Review Packet #3 - Random Topics

Topics 1, 4

1) a) three points

75.0 mL = 0.0750 L = V

$n = PV / RT = [(750/760) \text{ atm} \times 0.0750\text{L}] / [(0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}) (20\ °\text{C} + 273)] = 0.00308 \text{ mol } CO_2$

$= 3.08 \times 10^{-3} \text{ mol } CO_2$

$3.08 \times 10^{-3} \text{ mol } CO_2 \times (44.0 \text{ g } CO_2 / 1 \text{ mol } CO_2) = 0.136 \text{ g } CO_2 = 1.36 \times 10^{-1} \text{ g } CO_2$

b) two points

$CaCO_3(s) \text{ ---> } CO_2(g) + CaO(s)$ $MgCO_3(s) \text{ ---> } CO_2(g) + MgO(s)$

c) two points

$0.0448 \text{ g Ca} \times (1 \text{ mol Ca} / 40.08 \text{ gCa}) \times (1 \text{ mol } CaCO_3 / 1 \text{ mol Ca}) \times (100.0 \text{ g } CaCO_3 / 1 \text{ mol } CaCO_3) =$

$0.112 \text{ g } CaCO_3$

$(0.112 \text{ g } CaCO_3 / 0.2800 \text{ g sample}) \times 100\% = 40.0\%$

d) two points

$0.2800 \text{ g sample} \times 60\% = 0.168 \text{ g } MgCO_3$

$0.168 \text{ g } MgCO_3 \times (1 \text{ mol } MgCO_3 / 84.31 \text{ g } MgCO_3) \times (1 \text{ mol MgO} / 1 \text{ mol } MgCO_3) \times (40.30 \text{ g MgO} / 1$
$\text{mol MgO}) = 0.0802 \text{ g MgO}$

2) a) 2 points

95 g F x (1 mole F / 19.0 g F) = 5 mole F atoms

5 g H x (1 mole H / 1.00 g H) = 5 mole H atoms

Therefore HF. One point was awarded if H_5F_5 or other 1:1 ratios were given.

b) 2 points

Amount of F in UF_6 = (4.267 g) ((6 x 19.0) / (238 + 6 x 19.0))= 1.38 g F

Fraction of F in HF = (0.970 g x 0.95) / 1.38 g

Fraction of F in solid = 1 - 0.67 = 0.33

c) 4 points

Mass of U = 4.267 g - 1.38 g = 2.89 g U Mass of F = 1.38 g x 0.333 = 0.46 g F

Mass of O = 3.730 g - (2.89 + 0.46) = 0.38 g O

2.89 g U x (1 mole U / 238 g U) = 0.012 mole U atoms 0.460 g F x (1 mole F / 19.0 gF) = 0.024 mole F atoms

0.38 g O x (1 mole O / 16.0 g O) = 0.024 mole O atoms

Therefore solid product is UO_2F_2

d) 1 point

$UF_6 + 2\ H_2O \text{ ---> } UO_2F_2 + 4\ HF$

3) a) three points

$7.2 \text{ g } H_2O \div 18.0 \text{ g/mol} = 0.40 \text{ mol } H_2O$ $0.40 \text{ mol } H_2O \times (2 \text{ mol H} / 1 \text{ mol } H_2O) = 0.80 \text{ mol H}$

$7.2 \text{ L } CO_2 \div 22.4 \text{ L/mol} = 0.32 \text{ mol } CO_2$ $0.32 \text{ mol } CO_2 \times (1 \text{ mol C} / 1 \text{ mol } CO_2) = 0.32 \text{ mol C}$

OR

$n = PV \div RT = [(1 \text{ atm}) (7.2 \text{ L})] \div [(0.0821 \text{ L atm mol}^{-1} \text{ K}^{1}) (273 \text{ K})] = 0.32 \text{ mol } CO_2$

0.80 mol H ÷ 0.32 = 2.5 0.32 mol C ÷ 0.32 = 1

2.5 x 2 = 5 mol H 1 x 2 = 2 mol C

empirical formula = C_2H_5

b) two points

mol O_2 for combustion = mol CO_2 + 1/2 mol H_2O = 0.32 + 0.20 = 0.52 mol O_2

0.52 mol O_2 x 32 g/mol = 17 g O_2

alternate approach for mol O_2 from balanced equation

$C_2H_5 + 13/4\ O_2 \text{ ---> } 2\ CO_2 + 5/2\ H_2O$

other ratio examples:

1, 6.5 ---> 4, 5

0.25, 1.625 ---> 1, 1.25

mol O_2 = 0.40 mol H_2O x (13/4 mol O_2 / 5/2 mol H_2O) = 0.52 mol O_2

Note: starting moles of C_2H_5 = 0.16 mol C_2H_5

c) three points (MM stands for molar mass)

$\Delta T = (K_f\ (g/MM))$ / kg of solvent

0.5 °:C = ((4.68 °:C kg $mol^{-:1}$) x (0.60 g / MM)) / 0.1 kg

MM = (4.68 x 0.60) / (0.5 x 0.1) = 56 or 6 x 10^1

an alternate solution for (c)

molality = 0.5 °:C / (4.68 0.5 °:C/*m*) = 0.107 *m*

mol solute =(0.107 mol / kg solvent) x 0.100 kg solvent = 0.0107 mol

MM = 0.60 g / 0.0107 mol = 56 or 6 x 10^1

d) one point

(56 g/mol of cmpd) / (29 g/mol of empirical formula) = 1.9 empirical formula per mol

OR

6 x 10^1 / 29 = 2.1

empirical formula times 2 equals molecular formula = C_4H_{10}

Topic 2

1) a) two points

When nucleons are combined in nuclei, some of their mass is converted to energy (binding energy) which is released and stabilizes the nucleus. (Key concepts: mass defect; binding energy)

b) two points

Alpha particles have a greater mass than beta particles. Thus their speed (penetrating potential) is less. (Alternate explanation could be based on charge.)

c) two points

The neutron/proton ratio in Sr-90 and Cs-137 is too large and they emit beta particles (converting neutrons to protons) to lower this ratio.

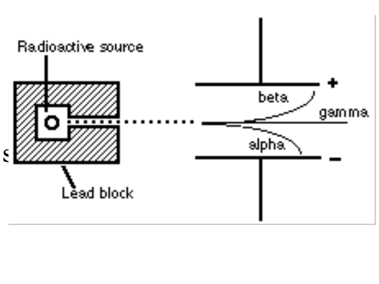
d) two points

Large amounts of energy are neded to initiate fusion reactions in order to overcome the repulsive forces between the positively charged nuclei. Large amounts of energy are not required to cause large nuclei to split.

(a) $^{234}_{94}Pu \rightarrow {}^{4}_{2}\alpha + {}^{230}_{92}U$

(b) This mass defect has been converted into energy. $\Delta E = \Delta mc^2$

(c) An alpha particle, α or He nuclei, has a 2+ charge and would be attracted to the (-) side of the electric field. A beta particle, β, or electron, has a single negative charge and is attracted to the positive side of the electric field, but since it is much lighter and faster than an alpha it would not be as strongly deflected. Gamma, γ, rays are not charged and, therefore, not deflected by the electric field.



1) a) two points K conducts because of its metallic bonding or "sea" of mobile e's

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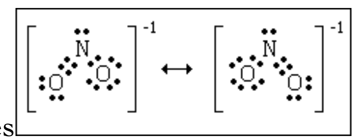
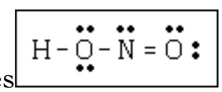
KNO_3 does not conduct because it is ionically bonded and has immobile ions (or imm. e's)
b) two points
$SbCl_3$ has a measurable dipole moment because it has a lone pair of e's which causes a dipole or its dipoles do not cancel or it has a trigonal pyramidal structure or clear diagram illustrating any of the above. $SbCl_5$ has no dipole moment because its dipoles cancel or it has a trigonal bipyramidal structure or clear diagram illustrating either of the above
c) two points
CBr_4 boils at a higher T than CCl_4 because it has stronger intermolecular forces (or van der Waals or London dispersion). These stronger forces occur because CBr_4 is larger and/or has more electrons than CCl_4. (Note added to scoring standard: student misconception of inter-, with "inter-" double underlined.)
d) two points
NaI has greater aqueous solubility than I_2 because NaI is ionic (or polar) whereas I_2 is nonpolar (or covalent). H_2O, being polar, interacts with the ions of NaI but not with I_2. (Like dissolves like accepted if polarity of H_2O clearly indicated.)

2) (a) two points Hydrogen bonding (or dipole-dipole attraction) in HF is greater than it is in HCl
Note: only one point earned if simply stated that HF has greater intermolecular forces than HCl
(b) two points
AsF_3 has a trigonal pyramid shape and bond dipoles do NOT cancel (or asymmetric molecule)
AsF_5 has a trigonal bipyramid shape and bond dipoles cancel (or symmetric shape)
Notes: Must refer to shape in order to earn pt.; one pt. earned if only correct Lewis structures are given.
(c) two points

NO_2^- has resonance structures  HNO_2 has no resonance structures 
OR one N-O single bond, one N=O double bond
Note: one point earned if only correct Lewis structures, including resonance for NO_2^- given.
(d) two points Sulfur uses d orbitals (or expanded octet), oxygen has no d orbitals in its valence shell OR Sulfur is a larger atom, can accomodate more bonds.

3 (a) Xe and Ne are monatomic elements held together by London dispersion (van der Waals) forces. The magnitude of such forces is determined by the number of electrons in the atom. A Xe atom has more electrons than a neon atom has. (Size of the atom was accepted but mass was not.)

(b) The electrical conductivity of copper metal is based on mobile valence electrons (partially filled bands). Copper chloride is a rigid ionic solid with the valence electrons of copper localized in individual copper(II) ions.

(c) SiO_2 is a covalent network solid. There are strong bonds, many of which must be broken simultaneously to volatilize SiO_2. CO_2 is composed of discrete, nonpolar CO_2 molecules so that the only forces holding the molecules together are the weak London dispersion (van der Waals) forces.

(d) In NF_3 a lone pair of electrons on the central atom results in a pyramidal shape. The dipoles don't cancel, thus the molecule is polar.

While in BF_3 there is no lone pair on the central atom so the molecule has a trigonal planar shape in which the dipoles cancel, thus the molecule is nonpolar.