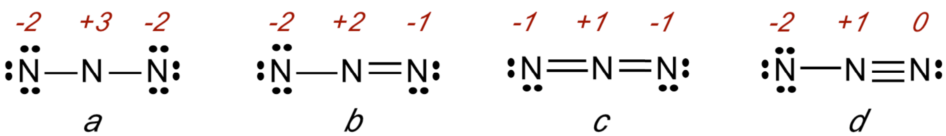
$\Delta H° = (D_{N=N} + 2D_{H-H}) - (4D_{N-H})$ = [418 + 2(436)] – 4(391) = -274 kJ mol^{-1} (Chapt 9)

(Questions 18-19) Consider the following resonance forms for the azide ion N_3^-



18. In resonance structure **c**, what is the formal charge on the central N?

1) +3 2) –2 3) –1 4) 0 5) +1



(5) **(Chapt 9)**

19. Which resonance structure is lowest in energy?

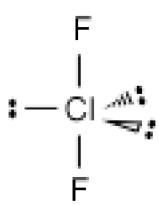
1) a 2) b 3) c 4) d 5) all same

(3) **(Chapt 9)**

20. Draw the Lewis structure for $\mathbf{ClF_2^-}$. The molecular geometry is:

1) square planar 2) square pyramidal 3) trigonal bipyramidal

4) octahedral 5) none of the above



(5) **it's linear!** **(OWL, Chapt 9)**

21. The molecular ion $\mathbf{ClF_2^-}$ is:

1) polar 2) nonpolar 3) can't tell

(2) nonpolar – the individual dipoles out. **(OWL, Unit 9b)**

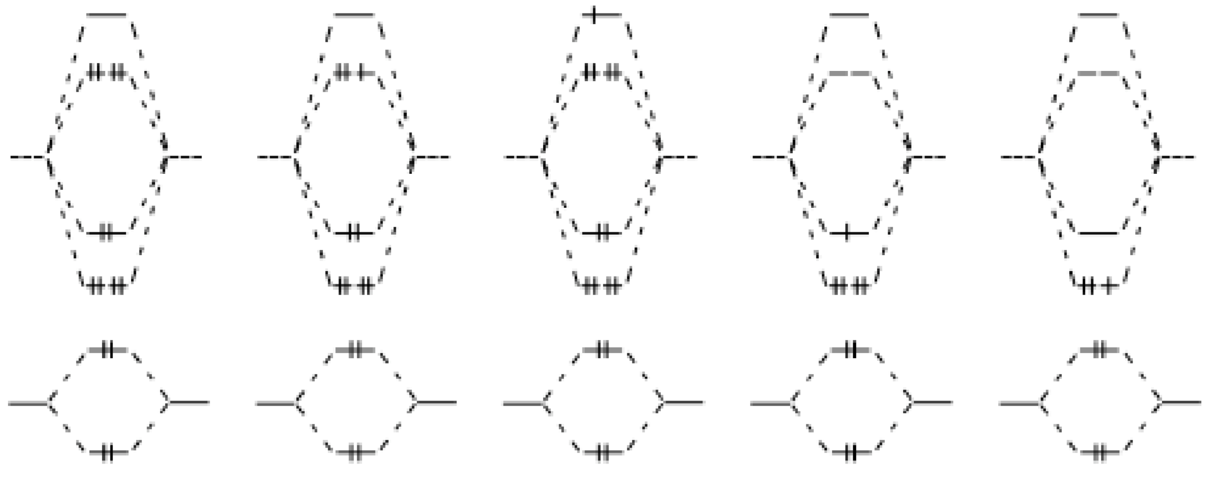
22. In $\mathbf{ClF_2^-}$, what is the hybridization on **Cl**?

1) sp^3d^3 2) sp^3d^2 3) sp^3d 4) sp^3 5) sp^2

(3) five orbitals required **(OWL, Chapt 10)**

 Name: ______________________________

23. Which of the following molecular orbital representations correctly describes F_2^+?



(1) (2) (3) (4) (5)

(2) – 13 electrons – from OWL 10-5c

24. From molecular orbital theory, the bond order in F_2^+ is:

1) single 2) double 3) 0.5 4) 1.5 5) 2.5

(4) **(OWL, Unit 10-5c)**

25. The molecule F_2^+ is predicted to be:

1) paramagnetic 2) diamagnetic 3) can't tell

(1)

26. Consider the molecular orbital diagram shown at right:

This energy diagram best describes:

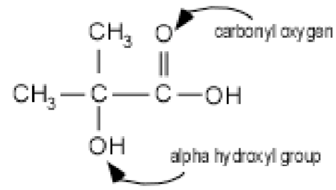
1) O_2 2) NO^- 3) NO^+ 4) N_2

(2) count electrons!! – from OWL 10-5c w/ a minor twist

Note that O is more electronegative, and therefore lower in energy, than N (O is on the right). **(OWL, Chapt 10)**

 Name: ______________________________

27. Trendy anti-wrinkle creams advertise the presence of "alpha hydrox" as a key component. A structure of an alpha hydroxy acid is shown at right. In this molecule, what is the hybridization at the ***carbonyl oxygen***? Hint: the oxygen atom is "happy."



1) sp 2) sp^2 3) sp^3 4) sp^3d 5) sp^3d^2

(2) To complete the octet on O and make it "happy," we need to add two pairs of electrons. This places 3 "electron groupings" around O and therefore we need hybridization that gives us 3 hybrid orbitals. **(Chapter 10)**

28. Write the balanced, ***net ionic equation*** corresponding to the reaction of **sodium nitrate** and **barium hydroxide**. In your net ionic equation, the coefficient in front of $\mathbf{OH^-}$ (aq) is:

1) 1 2) 2 3) 3 4) 4
5) 0 (OH^- doesn't occur in the net ionic equation)

(5) everything is soluble, no net ionic equation **(OWL, Unit 5-2c)**

29. Write the balanced, ***net ionic equation*** corresponding to the reaction of **potassium nitrate** and **iron(II) iodide**. In your net ionic equation, the coefficient in front of $\mathbf{NO_3^-}$ (aq) is:

1) 1 2) 2 3) 3 4) 4
5) 0 (NO_3^- doesn't occur in the net ionic equation)

(5) everything is soluble, no net ionic equation **(OWL, Unit 5-2d)**

30. Mixing $\mathbf{Na_2CO_3}$ with **KCl** in water leads to precipitation of:

1) a CO_3^{2-} salt 2) a Na^+ salt 3) a Cl^- salt
4) everything precipitates 5) no precipitation

(5) **(OWL, inspired by Unit 5-2d)**

31. Gold can be dissolved from gold-bearing rock by treating the rock with sodium cyanide in the presence of oxygen.

$$4Au\ (s) + 8NaCN\ (aq) + O_2\ (g) + 2H_2O\ (l) \rightarrow 4NaAu(CN)_2\ (aq) + 4NaOH\ (aq)$$

For this reaction, what is the reducing agent?

1) Au 2) NaCN 3) O_2 4) H_2O 5) H^+

(1) Au **(Textbook problem 5-122)**

 Name: ______________________________

32. What is the oxidation number of antimony in Sb_2O_5?

1) +2 2) –2 3) +5 4) –5 5) 0

(3) +5 **(OWL Unit 5-8b)**

33. Hydrogen peroxide, H_2O_2, is a reasonably strong:

1) acid 2) base 3) oxidizing agent 4) reducing agent

(3) O has an oxidation number of –1, it wants to be –2 **(OWL Unit 5-8b)**

34. In general, strong acids are:

1) good oxidants 2) good reductants 3) insoluble

4) strong electrolytes 5) weak electrolytes

(4) strong electrolyte == well-dissociated **(OWL Unit 5-5b)**

35. In an endothermic process:

1) work is performed on the surroundings
2) heat is transferred to the surroundings
3) work is performed on the system
4) heat is transferred to the system

(4) **(Chapter 6)**

36. Ability to do work is best described as:

1) ΔH 2) q 3) ΔE 4) ΔE-q 5) ΔG

(4) Ability to do work is w. ΔE=q+w **(Chapter 6)**

37. A positive value of ΔE means that:

1) heat is tranferred to the surroundings

2) heat is transfered to the system

3) energy in the form of heat and/or work is transferred to the surroundings

4) energy in the form of heat and/or work is transferred to the system

(4) **(Chapter 6)**

38. An automobile engine generates **2575** Joules of heat that must be carried away by the cooling system. The internal energy changes by **–3258** Joules in this process.

How much work to push the pistons is available in this process ?

1) 4918 J 2) 5833 J 3) 683 J 4) 6283 J 5) 773 J

$\Delta E = q + w \qquad w = \Delta E - q = (-3258\ J) - (-2575\ J) = -683\ J$

(3) w is negative. The system does work on the surroundings. **(Chapter 6)**

 Name: ______________________________

39. An instant ice pack for first-aid treatment uses the dissolution of an ionic salt in water to provide cold therapy. Given the standard molar enthalpies of formation shown at right, determine ΔH for the reaction:

Subst	$\Delta H_f°$ (kJ/mol)
NH_4^+ (aq)	-132.51
NO_3^- (aq)	-205.0
Cl^- (aq)	-167.2
NH_4NO_3 (s)	-365.56
NH_4Cl (s)	-314.43

$NH_4NO_3\ (s) \rightarrow NH_4^+\ (aq) + NO_3^-\ (aq)$

1) –28.05 kJ mol^{-1} 2) +28.05 kJ mol^{-1}

3) –14.72 kJ mol^{-1} 4) +14.72 kJ mol^{-1}

5) not enough information to determine

(2) $\left[(-132.51)+(-205.0)\right]-\left[(-365.56)\right]=28.05\ kJ\ mol^{-1}$ **(Chapt 6)**

40. Given the information on page 1, what is the heat required to vaporize water at 298 K?

1) –40.65 kJ mol^{-1} 2) 40.65 kJ mol^{-1} 3) 44.00 kJ mol^{-1}

4) –44.00 kJ mol^{-1} 5) not enough information to determine

(5) From what you are given, you cannot compute this. The value for ΔHvap given on page 1 is at the boiling point, 373K, not 298K. To complete this question, you'd need the heat capacities for liquid water and for water vapor. **(Chapt 6)**

41. A 45.5 g sample of copper at 99.8 °C is dropped into a beaker containing 152 g of water at 18.5 °C. When thermal equilibrium is reached, what is the final temperature of the copper? The specific heat capacities of water and copper are 4.184 and 0.385 J g^{-1} K^{-1}, respectively.

1) 25.3 °C 2) 12.5 °C 3) 37.0 °C 4) 90.1 °C 5) 20.7 °C

$$q_{metal}+q_{water}=0$$

$$\left(0.385\ J\ g^{-1}\ K^{-1}\right)(45.5g)(x-99.8)K+\left(4.184\ J\ g^{-1}\ K^{-1}\right)(152g)(x-18.5)K=0$$

$$(x-99.8)K=\frac{-\left(4.184\ J\ g^{-1}\ K^{-1}\right)}{\left(0.385\ J\ g^{-1}\ K^{-1}\right)}\frac{(152g)}{(45.5g)}(x-18.5)K=-36.30(x-18.5)K$$

$$x-99.8=-36.30x-(18.5)(-36.30)$$

$$x+36.30x=99.8+671.6=771.4$$

$$x=20.7$$

(5) See also example 6.2 **(Text problem 6-20)**

42. Given the following information:

N_2 (g) + $2O_2$ (g) → N_2O_4 (g) ΔH° = 9.2 kJ

$2N_2O$ (g) → $2N_2$ (g) + O_2 (g) ΔH° = -164.2 kJ

what is the standard enthalpy change for the reaction:

$2N_2O$(g) + $3O_2$ (g) → $2N_2O_4$ (g) ΔH° = ?

1) –155 kJ mol^{-1} 2) –146 kJ mol^{-1} 3) 155 kJ mol^{-1}

4) 146 kJ mol^{-1} 5) not enough information to determine

$2N_2$ (g) + $4O_2$ (g) → $2N_2O_4$ (g) ΔH° = 2(9.2) kJ

$2N_2O$ (g) → $2N_2$ (g) + O_2 (g) ΔH° = -164.2 kJ

(2) ΔH° = (18.4 – 164.2) kJ mol^{-1}= –145.8 kJ mol^{-1} (Owl, Unit 6-6c)

43. The average molecular speed in a sample of N_2 gas is 408 m/s at 303 K. The average molecular speed in a sample of NO_2 gas at the same temperature is:

1) 408 m s^{-1} 2) 381 m s^{-1} 3) 478 m s^{-1} 4) 326 m s^{-1} 5) 318 m s^{-1}

(5) Same temperature means same kinetic energy, so (OWL, Unit 12-6d)

Note: as corrected at the exam, in the question, replace "average molecular speed" by "root mean square velocity"

$$KE = \frac{1}{2} m_{N_2} u_{N_2}^2 = \frac{1}{2} m_{NO_2} u_{NO_2}^2$$

$$u_{NO_2}^2 = \frac{m_{N_2}}{m_{NO_2}} u_{N_2}^2 = \frac{\left(2x14.01\ g\ mol^{-1}\right)}{\left(14.01\ g\ mol^{-1}\right) + \left(2x16.00\ g\ mol^{-1}\right)} \left(408\ m\ s^{-1}\right)^2$$

$$= 101376 \left(m\ s^{-1}\right)^2 = \left(318\ m\ s^{-1}\right)^2$$

44. A 1.28 mol sample of Ar gas is confined in a 31.5 liter container at 26.5 °C. If 1.28 mol of F_2 gas is added while maintaining constant temperature, the average kinetic energy per molecule will:

1) decrease 2) remain the same 3) increase

4) not enough information 5) I don't have a clue

(2) Temperature determines average kinetic energy (Chapter 12)

 Name: ______________________________

45. A sample of Cl_2 gas is confined in a 2.0 liter container at 50 °C. Then 2.5 mol of He is added, holding both the volume and temperature constant. The pressure will increase because:

1) As the number of molecule-wall collisions increases, the force per collision increases.
2) With more molecules in the container, the molecules have higher average speeds.
3) With more molecules per unit volume, there are more molecules hitting the walls of the container.
4) With higher average speeds, on average the molecules hit the walls of the container with more force.
5) None of the Above

(3) **(Chapter 12)**

46. In our bodies, sugar is broken down with oxygen to produce water and carbon dioxide. How many moles of glucose ($C_6H_{12}O_6$) are required to react completely with 33.6 L of oxygen gas (O_2) according to the following reaction at 0 °C and 1 atm pressure? Note that the reaction may need balancing.

$$C_6H_{12}O_6\ (s) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$$

1) 6.0 mol 2) 0.250 mol 3) 0.319 mol 4) 0.637 mol 5) 7.13 mol

(2) First, balance the reaction:

$$C_6H_{12}O_6\ (s) + 6O_2\ (g) \rightarrow 6CO_2\ (g) + 6H_2O\ (l)$$

6 mol of oxygen reacts with 1 mol of glucose, so first find the the number of moles of O_2 gas: $n = \frac{PV}{RT} = \frac{(1\ atm)(33.6\ L)}{(0.0820\ atm\ \ L\ \ mol^{-1}\ \ K^{-1})(273\ K)} = 1.50\ mol$

Therefore, we need $\left(\frac{1}{6}\right)1.50\ mol = 0.250\ mol$ **(OWL, Unit 12-3b)**

47. What is the total volume of gaseous products formed when 160 L of bromine trifluoride (BrF_3) react completely to form Br_2 and F_2? (All gases are at the same temperature and pressure, before and after.)

1) 85 L 2) 190 L 3) 380 L 4) 320 L 5) 160 L

(4) First, write a balanced equation:

$$2BrF_3 \rightarrow Br_2 + 3F_2$$

Look at mole ratios. 4 moles of gases are derived from 2 moles of reactants. Therefore, the volume should double. **(OWL, Unit 12-3b)**

 Name: ______________________________

48. The temperature of the atmosphere on Mars can be as high as 27 °C at the equator at noon, and the atmospheric pressure is about 9.0 mm of Hg. If a spacecraft could collect 8.20 m^3 of this atmosphere, compress it to a small volume, and send it back to earth, about how many moles would the sample contain?

1) 0.120 mmol 2) 0.395 mmol 3) 3.95 mol 4) 0.13 mol 5) 1.2 mol

$$n = \frac{PV}{RT} = \frac{(9.0mm)(8.2m^3)}{(0.0820\ atm\ L\ K^{-1}\ mol^{-1})(27+273)K}\left(\frac{atm}{760mm}\right)\left(\frac{100cm}{m}\right)^3\left(\frac{L}{1000cm^3}\right) = 3.95\ mol$$

(3) **(Chapter 12)**

49. What is the average kinetic energy of an N_2 molecule confined in 3.1 L at 1.0 atm and 25°C?

1) $5.71\text{x}10^{3}$ J 2) $9.48\text{x}10^{3}$ J 3) $5.71\text{x}10^{-21}$ J 4) $6.17\text{x}10^{-21}$ J 5) $3.21\text{x}10^{-21}$ J

(4)

$$\overline{K.E.} = \frac{1}{2}m\overline{u^2} \text{ (per molecule)} \qquad \overline{u^2} = \frac{3RT}{M}$$

$$\overline{K.E.} = \frac{1}{2}m\frac{3RT}{M}\left(\frac{M\ N_o^{-1}}{m}\right) = \frac{3}{2}\frac{RT}{N_o} = \frac{3}{2}\frac{(8.314\ J\ K^{-1}\ mol^{-1})(25+273)K}{(6.022\text{x}10^{23}\ mol^{-1})} = 6.17x10^{-21}\ J$$

(Chapter 12)

50. The correct designator for this course is:

1) Chem 111 2) Chem 262 3) Econ 3.33 4) Sports 01 5) Bio 233

(1)