Chemistry 141 Name

Dr. Cary Willard

Exam 2a October 16, 2013

Multiple Choice (30 points)

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Page 8 (12 points)

Page 9 (12 points)

Total (102 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

Constants

Avogadro’s 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

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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. Determine the oxidizing agent in the following reaction.

Ni(s) + 2 AgClO4(aq) → Ni(ClO4)2(aq) + 2 Ag(s)

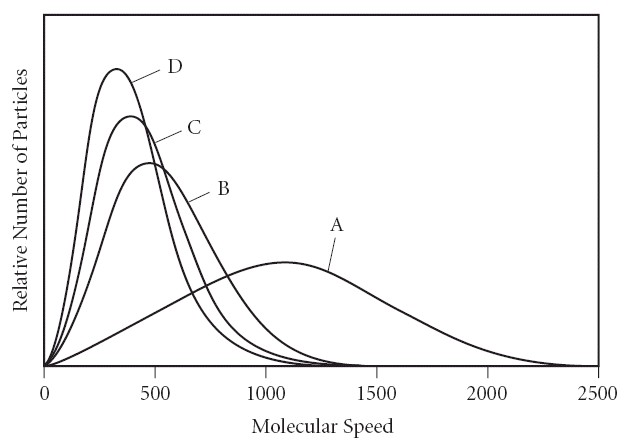
* 1. Ni
  2. Cl
  3. Ag
  4. O
  5. This is not an oxidation-reduction reaction.

1. What is the oxidation number of the sulfur atom in K2SO4 ?
   1. −2
   2. +6
   3. +2
   4. −4
   5. +4
2. Determine the oxidation state of hydrogen in H2.
   1. +5
   2. +3
   3. 0
   4. +2
   5. +4
3. Which of the following is an oxidation-reduction reaction?
   1. HI(aq) + LiOH(aq) → LiI(aq) + H2O(l)
   2. NaCl(aq) + AgNO3(aq) → AgCl(s) + NaNO3(aq)
   3. Pb(C2H3O2)2(aq) + 2 NaCl(aq) → PbCl2(s) + 2 NaC2H3O2(aq)
   4. Mg(s) + 2 HCl(aq) → MgCl2(aq) + H2(g)
   5. All of the above are oxidation-reduction reactions.
4. What element is being reduced in the following redox reaction?

MnO4⁻(aq) + H2C2O4(aq) → Mn2+(aq) + CO2(g)

* 1. Mn
  2. C
  3. O
  4. H
  5. None, this is not a redox reaction.

1. 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.



1. Which of the gases in the graph at the right has the largest molar mass?
   1. A
   2. B
   3. C
   4. D
   5. There is not enough information to determine.
2. Which of the following statements is TRUE?
   1. At a given temperature, lighter gas particles travel more slowly than heavier gas particles.
   2. The smaller a gas particle, the slower it will effuse
   3. The higher the temperature, the lower the average kinetic energy of the sample.
   4. At low temperatures, intermolecular forces become important and the pressure of a gas will be lower than predicted by the ideal gas law.
   5. None of the above statements are true.
3. Which of the following compounds will behave LEAST like an ideal gas at low temperatures?
   1. He
   2. SO2
   3. H2
   4. N2
   5. F2
4. Which of the following samples will have the greatest volume at STP?
   1. 22 g Ne
   2. 22 g He
   3. 22 g O2
   4. 22 g Cl2
   5. All of these samples would have the same volume at STP.
5. Which of the following statements is TRUE?
   1. State functions do not depend on the path taken to arrive at a particular state.
   2. ΔErxn can be determined using constant volume calorimetry.
   3. Energy is neither created nor destroyed, excluding nuclear reactions.
   4. ΔHrxn can be determined using constant pressure calorimetry.
   5. All of the above are true.
6. Choose the thermochemical equation that illustrates ΔH°f for Li2SO4.
   1. 2 Li+(aq) + SO42-(aq) 🡪 Li2SO4(aq)
   2. 2 Li(s) + 1/8 S8 (s, rhombic) + 2 O2(g) → Li2SO4 (s)
   3. Li2SO4 (aq) → 2 Li+ (aq) + SO42-(aq)
   4. 8 Li2SO4 (s) → 16 Li(s) + S8 (s, rhombic) + 16 O2 (g)
   5. 16 Li(s) + S8 (s, rhombic) + 16 O2 (g) → 8 Li2SO4 (s)
7. Calculate the change internal energy (ΔE) for a system that is giving off 65.0 kJ of heat and is performing 855 J of work on the surroundings.
   1. 64.1 kJ
   2. -64.1 kJ
   3. -65.9 kJ
   4. 9.00 x 102 kJ
   5. -9.00 x 102 kJ
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 Pb, CPb= 0.128 J/g°C
   2. 10.0 g Cu, CCu = 0.385 J/g°C
   3. 10.0 g H2O, CH2O = 4.18 J/g°C
   4. 10.0 g EtOH, CEtOH = 2.42 J/g°C
   5. 10.0 g Al, CAl = 0.903 J/g°C
9. Identify a substance that is not in its standard state.
   1. O2
   2. Zn
   3. O3
   4. H
   5. Xe

Problems

1. (8 points) A chemical engineer determines the mass percent of iron in an ore sample by converting the Fe to Fe2+ in acid and then titrating the Fe2+ with MnO4−. A 1.1081 g sample was dissolved in acid and then titrated with 46.88 mL of 0.03190 M KMnO4.
   1. The unbalanced equation for this reaction is shown below. Write a correctly balanced reaction (acidic).

Fe2+ + MnO41− 🡪 Fe3+ + Mn2+

( Fe2+ 🡪 Fe3+ + 1 e− ) 5

MnO41− + 8 H+ + 5e−🡪 Mn2+ + 4 H2O

------------------------------------------------------------------------------------------------

5Fe2+ + MnO41− + 8 H+ 🡪 5Fe3+ + Mn2+ + 4 H2O

* 1. Calculate the mass percent of iron in the ore.

1. (8 points)A sample of sulfur hexafluoride gas occupies a volume of 6.10 L at 198oC and 3.75 atm pressure.
   1. Assuming that the pressure remains constant, what temperature (in oC) is needed to reduce the volume to 2.50 L?.
   2. Can the volume also be reduced by changing the pressure? If so, what would the new pressure need to be if the temperature is kept constant?
2. (8 points) A 0.483 g sample of a liquid hydrocarbon known to consist of molecules with five carbon atoms is vaporized in a 0.204 L flask by immersion in a water bath at 101oC. The barometric pressure is 767 torr. Calculate the molar mass of the hydrocarbon and propose a molecular formula for it.

5 carbons have a mass of 60.05 g leaving 12.1 grams of hydrogen. This corresponds to 12 H so the molecular formula is C5H12.

1. (8 points) How many liters of hydrogen gas are collected over water at 18oC and 725 torr when 0.852 g of lithium reacts with water? The reaction is

2 Li(s) + 2 H2O(l) 🡪 2 LiOH(aq) + H2(g)

Moles hydrogen produced

Because the hydrogen gas is collected over water the pressure due to the water vapor needs to be subtracted.

1. (6 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 4.27 atm. The vessel is heated to 1000K and after cooling back to the original temperature the new pressure is 6.04 atm. Calculate the partial pressure of all gases present at the end of the reaction.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | PCl5(g) | 🡪 | PCl3(g) | + | Cl2(g) |  | Total P |
| I | 4.27 atm |  | 0 atm |  | 0 atm |  | 4.27 atm |
| D | - x |  | + x |  | + x |  | +x (= +1.77 atm) |
| E | 4.27 – x  =4.27-1.77  =2.50 atm |  | x = 1.77 atm |  | x = 1.77 atm |  | 6.04 atm |

1. (4 points) Use kinetic molecular theory to explain the change in gas pressure that results from warming a sample of gas.

As the gas warms, the individual molecules begin to move faster. Because they are moving faster, they strike the walls of the container harder resulting in higher pressure.

1. (6 points) A sample of an unknown gas effuses in 15.1 minutes. An equal volume of H2 in the same apparatus at the same temperature and pressure effuses in 2.42 minutes. What is the molar mass of the unknown gas?
2. (6 points) A chemical engineer studying the properties of fuels placed 1.5000 g of a hydrocarbon in the bomb of a calorimeter and filled it with oxygen gas. The bomb was immersed in 2.700 kg of water and the reaction initiated. The calorimeter and its contents temperature rose from 20.00oC to 23.55oC. If the calorimeter (excluding the water) had a heat capacity of 403 J/K, what was the heat of combustion in kJ per gram of the fuel?

qgained = qlost

qreaction = qgained water + qgained calorimeter

Because this is an exothermic reaction, the value of q must be negative so

qreaction = −41.5 kJ

1. (6 points) Given the following data

2 ClF(g) + O2(g) 🡪 Cl2O(g) + F2O(g) ΔH = 167.4 kJ

2 ClF3(g) + 2 O2(g) 🡪 Cl2O(g) + 3 F2O(g) ΔH = 341.4 kJ

2 F2(g) + O2(g) 🡪 2 F2O(g) ΔH = −43.4 kJ

Calculate ΔH for the reaction

ClF(g) + F2(g) 🡪 ClF3(g)

2 ClF(g) + O2(g) 🡪 Cl2O(g) + F2O(g) ΔH = +167.4 kJ

2 F2(g) + O2(g) 🡪 2 F2O(g) ΔH = −43.4 kJ

Cl2O(g) + 3 F2O(g) 🡪 2 ClF3(g) + 2 O2(g) ΔH = −341.4 kJ

2 ClF(g) + 2 F2(g) 🡪 2 ClF3(g) ΔH = −217.4 kJ

ClF(g) + F2(g) 🡪 ClF3(g) ΔH = −108.7 kJ

1. (12 points) Stearic acid (C18H36O2) is a typical fatty acid, a molecule with a long hydrocarbon chain and an organic acid group (COOH) at the end. It is used to make cosmetics, ointments, soaps, and candles and is found in animal tissue as part of many saturated fats. In fact, when you eat meat, chances are that you are injesting some fats that contain stearic acid.

ΔHfo, C18H36O2 *(s)* = −948 kJ/mol

ΔHfo, H2O*(l)* = −285.8 kJ/mol

ΔHfo, H2O *(g)* = −241.8 kJ/mol

ΔHfo, CO2*(g)* = −393.5 kJ/mol

* 1. Write a balanced equation for the complete combustion of stearic acid with oxygen gas to form water vapor and carbon dioxide. (Balance with 1 as the coefficient for stearic acid.)

C18H36O2 (s) + 52/2 O2 (g) 🡪 18 CO2(g) + 18 H2O(g)

* 1. Calculate the ΔHo for this reaction

ΔHrxn= 18(ΔHfo,CO2,g) + 18(ΔHfo,H2O,g) −1(ΔHfo, C18H36O2,s)

= 18 mol(−393.5 kJ/mol) + 18 mol (−241.8 kJ/mol) – 1 mol (−948 kJ/mol)

= −7083.0 kJ + −4352.4 kJ + +948 kJ

= −10487 kJ

* 1. Calculate the heat in kJ and kcal when 1.00 g of stearic acid is burned completely.
  2. The nutritional information for a candy bar states that one serving contains 11.0 g of fat and 100. Cal (1 Cal=1kcal). Is this information consistent with your answer for part c?

The value is correct to 1 significant figure. It is incorrect to say that it is correct to three significant figures as the label suggests.