What is the most likely mode of decay for each of the following nuclides?

- Carbon – 15

Ans: Beta decay

- Uranium – 238 (atomic number 92)

Ans: alpha decay

- Nitrogen – 12

Ans: positron emission (or electron capture)

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1. 100.0 g of an inorganic compound is found to contain 34.0 g of copper, 15.0 g of nitrogen, and 51.2 g of oxygen. Determine the empirical formula of the compound given that the atomic mass (g/mol) of Cu, N, and O is 64.0; 14.0, and 16.0 respectively.

Ans: CuN_2O_6 [OR $Cu(NO_3)_2$]

Cu = $\frac{34.0}{64} = 0.53$ N = $\frac{15.0}{14} = 1.1$ O = $\frac{51.2}{16} = 3.2$ Hence ratio = 1 : 2 : 6

2. 30.1 g of an inorganic compound is found to contain 15.0 g of copper, 7.62 g of sulphur, and 7.58 g of oxygen. Determine the empirical formula of the compound given that atomic masses (g/mol) of Cu, N, and O are 64.0; 14.0, and 16.0 respectively.

Ans: $CuSO_2$

Cu = $\frac{15.0}{64} = 0.234$ S = $\frac{7.50}{32} = 0.234$ O = $\frac{7.58}{16} = 0.474$ Hence ratio = 1 : 1 : 2

3. 40.0 g of an inorganic compound is found to contain 20.4 g of copper, 3.88 g of carbon and 15.6 g of oxygen. Determine the empirical formula of the compound given that atomic masses (g/mol) of Cu, C and O are 64.0; 12.0 and 16.0, respectively.

Ans: $CuCO_3$

Cu = $\frac{20.4}{64} = 0.32$ C = $\frac{3.88}{12} = 0.32$ O = $\frac{15.6}{16} = 0.98$ Hence ratio = 1 : 1 : 3

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1. The gaseous molecules, methane and oxygen are mixed in a 2:1 ratio by mass. What is the ratio of gases by volume? Take atomic masses (g/mol) of C, H and O as 12; 1.0 and 16, respectively.

Ans: 1:1

Molecular mass of CH_4 = 16

Molecular mass of O_2 = 32

Hence if present in 2:1 ratio, the number of moles and volume will be the same, hence 1:1

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products in a balanced equation of the reaction: $N_2 + O_2 + H_2O \rightarrow HNO_3$

Ans: 13

$2N_2 + 5O_2 + 2H_2O \rightarrow 4HNO_3$

3. The elements X and Y have 6 and 3 electrons respectively in their outermost shell. What is likely to be the formula of the compound formed between X and Y?

Ans: Y_2X_3

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1. Determine the most ionic compound in the list below:

$CaCl_2$; KCl; $MgCl_2$; $AlCl_3$; CsCl

Ans: CsCl

2. Which of the following compounds will exhibit the most hardness?

   MgO; Al_2O_3; Na_2O; CaO; Li_2O

Ans: Al_2O_3

3. Which of the following compounds has the highest covalent character?

   LiCl; NaCl; $BeCl_2$; RbCl; $MgCl_2$

Ans: $BeCl_2$

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1. 0.25 mol of a hydrocarbon with an empirical formula C_3H_5 has a mass of 41 g. Determine the molecular formula of the compound. Take the atomic mass of carbon and hydrogen (g/mol) as 12 and 1.0, respectively.

Ans: $C_{12}H_{20}$

Molar mass = 41/0.25 = 164 g/mol

n = 164/41 = 4; Hence molecular formular = $C_{12}H_{20}$

2. An organic compound has the formula $C_XH_8O_4$. If 0.015 mol of the compound has a mass of 1.98 g, determine the value of X, per formula unit of the molecule. Take the atomic mass of carbon, oxygen and hydrogen (g/mol) as 12, 16 and 1.0, respectively.

Ans: X = 5 carbon atoms

Molar mass = 1.98/0.015 = 132 g/mol

X = (132-72)/12 = 5

3. Given that one molecule of an organic compound with the empirical formula CH_2O has a mass of 2.0×10^{-22} g, determine the molecular formula of the compound. Take the atomic mass of carbon, oxygen and hydrogen (g/mol) as 12, 16 and 1.0 respectively and Avogadro's number as 6.0×10^{23}.

Ans: $C_4H_8O_4$

Molar mass = $2.0 \times 10^{-22} \times 6.0 \times 10^{23}$ = 120 g/mol

n = 120/30 = 4; Hence molecular formula = $C_4H_8O_4$

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1. Given Avogadro's number as 6.02×10^{23}, what is the mass present in 1.51×10^{23} molecules of benzaldehyde, C_7H_6O? Take the atomic mass (g/mol) of C, H and O as 12.0, 1.00 and 16.0, respectively.

Ans: 26.5 g

Molecular mass of benzaldehyde = 106 g

Number of moles = $1.51 \times 10^{23} / 6.02 \times 10^{23}$ = 0.25 moles

Mass of benzaldehyde = 0.25 × 106 = 26.5

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $SiO_2 + HF \rightarrow SiF_4 + H_2O$

Ans: 8

$$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$$

3. How many sigma and pi bonds each are present in methanal?

Ans: 1 pi bond and 3 sigma bonds

Identify the following species found on the Periodic Table given the information below:

1. Mass number 33; neutron number 18; number of electrons 18

Ans: P^{3-}

2. Mass number 55; neutron number 30; number of electrons 22

Ans: Mn^{3+}

3. Mass number 66; neutron number 36; number of electrons 28

Ans: Zn^{2}

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1. Determine the percentage of phosphorus present in phosphorus pentoxide (P_2O_5) given the relative atomic masses of phosphorus and oxygen as 31 and 16 respectively.

Ans: 44 %

Molar mass of (P_2O_5) = 142 percentage of P = $\frac{62}{142} \times 100 = 44\%$

2. Determine the percentage of chromium present in the chromium oxide Cr_2O_3 given the relative atomic masses of chromium and oxygen as 52 and 16 respectively.

Ans: 68 %

Molar mass of (Cr_2O_3) = 152 percentage of P = $\frac{104}{152} \times 100 = 68\%$

3. Determine the percentage of chlorine present in dichlorine hexoxide (Cl_2O_6) given the relative atomic masses of Chlorine and oxygen as 35 and 16 respectively.

Ans: 42 %

Molar mass of (Cr_2O_3) = 166 percentage of P = $\frac{70}{166} \times 100 = 42\%$

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1. Calculate the number of moles of hydrogen gas released when 6.0 moles of Aluminum react with excess hydrochloric acid.

Ans: 9.0 moles

$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products in a balanced equation of the reaction: $SiCl_4 + H_2O \rightarrow SiO_2 + HCl$

Ans: 8

$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

3. Which nuclear species is formed when carbon-14 is bombarded with a proton to produce nitrogen-14?

Ans: Neutron

Give the name of the major product formed in each of the following reactions

1. The Reaction of benzene with chlorine in the presence of aluminum chloride

Ans: chlorobenzene

2. The reaction of 2-methylpropane with a limited amount of chlorine gas

Ans: 2-chloro-2-methyl propane

3. The reaction of butanoic acid and methylamine

Ans: N-methyl butanamide

During the production of pure iron, Fe_2O_3 reacts with carbon monoxide, CO, according to the reaction: $Fe_2O_3 + 3\ CO \rightarrow 2Fe + 3CO_2$

1. Given that 80 g of Fe_2O_3 and 84 g of CO react, determine which reactant is the limiting reagent and by what amount. You are given molecular mass of Fe_2O_3 and CO as 160 and 28 g/mol, respectively.

Ans: Fe_2O_3, limited by 0.50 mol

n Fe_2O_3 = 80/160 = 0.50 mol n CO = 84/28 = 3.0 mol

n Fe_2O_3 required = $\frac{1}{3} \times 3.0$ mol = 1.0 mol; but only 0.50 mol present

2. Given that 80 g of Fe_2O_3 and 84 g of CO reacts, determine which reactant is in excess and by what amount. You are given molecular mass of Fe_2O_3 and CO as 160 and 28 g/mol, respectively.

Ans: CO, excess by 1.5 mols

n Fe_2O_3 = 80/160 = 0.50 mol n CO = 84/28 = 3.0 mol

n CO required = $\frac{3}{1} \times 0.50$ mol = 1.5 mol; but 3.0 mol present

3. How many grams of iron will be produced from the reaction of excess Fe_2O_3 and 84 g of CO? You are given molecular mass of Fe_2O_3 and CO as 160 and 28 g/mol respectively and atomic mass of Fe as 56 g/mol.

Ans: 112 g

n CO = 84/28 = 3.0 mol n Fe = = $\frac{2}{3} \times 3.0$ mol = 2.0 mol

1. How many moles of phosphorus is present in 14.2 g of P_4O_{10}? Take the atomic mass (g/mol) of phosphorus and oxygen as 31 and 16, respectively.

Ans: n(P) = 0.20 mol

n(P_4O_{10}) = 14.2/284 = 0.050 mol; P = 4 × 0.05 = 0.20 mol

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Ans: 13

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

3. How many unpaired electrons are present in the molecule NO?

Ans: one (1)

Write the equilibrium constant expression Kc for the following reversible reactions:

1. $CH_4\,(g) + H_2S\,(g) \rightleftharpoons CS_2\,(g) + 4\,H_2\,(g)$

Ans: Kc = $\dfrac{[CS_2]\,[H_2]^4}{[CH_4]\,[H_2S]}$

2. $2\,Pb(NO_3)_2\,(s) \rightleftharpoons 2\,PbO\,(s) + 4\,NO_2\,(g) + O_2\,(g)$

Ans: Kc = $[NO_2]^4\,[O_2]$

3. $N_2H_4\,(g) + 6\,H_2O_2\,(g) \rightleftharpoons 2\,NO_2\,(g) + 8\,H_2O\,(g)$

Ans: Kc = $\dfrac{[NO_2]^2\,[H_2O]^8}{[N_2H_4]\,[H_2O_2]^6}$

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1. What mass of methanoic acid is required to completely neutralise a solution made of 50.0 cm^3 of 0.200 $moldm^{-3}$ NaOH? Take atomic mass (g/mol) of C as 12; O as 16; H as 1.0.

Ans: 0.46 g

Moles of NaOH = 0.20 $moldm^{-3}$ × 0.050 dm^3 = 0.010 mol = moles of HCOOH

Mass of HCOOH needed = 46 × 0.010 = 0.46 g

2. Calculate the mass of solid that remains when 200 cm^3 solution of Na_2CO_3 of concentration 0.25 $moldm^{-3}$ is heated to dryness. Take the atomic mass (g/mol) of Na as 23; O as 16; and C as 12

Ans: 5.3 g

Moles of Na_2CO_3 = 0.20 × 0.25 = 0.050 mol

Molar mass = 106 g/mol. Hence mass present = 0.050 × 106 = 5.3 g

3. What mass of Na_2SO_4 must be dissolved in 100 cm^3 of solution to obtain a concentration of 0.50 $moldm^{-3}$? Atomic mass (g/mol) of Na = 23; O = 16; S = 32

Ans: 7.1 g

Moles of Na_2SO_4 = 0.10 × 0.50 = 0.050 mole

Mass of Na_2SO_4 = 0.050 × 142 = 7.1 g

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1. Upon combustion, 0.40 g of a hydrocarbon produces 1.1 g of carbon dioxide. Determine the percentage composition of carbon in the compound. (C = 12; O=16, H = 1.0)

Ans: 75 %

Mass of C = 12/44 × 1.1 = 0.30 g

% C = 0.30/0.40 × 100 = 75 %

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $Ag_2S \rightarrow Ag + S_8$

Ans: 25

$8\ Ag_2S \rightarrow 16\ Ag + S_8$

3. Which of the hybrid orbitals in carbon has the highest percentage of s-character?

Ans: sp orbital (50%)

Give the name of the major product formed from the reaction of HBr with each of the following:

1. 1-pentene

Ans: 2-bromopentane

2. 2-methyl-2-butene

Ans: 2-bromo-2-methylbutane

3. Cyclohexene

Ans: Bromo cyclohexane (or 1-bromo cyclohexane)

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1. What mass of oxygen is needed to produce 90 g of water given that an excess amount of hydrogen reacts? Take the atomic mass (g/mol) of H and O as 1.0 and 16 respectively.

Ans: 80 g

Mol of $H_2O = 90/18 = 5.0$ mol.

n $O_2 = 5.0/2 = 2.5$ mol Hence mass $= 2.5 \times 32 = 80$ g

2. Determine the mass of Na_2CO_3 needed to produce 0.150 mol of carbon dioxide gas in a thermal decomposition reaction. Take the atomic mass (g/mol) of Na, C, and O as 23.0, 12.0 and 16.0 respectively.

Ans: 15.9 g

Molar mas of $Na_2CO_3 = 106$ since mole ratio is 1:1, mass $= 106 \times 0.150 = 15.9$ g

3. Based on a reaction with solid carbon, determine the mass of oxygen needed to produce 16.8 g of carbon monoxide given that, oxygen is limited. Take the atomic mass (g/mol) of C and O as 12 and 16 respectively.

Ans: 9.6 g

Mol of $CO = 16.8/28 = 0.60$ mol mol of $O_2 = 0.60/2 = 0.30$ mol

Mass of $O_2 = 9.6$ g

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1. Given Avogadro's number as 6.0×10^{23}, how many atoms of oxygen are present in 4.0 moles of SO_3?

Ans: 7.2×10^{24}

Number of atoms $= 6.0 \times 10^{23} \times 4$ mol $\times 3$ O atoms $= 7.2 \times 10^{24}$

2. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $C_6H_8 + O_2 \rightarrow CO_2 + H_2O$

Ans: 19

$C_6H_8 + 8O_2 \rightarrow 6CO_2 + 4H_2O$

3. What is the maximum number of hydrogen bonds formed by a water molecule in ice?

Ans: four (4)

Indicate the values of all quantum numbers permissible for the following orbitals

1. 4p

Ans: *n = 4, l = 1, ml = -1, 0, +1*

2. 3d

Ans: n = 3, l = 2, ml = -2, -1, 0, +1, +2

3. 5s

Ans: n = 5, l = 0, ml = 0

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1. Calculate the solubility in mg/dm^3 of $BaCrO_4$ at 25 °C given its solubility product is 1.0×10^{-10}. Take the molecular mass of $BaCrO_4$ as 253 g/mol.

Ans: 2.53 mg/dm3

Solubility = $\sqrt{1.0 \times 10^{-10}} = 1.0 \times 10^{-5}$ mol/dm^3

Solubility in mg/dm^3 = $1.0 \times 10^{-5} \times 253 \times 1000 = 2.53$ mg

2. Calculate the molar solubility of $BaSO_4$ in a 0.010 moldm^3 solution of $Ba(NO_3)_2$ given that the solubility product of 1.1×10^{-10}.

Ans: 1.1×10^{-8} mol/dm^3

$BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$

$0.01 + s$

Solubility, s = $1.1 \times 10^{-10} / 0.010 = 1.1 \times 10^{-8}$ mol/dm^3

3. Calculate the molar solubility of $Cu(OH)_2$ in a solution of pH 10. Solubility product of $Cu(OH)_2$ is 2.6×10^{-19}.

Ans: 2.6×10^{-15} mol/dm^3

OH^- = 0.00010 mol/dm^3

$Cu(OH)_2 \rightleftharpoons Cu^{2+} + 2OH^-$

$2s + 0.00010$

Solubility, s = $2.6 \times 10^{-19} / 0.00010 = 2.6 \times 10^{-15}$

---

1. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $Al + Fe_3N_2 \rightarrow AlN + Fe$

Ans: 8

$2Al + Fe_3N_2 \rightarrow 2AlN + 3Fe$

2. Given that, the atomic masses of manganese and astatine are 55 and 210 respectively, what mass of astatine will have the same number of particles as 2.2 g of manganese?

Ans: 8.4 g

Moles of Mg = 2.2/55.0 = 0.040

Hence equivalent mass of At = 0.040 × 210 = 8.4 g

3. To determine the formula of a hydrocarbon, 0.66 g of the hydrocarbon produced 2.2 g of carbon dioxide when burned. Determine the percentage composition of carbon in the compound. (C = 12; O= 16, H = 1.0)

Ans: 91 %

Mass of C = 12/44 × 2.2 = 0.60 g

% C = 0.60/0.66 × 100 = 91 %

Indicate the cell notation for each of the following cell reactions

1. $Cu\ (s) + 2\ Fe^{3+}\ (aq) \rightarrow Cu^{2+}\ (aq) + 2\ Fe^{2+}\ (aq)$

   Ans: Cu | Cu^{2+} || Fe^{2+}, Fe^{3+} | Pt

2. $2\ Ag\ (s) + 2\ H^{+}\ (aq) \rightarrow 2\ Ag^{+}\ (aq) + H_2\ (g)$

   Ans: Ag | Ag^{+} || H^{+} | H_2 | Pt

3. $2\ Cl^{-}\ (aq) + 2\ Fe^{3+}\ (aq) \rightarrow Cl_2\ (g) + 2\ Fe^{2+}\ (aq)$

   Ans: Pt | Cl_2 | Cl^{-} || Fe^{2+}, Fe^{3+} | Pt

---

1. Determine the percent composition of carbon present in nicotine ($C_{10}H_{14}N_2$) given the relative atomic masses of carbon, hydrogen, nitrogen and oxygen as 12, 1.0, 14 and 16 respectively.

Ans: 74 %

Molar mass of ($C_{10}H_{14}N_2$) = 162 percentage of C = $\frac{120}{162} \times 100 = 74\%$

2. Determine the percent composition of carbon present in the alkaloid cytisine ($C_{11}H_{14}N_2O$) given the relative atomic masses of carbon, hydrogen, nitrogen, and oxygen as 12, 1.0, 14 and 16 respectively.

Ans: 69 %

Molar mass of ($C_{11}H_{14}N_2O$) = 190 Percentage of C = $\frac{132}{190} \times 100 = 69\%$

3. Determine the percent composition of carbon present in the drug, pregabalin ($C_8H_{17}NO_2$) given the relative atomic masses of carbon, hydrogen, nitrogen, and oxygen as 12, 1.0, 14 and 16 respectively.

Ans: 60 %

Molar mass of ($C_8H_{17}NO_2$) = 159 Percentage of C = $\frac{96}{159} \times 100 = 60\ \%$

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1. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $SiCl_4 + H_2O \rightarrow H_4SiO_4 + HCl$

Ans: 10

$SiCl_4 + 4H_2O \rightarrow H_4SiO_4 + 4HCl$

2. Given that 0.20 moles of a compound A_3B weighs 28 g, determine the atomic mass of element A if the atomic mass of element B is 14 g.

Ans: 42 g/mol

Molecular mass of compound = 28/0.2 = 140

Mass of element A = (140-14)/3 = 42 g/mol

3. What is the maximum number of hydrogen bonds formed by molecules of trimethylamine?

Ans: zero (0)

The contact process for the manufacture of sulfuric acid involves the following equilibrium reaction: $2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g)$ $\Delta H = -196\ kJmol^{-1}$

State and explain the effect of each of the following actions on the equilibrium of the reaction

1. An increase in pressure

Ans: **Equilibrium will shift toward the formation of more product (right/forward)**

An increase in pressure will favour the side with fewer moles of gas. Mole of reactants is 3 and moles of product is 2, hence pressure will favour formation of product/forward reaction

2. An increase in temperature

Ans: **Equilibrium will shift toward the formation of more reactants (left/backwards)**

Since reaction is exothermic, increase in temperature will favour the formation of reactants

3. A decrease in the amount of oxygen gas

Ans: **Equilibrium will shift toward the formation of more reactants (left/backwards)**

More SO_3 will breakdown to form O_2 in other to negative the effect of the reduced concentration of O_2.

1. Ethyne reacts with oxygen in a ratio of 2:5. Calculate the enthalpy of bonds broken in this reaction. You are given the following bond energies in kJ/mol: C≡C = 840; C–H = 415; O=O = 500

Ans: 3500 kJ/mol

2 C≡C = 840 × 2 = 1680
4 C–H = 415 × 4 = 1660
5 O=O = 500 × 5 = 2500

Total bond energy = 5840 kJ/mol

2. Given that 4 moles of CO_2 and 2 moles of H_2O are produced from the reaction of ethyne and oxygen, calculate the enthalpy of bonds formed in the reaction. You are given the following bond energies in kJ/mol: C=O = 800; H–O = 460.

Ans: –8240 kJ/mol *(please ignore negative sign)*

8 C=O = 800 × 8 = 6400
4 H–O = 460 × 4 = 1840

Total = 8240 kJ/mol

3. Nitrogen triiodide, NI_3 decomposes to form nitrogen gas and iodide. Calculate the enthalpy change for this reaction. You are given the following bond energies in kJ/mol: N–I = 160; N≡N = 950; I–I = 150

Ans: 620 kJ/mol

Bonds broken	*Bonds formed*
3 N–I = 160 × 3 = 480	N≡N = 950
	I–I = 150

Enthalpy change = 1100 – 480 = 620 kJ/mol

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1. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $FeS_2 + O_2 \rightarrow Fe_2O_3 + SO_2$

Ans: 25

$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

2. Given the atomic masses of nitrogen, hydrogen, oxygen and cerium as 14, 1.0, 16, and 140, g/mol respectively, determine the mass of 1.0 mole of ammonium cerium (IV) nitrate, $(NH_4)_2Ce(NO_3)_6$

Ans: 546 g/mol

17×2 + 140 + 62×6 = 546 g/mol

3. Name the nuclide formed when Vanadium-52 undergoes a beta decay?

Ans: Chromium-52

Reforming of petroleum helps to convert high molecular weight hydrocarbons into low molecular weight high octane products. Name <u>one</u> major reaction that occurs during catalytic reforming of petroleum.

Ans:

1. **Dehydrogenation**
2. **Isomerization**
3. **Cyclization**
4. **Aromatization**
5. **Hydrocracking**

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1. A molecule of an organic compound contains 8 carbon atoms which account for a total of 60% of its molecular mass. Determine the molecular mass of the compound given that the atomic mass of carbon is 12.

Ans:160 g/mol

Total mass of Carbon = 12 × 8 = 98 g

Molecular Mass = (100 × 96) / 60 = 160 g/mol

2. A hydrocarbon contains 13 carbon atoms which account for a total of 65 % of its molecular mass. Determine the molecular mass of the compound given that the atomic mass of carbon is 12.

Ans: 240 g/mol

Total mass of Carbon = 12 × 13 = 156 g

Molecular Mass = (100 × 156) / 65 = 240 g/mol

3. An aliphatic diol with molecular mass 174 g/mol contains 10 carbon atoms. Determine the number of hydrogen atoms present in the alcohol given that the atomic mass of carbon is 12, oxygen is 16 and hydrogen is 1.0

Ans: 22

Total mass of carbon = 12 × 10 = 120

Mass of oxygen = 16 × 2 = 32

Hence mass of H = 174 – 152 = 22

---

1. How many moles of oxygen atoms are present in 2.4 g of S_2O_8? Take the atomic mass (g/mol) of sulphur and oxygen as 32 and 16, respectively.

Ans: 0.10 mol

$n(S_2O_8) = 2.4/192 = 0.0125$ mol. $n(O) = 8 \times 0.0125 = 0.10$ mol

2. The gaseous molecules: N_2O and CO_2 are mixed in a ratio of 1:3 by mass. What is the ratio of gases by volume? Take atomic masses of N, C and O as 14; 12 and 16, respectively.

Ans: 1:3

Molecular mass of N_2O = 44

Molecular mass of CO_2 = 44

Since molecular mass is the same, volume ratio will be same, Hence 1:3

3. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $HNO_3 \rightarrow H_2O + NO_2 + O_2$

Ans: 11

$4HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$ (Accept only integers)

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1. Which nuclear species is formed when boron-10 is bombarded with a proton to produce boron-8?

Ans: Tritium

2. Identify the nuclear species formed when oxygen-16 is bombarded with nitrogen-14 to produce fluorine-16

Ans: carbon-14

3. Identify the nuclear species formed when Neon-20 is bombarded with deuterium to produce an alpha particle.

Ans: Fluorine-18

4. Identify the nuclide formed when chlorine-33 undergoes a positron decay?

Ans: sulphur-33

Given the following reduction enthalpies, write the standard cell notation for the cell reactions occurring and indicate the value of the emf.

1. Cu^{2+} / Cu E^o = 0.337 V
   Ag+ / Ag E^o = 0.800 V

Ans: Cu | Cu^{2+} || Ag^+ | Ag emf = 0.468 V

2. Sn^{2+} / Sn E^o = – 0.137 V
   Fe^{3+} / Fe^{2+} E^o = 0.770 V

Ans: Sn | Sn^{2+} || Fe^{2+}, Fe^{3+} | Pt emf = 0.907 V

3. Sn^{4+} / Sn^{2+} E^o = 0.148 V
   Pb^{4+} / Pb^{2+} E^o = 1.667 V

Ans: Pt | Sn^{2+}, Sn^{4+} || Pb^{4+}, Pb^{2+} | Pt emf = 1.519 V

4. Ti^{2+} / Ti E^o = – 0.163 V
   U^{4+} / U^{3+} E^o = – 0.609 V

Ans: Pt | U^{3+}, U^{4+} || Ti^{2+}| Ti emf = 0.446 V

---

1. Given the atomic masses of magnesium, boron and oxygen as 24, 11, and 16 g/mol respectively, determine the mass of 2.0 moles of magnesium borate, $Mg_3(BO_3)_2$

Ans: 380 g

24×3+59×2 = 190 g/mol
Mass of 2.0 moles = 190×2 = 380 g

2. Determine the maximum amount (in grams) of ammonia produced when 11.2 g each of hydrogen gas and nitrogen gas react according to the equation: $N_2 + 3\ H_2 \rightleftharpoons 2\ NH_3$
   Take atomic mass of nitrogen and hydrogen as 14.0 and 1.00, respectively.

Ans:13.6 g

$N_2 + 3\ H_2 \rightleftharpoons 2\ NH_3$

$n(N_2)$ = 11.2/28 = 0.400 mole; H_2 is in excess

mass of NH_3 = 0.400 × 17 × 2 = 13.6 g

3. Determine the **sum** of the stoichiometric coefficients of all reactants and products present in a balanced equation of the reaction: $C_2H_2 + O_2 \rightarrow CO_2 + H_2O$

Ans: 13

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

---

1. What is the change in the oxidation state of the reducing agent present in the reaction: $Cr(OH)_3 + Br_2 \rightarrow CrO_4^{2-} + Br^-$

Ans: +3 to +6 (or a change of +3)

2. What is the oxidation state of the oxidized form of the reducing agent present in the reaction: $Cr_2O_7^{2-} + C_2H_5OH \rightarrow Cr^{3+} + CO_2$

Ans: +4

3. How many moles of an ideal gas are present in 2.5 dm^3 of gas at a temperature of 27 °C and 100 kPa? Take the molar gas constant to be 8.3 $JK^{-1}mol^{-1}$

Ans: 0.10 mol

PV=nRT

Mole of gas = PV/RT = 100000 × 0.0025/(8.3 × 300) = 0.10 mol

4. 4.00 moles of a compound have a mass of 420 g. What is the molecular mass of the compound?

Ans: 105 g/mol

Molecular mass = 420/4.0 = 115 g/mol