Chemistry 141 Name

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Exam 1a March 20, 2012

Multiple Choice (20 points)

Page 4 (5 points)

Page 5 (16 points)

Page 6 (16 points)

Page 7 (16 points)

Page 8 (8 points)

Page 9 (8 points)

Page 10 (12 points)

Total (101 points)

All work must be shown to receive credit. Give all answers to the correct number of significant figures

Chemistry Formulas

Kinetic energy = ½ mv2

w = -PΔV

Ptotal = P1+P2+P3+…

u = (3RT/MW)½

ΔG = ΔH - TΔS

PV = nRT

Rate ∝ (MW)-½

P1=X1\*Ptotal

C = q/ΔT

Ptotal = P1 + P2 + P3 + …

M = mol/L

K = oC + 273.16

w=dxF

E = mc2

M1V1 = M2V2

Ptotal = P1 + P2 + P3 + …

M = mol/L

Avogadros number = 6.022 x 1023 /mol

Density of H*2*O(l) = 1.00 g/mL

h = 6.626 x 10-34 J sec

c= 2.9979 x 108 m/sec

e = 1.602 x 10-19 C

K = oC + 273.16

1 kcal = 4.184 kJ

R = 0.0821 L atm/mol K = 62.4 L torr/mol K = 8.31 kJ/mol K

760 torr = 760 mm Hg = 1.00 atm = 101 kPa = 14.6 psi = 30 in Hg

ΔHfo, B5H9*(l)* = 73.2 kJ/mol

ΔHfo, B2O3*(s)* = −1263.6 kJ/mol

ΔHfo, H2O*(l)* = −285.8 kJ/mol

ΔHfo, H2O *(g)* = −-241.8 kJ/mol

Grossmont College

Periodic Table

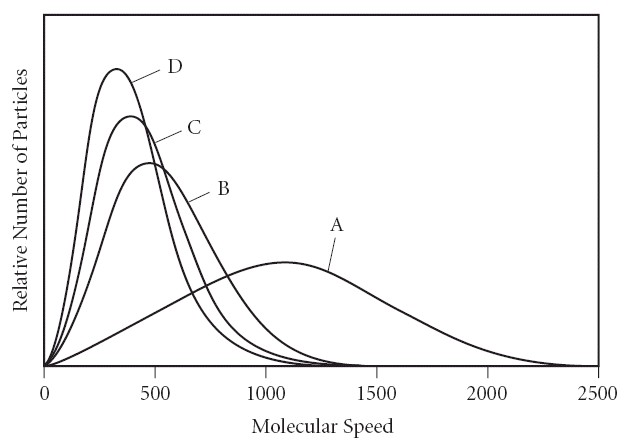
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| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | NOBLE GASES |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 3  **Li**  6.941 | 4  **Be**  9.012 |  |  |  |  |  |  |  |  |  | |  | 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**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 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**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 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**  180.9 | 74  **W**  183.9 | 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  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  162.5 | 67  **Ho**  164.9 | 68  **Er**  167.3 | 69  **Tm**  168.9 | 70  **Yb**  173.0 | 71  **Lu**  175.0 |
| 90  **Th**  232.0 | 91  **Pa**  231.0 | 92  **U**  238.0 | 93  **Np**  (237) | 94  **Pu**  (244) | 95  **Am**  (243) | 96  **Cm**  (247) | 97  **Bk**  (247) | 98  **Cf**  (251) | 99  **Es**  (252) | 100  **Fm**  (257) | 101  **Md**  (258) | 102  **No**  (259) | 103  **Lr**  (260) |

Lanthanide series

Actinide series

Multiple Choice (30 points) – Give the best answer for each of the following questions.

1. Which of the following gas samples would be most likely to behave ideally under the stated conditions?
   1. CO at 200 atm and 25°C
   2. SO2 at 2 atm and 0 K
   3. N2 at 1 atm and -70°C
   4. Ne at STP
   5. O2 at 400 atm and 25°C
2. Which of the following samples will have the lowest pressure if they are all at the same temperature and in identical containers (same V)?
   1. 15 g F2
   2. 15 g Kr
   3. 15 g Ne
   4. 15 g CO2
   5. All of these samples will have the same pressure.
3. Which of the following samples has the greatest density at STP?
   1. NO2
   2. Xe
   3. SO2
   4. SF6
   5. All of these samples have the same density at STP.
4. A mixture of 1.0 mol He and 1.0 mol Ne are at STP in a rigid container. Which of the following statements is TRUE?
   1. Both gases have the same average kinetic energy.
   2. Both gases contribute equally to the density of the mixture under these conditions.
   3. Both gases have the same molecular speed.
   4. The mixture has a volume of 22.4 L
   5. All of the above are TRUE.
5. Which of the gases in the graph to the right has the largest molar mass?
   1. D
   2. C
   3. B
   4. A
   5. There is not enough information to determine.
6. Three identical flasks contain three different gases at standard temperature and pressure. Flask A contains C2H4, flask B contains O3, and flask C contains F2. Which flask contains the largest number of molecules?
   1. flask A
   2. flask B
   3. flask C
   4. All contain same number of molecules.
   5. Not enough information to determine
7. Which of the following is TRUE if ΔEsys = -95 J?
   1. The system is gaining 95 J, while the surroundings are losing 95 J.
   2. Both the system and the surroundings are gaining 95 J.
   3. Both the system and the surroundings are losing 95 J.
   4. The system is losing 95 J, while the surroundings are gaining 95 J.
   5. None of the above are true.
8. Which of the following substances (with specific heat capacity provided) would show the greatest temperature change upon absorbing 100.0 J of heat?
   1. 10.0 g Ag, CAg = 0.235 J/g°C
   2. 10.0 g H2O, CH2O = 4.18 J/g°C
   3. 10.0 g ethanol, Cethanol = 2.42 J/g°C
   4. 10.0 g Fe, CFe = 0.449 J/g°C
   5. 10.0 g Au, CAu = 0.128 J/g°C
9. Which of the following processes is endothermic?
   1. The freezing of water.
   2. The vaporization of rubbing alcohol.
   3. The combustion of propane.
   4. A hot cup of coffee (system) cools on a countertop
   5. The chemical reaction in a "hot pack" often used to treat sore muscles.
10. Choose the reaction that illustrates ΔH°f for Ca(NO3)2.
    1. Ca2+(aq) + 2 NO3-(aq) → Ca(NO3)2(aq)
    2. Ca(s) + 2 N(g) + 6 O(g) → Ca(NO3)2(s)
    3. Ca(NO3)2(aq) → Ca2+(aq) + 2 NO3-(aq)
    4. Ca(NO3)2(s) → Ca(s) + N2(g) + 3O2(g)
    5. Ca(s) + N2(g) + 3O2(g) → Ca(NO3)2(s)

Problems

1. (5 points) Why is mercury a more suitable substance to use in a barometer than water?

Mercury is more dense so that the barometer does not need to be as long. Also, the vapor pressure of mercury is much less than the vapor pressure of water so that it does not easily evaporate and generate a back pressure in the barometer.

1. (8 points) At 46oC a sample of ammonia gas exerts a pressure of 7.38 atm.
   1. What is the pressure when the volume of the gas is decreased from 85.0 mL to 35.2 mL?
   2. What will be the temperature (oC) of the original sample of ammonia if the pressure is increased to 9.22 atm?
2. (8 points) In alcohol fermentation, yeast converts glucose to ethanol and carbon dioxide.

C6H12O6*(s)* 🡪 2 C2H5OH*(l)* + 2 CO2*(g)*

If 5.97 g of glucose are reacted and 1.44 L of CO2 gas are collected at 293K and 0.984 atm, what is the percent yield of the reaction?

Theoretical yield

Actual yield

Percent yield

1. (8 points) Phosphorous pentachloride decomposes to form phosphorus trichloride and chlorine gas as demonstrated in the following chemical equation:

PCl5(g) 🡪 PCl3(g) + Cl2(g)

A 5.00 L round bottom flask is filled with phosphorus pentachloride with a pressure of 1.63 atm. The vessel is heated to 1000K and after cooling back to the original temperature the new pressure is 2.37 atm. Calculate the partial pressure of all gases present at the end of the reaction.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | PCl5(g) | 🡪 | PCl3(g) | + | Cl2(g) |  | Total P |
| I | 1.63 atm |  | 0 atm |  | 0 atm |  | 1.63 atm |
| D | -x |  | + x |  | + x |  | + x (=0.74 atm) |
| E | 1.38 - x |  | x |  | x |  | 2.37 atm |

Final pressure PCl5 = 1.63 atm – 0.74 atm = 0.89 atm

Final pressure PCl3 = final pressure Cl2 = 0.74 atm

1. (8 points) Nickel forms a gaseous compound of the formula Ni(CO)x. What is the value of x given the fact that under the same conditions of temperature and pressure, methane (CH4) effuses 3.3 times faster than the compound?

174 g/mol – 58.69 g/mol = 115 g/mol of CO

115 g/mol /28.01 g/mol per CO unit = 4 CO units

So formula is Ni(CO)4

1. (8 points) Mothballs are composed primarily of the hydrocarbon naphthalene (C10H8). When 1.025 g of naphthalene burns in a bomb calorimeter, the temperature rises from 24.51oC to 32.33 oC. Find the heat of reaction for naphthalene in kJ/g and kJ/mol. The heat capacity of the calorimeter is 5.11 kJ/oC.

Heat released by naphthalene = heat gained by calorimeter

1. (8 points) Pentaborane-9, B5H9, is a colorless, highly reactive liquid that will burst into flame when expoed to oxygen. The reaction is

2 B5H9(l) + 12 O2(g) 🡪 5 B2O3(s) + 9 H2O(l)

Calculate the amount of energy released when a 15.00 g simple of pentaborane-9 is burned in the presence of oxygen. (Heat of formation data on cover page)

ΔHrxn=5(ΔHfo,B2O3,s) + 9(ΔHfo,H2O,l) −2(ΔHfo,B5H9,l) – 12(ΔHfo,H2O,l)

=5 (−1263.6 kJ/mol) + 9(−285.8 kJ) −2(73.2 kJ)

= −6318 + −2572 kJ − +146.4 kJ = −9036 kJ

Amount of heat released/absorbed by reaction \_\_\_\_\_\_\_\_\_\_\_\_\_\_

qrxn = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. (8 points) A person drinks five glasses of cold water (3.0oC) every day. The volume of each glass is 265 mL. How many M&M’s does this person need to eat to supply the body with enough energy to heat this water up to body temperature (37oC)? A single M&M provides 4.3 Cal of energy.

Heat released M&Ms = heat gained heating water

1. (8 points) A very useful synthetic reaction in organic chemistry is the enamine alkylation. Use bond energies to determine the approximate enthalpy of this reaction.



Bonds Broken

N—C +293 kJ

C=C +611 kJ

C—Cl +330 kJ

2 O—H 2(+464 kJ) = +928 kJ

Total broken +2162 kJ

Bonds Formed

2 C—C 2(−347 kJ) = − 694 kJ

C=O −741 kJ

N—H − 389 kJ

H—Cl − 431 kJ

Total formed −2255 kJ

Energy of reaction − 93 kJ

1. (12 points) An atom will emit an electron when it is struck by light with a frequency of 5.72 x 1014 Hz.
   1. Calculate the wavelength of the light in nm.
   2. Calculate the energy of one photon of the light
   3. Calculate the energy in kJ required to ionize a mole of this element.
   4. If light with a wavelength of 322 nm is shined on this element, what kinetic energy will the emitted electrons have?