Chemistry 141 Name

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Exam 2a October 22, 2012

Multiple Choice (30 points)

Page 5 (16 points)

Page 6 (16 points)

Page 7 (16 points)

Page 8 (16 points)

Page 9 (12 points)

Total (106 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) |  | |  |  |  |  |  |  |  |

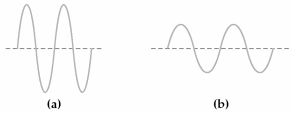
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  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. For which should the standard heat of formationΔ*Hof*, be zero at 25oC?
   1. O2(*g*)
   2. O3(*g*)
   3. O(*g*)
   4. all the above
2. The values ofΔ*Hf* for the three states of benzene are approximately -22 kcal/mol, -11 kcal/mol, and 20kcal/mol. Which is the value for solid benzene?
   1. −22 kcal/mol
   2. 20 kcal/mol
   3. -11 kcal/mol
   4. cannot be determined without additional information
3. Which equation represents the reaction whose Δ*H*, represents the standard enthalpy of formation of CHCl3(*l*) at 25oC? (*i.e.*, for which is Δ*H* = Δ*H of* of CHCl3)
   1. CHCl3(*l*) 🡪 C(*s*) + H(*g*) + 3 Cl(*g*)
   2. C(*s*) + H(*g*) + 3 Cl(*g*) 🡪 CHCl3(*l*)
   3. C(*s*) + 1/2 H2(*g*) + 3/2 Cl2(*g*) 🡪 CHCl3(*l*)
   4. 2 C(*s*) + H2(*g*) + 3 Cl2(*g*) 🡪 2 CHCl3(*l*)
4. For a particular process that is carried out at constant pressure, *q* = 125 kJ and *w* =−15 kJ. Therefore,
   1. ΔE = 140 kJ and Δ*H* = 125 kJ.
   2. ΔE = 110 kJ and Δ*H* = 125 kJ.
   3. ΔE = 125 kJ and Δ*H* = 140 kJ.
   4. ΔE = 125 kJ and Δ*H* = 110 kJ.
5. Which of the following instruments directly measures the pressure of a gas?
   1. polarimeter
   2. gas chromatograph
   3. manometer
   4. spectrometer
6. If the number of moles of gas is doubled at constant temperature and volume, the pressure of the gas
   1. remains the same
   2. is halved
   3. is quadrupled
   4. is doubled
7. . A process by which gas molecules escape through a tiny hole in a membrane into a vacuum without collisions is called
   1. diffusion
   2. sublimation
   3. Boyle's law
   4. effusion
8. Which one of the following gases will have the **lowest** rate of effusion?
   1. SCl4
   2. SF4
   3. SO3
   4. S2O5
9. 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.
10. You are given two flasks of equal volume. One contains H2 at 0oC and 1 atm while the other contains CO2 at 0oC and 2 atm. Which of the following quantities will be the same for both flasks?
    1. average molecular kinetic energy
    2. average molecular speed
    3. number of molecules present
    4. density
11. 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.
12. The greater the energy of a photon, the
    1. longer the wavelength and the higher the frequency.
    2. longer the wavelength and the lower the frequency.
    3. shorter the wavelength and the lower the frequency.
    4. shorter the wavelength and the higher the frequency.
13. What is a quantum of light called?
    1. the amplitude
    2. the wavelength
    3. a photon
    4. the frequency
14. The intensity of a beam of light is related to its
    1. relative number of photons.
    2. frequency.
    3. wavelength.
    4. speed.



1. Two electromagnetic waves are represented on the right. Wave (a) has the
   1. longer wavelength and higher frequency than wave (b).
   2. shorter wavelength and higher frequency than wave (b)
   3. longer wavelength and lower frequency than wave (b).
   4. shorter wavelength and lower frequency than wave (b).

Problems

1. (8 points) At 15oC a sample of freon gas in a 12.8 L tank exerts a pressure of 7.92 atm.
   1. To what size tank must the Freon be transferred to reduce the pressure to 5.50 atm?
   2. Can the pressure instead be reduced by decreasing the temperature? If so, what would the temperature need to be?
2. (8 points) A refrigerator has been developed that uses compressed helium as a refrigerant gas. A typical system uses 7.00 in3 of He compressed to 195 psi at 20oC. What mass of helium in grams is needed for one refrigerator?
3. (8 points) Elodea is a green plant that carries out photosynthesis in under water. The overall reaction for this process is

6 CO2*(g)* + 6 H2O*(l)*🡪 C6H12O6*(s)* + 6 O2*(g)*

In an experiment, some elodea produce 122 mL of O2(g) collected over water at 743 torr and 20oC. What mass of glucose will also be produced by this reaction?

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

Mass glucose produced

1. (8 points) One of the methods used to manufacture carbon tetrachloride is to react carbon disulfide with chlorine gas. The equation for this reaction is shown below:

CS2(g) + 3 Cl2(g) 🡪 S2Cl2(g) + CCl4(g)

If a mixture of CS2 and Cl2 with a total pressure of 8.00 atm is placed into a 40.0 L stainless steel reactions vessel, the pressure will decrease to 6.72 atm after 3.0 hours. If the temperature is held constant at 200oC, what will the final pressure of carbon tetrachloride be?

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | CS2(g) | + | 3 Cl2(g) | 🡪 | S2Cl2(g) | + | CCl4(g) |  | Total P |
| I | ? atm |  | ? atm |  | 0 atm |  | 0 atm |  | 8.00 atm |
| D | -x |  | - 3x |  | + x |  | + x |  | -2x(= -1.28 atm) |
| E | ? - x |  | ? - 3x |  | x |  | x |  | 6.72 atm |

Final pressure CCl4 = x = 0.64 atm

1. (8 points) It took 6.5 minutes for 1.0 L of helium to effuse through a porous barrier. How long will it take for 1.0 L of chlorine gas to effuse under identical conditions?

ΔHfo, NH4ClO4*(s)* = −295 kJ/mol

ΔHfo, Al2O3*(s)* = −1676 kJ/mol

ΔHfo, AlCl3*(s)* = −704 kJ/mol

ΔHfo, NO*(g)* = +90. kJ/mol

ΔHfo, H2O*(l)* = −285.8 kJ/mol

ΔHfo, H2O *(g)* = −241.8 kJ/mol

1. (8 points) A mixture of aluminum and ammonium perchlorate is sometimes used as a fuel for rockets used to send supplies to the space station. A possible reaction is

3 Al(s) + 3 NH4ClO4(s) 🡪 Al2O3(s) + AlCl3(s) + 3 NO(g) + 6 H2O(g)

* 1. Calculate the ΔHo for this reaction

ΔHrxn= (ΔHfo,Al2O3,s) + (ΔHfo,AlCl3,s) + 3(ΔHfo,NO,g) +6(ΔHfo,H2O,g) −3(ΔHfo,NH4ClO4,s)

= (−1676 kJ/mol) + (−704 kJ/mol) +3(90 kJ/mol) + 6(−241.8 kJ/mol) − 3 (−295 kJ/mol)

= −1676 + −704 kJ + +270. kJ + −1451 kJ + +885 kJ = −2676 kJ

* 1. Calculate the number of grams of ammonium perchlorate needed on board to generate 2.00 MJ of energy.

1. (8 points) A student buys a bag of Halloween candy and wants to know how many calories he is consuming after eating one candy. They try an experiment. They light a piece of candy and let it burn under a beaker of water. If the beaker contains 250.0 g of water and the temperature increases from 18.5oC to 86.3oC, how many Calories are in the candy? (Remember that one food Calorie is equivalent to 1000 chemistry calories!)

Heat released candy = 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—Br +276 kJ

2 O—H 2(+464 kJ) = +928 kJ

Total broken +2108 kJ

Bonds Formed

2 C—C 2(−347 kJ) = − 694 kJ

C=O −741 kJ

N—H − 389 kJ

H—Br − 368 kJ

Total formed −2192 kJ

Energy of reaction − 84 kJ

1. (12 points) An atom will emit an electron when it is struck by light with a frequency of 8.42 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. What wavelength of the light in nm must be used to eject electrons with a kinetic energy of 2.58 x 10-19 J?