Chemistry 141 Name Key

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Exam 2A April 2008

Multiple Choice (28 points)

Page 1 (17 points)

Page 2 (19 points)

Page 3 (22 points)

Page 4 (21 points)

Total (107 points)

Percent

Formulas

|  |  |  |
| --- | --- | --- |
| Kinetic energy = ½ mv2  w = -PΔV  ΔG = ΔH - TΔS  w=dxF  C = q/ΔT  ΔGo = -nFEo  ΔG = - RTlnK  E = mc2  E = IR | PV = nRT  Ptotal = P1+P2+P3+…  P1=X1\*Ptotal  Ba(Na)2 = fruit  Ptotal = P1 + P2 + P3 + …  M = mol/L  m = mol/kg solvent  Xi = moli/ moltotal  u = (3RT/MW)½  Rate ∝ (MW)-½ | HΨ=EΨ  Amp = C/sec  π= iMRT  E = hν = hc/λ  E = nhν = nhc/λ  M1V1 = M2V2  Psoln = (Psolv)(Xsolv)  ΔTf = i(kf)(m)  ΔTb = i(kb)(m) |

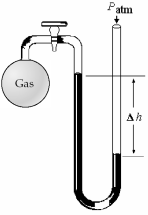
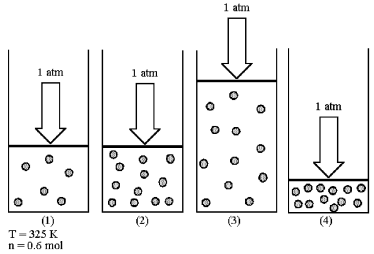
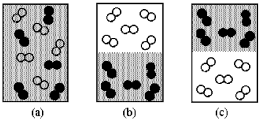


Constants

|  |  |
| --- | --- |
| F = 9.65 x 104 C  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  1 kcal = 4.184 kJ  K = oC + 273.16  Kw = 1.0 x 10-14M2 | mass electron = 9.109 x 10-31 kg  Standard Temperature and Pressure = 0oC and 1 atm  R = 0.0821 L atm/mol K= 8.314 J/K mol= 1.987 cal.mol K = 62.4 L torr/mol K  760 torr = 760 mm Hg = 1.00 atm = 101 kPa = 14.6 psi = 30 in Hg |
| Specific heat Al 0.902 J/g K  Specific heat Cu 0.385 J/g K | Specific heat water = 4.184 J/g K  Hvaporization (H2O) = 2260 J/g |



Part I -- Multiple choice questions (28 points)

1. The nutritional calorie (abbreviated Cal) is equal to
   1. 4.184 J.
   2. 4.184 cal.
   3. 1 kcal.
   4. 1 mcal.
   5. None of the above.
2. For which should the standard heat of formation *Hof*, be zero at 25oC?
   1. O(*g*)
   2. O2(*g*)
   3. O3(*g*)
   4. all the above
   5. none of the above
3. 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. 2 CH4(*g*) + 3 Cl2(*g*) 🡪 2 CHCl3(*l*) + H2(*g*)
   2. C(*s*) + H(*g*) + 3 Cl(*g*) 🡪 CHCl3(*l*)
   3. 2 C(*s*) + H2(*g*) + 3 Cl2(*g*) 🡪 2 CHCl3(*l*)
   4. C(*s*) + 1/2 H2(*g*) + 3/2 Cl2(*g*) 🡪 CHCl3(*l*)
   5. CHCl3(*l*) 🡪 C(*s*) + H(*g*) + 3 Cl(*g*)
4. For a particular process that is carried out at constant pressure, *q* = 125 kJ and *w* = -15 kJ. Therefore,
   1. ** = 140 kJ and *H* = 125 kJ.
   2. ** = 125 kJ and *H* = 140 kJ.
   3. ** = 125 kJ and *H* = 110 kJ.
   4. ** = -15 kJ and *H* = 125 kJ.
   5. ** = 110 kJ and *H* = 125 kJ.
5. 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. have a low density
   2. have a high density
   3. be mercury
   4. be a solid
   5. have a high heat capacity
6. What is the pressure (in mm Hg) of the gas inside the above apparatus if the outside pressure, Patm, is 740 mm Hg and the difference in mercury levels, *h*, is 30 mm Hg?
   1. 770 mm Hg
   2. 740 mm Hg
   3. 710 mm Hg
   4. 30 mm Hg
   5. Unable to determine
7. Which statement about real gases is **true**?
   1. Forces of attraction and repulsion exist between gas particles at close range.
   2. The mass of the gas particles is zero.
   3. The behavior of real gases can be exactly predicted using the ideal gas law.
   4. The volume of the gas particles is zero.
   5. All of the above are true of real gases.
8. Some assumptions from the kinetic molecular theory are listed below. Which one is most frequently cited to explain compressibility of a gas?
   1. The average kinetic energy of gas particles is proportional to the Kelvin temperature.
   2. Collisions of gas particles are elastic and total kinetic energy of the gas is constant.
   3. A gas consists of tiny particles moving in random straight line motion.
   4. The volume of the particles is negligible compared to the volume of the gas.
9. Assume that you have a sample of gas in a cylinder with a moveable piston, as shown in diagram (1). The initial pressure, number of moles, and temperature of the gas are noted on the diagram. Which diagram (2)-(4) most closely represents the result of doubling the number of moles of gas while keeping the pressure and temperature constant?
   1. Diagram (2)
   2. Diagram (3)
   3. Diagram (4)
   4. Unable to determine from data
10. Mendeleev arranged the elements according to
    1. atomic weight and chemical reactivity.
    2. atomic number and atomic weight.
    3. electron configuration and atomic weight.
    4. physical state and relative abundance.
11. Assume that you have a mixture of nitrogen (molecular mass = 28 amu), represented by unshaded spheres, and chlorine (molecular mass = 71 amu), represented by shaded spheres at 300 K. Which of the drawings best represents the mixture?
    1. Drawing (a)
    2. Drawing (b)
    3. Drawing (c)
    4. Unable to determine
12. What is a quantum of light called?
    1. the amplitude
    2. the wavelength
    3. a photon
    4. the frequency
    5. a particle
13. The number of orbitals in a given subshell, such as the 5*d* subshell, is determined by the number of possible values of
    1. *l*
    2. *ml*
    3. *n*
    4. *ms*
14. What are the possible values of *n* and *ml* for an electron in a 5p orbital?
    1. *n*= 1, 2, 3,4, or 5 and *ml* = -2, -1, 0, +1, or +2
    2. *n* = 5 and *ml* = -2, -1, 0, +1, or +2
    3. *n* = 1, 2, 3, 4, or 5 and *ml* =1
    4. *n* = 1 and *ml* = 0
    5. *n* = 5 and *ml* = 1

Part II – Problems

1. (5 points) A sample of argon gas has a volume of 6.28 L and a pressure of 0.325 atm at 31.4oC. If the pressure increases to 2.37 atm and the temperature decreases to 17.3oC, what is the final volume?

= 0.821 L

If use C get 0.474 L -- 2 pts

1. (7 points) “Strike anywhere” matches contain the compound tetraphosphorus trisulfide, which burns in oxygen gas to form tetraphosphorus decaoxide and sulfur dioxide gas. How many milliliters of sulfur dioxide, measured at 725 torr and 32oC, can be produced from burning 0.600 g of tetraphosphorus trisulfide?

Balanced equation for the reaction (if you do not know the formulas for the compounds, you may buy them from me for 2 points)

|  |
| --- |
| P4S3(s) + 8 O2(g) 🡪 P4O10(?) + 3 SO2(g) |

Or 215 mL SO2 gas formed

1. (5 points) Use kinetic molecular theory to explain the change in pressure that results from warming a sample of gas.

As the molecules begin to warm they move faster and exert a greater pressure on the surfaces around them.

1. (6 points) At a given pressure and temperature, it takes 4.55 minutes for a 1.5 L sample of He to effuse through a membrane. How long does it take for 1.5 L of F2 to effuse under the same conditions?

X = 14.0 min

1.48 min if upside down ½ credit

1. (7 points) The specific heat of aluminum is 0.902 J/g oC. When a 4 5.0 g aluminum statue is heated to 350.0 oC and dropped into a 25.0 g of water at 38.5oC, all of the heat lost by the aluminum is gained by the water. If the heat of vaporization of water is 2260 J/g, how many grams of water will evaporate? (Assume the water is well mixed and the temperature of the water rises uniformly.)

q aluminum cooling to 100oC = q water warming to 100oC + q water evaporating

1.64 g of water will evaporate!

1. (6 points) Calculate Hrxn for 2 NOCl(g) 🡪 N2(g) + O2(g) + Cl2(g) using the reactions below:

½ N2(g) + ½ O2(g) 🡪 NO(g) Hrxn = +90.3 kJ

NO(g) + ½ Cl2(g) 🡪 NOCl(g) Hrxn = −38.6 kJ

2 [ NOCl(g) 🡪 NO(g) + ½ Cl2(g) ] Hrxn = 2(+38.6 kJ)= +77.2 kJ

2 [NO(g) 🡪 ½ N2(g) + ½ O2(g) ] Hrxn = 2 (−90.3 kJ) = −180.6 kJ

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2 NOCl(g) 🡪 N2(g) + O2(g) + Cl2(g) Hrxn = −103.4 kJ

1. (8 points) Use bond energies to estimate the energy of the following reaction. (Be sure to pay attention to the balancing!)



|  |  |  |  |
| --- | --- | --- | --- |
| Bonds Broken | | Bonds Formed | |
| 6 Cl-N | 6(200kJ) = +1200 kJ | 1 N≡N | 1(−945 kJ) = −945 kJ |
|  |  | 3 Cl-Cl | 3(−243kJ) = −729 kJ |
|  |  |  |  |
|  | +1200 kJ |  | −1674 kJ |

total energy change = + 1200 kJ + (−1674 kJ) = −474 kJ

-4 if backwards

1. (6 points) You hold a gram of copper in one hand and a gram of aluminum in the other. Each metal was originally at 0oC. (Both metals are in the shape of a little ball that fits into your hand.) If they both take up heat at the same rate, which will warm to your body temperature first? Explain your reasoning.

The copper will warm to your body temperature faster because it takes less heat to change the temperature of copper than aluminum as evidenced by their specific heats.

Must specify different amounts of heat to change temperature. If no mention of temp then -2 points.

Specific heat Al 0.902 J/g K

Specific heat Cu 0.385 J/g K

1. (8 points) Enormous numbers of microwave photons are needed to warm macroscopic samples of matter. A portion of soup containing 275 g of water is heated in a microwave oven from 20.0oC to 98oC, with radiation of wavelength 1.55 x 10-2 m. How many photons are absorbed by the water in the soup?

heat required to heat soup to 98o = (78 K)(4.184 J/g K)(275 g) = 89700 J = 89.7 kJ

1. (10 points) The ionization energy of tellurium is 869 kJ/mol.

-3 overall if forget to change to per electron

* 1. What is the energy required to eject one electron from an atom of tellurium?
  2. What is the frequency of light required to just eject an electron from an atom of tellurium?
  3. What is the wavelength of this light?
  4. What frequency of light would be required to eject an electron with a kinetic energy of 5.4 x 10-19 J?

energy of light

= ionization energy + kinetic energy

= 1.44 x 10-18J + 5.4 x 10-19 J = 1.98 x 10-18 J

1. (6 points) Give a possible set of quantum numbers for an electron in the following orbitals:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **5d** | **7s** | **3p** |
| ***n*** | **5** | **7** | **3** |
| ***l*** | **2** | **0** | **1** |
| ***ml*** | **2, 1, 0, -1, or -2** | **0** | **1, 0, or -1** |
| ***ms*** | **½ or – ½** | **½ or – ½** | **½ or – ½** |

1. (5 points) What physical meaning is attributed to the square of the wave function ψ2?

ψ2 describes the probability function for an orbital. It describes the region in space where the electron has a high probability of existing.