Chemistry 141 Name Key

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Exam 2B March 25, 2010

Multiple Choice (30 points)

Page 1 (8 points)

Page 2 (16 points)

Page 3 (13 points)

Page 4 (21 points)

Page 5 (20 points)

Page 6 (12 points)

Total (120 points)

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

HΨ=EΨ

M1V1 = M2V2

Ptotal = P1 + P2 + P3 + …

M = mol/L

Constants

h = 6.626 x 10-34 J sec

c= 2.9979 x 108 m/sec

e = 1.602 x 10-19 C

NA = 6.022 x 1023/mol

k = 1.381 x 10-23 J/K

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

Standard Temperature and Pressure = 0oC and 1 atm

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

Specific heat water = 4.184 J/g K

Specific heat Al = 0.902 J/ g K

Specific heat Cu = 0.385 J/g K

ΔHvaporization (H2O) = 2260 J/g

ΔHfusion (H2O) = 333 J/g

mass electron = 9.109 x 10-31 kg

TB07_001Part I -- Multiple choice questions (30 points)

1. Suppose you needed to closely monitor small changes in pressure inside a container using an open end manometer. For the best accuracy, the substance in the manometer should
   1. Be mercury
   2. Be a solid
   3. Have a low density
   4. Be a gas
   5. Have a high density
2. If the pressure of a sample of gas is doubled at constant temperature, the volume of the gas
   1. Is quadrupled
   2. Is doubled
   3. Is tripled
   4. Remains the same
   5. Is halved
3. . Some assumptions from the kinetic molecular theory are listed below. Which one is most frequently cited to explain compressibility of a gas?
   1. The volume of the particles is negligible compared to the volume of the gas.
   2. A gas consists of tiny particles moving in random straight line motion.
   3. The average kinetic energy of gas particles is proportional to the Kelvin temperature.
   4. Collisions of gas particles are elastic and total kinetic energy of the gas is constant.
   5. The speed of a gas particle is inversely related to its molar mass
4. The nutritional calorie (abbreviated Cal) is equal to
   1. 4.184 J
   2. 1 kcal
   3. 4.184 cal
   4. 0.001 kcal
   5. 1000 kcal
5. Which statement about real gases is **true**?
   1. The mass of the gas particles is zero.
   2. The behavior of real gases can be exactly predicted using the ideal gas law.
   3. Forces of attraction and repulsion exist between gas particles at close range.
   4. The volume of the gas particles is zero.
   5. There are no attractive forces between gas particles, only repulsive forces.
6. For a particular process that is carried out at constant pressure, *125 kJ of heat is absorbed* and 15 kJ of work is done. Therefore,
   1. Δ*E* = +125 kJ and Δ*H* = +110 kJ.
   2. Δ*E* = −140 kJ and Δ*H* = −125 kJ.
   3. Δ*E* = −110 kJ and Δ*H* = +125 kJ.
   4. Δ*E* = −125 kJ and Δ*H* = 140 kJ.
   5. Δ*E* = +110 kJ and Δ*H* = +125 kJ
7. A process is carried out at constant pressure. Given that *E* is positive and *H* is negative,
   1. the system absorbs heat and expands during the process.
   2. the system loses heat and expands during the process.
   3. the system loses heat and contracts during the process.
   4. the system absorbs heat and contracts during the process.
   5. The system loses heat and there is no volume change during the process.
8. For which should the standard heat of formation *Hof*, be zero at 25oC?
   1. O3(*g*)
   2. O2(*g*)
   3. O(*g*)
   4. H2O(*g*)
   5. all the above are zero
9. Which equation represents the reaction whose *H*, represents the standard enthalpy of formation of CHCl3(*l*) at 25oC? (*i.e.*, for which is *H* = *Hof* of CHCl3)
   1. C(*s*) + 1/2 H2(*g*) + 3/2 Cl2(*g*) 🡪 CHCl3(*l*)
   2. CHCl3(*l*) 🡪 C(*s*) + H(*g*) + 3 Cl(*g*)
   3. C(*s*) + H(*g*) + 3 Cl(*g*) 🡪 CHCl3(*l*)
   4. 2 C(*s*) + H2(*g*) + 3 Cl2(*g*) 🡪 2 CHCl3(*l*)
   5. CHCl3(*l*) 🡪 C(*s*) + 1/2 H2(*g*) + 3/2 Cl2(*g*)
10. The values of *Hof* for the three states of benzene are approximately –22 kcal/mol, –11 kcal/mol, and +20 kcal/mol. Which is the value for liquid benzene?
    1. –22 kcal/mol
    2. –13 kcal/mol
    3. –11 kcal/mol
    4. +20 kcal/mol
    5. cannot be determined without additional information
11. According to the kinetic molecular theory, the pressure of a gas in a container will increase if the
    1. number of collisions with the container wall decreases.
    2. temperature of the gas increases.
    3. number of moles of the gas decreases.
    4. volume of the container increases.
    5. Temperature of the gas decreases
12. What is the height of a column of water that exerts the same pressure as a column of mercury with a height of 3.00 cm?
    1. 0.0735 cm
    2. 13.6 mm
    3. 40.8 mm
    4. 40.8 cm
    5. 0.221 cm
13. Given the heat of reaction for the metabolism of tristearin, a dietary fat is

2 C57H110O6(s) + 163 O2(g) 🡪 114 CO2(g) + 110 H2O(l) H= –75520 kJ.

What is the heat of reaction for 57 CO2(g) + 55 H2O(l) 🡪 C57H110O6(s) + 81.5 O2(g)?

* 1. +151100 kJ
  2. +75,520 kJ
  3. –75,520 kJ
  4. –39760 kJ
  5. +39760 kJ

1. What is the pressure in a gas container that is connected to an open-end U-tube manometer if the pressure of the atmosphere is 735 torr and the level of mercury in the arm connected to the container is 6.92 cm lower than the level of mercury open to the atmosphere?
   1. 666 mm Hg
   2. 735 mm Hg
   3. 742 mm Hg
   4. 728 mm Hg
   5. 804 mm Hg
2. Which one of the following gases will have the **lowest** rate of effusion?
   1. SF4
   2. SO3
   3. SO2
   4. S2O5
   5. SCl4

Part II -- Problems (70 points) have 56 points need 14 more

1. (5 points) What is the volume occupied by 3.54 g of methane (CH4) gas at a pressure of 593 torr and a temperature of 45.3 oC?
2. (5 points) An automobile tire has a maximum rating of 52.7 psi. The tire is inflated (while cold) to a volume of 11.8 L and a pressure of 50.7 psi at a temperature of 12.0oC. While driving on a hot day, the tire warms to 75.0oC and its volume expands to 12.2 L. Calculate the final pressure in the tire. Does the pressure in the tire exceed its maximum rating?

|  |  |  |  |
| --- | --- | --- | --- |
| P1 | 50.7 psi | P2 | ? |
| V1 | 11.8 L | V2 | 12.2 L |
| T1 | 12.0oC = 285.2 K | T2 | 75.0oC = 348.2K |
| n1 | constant | n2 | Constant |

The tire exceeds it max rating.

1. (6 points) Consider the following reaction: 2 SO2(g) + O2(g) 🡪 2 SO3(g)
   1. If 528.5 mL of SO2 is allowed to react with 285.3 mL of O2 (both measured at 382 K and 62.0 torr), how many mL of SO3 will be produced?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | x=264.3 mL |  | x=285.3 mL |  |  |
|  | 2 SO2 | + | O2 | 🡪 | 2 SO3 |
| I | 528.5 mL |  | 285.3 mL |  |  |
|  | -2x |  | -x |  | +2x |
| E | 0 mL |  | 285.3mL-264.3 mL = 21.0 mL |  | 2(264.3 mL) =528.5 mL |

528 5 mL of SO3 will be produced.

* 1. If 218.5 mL of SO3 are produced, what is the percent yield?

1. (12 points) An impure sample of calcium carbonate was heated to produce carbon dioxide according to the following equation CaCO3🡪 CaO + CO2. The carbon dioxide was collected by displacing water as you did in the alloy lab. If a 36.3 g sample of the calcium carbonate sample produced 4.25 L of gas with a pressure of 736 torr at 20.0oC. Answer the following questions regarding this experiment.
   1. What was the final pressure of CO2?,
   2. How many moles of CO2 were produced?
   3. How many grams of calcium carbonate were in the sample?
   4. What was the percent calcium carbonate in the sample?
   5. (3 pt extra credit) There was a poor assumption made when designing this experiment. What was the problem with the design of this experiment and how did it affect the results?

Carbon dioxide is soluble in water so not all of the carbon dioxide will be collected resulting in a low value for the percent purity.

1. (6 points) A chemical engineer studying the properties of fuels placed 1.500 g of a hydrocarbon in the bomb of a calorimeter and filled it with O2 gas. The bomb was immersed in 2.500 L of water and the reaction initiated. The water 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 per gram of the fuel?

1. (8 points) Iron metal is produced in a blast furnace through a complex series of reactions that involve reduction of iron(III) oxide with carbon monoxide. The overall balanced equation for this reaction is Fe2O3(s) + 3 CO(g) 🡪 2 Fe(s) + 3 CO2(g). Use the equations below to calculate Horxn for this reaction.

3 Fe2O3(s) + CO(g) 🡪 2 Fe3O4(s) + CO2(g) Ho = –48.5 kJ

Fe(s) + CO2(g) 🡪 FeO(s) + CO(g) Ho = –11kJ

Fe3O4(s) + CO(g) 🡪 3 FeO(s) + CO2(g) Ho = +22 kJ

3 Fe2O3(s) + CO(g) 🡪 ~~2 Fe~~~~3~~~~O~~~~4~~~~(s)~~ + CO2(g) Ho = –48.5 kJ

~~2 Fe~~~~3~~~~O~~~~4~~~~(s)~~ + 2 CO(g) 🡪 ~~6 FeO(s)~~ + 2 CO2(g) Ho = +44 kJ

~~6 FeO(s)~~ + 6 CO(g) 🡪 6 Fe(s) + 6 CO2(g) Ho = +33 kJ

3 Fe2O3(s) + 9 CO 🡪 6 Fe + 9 CO2 Ho = +28 kJ

Fe2O3(s) + 3 CO 🡪 2Fe + 3 CO2 Ho = +9.5 kJ

1. (8 points) Acetylene burns in air according to the following equation

2 C2H2(g) + 5 O2(g) 🡪 4 CO2(g) + 2 H2O(g) Hrxn = –2511.6 kJ

* 1. How much energy is released when 35.0 g of acetylene burns in excess oxygen?

Or 1690 kJ energy released

* 1. Given that Hf of CO2(g) = –393.5 kJ/mol and Hf of H2O(g) = –241.8 kJ/mol, what is the Hf of C2H2(g)?

1. (6 points) Use bond energies to calculate the heat of reaction for CO2 + 2 NH3 🡪 NH2CONH2 + H2O The molecular structures are shown below:



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bonds Broken |  |  | Bonds Formed |  |
| C=O | +741 kJ |  | 2 C-N | 2(–293 kJ) |
| 2 N-H | 2(+389 kJ) |  | 2 O-H | 2(–464 kJ) |
|  |  |  |  |  |
|  | +1519 kJ |  |  | –1514 kJ |

Net change +5 kJ or energy of the reaction = +5 kJ