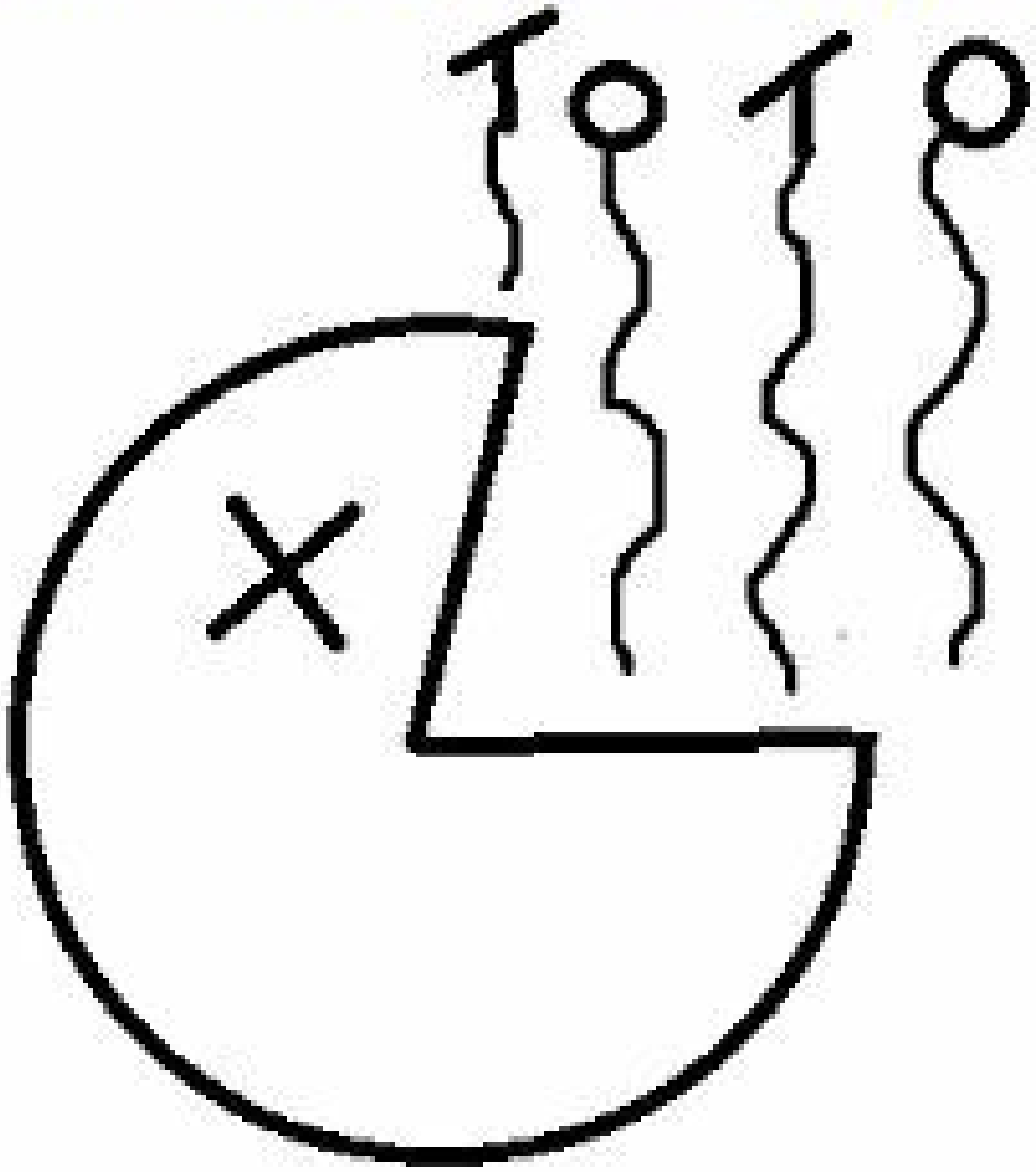
Stoichiometry past papers questions



2023 test 1

QUESTION TWO (STOICHIOMETRY AND MOLE CONCEPT) [25 marks]

Compound A (Fe_xO_y) comprises of 30.02% oxygen.

a) Determine the actual value of x and y [4]

b) Write down the systematic name of compound A [1]

c) If 50.0 g of compound A reacts with 40.0 g of carbon monoxide to produce iron metal and carbon dioxide gas, prove that compound A is a limiting reagent in this reaction. [10]

d) 0.658 g of a compound containing only carbon, hydrogen and oxygen is burned in excess oxygen gas, 1.285 g of carbon dioxide and 0.658g of water are produced. If the molar of the compound is determined to be 90g/mol. Determine the molecular formula. [10]

2022 test 1

QUESTION 2: STOICHIOMETRY [25 MARKS]

a) Zinc (Zn) is a silvery metal that is used in making brass (with copper) and in plating iron to prevent corrosion. How many moles of Zn are there in 45.9 g of Zn? [2]

b) Sulfur (S) is a nonmetallic element that is present in coal. When coal is burned, sulfur is converted to sulfur dioxide and eventually to sulfuric acid, which gives rise to the acid rain phenomenon. How many atoms are in 25.1 g of S? [2]

c) Lithium carbonate (Li_2CO_3) was the first "mood-stabilizing" drug approved by the FDA for the treatment of mania and manic-depressive illness, also known as bipolar disorder. Calculate the percent composition ~~by mass of lithium carbonate~~. [3]

d) Iron (Fe), the main component of steel, is the most important metal in industrial society. How many Fe atoms are in 95.8 g of Fe? [3]

e) During excessive physical activity, lactic acid (Molar mass = 90.08 g/mol) forms in muscle tissue and is responsible for muscle soreness. Elemental analysis shows that this compound contains 40.0 mass % C, 6.71 mass % H, and 53.3 mass % O. [10]

i. Determine the empirical formula of lactic acid.
ii. Determine the molecular formula.

f) When potassium chromate (K_2CrO_4) is added to a solution containing 0.500 g silver nitrate ($AgNO_3$), solid silver chromate (Ag_2CrO_4) is formed. Write a balanced chemical equation and find the percent yield if 0.455 g of silver chromate is obtained. [5]

3: REACTIONS IN AQUEOUS SOLUTIONS & STOICHIOMESTRY ✓ [20 Marks]

a) The oxidation number of an element is the "charge" the element would have if all of its bonds were completely ionic, that is, if the electron pairs of each bond were transferred to the more electronegative atom. Determine the oxidation state of: [2]

i) Chromium in $K_2Cr_2O_7$

ii) Lead in $Pb(OH)_4^{2-}$

b) Identify the oxidizing and reducing agent in the following reaction [2]

$$2Fe^{2+} + H_2O_2 + 2H^+ \rightarrow 2Fe^{3+} + 2H_2O$$

c) Nickel nitrate, $Ni(NO_3)_2$ reacts with sodium hydroxide (NaOH) to produce sodium nitrate ($NaNO_3$) and a solid nickel (II) hydroxide, $Ni(OH)_2$ Write balanced *molecular*, *ionic*, and *net ionic* equations for the reaction. Assume all reactions occur in aqueous solution. Include states of matter in your balanced equation. [6]

d) Solid sodium and iron (III) oxide are involved in a reaction that is one of many reactions responsible for inflating a car airbag. [10]

$$6Na + Fe_2O_3 \rightarrow 3Na_2O + 2Fe$$

If 100.0 g Na and 100.0 g Fe_2O_3 are used, determine:

i) limiting reactant

ii) moles excess reactant

iii) mass of solid iron produced

iv) mass of excess reactant left over

v) what is the percent yield if 58.8 g of solid iron were produced?

2021 test 1

QUESTION 2: STOICHIOMETRY [25 MARKS]

a) Ammonia (NH_3) reacts with fluorine (F_2) to produce dinitrogen tetrafluoride (N_2F_4) and hydrogen fluoride (HF). In an experiment 4.0 g of NH_3 and 14.0 g of F_2 are combined.

i) Write a balanced chemical equation for the reaction [2]

ii) Which reactant is the limiting reactant? [6]

iii) How many grams of N_2F_4 can theoretically be prepared from this experiment? [4]

iv) If 4.80 g N_2F_4 are obtained from this experiment, what is the percentage yield? [3]

b) When 12.10 g of tert-butyl ether (a compound of C, H, and O) are completely burned in an apparatus, 30.1 g of CO_2 and 14.8 g of H_2O are formed. What is the empirical formula of the compound? [10]

Compound/ion	Element: Oxidation Number
KNO_3	N:
AlH_3	Al:
NH_4^+	H:
$H_2PO_4^-$	P:

[4]

b) Bromine trifluoride ($BrCl_3$) is a strong ionizing inorganic solvent. It is also used for manufacturing uranium hexafluoride (UF_6) while processing and reprocessing nuclear fuel.

i. Write a balanced chemical equation for the dissociation of liquid Bromine trifluoride to form chlorine and bromine in solution, [2]

ii. If 3.54 moles of $BrCl_3$ reacts according to the equation, how many moles of Cl_2 will be formed? How many moles of Br_2 will be formed? [4]

iii. To ensure stability of uranium hexafluoride (UF_6), an 8.19 g compound of C, H, and O is burned in a cylinder. From this, 20.3 g of CO_2 and 10.1 g of H_2O are formed. What is the empirical formula of the compound? [10]

2020 sessional

QUESTION 7: REACTIONS IN SOLUTION & STOICHIOMESTRY [20 Marks]

a) In a reaction between iron, Fe, and hydrochloric acid, HCl, two products, $FeCl_2$ and H_2, can be formed according to the equation

$$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$$

In an experiment, 22.40 g Fe and 27.38 g HCl are reacted

i) Which one is the limiting reactant? [2]

ii) How much H_2 in grams is produced? [2]

iii) How many grams of the reactant in excess will remain after the reaction has topped? [2]

iv) How many grams of $FeCl_2$ would be produced after the reaction has stopped? [2]

v) If 27.20 g of $FeCl_2$ were formed, calculate the percentage yield for this reaction. [2]

b) A sample of a compound is found to contain 64.80 % carbon, 13.62 % hydrogen, and 21.58 % oxygen by weight.

i) What is the empirical formula for this compound? [6]

ii) The molecular weight for this compound is 74.14 g/mol. What is its molecular formula? [4]

2019 test 2

QUESTION TWO **[25 MARKS]**

STOICHIOMETRY

a) Carbon dioxide in the air of a spacecraft can be removed by reacting it with lithium hydroxide to give lithium carbonate and water. On average, a person will exhale about one kilogram of CO_2 per day.

i) Write a balanced equation for the reaction. [2]

ii) If you react the given amount of carbon dioxide with 1.5 kg of lithium hydroxide, identify the limiting reagent. [3]

iii) How many kgs of lithium carbonate do you expect from the quantities of the reactants given? [3]

iv) If 1,259.20 g of lithium carbonate is produced, calculate the percentage yield of lithium carbonate. [3]

v) How much in moles is the excess reagent? [3]

vi) Calculate the percentage composition of each element in lithium carbonate. [3]

2019 test 2

b) Nicotine, an alkaloid in the nightshade family of plants that is mainly responsible for the addictive nature of cigarettes, contains 74.02% C, 8.710% H, and 17.27% N. If 40.57 g of nicotine contains 0.2500 mol nicotine, what is the molecular formula of nicotine? [5]

c) Dianabol is one of the anabolic steroids that has been used by some athletes to increase the size and strength of their muscles. It is similar to the male hormone testosterone. Some studies indicate that the desired effects of the drug are minimal, and the side effects, which include sterility and increased risk of liver cancer and heart disease, keep most people from using it. The molecular formula of Dianabol, which consists of carbon, hydrogen, and oxygen, can be determined using the data from two different experiments. In the first experiment, 14.765 g of Dianabol is burned, and 43.257 g CO_2 and 12.395 g H_2O are formed. In the second experiment, the molecular mass of Dianabol is found to be 300.44 g/mol. What is the molecular formula for Dianabol? [6]

QUESTION 1: INTRODUCTION AND STOICHIOMETRY [20 MARKS]

(a) Four students weigh an item using different scales. These are the values they report:

(i) 20.03 g
(ii) 20.0 g
(iii) 0.2003 kg
(iv) 20 g

How many significant figures should be assumed in each measurement? [2]

(b) The following archery targets show marks that represent the results of four sets of measurements.

A B C D

Which target shows:

(i) a set of measurements that is both precise and accurate?
(ii) a set of measurements that is neither precise nor accurate?
(iii) a precise but inaccurate set of measurements?
(iv) an accurate but imprecise set of measurements? [2]

(c) A piece of iron (5.59 g) is ignited in a vessel containing 1.60 g of oxygen gas to form Fe_3O_4.

(i) Write a balanced equation for the reaction [1]
(ii) Deduce which reactant is in excess [2]
(iii) For the reactant in excess calculate the amount in moles by which it is in excess. [2]
(iv) Using the limiting reagent, determine how much of the product you would expect. [2]
(v) If the actual mass of the product obtained is 4.64g, calculate the percentage yield. [2]

(d) A compound contains carbon and hydrogen only. On combustion, 0.150 g of the compound gives 0.488 g CO_2 and 0.150 g H_2O. The molar mass is found to be 52.0g.

(i) What is the mass percentage of each element in the compound? [3]
(ii) Calculate the empirical formula of the compound. [2]
(iii) Calculate the molecular formula of the compound. [2]

2018 test 1

QUESTION 2 **25 MARKS**

(a) The percentage composition of caffeine is 49.5% C, 5.15% H, 28.9% N, and 16.5% O.

i) What is the empirical formula of caffeine? [2]

ii) Determine the molecular formula of caffeine if its molar mass is 195g/mol [2]

(b) A solution containing 3.5 g of sodium phosphate is mixed with a solution containing 6.4 g of barium nitrate.

i) Write a balanced equation for the reaction taking place [2]

ii) Write the complete ionic equation for the reaction taking place [2]

iii) Write the net ionic equation for the reaction taking place [2]

iv) Calculate the number of moles for each reactant [3]

y) Determine the limiting reagent for this reaction [2]

yi) For the reagent in excess, calculate the mass that remains after the reaction [3]

vii) Calculate the mass of barium phosphate formed in this reaction [3]

(c) In an experiment, 5.50 g of $SOCl_2$ was obtained from the reaction of 5.80 g of SO_2 with excess PCl_5 according to the following reaction equation:

$$SO_2(l) + PCl_5(l) \rightarrow SOCl_2(l) + POCl_3(l)$$

i. What is the theoretical yield of $SOCl_2$? [2]

ii. Determine the percentage yield of $SOCl_2$ [2]

The Periodic Table

1	2											3	4	5	6	7	0
1 **H** 1.01				Atomic Number **Element** Atomic Mass													2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											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** 22.99	12 **Mg** 24.31											13 **Al** 26.98	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** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	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** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 **Uut** (284)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (291)	117 **Uus** (Unknown)	118 **Uuo** (294)

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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** (262)

TABLE OF FUNDAMENTAL CONSTANTS

Quantity	symbol	Value	Power of ten	Units
Speed of light	c	2.9979	10^{8}	m s^{-1}
Elementary charge	e	1.602	10^{-19}	C
Faraday's constant	$F=N_Ae$	9.6485	10^{4}	C mol^{-1}
Boltzmann's constant	k	1.380 65	10^{-23}	J K^{-1}
Gas constant	$R=N_Ak$	8.314 47 8.314 47 8.205 74 6.236 37	 10^{-2} 10^{-2} 10	J K^{-1} mol^{-1} L bar K^{-1} mol^{-1} L atm K^{-1} mol^{-1} L Torr K^{-1} mol^{-1}
Planck's constant	h	6.626 08	10^{-34}	Js
Avogadro's constant	N_A	6.022 14	10^{23}	mol^{-1}
Atomic mass unit	m_u	1.660 54	10^{-27}	Kg
Mass				
Electron	m_e	9.109 38	10^{-31}	Kg
Proton	m_p	1.672 62	10^{-27}	Kg
neutron	m_n	1.674 93	10^{-27}	kg
Rydeberg constant	R_H	1.097 37	10^{7}	m^{-1}
1 atm = 760 mmHg = 760 Torr = 1.01325 x 10^5 Nm^{-2} = 1.01325 x10^5 Pa= 1.01325 bar				