

## CHEMISTRY

### BOOKS - P BAHADUR CHEMISTRY (HINGLISH)

#### MOLE AND EQUIVALENT CONCEPT

##### Exercise (Mole concept 1) Elementary numerical problem

1.  $1.7g$  of silver nitrate dissolved in  $100g$  of water is taken.  $0.585g$  of sodium chloride dissolved in  $100g$  of water is added to it an chemical reaction occurs.  $1.435g$  of silver chloride and  $0.85g$  of sodium nitrate are formed. Justify that the data obey law of conservation of mass.



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2. a. When  $4.2\text{g NaHCO}_3$  is added to a solution of  $\text{CH}_3\text{COOH}$  is released into atmosphere. The residue is the found to weigh  $12.0\text{g}$ . Show that these observations are in agreement with the law of conservation of weigh.

b. If  $6.3\text{g}$  of  $\text{NaHCO}_3$  are added to  $15.0\text{g CH}_3\text{COOH}$  solution. The residue is found to weigh  $18.0\text{g}$  what is the mass of  $\text{CO}_2$  released in this reaction?



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3.  $1.08\text{g}$  of copper wire was allowed to react with nitric acid. The resulting solution was dried and ignited when  $1.35\text{g}$  of copper oxide was obtained. In another experiment  $2.30\text{g}$  of copper oxide was heated in presence of hydrogen yielding  $1.84\text{g}$  of copper.

Show that the above data in accordance with law of constant proportion.



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4. Carbon and oxygen are known to form two compounds. The carbon content in one of these is 42.9 % while in the other it is 27.3 % . Show that this data is in agreement with the law of multiple proportions.



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5. The % composition of  $NH_3$ ,  $H_2O$  and  $N_2O_3$  is as given below:

$NH_3 \rightarrow 82.35\% N$  and  $17.65\% H$

$H_2O \rightarrow 88.90\%$  and  $11.10\% H$



On the basis of above data prove law of reciprocal proportions.

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6. 8 litre of  $H_2$  and 6 litre of  $Cl_2$  are allowed to react to maximum possible extent. Find out the final volume of reaction mixture. Suppose  $P$  and  $T$  remains constant throughout the course of reaction.

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7. How many molecule are present in one  $mL$  of water vapour of  $STP$  ?

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8. Naturally occurring chlorine is 75.53%  $Cl^{35}$  which has an atomic mass of  $34.969\text{amu}$  and 24.47%  $Cl^{37}$ , 24.47%  $Cl^{37}$ , which has a mass of 36.966 amu. Calculate the average atomic mass of chlorine.

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9. Calculate the mass in  $g$  of

(a) 2g-atom of  $Mg$

(b) 3N atoms of  $Mg$ .

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10. Calculate the mass in  $g$  of

(a) 2mole of  $CO_2$

(b)  $2N$  molecules of  $CO_2$

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11. How many molecule are in  $5.23g$  of glucose ( $C_6H_{12}O_6$ ) ?

Also calculate the number of  $C$ ,  $H$  and  $O$  atoms.

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12. The specific heat of metal is  $1Jg^{-1}K^{-1}$ . If equivalent weight of metal is 9, carbon atoms, 13 hydrogen atoms and  $2.33 \times 10^{-23}g$  of other component?

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13. What is the molecular weight of a substance, each molecule of which contains 9 carbon atoms, 13 hydrogen atoms and  $2.33 \times 10^{-23} g$  of other component ?

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14. What is the weight of  $3.01 \times 10^{23}$  molecules of ammonia?

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15. How many years it would take to spend Avogadro's number of rupees at the rate of 1 million rupees in one second?

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16. How many of  $g$  of  $S$  are required to produce 10moles and 10g of  $H_2SO_4$  respectively?



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17. Calculate the number of  $Cl^-$  and  $Ca^{2+}$  ions in 333g anhydrous  $CaCl_2$ .



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18. (a) 2 Calculate the number of moles of water in  $366gBaCl_2 \cdot 2H_2O$ .

(b) Calculate the value of  $X$  ( in terms of mole) if  $X = 9.4gPhenol + 6.02 \times 10^{22}$  molecules phenol + 0.2mole phenol.



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**19.** Which of the following will weigh maximum amount?

(a).  $20g$  iron, (b)  $1.2g$  atom of  $N$ ,

(c)  $1 \times 10^{23}$  atoms of carbon,

(d)  $1.12litre$  of  $O_2$  at  $STP$ .

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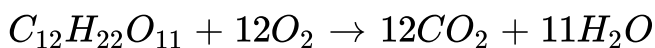
**20.** From  $280mg$  of  $CO$ ,  $10^{21}$  molecules are removed. How many  $g$  and mole of  $CO$  are left?

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21.  $P$  and  $Q$  are two elements which form  $P_2Q_3$ ,  $PQ_2$  molecules. If 0.15 moles of  $P_2Q_3$  and  $PQ_2$  weigh 15.9g and 9.3g, respectively, what are the atomic weights of  $P$  and  $Q$ ?

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22. Sugar reacts with oxygen as:



How many g of  $CO_2$  is produced per g of sucrose (sugar) used?

How many moles of oxygen are needed to react with 1.0g Sugar?

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23. The mass of one litre sample of ozonised oxygen at  $NTP$  was found to be 1.5g. When 100mL of this mixture at  $NTP$

were treated with turpentine oil, the volume was reduced to  $90\text{mL}$ . Hence calculate the molecular mass of ozone.

(Turpentine oil absorbs ozone)

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**24.**  $Fe(SO_4)_3$  is empirical formula of a crystalline compound to iron. It is used in water and sewage treatment to aid in the removal of suspended impurities. Calculate the mass percentage of iron, sulphur and oxygen in this compound.

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**25.**  $5.325\text{g}$  sample of methyl benzoate, a compound used in the manufacture of perfumes is found to contain  $3.758\text{g}$  of carbon,  $0.316\text{g}$  of hydrogen and  $1.251\text{g}$  of oxygen. What is empirical

formula of compound. If mol. Weight of methyl benzoate is 136.0, calculate its molecular formula.

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**26.** Potassium chromate is isomorphous to potassium sulphate ( $K_2SO_4$ ) and it is found to have 26.78% *Cr*. Calculate the at. Wt. of *Cr* if at. Wt of potassium is 39.10.

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**27.** A hydrate of iron (III) thiocyanate  $Fe(SCN)_3$ , was found to contain 19%  $H_2O$ . What is the formula of the hydrate ?

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28. (i) Butyric acid contains only  $C$ ,  $H$  and  $O$ .  $44.24\text{mg}$  sample of butyric acid is completely burned. It gives  $8.45\text{mg}$  of carbon dioxide ( $CO_2$ ) and  $3.46\text{mg}$  of water. What is the mass percentage of each element in butyric acid?

(ii) If the elemental composition of butyric acid is found to be  $54.2\% C$ ,  $9.2\% H$  and  $36.6\% O$ , determine the empirical formula.

(iii) The molecular mass of butyric acid was determined of experiment to be 88. What is the molecular formula ?



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29. Calculate the percentage composition in terms of mass of solution obtained by mixing  $300\text{g}$  of a  $25\%$  and  $400\text{g}$  of a  $40\%$  solution by mass.



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30. How much  $CaCl_2 \cdot 6H_2O$  and water must be weighed to prepare 100g of a solution that is 5.0 %  $CaCl_2$  ?

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31. Calculate the concentration of a solution obtained by mixing 300g of 25 % by weight solution of  $NH_4Cl$  and 150g of 40 % by weight solution of  $NH_4Cl$ .

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32. Calculate the mass of chloride ion in 1 litre of:

(a) 10 % by weight of  $NaCl$  solution having density  $1.07g/mL$ ,  
and

(b) 10 % by weight of  $AlCl_3$  solution having density  $1.10g/mL$

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**33.** Persons are medically considered to have lead poisoning if they have a concentration greater than 10 micrograms of lead per decilitre of blood. What is the concentration in parts per billion?

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**34.** What is the total molar concentration of ions in  $0.350M$  solution of  $Na_2SO_4$  assuming its complete ionisation?

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35. How many moles of  $NaOH$  are contained in  $27mL$  of  $0.15MNaOH$ ?



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36. A sample of  $NaNO_3$  weighing  $0.38g$  is placed in a  $50.0mL$  volumetric flask. The flask is then filled with water to the mark on the neck. What is the molarity of the solution?



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37. In a reaction vessel  $0.184g$  of  $NaOH$  is required to be added for completing the reaction. How many millilitre of  $0.150MNaOH$  solution should be added for this requirements?



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**38.** Commercially available concentrated hydrochloric acid contains 38%  $HCl$  by mass. (a) What is the molarity of this solution? The density is  $1.19\text{gmL}^{-1}$  ?

(b) What volume of concentrated  $HCl$  is required to make 1.00litre of  $0.10M HCl$ ?

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**39.** Concentrated nitric acid used for laboratory works is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of solution is  $1.504\text{gmL}^{-1}$  ?

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40. A solution of glucose in water is labelled as 10 percent  $w/w$ , what would be the molality and mole fraction of each component in the solution? If the density of the solution is  $1.2 \text{ gmL}^{-1}$ , then what shall be the molarity of the solution?

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41. An antifreeze solution is prepared from  $222.6 \text{ g}$  of ethylene glycol  $[C_2H_4(OH)_2]$  and  $200 \text{ g}$  of water. Calculate the molality of the solution. If the density of the solution is  $1.072 \text{ gmL}^{-1}$  then what shall be the molarity of the solution?

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42. Calculate the amount of oxalic acid ( $H_2C_2O_4 \cdot 2H_2O$ ) required to obtain 250m of deci-molar solution.



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43. 4g of  $NaOH$  are present in  $0.1dm^3$  solution have

- (a) mole fraction of  $NaOH$ ,
- (b) molality of  $NaOH$  solution,
- (c) molarity of  $NaOH$  solution,
- (d) normality of  $NaOH$  solution.



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44. Find the molality of  $H_2SO_4$  solution whose specific gravity is  $1.98mL^{-1}$  and 90% by volume  $H_2SO_4$

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**45.** A sample of drinking water was found to be severely contaminated with chloroform,  $CHCl_3$ , supposed to be carcinogen. The level of contamination was 15 ppm (by mass).

(i) Express this in per cent by mass.

(ii) Determine the molality of chloroform in the water sample.

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**46.** An aqueous solution of sodium chloride is marked 10% ( $w/w$ ) on the bottle. The density of the solution is  $1.071\text{gmL}^{-1}$ . What is the molality and molarity? Also, what is the mole fraction of each components in the solution?

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47. How many gram of  $Al_2(SO_4)_3$  are present in 100mL of 0.15m solution of  $Al_2(SO_4)_3$ ? The density of solution is 1.4g/mL.



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48. How much 1.0MHCl should be mixed with what volume of 0.250MHCl in order to prepare 2.0litre of 0.50MHCl?



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49. What will be the final concentration of solution when 2.0litre of 3.0M sugar solution and 3.0lite of 2.5M sugar solutions are mixed? If the solution is now diluted to 10litre what molarity will it have?

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50. A sample of  $H_2SO_4$  (density  $1.787\text{ gmL}^{-1}$ ) is labelled as 80 % by weight. What is molarity of acid? What volume of acid has to be used to make 1 litre of  $0.2M H_2SO_4$ ?

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51. What are the final concentrations of all the ions when following are mixed?

50 mL of  $0.12M Fe(NO_3)_3$ , 100 mL of  $0.10M FeCl_3$  and  
100 mL of  $0.26M Mg(NO_3)_2$

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**52.** Calculate the mass of  $BaCO_3$  produced when excess  $CO_2$  is bubbled through a solution containing 0.205 moles of  $Ba(OH)_2$ .



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**53.** The vapour density of a mixture containing  $NO_2$  and  $N_2O_4$  is 38.3 at  $27^\circ C$ . Calculate the mole of  $NO_2$  in 100g mixture.



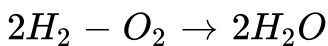
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**54.** The vapour density of a mixture containing  $NO_2$  and  $N_2O_4$  is 38.3 at  $27^\circ C$ . Calculate the mole of  $NO_2$  in 100 mole mixture.



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55. Calculate the moles of  $H_2O$  vapours formed if 1.57 mole of  $O_2$  are used in presence of excess of  $H_2$  for the given change,



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56. Potassium bromide  $KBr$  contains 32.9% potassium by mass. If 6.40g of bromine reacts with 3.60g of potassium, calculate the number of moles of potassium which combine with bromine to form  $KBr$ .



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57. 23g sodium metal reacts with water. Calculate the:

(a) volume of  $H_2$  liberated at  $NTP$



(b) moles of  $H_2$  liberated,

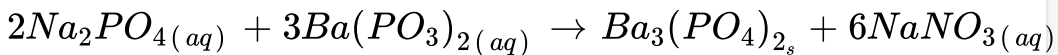
(c) weight of  $H_2$  liberated.

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**58.** How many moles of potassium chlorate to be heated to produce 5.6 litre oxygen at *STP* ?

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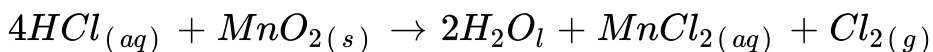
**59.** For the reaction,



Suppose that a solution containing 32.8g of  $Na_2PO_4$  and 26.1g of  $Ba(NO_3)_2$  is mixed. How many g of  $Ba_3(PO_4)_2$  are formed?

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**60.** Chlorine is prepared in the laboratory by treating manganese dioxide ( $MnO_2$ ) with aqueous hydrochloric acid according to the reaction,



How many gram of  $HCl$  react with  $5.0g$  of manganese water to make  $250.0mL$  solution.



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**61.** A  $5.0g$  quantity of white phosphorus was burned in an excess of oxygen and the product was dissolved in water to make  $250.0mL$  solution.

(a) Write balanced equations for the reaction.

(b) When the solution was treated with an excess of aqueous  $Ca(NO_3)_2$ , a white precipitate was obtained. What was it and

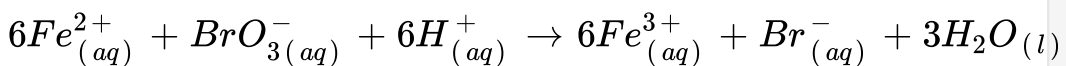
how much it formed?

(c) The precipitate in part (b) was removed and the solution was treated with an excess of  $Zn$ , yielding a colourless gas collected at  $20^{\circ}C$  and  $742\text{mm of Hg}$ . What was the gas and how much volume of it was formed?



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**62.** The concentration of  $Fe^{2+}$  ion in aqueous solution can be determined by redox titration with bromate ion according to reaction:

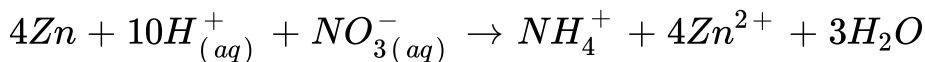
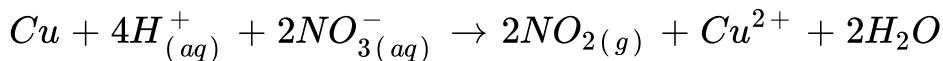


What is the molar concentration of  $Fe^{2+}$  if  $31.50\text{mL}$  of  $0.105\text{M KBrO}_3$  is required for complete neutralisation of  $10.0\text{mL}$  of  $Fe^{2+}$  solution?



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**63.** What volume of  $3.0M\text{HNO}_3$  can react completely with  $15.0\text{g}$  brass ( $90\%$   $\text{Cu}$  and  $10\%$   $\text{Zn}$ ) according to equation:

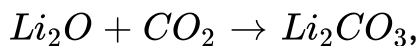


Also report what volume of  $\text{NO}_2$  gas at  $25^\circ\text{C}$  and  $1.0\text{atm}$  will be produced?



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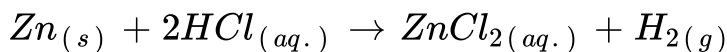
**64.** Chemical absorbents can be used to remove exhaled  $\text{CO}_2$  of space travellers in short space flight.  $\text{Li}_2\text{O}$  is one of the most efficient in terms of absorbing capacity per unit weight. If the reaction is:



What is the absorption efficiency of pure  $Li_2O$  in litre  $CO_2(STP)$  per kg?

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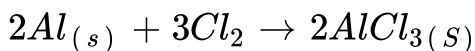
**65.** Zinc and hydrochloric acid react according to the reaction:



If 0.30 mole of  $Zn$  are added to hydrochloric acid containing 0.52 mole  $HCl$ , how many moles of  $H_2$  are produced?

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**66.** A mixture of 1.0 mole of  $Al$  and 3.0 mole of  $Cl_2$  are allowed to react as:



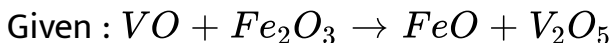
(a) Which is limiting reagent?

(b) How many moles of  $AlCl_3$  are formed?

(c) Moles of excess reagent left unreacted.

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67. Calculate the weight of  $FeO$  produced from  $2gVO$  and  $5.75g$  of  $Fe_2O_3$ . Also report the limiting reagent.



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68.  $4g$  of an impure sample of  $CaCO_3$  on treatment with excess  $HCl$  produces  $0.88g$   $CO_2$ . What is per cent purity of  $CaCO_3$  sample?

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69. Calculate the weight of lime ( $CaO$ ) obtained by heating  $300\text{kg}$  of  $90\%$  pure limestone ( $CaCO_3$ ).



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70. A mixture of  $FeO$  and  $Fe_3O_4$  when heated in air to constant weights, gains  $5\%$  in its weight. Calculate the composition of the mixture.



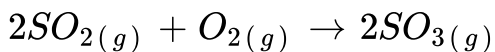
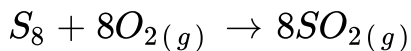
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71.  $1.67\text{ g}$  mixture of  $Al$  and  $Zn$  was completely dissolved in acid and evolved  $1.69\text{ L}$  of  $H_2$  at STP. Calculate the weight  $Al$  and  $Zn$  in the mixture.



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**72.** Sulphur trioxide may be prepared by the following two reactions:

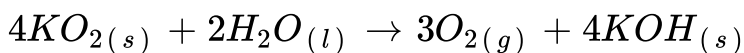


How many grams of  $SO_3$  will be produced from 1 mole of  $S_8$ ?



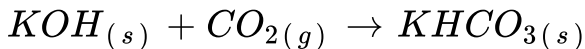
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**73.** Potassium superoxide  $KO_2$ , is utilised in closed system breathing apparatus. Exhaled air contains  $CO_2$  and  $H_2O$ , both of which are removed and the removal of water generates oxygen for breathing by the reaction



The potassium hydroxide removes  $CO_2$  from the apparatus by the reaction:





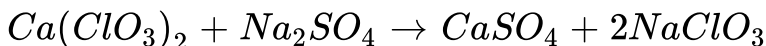
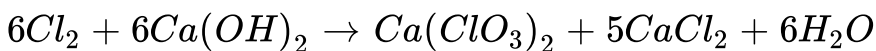
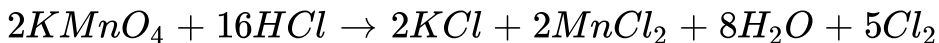
(a) What mass of  $KO_2$  generates 20gm of oxygen?

(b) What mass of  $CO_2$  can be removed from the apparatus by

$CO_2$  can be removed from the apparatus by 100gm of  $KO_2$ ?

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**74.** Sodium chlorate,  $NaClO_3$ , can be prepared by the following series of reactions:



What mass of  $NaClO_3$  can be prepared from 100mL of concentrated HCl (density 1.18gm/mL and 36% by mass)?

Assume all other substances are present in excess amounts.

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75. How much  $CO$  is produced by the reaction of  $1.0\text{kg}$  octane and  $1.0\text{kg}$  oxygen. Also report the limiting reagent for this reaction.

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76. A  $40\text{mL}$  mixture of methane and ethylene when exploded with certain volume of oxygen which is just sufficient for combustion produced  $60\text{mL}$  of  $CO_2$  gas. Calculate the ratio between the volumes of  $CH_4$  and  $C_2H_4$  in the mixture. What volume of oxygen is required if the ratio between the volumes of  $C_2H_4$  and  $CH_4$  is first reversed and then doubled? What volume of  $CO_2$  is produced? Assume, all the volumes being measured under identical conditions.

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77. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 litre (Measured at STP) of this welding gas is found weigh 11.6g. Calculate

- (i) empirical formula,
- (ii) molar mass of the gas, and
- (iii) molecular formula.



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78. A gaseous alkane on complete combustion gives  $CO_2$  and  $H_2O$ . If the ratio of moles  $O_2$  needed for compustion and moles of  $CO_2$  formed is 5 : 3 find out the formula of alkane.



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**79.** Insulin contains 3.4% sulphur. Calculate minimum mol.wt. of insulin.

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**80.** Haemoglobin contains 0.25% iron by weight. The molecular weight of haemoglobin is 896000. Calculate the number of iron atom per molecule of haemoglobin.

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**81.** Weight of 1 litre milk is 1.032kg. It contains butter fat (density  $865\text{kgm}^{-3}$ ) to the extent of 4.0% by wt/volume. Calculate the density of the fat-free skimmed milk.



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**82.** Chlorophyll, the green colouring matter of plants responsible for photosynthesis, contains 2.68 % of magnesium by mass. Calculate the number of magnesium atoms in 2.00g of chlorophyll.



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**83.** A one litre solution  $0.2M Mg(NO_3)_2$ ,  $0.2M Al(NO_3)_3$  and  $0.5M Th(NO_3)_4$ . What is the total ionic strength of solution?



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**84.**  $1g$  of a metal (specific heat =  $0.06cal/g$ ), combines with oxygen to form  $1.08g$  of oxide. What is the atomic mass of metal? Also report its valency.



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**85.** For the dissolution of  $1.08g$  of metal,  $0.49g$  of  $H_2SO_4$  was required. If specific heat of metal is  $0.06cal/g$ , what is its atomic mass?



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**86.** Determine the equivalent weight of each given below, if formula weight of these compounds are  $X$ ,  $Y$  and  $Z$  respectively:

(i)  $Na_2SO_4$ , (ii)  $Na_3PO_4 \cdot 12H_2O$

(iii)  $Ca_3(PO_4)_2$

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**87.** Calculate equivalent weight of  $Cu$  in  $CuO$  and  $Cu_2O$ . At.wt. of  $Cu = 63.6$ .

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**88.** The vapour density of a metal chloride is 85. If equivalent weight of metal is 7.01. calculate the at.wt. of metal.

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89. Water contaminated with  $H_2S$  can be freed from  $H_2S$  by passing  $Cl_2$  through it. If the  $H_2S$  content in contaminated water is 22 ppm by mass how much  $Cl_2$  is needed to remove all the  $H_2S$  from  $2 \times 10^2$  gallons of water. ( $1\text{gallon} = 3.785\text{litre}$ )

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90. Calculate the degree of hardeners of river water whose  $100\text{mL}$  solution required  $1.68\text{mL}$  of  $0.1\text{NH}_2\text{SO}_4$ .

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91. What weight of  $AgCl$  would be precipitated if  $10\text{mLHCl}$  gas  $12^\circ C$  and  $750\text{mm}$  pressure were passed into excess of silver nitrate?



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92. When dissolved in dilute  $H_2SO_4$ ,  $0.275g$  of metal evolved  $119.7mL$  of  $H_2$  at  $20^\circ C$  and  $780.4mm$  pressure.  $H_2$  was collected over water. Aqueous tension is  $17.4 mm$  at  $20^\circ C$ . Calculate equivalent weight of metal.

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93. Find the milli-equivalent of:

(a)  $Ca(OH)_2$  in  $111g$ ,

(b)  $NaOH$  in  $30g$ ,

(c)  $H_2SO_4$  in  $4.9g$ .

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94. Find the weight of  $NaOH$  in its 60 milli-equivalents.



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95. Find the normality of  $H_2SO_4$  having 50 milli-equivalents in 3litre.



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96. Find the weight of  $H_2SO_4$  in  $1200mL$  of a solution of  $0.4N$  strength.



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97. Calculate the normality of mixture obtained by mixing

a.  $100mL$  of  $0.1NHCl$  +  $50mL$  of  $0.25NNaOH$

b.  $100\text{mL of } 0.2\text{M H}_2\text{SO}_4 + 200\text{mL of } 0.2\text{M HCl}$

c.  $100\text{mL of } 0.2\text{M H}_2\text{SO}_4 + 100\text{mL of } 0.2\text{M NaOH}$

d.  $1\text{g equivalent of } \text{NaOH} + 100\text{mL of } 0.1\text{M HCl}$



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**98.** What volume of water is required to make  $0.20\text{N}$  solution from  $1600\text{mL}$  of  $0.2050\text{N}$  solution?



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**99.** How would you prepare exactly  $3.0\text{litre}$  of  $1.0\text{M NaOH}$  by mixing proportions of stock solutions of  $2.50\text{M NaOH}$  and  $0.40\text{M NaOH}$ ? No water is to be used.



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100. What weight of  $Na_2CO_3$  of 95% purity would be required to neutralize 45.6 mL of 0.235 N acid?

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101. Calculate normality of  $NH_4OH$  when 2g is present in 800 mL solution. Also calculate its molarity.

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102. What is the strength in g per litre of a solution of  $H_2SO_4$ , 12 mL of which neutralized 15 mL of  $N/10 NaOH$  solution?

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**103.** The acidic substance in vinegar is acetic acid ( $CH_3COOH$ ). When  $6.0g$  of a certain vinegar was titrated with  $0.1MNaOH$ .  $40.11mL$  of base had to be added to reach the equivalence point. What per cent by mass of this sample of vinegar is acetic acid?



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**104.** What is the purity of conc.  $H_2SO_4$  (density  $1.8g/mL$ ) if  $5mL$  of it is neutralized completely with  $84.6mL$  of  $2.0NNaOH$ ?



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**105.** Suppose  $5g$  of acetic acid are dissolved in one litre of ethanol. Assume no reaction in between them. Calculate

molality of resulting solution if density of ethanol is  $0.789 / mL$ .

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**106.** Sea water  $65 \times 10^{-3} g$ /litre of bromide ions. If all the bromide ions are converted to produce  $Br_2$ , how much sea water is needed to prepare  $1kgBr_2$ ?

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**107.**  $20mL$  of  $0.2M Al_2(SO_4)_3$  mixed with  $20mL$  of  $0.6M BaCl_2$ .

Calculate the concentration of each ion in solution.

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**108.** 1.12g impure sample of calcium oxide was dissolved in water and the solution was completely neutralised by 21mL of 0.8N acid. What is purity of  $CaO$ ?



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**109.** 25mL of 0.2M phosphorus acid ( $H_3PO_3$ ) neutralises exact 80mL of a solution containing 10g NaOH (50% pure) per dm<sup>3</sup>. Report basicity of acid and write balanced chemical equation for neutralisation.



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**110.** A 100.0mL solution containing  $HCl$  and  $HBr$  was titrated with 0.1235M NaOH. The volume of base required to

neutralise the acid was  $47.14\text{mL}$ . Aqueous  $\text{AgNO}_3$  was then added to precipitate  $\text{Cl}^-$  and  $\text{Br}^-$  ions as  $\text{AgCl}$  and  $\text{AgBr}$ . The mass of silver halides obtained was  $0.9974\text{g}$ . What were the molarities of  $\text{HCl}$  and  $\text{HBr}$  in solution?

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**111.**  $25.0$  litre of natural gas measured at  $25^\circ\text{C}$  and  $740\text{mm}$  of  $\text{Hg}$  is bubbled through  $\text{Pb}_{(aq)}^{2+}$  to give  $0.535\text{g}$  of solid residue. If natural gas contains  $\text{H}_2\text{S}$ , the only component responsible for the formation of solid residue, calculate the volume % of  $\text{H}_2\text{S}$ , in natural gas.

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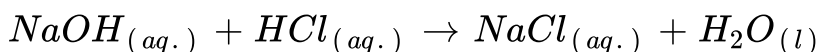


112. 30 mL of  $0.2N BaCl_2$  is mixed with 40 mL of  $0.3N Al_2(SO_4)_3$ . How many g of  $BaSO_4$  are formed?



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113. Calculate the volume of  $1.00 mol L^{-1}$  aqueous sodium hydroxide that is neutralized by  $200 mL$  of  $2.00 mol L^{-1}$  aqueous hydrochloric acid and the mass of sodium chloride produced. Neutralization reaction is,



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114. How many ml of 0.1 HCl is required to react completely with 1.0g mixture of  $Na_2CO_3$  and  $NaHCO_3$  containing equimolar

amounts of both ?

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**115.** Calculate the percentage of  $BaO$  in  $29.0g$  mixture of  $BaO$  and  $CaO$  which just reacts with  $100.8mL$  of  $6.0MHCl$ .

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**116.** A mixture of  $Xe$  and  $F_2$  was heated and the white solid so formed reacted with  $H_2$  to give  $81mL$  of  $Xe$  at  $STP$  and  $HF$ . The  $HF$  formed required  $68.43mL$  of  $0.3172MNaOH$  for complete neutralisation. Determine empirical formula of white solid.

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117. A sample of pure lead weighing  $2.07g$  is dissolved in nitric acid to give a solution of lead nitrate. This solution is treated with hydrochloric acid, chlorine gas and ammonium chloride. The result is a precipitate of  $(NH_4)_2PbCl_6$ . What is the maximum weight of this product that could be obtained from the lead sample?

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## Exercise (2) previous year numerical problems

1. A plant virus is found to consist of uniform cylindrical particle of  $150\text{\AA}$  in diameter  $5000\text{\AA}$  long. The specific volume of the virus is  $0.75\text{ mLg}^{-1}$ . If the virus is considered to be a single particle, find its molar mass.

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2. Calculate the molarity of water if its density is  $1000 \text{kgm}^{-3}$

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3. Around 20 % surface sites have adsorbed  $N_2$ . On heating  $N_2$  gas evolved from sites and were collected at 0.001 atm and 298 K in a container of volume  $2.46 \text{cm}^3$  the density of surface sites is  $6.023 \times 10^{14} \text{cm}^{-2}$  and surface area is  $1000 \text{cm}^2$  find out the number of surface sites occupied per molecule of  $N_2$ .

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4. The reaction,  $2C + O_2 \rightarrow 2CO$  is carried out by taking 24 g of carbon and 96 g  $O_2$ , find out :

(a) Which reactant is left in excess ?

(b) How much of it is left ?

(c) How many mole of  $CO$  are formed ?

(d) How many  $g$  of other reactant should be taken so that nothing is left at the end of reaction ?

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5. A mixture of  $20mL$  of  $CO$ ,  $CH_4$  and  $N_2$  was burnt in excess of  $O_2$  resulting in reduction of  $13mL$  of volume. The residual gas was then treated with  $KOH$  solution to show a contraction of  $14mL$  in volume. Calculate volume of  $CO$ ,  $CH_4$  and  $N_2$  in mixture. All measurements are made at constant pressure and temperature.

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6. Calculate the molality of 1L solution of 93%  $H_2SO_4$  (Weight/volume) The density of the solution is 1.84g.

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7. A mixture of  $HCOOH$  and  $H_2C_2O_4$  is heated with conc.  $H_2SO_4$ . The gas produced is collected and on treating with  $KOH$  solution the volume of the gas decreases by  $1/6th$ . Calculate molar ratio of two acids in original mixture.

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8. A sample of  $Mg$  was burnt in air to give a mixture of  $MgO$  and  $Mg_3N_2$ . The ash was dissolved in 60Meq. of  $HCl$  and the resulting solution was back titrated with  $NaOH$ . 12Meq. Of  $NaOH$  was then added and the solution distilled. The

ammonia released was then trapped in  $10Meq.$  of second acid solution. Back titration of this solution required  $6Meq.$  of the base Calculate the percentage of  $Mg$  burnt to the nitride.

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9. For the reaction,  $N_2O_5(g) \rightleftharpoons 2NO_2(g) + 0.5O_2(g)$ ,

Calculate the mole fraction of  $N_2O_5(g)$  decomposed at a constant volume and temperature, if the initial pressure is  $600mmHg$  and the pressure at any time is  $960mmHg$ . Assume ideal gas behaviour.

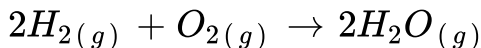
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10. *n*-butane is produced by the monobromination of ethane followed by Wurtz reaction. Calculate the volume of ethane at

*NTP* to produce 55g n-butane if the bromination takes place with 90 % yield and the Wurtz reaction with 85 % yield.

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11. A mixture in which the mole ratio of  $H_2$  and  $O_2$  is 2:1 is used to prepare water by the reaction.



The total pressure in the container is 0.8atm at  $20^\circ C$  before the reaction. Determine the final pressure at  $120^\circ C$  after reaction assuming 80 % yield of water.

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12.  $8.0575 \times 10^{-2}kg$  of Glauber's salt is dissolved in water to obtain  $1dm^3$  of a solution of density  $1077.2kgm^{-3}$ . Calculate



the molarity, molality and mole fraction of  $Na_2SO_4$  in solution.

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**13.** A solid mixture  $5g$  consists of lead nitrate and sodium nitrate was heated below  $600^\circ C$  until weight of residue was constant. If the loss in weight is  $28\%$  find the amount of lead nitrate and sodium nitrate in mixture.

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**14.** A mixture of ethane ( $C_2H_6$ ) and ethene ( $C_2H_4$ ) occupies  $40L$  at  $1.00atm$  and at  $400K$ . The mixture reacts completely with  $130g$  of  $O_2$  to produce  $CO_2$  and  $H_2O$ . Assuming ideal gas behaviour, calculate the mole fractions of  $C_2H_4$  and  $C_2H_6$  in the mixture.

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15. A sample of hard water contains  $96\text{ppm.}$  of  $\text{SO}_4^{2-}$  and  $183\text{ppm}$  of  $\text{HCO}_3^-$ , with  $\text{Ca}^{2+}$  as the only cation. How many moles of  $\text{CaO}$  will be required to remove  $\text{HCO}_3^-$  from  $1000\text{kg}$  of this water? If  $1000\text{kg}$  of this water is treated with the amount of  $\text{CaO}$  calculated above, what will be the concentration (in ppm) of residual  $\text{Ca}^{2+}$  ions (Assume  $\text{CaCO}_3$  to be completely insoluble in water)? If the  $\text{Ca}^{2+}$  ions in one litre of the treated water are completely exchange with hydrogen ions, what will be its  $\text{pH}$  (One ppm means one part of the substance in one million part of water, weight / weight)?

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16. 1g charcoal is placed in 100mL of 0.5M  $CH_3COOH$  to form an adsorbed mono-layer of acetic acid molecule and thereby the molarity of  $CH_3COOH$  reduces to 0.49. Calculate the surface area of charcoal adsorbed by each molecule of acetic acid.

Surface are of charocal =  $3.01 \times 10^2 m^2 / g$ .



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17. Calculate the amount of calcium oxide required when it reacts with 852g of  $P_4O_{10}$ .



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18. Calculate the number of oxalic acid molecules in 100mL of 0.02N oxalic acid

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19. Calculate the volume of 0.5 M  $H_2SO_4$  required to dissolve 0.5 g of copper (II) carbonate ( $CuCO_3$ ).

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20. What is the strength in g per litre of a solution of  $H_2SO_4$ , 12mL of which neutralized 15mL of  $N/10NaOH$  solution?

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21. The formula weight of an acid is 82.0. 100cm<sup>3</sup> of a solution of this acid containing 39.0g of the acid per litre were completely

neutralised by  $95.0\text{cm}^3$  of aqueous  $\text{NaOH}$  containing  $40.0\text{g}$  of  $\text{NaOH}$  per litre. What is the basicity of the acid?

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**22.** Upon mixing  $50.0\text{mL}$  of  $0.1\text{M}$  lead nitrate solution with  $50.0\text{mL}$  of  $0.05\text{M}$  chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentration of the species left behind in the final solution. Which is the limiting reagent?

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**23.**  $0.50\text{g}$  of a mixture of  $\text{K}_2\text{CO}_3$  and  $\text{Li}_2\text{CO}_3$  required  $30\text{mL}$  of  $0.25\text{NHCl}$  solution for neutralization. What is % composition of mixture?



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24. A mixture containing only  $Na_2CO_3$  and  $K_2CO_3$  and weighing  $1.22g$  was dissolved in water to form  $100mL$  of solution:  $20mL$  of this solution required  $40mL$  of  $0.1NHCl$  for neutralisation.

a. Calculate the weight of  $K_2CO_3$  in the mixture.

b. If another  $20mL$  of the same solution is treated with excess of  $BaCl_2$ , what will be the weight of precipitate thus obtained?

(Molar mass of  $Na_2CO_3 = 106$ ,  
 $K_2CO_3 = 138$ ,  $BaCO_3 = 197.4$ )



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25.  $5mL$  of  $8NHNO_3$ ,  $4.8mL$  of  $5NHCl$  and a certain volume of  $17MH_2SO_4$  are mixed together and made up to  $2litre$ .  $30mL$

of this acid mixture exactly neutralizes  $42.9\text{mL}$  of  $\text{Na}_2\text{CO}_3$  solution containing  $1\text{gNa}_2\text{CO}_3$ ,  $10\text{H}_2\text{O}$  in  $100\text{mL}$  of water. Calculate the amount of sulphate ions in  $g$  present in solution.



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### Exercise (3A) Objective problems:

1. The solubility of  $\text{K}_2\text{SO}_4$  in water is  $16\text{g}$  at  $50^\circ\text{C}$ . The minimum amount of water required to dissolve  $4\text{gK}_2\text{SO}_4$  is:

A.  $10\text{g}$

B.  $25\text{g}$

C.  $50\text{g}$

D.  $75\text{g}$

**Answer: B**



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2. One litre of  $N/2HCl$  solution was heated in a beaker. When the volume was reduced to  $600mL$ ,  $9.125g$  of  $HCl$  was lost out.

The new normality of solution is

a.  $\approx 0.4$

b.  $\approx 0.8$

c.  $\approx 0.4$  d.  $\approx 0.2$

A. 6.85

B. 0.685

C. 0.1043

D. 6.50



**Answer: B**



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3. The molarity of  $H_2SO_4$  is  $18M$ . Its density is  $1.8gmL^{-1}$ .

hence it's molality is

A. 36

B. 200

C. 500

D. 18

**Answer: C**



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4. Volume of  $2M HCl$  required to neutralise the solution containing 1mole of  $NH_4Cl$  and 1mole of  $NaOH$  is:

- A. 1litre
- B. 2litre
- C. 3litre
- D. 1 / 2litre

**Answer: D**

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5. 8g of sulphur are burnt to form  $SO_2$ , which is oxidised by  $Cl_2$  water. The solution is treated with  $BaCl_2$  solution. The amount of  $BaSO_4$  precipitated is:

A. 1.0mole

B. 0.5mole

C. 0.75mole

D. 0.25mole

**Answer: D**



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6. The density of  $1M$  solution of  $NaCl$  is  $1.0585gmL^{-1}$ . The molality of the solution is

A. 1.0585

B. 1.0

C. 0.10

D. 0.0585

**Answer: B**

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7. The percentage of sodium in a breakfast cereal labelled as  $110\text{mg}$  of sodium per  $100\text{g}$  of cereal is:

A. 11 %

B. 0.110 %

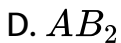
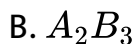
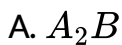
C. 0.110 %

D. 110 %

**Answer: C**

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8. Two element  $A$  (*at. wt.*75) and  $B$  (*at. wt.*16) combine to yield a compound. The % by weight of  $A$  in the compound was found to be 75.08. The formula of the compound is :



**Answer: B**



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9. Calculate the number of oxalic acid molecules in  $100mL$  of  $0.02N$  oxalic acid

A.  $6.023 \times 10^{20}$

B.  $6.023 \times 10^{21}$

C.  $6.023 \times 10^{22}$

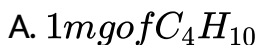
D.  $6.023 \times 10^{23}$

**Answer: A**



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**10.** Which sample contains the largest number of atoms?



**Answer: D**



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**11.** The total number of protons, electrons and neutrons in  $12g$  of  ${}_6C^{12}$  is:

A.  $1.084 \times 10^{25}$

B.  $6.022 \times 10^{23}$

C.  $6.022 \times 10^{22}$

D. 18

**Answer: A**



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12. 4.4g of  $CO_2$  and 2.24 litre of  $H_2$  at  $STP$  are mixed in a container. The total number of molecules present in the container will be:

A.  $6.022 \times 10^{23}$

B.  $1.2044 \times 10^{23}$

C. 2mole

D.  $6.023 \times 10^{24}$

**Answer: B**



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13. The hydrated salt,  $Na_2SO_4 \cdot nH_2O$  undergoes 55.9% loss in weight on heating and becomes anhydrous. The value of  $n$  will be:



A. 5

B. 3

C. 7

D. 10

**Answer: D**



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**14.** In which mode of expression, the concentration of a solution remains independent of temperature?

A. Molarity

B. Molality

C. Formality

## D. Normality

**Answer: B**



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15. The haemoglobin from the red blood corpuscles of most mammals contains approximately 0.33 % of iron by weight. The molecular weight of haemoglobin is 67, 200.

The number of iron atoms in each molecule of haemoglobin is (atomic weight of iron = 56):

A. 2

B. 3

C. 4

D. 5

**Answer: C**



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**16.** The pair of compounds which cannot exist in solution is:

A.  $NaHCO_3$  and  $NaOH$

B.  $Na_2SO_3$  and  $NaHCO_3$

C.  $Na_2CO_3$  and  $NaOH$

D.  $NaHCO_3$  and  $NaCl$

**Answer: A**



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17. The mole of fraction of  $NaCl$  in a solution containing 1mole of  $NaCl$  in 100g of water is:

A. 0.0177

B. 0.001

C. 0.5

D. 0.244

**Answer: A**



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18. 3.0 molal  $NaOH$  solution has a density of  $1.110g/mL$ . The molarity of the solution is:

A. 2.9732

B. 3.05

C. 3.64

D. 3.0504

**Answer: A**



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**19.** How many atoms are contained in a mole of  $Ca(OH)_2$ ?

A.  $30 \times 6.02 \times 10^{23}$  atoms/mol

B.  $5 \times 6.02 \times 10^{23}$  atoms/mol

C.  $6 \times 6.02 \times 10^{23}$  atoms/mol

D. none of these

**Answer: B**



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20. Insulin contains 3.4% sulphur. Calculate minimum mol.wt. of insulin.

A. 941.176

B. 944

C. 945.27

D. none of these

**Answer: A**



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21. One litre of  $CO_2$  is passed over hot coke. The volume becomes  $1.4L$ . Find the composition of products, assuming measurement at  $NTP$ .

A.  $0.6\text{litre } CO$

B.  $0.8\text{litre } CO_2$

C.  $0.6\text{litre } CO_2$

D. none of these

**Answer: C**



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22. Number of mole of  $1m^3$  gas at  $NTP$  are:

A.  $44.6$

B. 40.6

C. 42.6

D. 48.6

**Answer: A**



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**23.** Weight of oxygen in  $Fe_2O_3$  and  $FeO$  is in the simple ratio of:

A. 3 : 2

B. 1 : 2

C. 2 : 1

D. 3 : 1



**Answer: D**



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**24.** The weight of  $350\text{mL}$  of a diatomic gas at  $0^\circ\text{C}$  and  $2\text{ atm}$  pressure is  $1\text{g}$ . The weight in  $\text{g}$  of one atom at  $\text{NTP}$  is:

A.  $16/N$

B.  $32/N$

C.  $16N$

D.  $32N$

**Answer: A**



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25. In a gaseous reaction of the type

$aA + bB \rightarrow cC + dD$ , which is wrong:

- A.  $a$  litre of  $A$  combines with  $b$  litre of  $B$  to give  $C$  and  $D$
- B.  $a$  mole of  $A$  combines with  $b$  mole of  $B$  to give  $C$  and  $D$
- C.  $a$  g of  $A$  combines with  $b$  g of  $B$  to give  $C$  and  $D$
- D.  $a$  molecules of  $A$  combines with  $b$  molecules of  $B$  to give  $C$  and  $D$

**Answer: C**



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26. When 2.76g of silver carbonate is strongly heated, it yields a residue weighing

A. 2.16g

B. 2.48g

C. 2.32g

D. 2.64g

**Answer: A**



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27. How many g of  $KCl$  would have to be dissolved in  $60gH_2O$  to give 20 % by weight of solution?

A. 15g

B. 1.5g

C. 11.5g

D. 31.5g

**Answer: A**



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28. A partially dried clay mineral contains 8% d water. The original sample contained 12% water and 45% sillica.

The % if sillica in the partially dried sample is nearly:

A. 50 %

B. 49 %

C. 55 %

D. 47 %

**Answer: D**





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29. The per cent of  $N$  in 66 % pure  $(NH_4)_2SO_4$  sample is:

A. 32

B. 28

C. 14

D. none of these

**Answer: C**



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30. When the same amount of zinc is treated separately with excess of  $H_2SO_4$  and excess of  $NaOH$ , the ratio of volumes of  $H_2$  evolved is:

A. 1 : 1

B. 1 : 2

C. 2 : 1

D. 9 : 4

**Answer: A**



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**31.** If half mole of oxygen combine with  $Al$  to form  $Al_2O_3$  the weight of  $Al$  used in the reaction is:

A. 27g

B. 40.5g

C. 54g

D. 18g

**Answer: D**



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**32.** The specific heat of a metal is  $0.836\text{J}/\text{g}$ . The approximate at.wt.is:

A. 16

B. 64

C. 40

D. 32

**Answer: D**



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33. One mole of potassium chlorate is thermally decomposed and excess of aluminium is burnt is the gaseous product. How many mole of aluminium oxide are formed?

- A. 1
- B. 1.5
- C. 2
- D. 3

**Answer: A**



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34. A compound has the molecular formula  $X_4O_6$ . If 10g of  $X_4O_6$  has 5.72g  $X$ , atomic mass of  $X$  is:



A. 32amu

B. 37amu

C. 42amu

D. 98amu

**Answer: A**



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**35.** On repeated sparking,  $10\text{mL}$  of a mixture of carbon monoxide and nitrogen required  $7\text{mL}$  of oxygen for combustion. What was the volume of nitrogen? (All volumes are measured under identical conditions).

A.  $7/2\text{mL}$

B.  $4\text{mL}$

C.  $7mL$

D.  $17/2mL$

**Answer: B**



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**36.** Number of ions present in 2.0litre of a solution of  $0.8MK_4Fe(CN)_6$  is:

A.  $4.8 \times 10^{22}$

B.  $4.8 \times 10^{24}$

C.  $9.6 \times 10^{24}$

D.  $9.6 \times 10^{22}$

**Answer: B**



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37. The molality of 1L solution with  $x\%$   $H_2SO_4$  is equal to 9.

The weight of the solvent present in the solution is 910g. The

value of  $x$  is:

A. 90

B. 80.3

C. 40.13

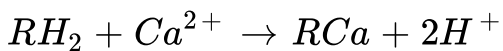
D. 9

**Answer: B**



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38.  $RH_2$  (ion exchange resin) can replace  $Ca^{2+}$  in hard water as.



1 litre of hard water passing through  $RH_2$  has  $pH=2$ . Hence hardness in  $ppm$  of  $Ca^{2+}$  is:

- A. 200
- B. 100
- C. 50
- D. 125

**Answer: A**



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39. The total ionic strength (total molarity of all ions containing  $0.1M$  of  $CuSO_4$  and  $0.1M$  of  $Al_2(SO_4)_3$  is:

A.  $0.2M$

B.  $0.7M$

C.  $0.8M$

D.  $1.2M$

**Answer: B**

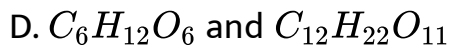
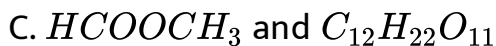


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40. The pair of species having same percentage of carbon is:

A.  $CH_3COOH$  and  $C_6H_{12}O_6$

B.  $CH_3COOH$  and  $C_2H_5OH$



**Answer: A**



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**41.** The isotopic abundance of  $C - 12$  and  $C - 14$  is 98 % and 2 % respectively. What would be the number of  $C - 14$  isotope in 12g carbon sample?

A.  $1.032 \times 10^{22}$

B.  $3.01 \times 10^{23}$

C.  $5.88 \times 10^{23}$

D.  $6.02 \times 10^{23}$

**Answer: A**



**Watch Video Solution**

**42.** Amount of oxygen required for combustion of  $1\text{kg}$  of a mixture of butane and isobutane is:

A.  $1.8\text{kg}$

B.  $2.7\text{kg}$

C.  $4.5\text{kg}$

D.  $3.58\text{kg}$

**Answer: D**



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43. Rakesh needs 1.71g of sugar ( $C_{12}H_{22}O_{11}$ ) to sweeten his tea. What would be the number of carbon atoms present in his tea?

A.  $3.6 \times 10^{22}$

B.  $7.2 \times 10^{21}$

C.  $0.05 \times 10^{23}$

D.  $6.6 \times 10^{22}$

**Answer: A**



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44. The total number of  $AlF_3$  molecule in a sample of  $AlF_3$  containing  $3.01 \times 10^{23}$  ions of  $F^-$  is:



A.  $9.0 \times 10^{24}$

B.  $3.0 \times 10^{24}$

C.  $7.5 \times 10^{23}$

D.  $10^{23}$

**Answer: D**



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**45. a.** What is the volume of one molecule of water (density of  $H_2O = 1gcm^{-3}$ )

b. What is the radius of the water molecule assuming it to be spherical.

c. Calculate the radius of the oxygen atom, assuming the oxygen atom occupies half of the volume occupied by the water molecule.

A.  $18\text{cm}^3$

B.  $22400\text{cm}^3$

C.  $6.023 \times 10^{-23}\text{cm}^3$

D.  $3.0 \times 10^{-23}\text{cm}^3$

**Answer: D**



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**46.** If 224 mL of triatomic gas has a mass of 1 g at 273 K and 1 atm. Pressure, then the mass of one atom is

A.  $8.30 \times 10^{-23}\text{g}$

B.  $2.08 \times 10^{-23}\text{g}$

C.  $5.53 \times 10^{-23}\text{g}$

D.  $6.24 \times 10^{-23} g$

**Answer: C**



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47. The percentage of  $P_2O_5$  in diammonium hydrogen phosphate is:

A. 77.58

B. 46.96

C. 53.78

D. 23.48

**Answer: C**



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48. The dehydration yield of cyclohexanol to cyclohexene is 75%. What would be the yield if 100g of cyclohexanol is dehydrated?

A. 61.7g

B. 16.5g

C. 6.15g

D. 615g

**Answer: A**



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49. The volume equivalent of  $CO_2$  (at *STP*) in the reaction,



A. 22.4litre

B. 112litre

C. 11.2litre

D. 5.6litre

**Answer: A**



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**50.** Potash alum and chrome alum are examples of:

A. Allotropy

B. Isomerism

C. Isomorphism

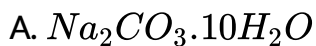
D. Tautomerism

**Answer: C**

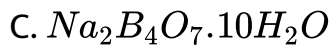


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**51. Which of the following is not primary standard?**



B. Oxalic acid



**Answer: D**



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52. The mole fraction of water in 20% (wt. /wt.) aqueous solution of  $H_2O_2$  is:

A.  $\frac{77}{68}$

B.  $\frac{68}{77}$

C.  $\frac{20}{80}$

D.  $\frac{80}{20}$

**Answer: B**



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53. Which is heaviest?

A. 25g of  $Hg$

B. 2 moles of  $H_2O$

C. 2 moles of  $CO_2$

D. 4 g – atom of O

**Answer: C**



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**54.** Total mass of neutrons in 7mg of  $^{14}C$  is:

A.  $3 \times 10^{20} kg$

B.  $4 \times 10^{-6} kg$

C.  $5 \times 10^{-7} kg$

D.  $4 \times 10^{-7} kg$

**Answer: B**



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55. The number of atoms in  $4.25\text{gNH}_3$  is approximately:

A.  $1 \times 10^{23}$

B.  $1.5 \times 10^{23}$

C.  $2 \times 10^{23}$

D.  $6 \times 10^{23}$

**Answer: D**



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56. The number of atomic weight scale is based on:

A.  $C^{12}$

B.  $O^{16}$

C.  $H^1$

D.  $C^{13}$

**Answer: A**



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57. Amount of oxygen in 32.2g of  $Na_2SO_4 \cdot 10H_2O$  is:

A. 20.8g

B. 26.71g

C. 2.24g

D. 2.08g

**Answer: B**



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58. At *STP* 5.6 litre of a gas weigh 60g. The vapour density of gas is:

- A. 60
- B. 120
- C. 30
- D. 240

**Answer: B**



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59. 10mole of  $kSO_2$  and 15mole of  $O_2$  were passed over catalyst to produce 8mole of  $SO_3$ . The ratio of  $SO_2$  and  $SO_3$  moles in mixture is:

A.  $5/4$

B.  $1/4$

C.  $1/2$

D.  $3/4$

**Answer: B**



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**60.** A gaseous alkane was exploded with oxygen. The volume of  $O_2$  for complete combustion to  $CO_2$  formed was in the ratio of 7: 4. The molecular formula of alkane is:

A.  $CH_4$

B.  $C_2H_6$

C.  $C_3H_6$

D.  $C_4H_{10}$

**Answer: B**



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61. Mole fraction of  $I_2$  in  $C_6H_6$  is 0.2. Calculate molality of  $I_2$  in  $C_6H_6$ . ( $M_w$  of  $C_6H_6 = 78 \text{ g mol}^{-1}$ )

A. 3.2

B. 6.40

C. 1.6

D. 2.30

**Answer: A**



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62. A solution is  $0.5M$  in  $MgSO_4$ ,  $0.1M$   $AlCl_3$  and  $0.2M$  in  $(NH_4)_2SO_4$ . The total ionic strength is:

A. 3.2

B. 2.4

C. 6.4

D. 4.3

**Answer: A**



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63. Equal masses of  $O_2$ ,  $H_2$  and  $CH_4$  are taken in a container.

The respective mole ration of these gases in container is:

A. 1:16:2

B. 16:1:2

C. 1:2:16

D. 16:2:1

**Answer: A**



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**64.** The mole fraction of the solute in one molal aqueous solution is:

A. 0.009

B. 0.0018

C. 0.027

D. 0.036

**Answer: B**



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**65.** In the solubility of liquid solutions:

- A. The solubility of a solute always increases with increasing temperature
- B. There is no noticeable temperature changes
- C. A positive enthalpy of solutions is when the system gains thermal energy on becoming saturated at the fixed temperature



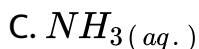
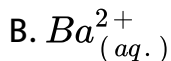
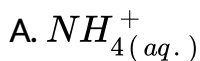
D. A positive heat of solution means heat is absorbed as the solute dissolve to form the saturated solution

**Answer: C**



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**66.** After equal volume of  $0.10M$  solutions of  $(NH_4)_2SO_4$  and  $Ba(OH)_2$  have been mixed, which of the following species is present in greatest concentration in solution?



**Answer: C**



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**67.** Chlorophyll, a green colouring matter contains 2.68%  $Mg$ .

The number of atoms of  $Mg$  present in 1g chlorophyll are :

A.  $6.72 \times 10^{20}$

B.  $6.72 \times 10^{21}$

C.  $6.72 \times 10^{22}$

D.  $6.72 \times 10^{23}$

**Answer: A**



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68. 16g of  $SO_x$  occupies 5.6litre at  $STP$ . Assuming ideal gas nature, the volume of  $x$  is:

A. 1

B. 2

C. 3

D. None of these

**Answer: B**



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69. The radius of a water molecule having density  $1.0gmL^{-1}$  is :

A.  $1.925\text{\AA}$

B.  $73.46\text{\AA}$

C.  $19.25\text{\AA}$

D.  $7.346\text{\AA}$

**Answer: A**



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**70.** Number of positive ions in 1.45 mole of  $K_2SO_4$  are:

A.  $1.75 \times 10^{24}$

B.  $8.73 \times 10^{23}$

C.  $8.73 \times 10^{24}$

D.  $1.75 \times 10^{23}$

**Answer: A**



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71. Equal moles of  $H_2O$  and  $NaCl$  are present in a solution. The molality of  $NaCl$  solution is:

A. 55.6

B. 5.56

C. 1

D. 0.5

**Answer: A**



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72. The weight of  $1 \times 10^{22}$  molecules of  $CuSO_4 \cdot 5H_2O$  is

A. 4.144g

B.  $5.144g$

C.  $6.144g$

D. None of these

**Answer: A**



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**73.** Weight of one atom an element is  $6.44 \times 10^{-23}g$ . Calculate g atom of elements in  $40kg$ .

A.  $10^2$

B.  $10^3$

C.  $10^4$

D.  $10^5$

**Answer: B**

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**74.** A compound contains  $10^{-2}\%$  of phosphorus. If atomic mass of phosphorus is 31, the molar mass of the compound having one phosphorus atom per molecule is:

A. 31

B.  $31 \times 10^2$

C.  $31 \times 10^4$

D.  $31 \times 10^3$

**Answer: C**

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75. Total number of electrons present in 11.2 *litre* of  $NH_3$  at *STP* are:

A.  $6.02 \times 10^{23}$

B.  $3.01 \times 10^{23}$

C.  $3.01 \times 10^{24}$

D.  $5.1 \times 10^{24}$

**Answer: B**



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76.  $Al_2(SO_4)_3 \cdot XH_2O$  has 8.1 % aluminium by mass. The value of  $X$  is:

A. 4



B. 10

C. 16

D. 18

**Answer: D**



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77. One litre of  $N_2$  and  $7/8$  litre of  $O_2$  under identical conditions of  $P$  and  $T$  are mixed. The amount of gases present in mixture show:

A.  $w_{N_2} = 3w_{O_2}$

B.  $w_{N_2} = 8w_{O_2}$

C.  $w_{N_2} = w_{O_2}$

D.  $w_{N_2} = 16w_{O_2}$

**Answer: C**



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**78.** Total number of atoms present in  $1.0\text{cm}^3$  of solid urea (density  $0.3\text{g}/\text{cm}^3$ ) at  $25^\circ\text{C}$  are:

A.  $3.01 \times 10^{21}$

B.  $2.41 \times 10^{22}$

C.  $3.01 \times 10^{22}$

D.  $2.41 \times 10^{23}$

**Answer: B**



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79. The density of liquid (mol.wt. = 70) is  $1.2\text{gmL}^{-1}$ . If  $2\text{mL}$  of liquid contains 35 drops, the number of molecules of liquid in one drop are:

A.  $\frac{1.2}{35} \times N_A$

B.  $\frac{1}{35} \times N_A$

C.  $\frac{1.2}{35^2} \times N_A$

D.  $1.2N_A$

**Answer: C**



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80. The atomic weight of a triatomic gas is  $a$ . The correct formula for the number of moles of gas in its  $w\text{g}$  is:

A.  $\frac{3w}{a}$

B.  $\frac{w}{3a}$

C.  $3wa$

D.  $\frac{a}{3w}$

**Answer: B**



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**81.** A solution required  $[OH^-] = 2M$ . If degree of dissociation of  $Mg(OH)_2$  is  $\alpha$ , what analytical molarity solution of  $Mg(OH)_2$  is

A.  $\alpha$

B.  $2\alpha$

C.  $\frac{1}{2\alpha}$

D.  $\frac{1}{\alpha}$

**Answer: D**



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**82.** In a compound  $A_xB_y$ :

A. Mole of  $A$  = Mole of  $B$  = Mole of  $A_xB_y$

B. Eq. of  $A$  = Eq. of  $B$  = Eq. of  $A_xB_y$

C.

$$y \times \text{mole of } A = x \times \text{mole of } B = (x + y) \times \text{mole of } A_xB_y$$

D.  $y \times \text{mole of } A = x \times \text{mole of } B$

**Answer: B**



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83. 20g of an acid furnishes 0.5mole of  $H_3O^+$  ions in its aqueous solution. The value of 1 equivalent of the acid will be:

A. 40g

B. 20g

C. 10g

D. 100g

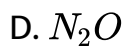
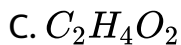
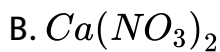
**Answer: A**



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84. Which is not a molecular formula?

A.  $C_6H_{12}O_6$

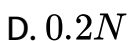
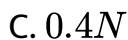


**Answer: B**



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**85.** 1.0g of pure calcium carbonate was found to require 50mL of dilute  $HCl$  for complete reactions. The strength of the  $HCl$  solution is given by:



**Answer: B**



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**86.**  $100\text{mL}$  each of  $0.5N\text{NaOH}$ ,  $N/5\text{HCl}$  and  $N/10\text{H}_2\text{SO}_4$  are mixed together. The resulting solution will be:

A. Acidic

B. Neutral

C. Alkaline

D. none of these

**Answer: C**



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87. Vapour density of a volatile substance is 4( $CH_4 = 1$ ). Its molecular weight would be:

- A. 8
- B. 2
- C. 64
- D. 128

**Answer: C**

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88. The equivalent weight of iron in  $Fe_2O$  would be:

- A. 18.6
- B. 26.66

C. 56

D. 112

**Answer: A**



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**89.**  $25\text{mL HNO}_3$ . If the volumes are mixed with  $75\text{mL}$  of  $4.0\text{M HNO}_3$ . If the volumes are additive, the molarity of the final mixture would be:

A.  $3.25\text{M}$

B.  $4.0\text{M}$

C.  $3.75\text{M}$

D.  $3.59\text{M}$

**Answer: C**

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90. To what extent must a given solution containing  $40\text{mgAgNO}_3\text{permL}$  be diluted to yield a solution containing  $6\text{mgAgNO}_3\text{permL}$  :

- A. Each  $mL$  must be diluted to  $2.5mL$
- B. To each  $mL$  of solution  $2.5mL$  of water should be added
- C. To  $1.5mL$  of solution  $2mL$  of water should be added
- D. To  $1.5mL$  of solution  $1.5mL$  of water should be added

**Answer: A**

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91. An oxide of metal have 20 % oxygen. The eq.wt. of oxide is:

A. 32

B. 40

C. 48

D. 52

**Answer: B**



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92. How much water is to be added to dilute  $10\text{mL}$  of  $10\text{N HCl}$  to make it decinormal?

A.  $990\text{mL}$

B.  $1010\text{mL}$

C.  $100\text{mL}$

D.  $1000\text{mL}$

**Answer: A**



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**93.** If  $250\text{mL}$  of a solution contains  $24.5\text{gH}_2\text{SO}_4$  the molarity and normality respectively are:

A.  $1\text{M}, 2\text{N}$

B.  $1\text{M}, 0.5\text{M}$

C.  $0.5\text{M}, 1\text{N}$

D.  $2\text{M}, 1\text{N}$

**Answer: A**



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94. 0.5 mole of  $H_2SO_4$  is mixed with 0.2 mole of  $Ca(OH)_2$ . The maximum number of mole of  $CaSO_4$  formed is:

A. 0.2

B. 0.5

C. 0.4

D. 1.5

Answer: A



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95. A metal oxide has 40% oxygen. The equivalent weight of the metal is:

A. 12

B. 16

C. 24

D. 48

**Answer: A**



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**96.** A solution contains  $Na_2CO_3$  and  $NaHCO_3$ .  $10\text{mL}$  of the solution required  $2.5\text{mL}$  of  $0.1\text{M } H_2SO_4$  for neutralisation using phenolphthalein as indicator. Methyl orange is then added when a further  $2.5\text{mL}$  of  $0.2\text{M } H_2SO_4$  was required. The amount of  $Na_2CO_3$  and  $NaHCO_3$  in 1 litre of the solution is:

A.  $5.3\text{g}$  and  $4.2\text{g}$

B.  $3.3g$  and  $6.2g$

C.  $4.2g$  and  $5.3g$

D.  $6.2g$  and  $3.3g$

**Answer: A**



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97.  $0.7g$  of  $Na_2CO_3 \cdot xH_2O$  were dissolved in water and the volume was made to  $100mL$ ,  $20mL$  of this solution required  $19.8mL$  of  $N/10HCl$  for complete neutralization. The value of  $x$  is:

A. 7

B. 3

C. 2



D. 5

**Answer: C**



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**98.** A sample of peanut oil weighing  $1.5763g$  is added to  $25mL$  of  $0.4210M KOH$ . After saponification is complete  $8.46mL$  of  $0.2732M H_2SO_4$  is needed to neutralize excess  $KOH$ . The saponification number of peanut oil is:

A. 209.6

B. 108.9

C. 98.9

D. 218.9

**Answer: A**



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**99.** Eq.wt. of an acid salt  $NaHSO_4$  is:

A.  $M / 1$

B.  $M / 2$

C.  $M / 3$

D. none of these

**Answer: A**



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**100.** When a metal is burnt, its weight is increased by 24%. The equivalent weight of the metal will be:

- A. 25
- B. 24
- C. 33.3
- D. 76

**Answer: C**

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**101.** 0.71g of chlorine combines with certain weight of a metal giving 1.11g of its chloride. The eq.wt. of the metal is:

- A. 40

B. 20

C. 80

D. none of these

**Answer: B**



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**102.** How many grams of phosphoric acid would be needed to neutralise 100g of magnesium hydroxide? (The molecular weight are:  $H_3PO_4 = 98$  and  $Mg(OH)_2 = 58.3$ )

A. 66.7g

B. 252g

C. 112g

D. 168g

**Answer: C**



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**103.**  $100\text{mL}$  of mixture of  $\text{NaOH}$  and  $\text{Na}_2\text{SO}_4$  is neutralised by  $10\text{mL}$  of  $0.5\text{MH}_2\text{SO}_4$ . Hence,  $\text{NaOH}$  in  $100\text{mL}$  solution is

A.  $0.2\text{g}$

B.  $0.4\text{g}$

C.  $0.6\text{g}$

D. none of these

**Answer: B**



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104. 0.05 moles of  $NaHCO_3$  will react with how many equivalent of  $Mg(OH)_2$ ?

A. 0.2Eq.

B. 0.05Eq.

C. 0.02Eq.

D. 0.01Eq.

**Answer: B**



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105.  $0.078g Al(OH)_3$  is dehydrated to  $Al_2O_3$ . The  $Al_2O_3$  so obtained reacted with 6 milli-equivalent of  $HCl$ . The equivalent of  $AlCl_3$  produced during the reaction are:

A.  $10^{-3}$

B.  $3 \times 10^{-3}$

C.  $4 \times 10^{-3}$

D.  $\frac{10^{-3}}{2}$

**Answer: B**



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**106.** Assuming 100 % ionisation, the solution having highest normality is:



D.  $1M\text{HNO}_3$

**Answer: C**



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**107.**  $100\text{mL}$  of a sample of hard water requires  $25.1\text{mL}$  of  $0.02\text{NH}_2\text{SO}_4$  for complete reaction, The hardness of water (density  $1\text{g}/\text{mL}$ ) is:

A. 200ppm

B. 250ppm

C. 251ppm

D. 258ppm

**Answer: C**







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108. The equivalent weight of potash alum

$(K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O)$  is

A.  $M/2$

B.  $M/3$

C.  $M/4$

D.  $M/8$

Answer: D



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109. Vapour density of a metal chloride is 6.6. Its oxide contains

53 % metal. The atomic weight of metal is:

A. 21

B. 54

C. 26.72

D. 2.086

**Answer: C**



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**110.**  $100\text{mL}$  of  $0.1\text{M}$  solution of  $\text{H}_2\text{SO}_4$  is used to prepare  $0.05\text{N}$  solution of  $\text{H}_2\text{SO}_4$ . What is the volume of water added to prepare the desired solution:

A.  $300\text{mL}$

B.  $400\text{mL}$

C.  $100\text{mL}$

D.  $200\text{mL}$

**Answer: A**

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**111.** Which does not change on dilution?

A. Molarity of solution

B. Molality of solution

C. Milli-moles and milli-equivalent of solution

D. Mole fraction of solute

**Answer: C**

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112.  $20\text{mL}$  of  $0.1\text{M H}_3\text{BO}_3$  solution on complete neutralisation requires .... mL of  $0.05\text{M NaOH}$  solution:

A.  $20\text{mL}$

B.  $40\text{mL}$

C.  $120\text{mL}$

D.  $80\text{mL}$

**Answer: B**



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113. Volume strength of  $\text{H}_2\text{O}_2$  labelled is  $10\text{vol.}$  What is normality of  $\text{H}_2\text{O}_2$ ?

A. 1.79

B. 12.79

C. 0.79

D. 5.6

**Answer: A**



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**114.** Find the weight of  $H_2SO_4$  in  $1200mL$  of a solution of  $0.2N$  strength.

A.  $11.76g$

B.  $12.76g$

C.  $13.76g$

D.  $23, 52g$

**Answer: A**



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**115.** Calculate the volume of 0.5 M  $H_2SO_4$  required to dissolve 0.5 g of copper (II) carbonate ( $CuCO_3$ ).

A.  $8.10mL$

B.  $16.20mL$

C.  $4.05mL$

D.  $12.05mL$

**Answer: A**



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116. 1g of calcium was burnt in excess of  $O_2$  and the oxide was dissolved in water to make up 1L solution. Calculate the normality of alkaline solution.

A. 0.05, 0.025

B. 0.1, 0.05

C. 0.1, 0.2

D. 0.01, 0.02

**Answer: A**



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117. Number of  $H^+$  ions in 100mL of 0.001M  $H_2SO_4$  is:

A.  $6 \times 10^{20}$

B.  $1.2 \times 10^{18}$

C.  $12 \times 10^{18}$

D.  $1.2 \times 10^{20}$

**Answer: D**



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**118.**  $3g$  of an oxide of a metal is converted completely to  $5g$  chloride. Equivalent weight of metal is:

A. 33.25

B. 3.325

C. 12

D. 20



**Answer: A**

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**119.**  $V_1 mL$  of  $NaOH$  of normality  $X$  and  $V_2 mL$  of  $Ba(OH)_2$  of normality  $Y$  are mixed together. The mixture is completely neutralised by  $100 mL$  of  $0.1 N HCl$ . If  $V_1/V_2 = \frac{1}{4}$  and  $\frac{X}{Y} = 4$ , what fraction of the acid is neutralised by  $Ba(OH)_2$ ?

- A. 0.5
- B. 0.25
- C. 0.33
- D. 0.67

**Answer: A**

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120. Weight of oxygen in  $Fe_2O_3$  and  $FeO$  in the simple ratio for the same amount of iron is:

A. 1 : 2

B. 2 : 1

C. 3 : 2

D. 1 : 3

**Answer: C**



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121. An aqueous solution of 6.3g oxalic acid dihydrate is made up to 250mL. The volume of 0.1N NaOH required to

completely neutralise  $10\text{mL}$  of this solution is

A.  $20\text{mL}$

B.  $40\text{mL}$

C.  $10\text{mL}$

D.  $15\text{mL}$

**Answer: B**



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**122.**  $0.63\text{g}$  of dibasic acid was dissolved in water. The volume of the solution was made  $100\text{mL}$ .  $20\text{mL}$  of this acid solution required  $10\text{mL}$  of  $N/5\text{NaOH}$  solution. The molecular mass of acid is:

A. 63

B. 126

C. 252

D. 128

**Answer: B**



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## Exercise(3B)Objective problems

1. Which quantity is (are) independent of temperature?

A. Mole fraction

B. Molality

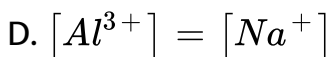
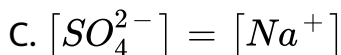
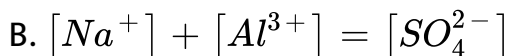
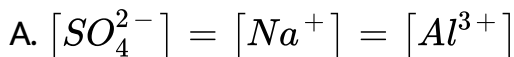
C. Molarity

D. % by weight

Answer: A::B::D

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2. Which one are correct about the solution that contains 3.42ppm  $Al_2(SO_4)_3$  and 1.42ppm  $Na_2SO_4$ ?



Answer: B::D

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3. One mole of  $CO_2$  contains:

A.  $6.023 \times 10^{23}$  g-atom of  $CO_2$

B.  $12.04 \times 10^{23}$  atom of oxygen

C.  $18.1 \times 10^3$  molecule of  $CO_2$

D.  $6.023 \times 10^{23}$  atom of carbon

**Answer: B::D**



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4. A mixture containing one mole of  $BaF_2$  and two mole of  $H_2SO_4$  will be neutralised by:

A. 1 mole  $KOH$

B. 4 mole  $KOH$

C. 2 mole  $KOH$

D. 2 mole  $Ca(OH)_2$

**Answer: C**



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5. 11.2litre of a gas  $STP$  weighs 14g. The gases would be:

A.  $N_2$

B.  $CO$

C.  $N_2O$

D.  $B_2H_6$

**Answer: A::B::D**



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6. Choose the correct statement (*S*):

- A. The no. of atoms present in a molecule of gas represented its atomicity
- B. One mole of electron weigh  $0.55\text{mg}$
- C. The extent of both inter and intramolecular *H*-bonding depends on the temperature
- D. None of these

**Answer: A::B::C**



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7. Sulphur molecule exists under various condition as  $S_8$ ,  $S_6$ ,  $S_4$ ,  $S_2$  and  $S$ . Which of the following statements (*s*) is (are) incorrect?

- A. Mass of one mole of each of these is same
- B. Number of molecules in one mole of each of these is same
- C. Number of atoms in one mole of each of these is same
- D. None of these

**Answer: A::C**



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8. The density of a  $3MNa_2S_2O_3$  (sodium thiosulphate) solution is  $1.25gmL^{-1}$ . Calculate:

a. % by weight of  $Na_2S_2O_3$

b. Mole fraction of  $Na_2S_2O_3$

c. Molalities of  $Na^{\oplus}$  and  $S_2O_3^{2-}$  ions.

A. The % weight of  $Na_2S_2O_3$  is 37.92

B. The mole fraction of  $Na_2S_2O_3$  is 0.065

C. The molality of  $Na^+$  is 8.732

D. The molality of  $S_2O_3^{2-}$  is 3.866

**Answer: A::B::D**



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9. 25 mL of 0.50 M  $H_2O_2$  solution is added to 50 mL of 0.20 M  $KMnO_4$  in acid solution. Which of the following statements is true?

A. 0.010 mole of oxygen is liberated

B. 0.005 mole of  $KMnO_4$  does not react with  $H_2O_2$

C. 0.0125g-mol. Of oxygen gas is evolved

D. In the final solution there are only water molecules and

$Mn^{2+}$  ions

**Answer: B::C**



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10.  $A$ g of a metal displaces  $V$  mL of  $H_2$  at  $NTP$  Eq.wt. of metal,

$E$  is (are):

$$A. E = \frac{A \times 1.008 \times 22400}{\text{Vol. of } H_2 \text{ displaced} \times 2}$$

$$B. E = \frac{A \times \text{Eq. mass of } H}{\text{mass of } H_2 \text{ displaced}}$$

$$C. E = \frac{A \times 1.008}{\text{Vol. of displaced} \times 0.000897}$$

D. None of these

**Answer: A::B::C**



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11. 2.0g of oleum is diluted with water. The solution was then neutralised by 432.5mL of 0.1N NaOH. Select the correct statements:

A. Equivalent of  $H_2SO_4 = 0.03$

B. Equivalent of  $SO_3 = 0.01325$

C. % of free  $SO_3 = 26.5$  in oleum

D. % of oleum = 108.11

**Answer: A::B::C::D**



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12. If one mole of  $H_3PO_x$  is completely neutralized by 40g of  $NaOH$ , select the correct statements ( $s$ ):

- A.  $x = 2$  and acid is monobasic
- B.  $x = 3$  and acid is dibasic
- C.  $x = 4$  and acid is tribasic
- D.  $x = 2$  and acid does not form acid salt

**Answer: A::D**

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13. Which of the following statements are correct?

- A. The equivalent weight of  $Ba_3(PO_4)_2$  is 100.1
- B. The equivalent weight of  $Na_3PO_4$  is 54.66
- C. The equivalent weight of  $H_3PO_4$  is 32.67
- D. The equivalent weight of  $Ca(OH)_2$  is 36.5

**Answer: A::B::C**



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**14.**  $H_2C_2O_4$  acts as an acid as well as an oxidising agent. The correct statements (*s*) about  $H_2C_2O_4$  is (are):

- A. It forms two series of salts
- B. Equivalent weight of  $H_2C_2O_4$  as an acid for complete neutralisation and as oxidant are same

C.  $100\text{mL}$  of  $0.1\text{M}$  solution of  $\text{KMnO}_4$  (acid) will be completely reduced by  $50\text{mL}$  of  $1\text{MH}_2\text{C}_2\text{O}_4$

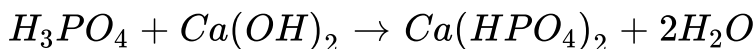
D.  $100\text{mL}$  of  $0.1\text{N}$  solution of  $\text{Ca}(\text{OH})_2$  will be completely neutralised by  $50\text{mL}$  of  $0.2\text{MH}_2\text{C}_2\text{O}_4$

**Answer: A::B::D**



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**15.** The reaction



Which statements (s) is (are) true?

A. Equivalent weight of  $\text{H}_3\text{PO}_4$  is 49

B. For complete neutralization  $3/2$  mole of  $\text{Ca}(\text{OH})_2$  are needed

C. Resulting mixture is neutralised by 1 mole of  $KOH$

D. Equivalent weight of  $H_3PO_4$  is 98

**Answer: A::B::C**



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### Exercise (4) Objective problems

1. Number of atoms in  $558.5gFe$  (at. wt. 55.85) is:

A. Twice that in  $60g$  carbon

B.  $6.023 \times 10^{22}$

C. Half in  $8gHe$

D.  $558.5 \times 6.023 \times 10^{23}$



**Answer: A**



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2. Which of the following with increase in temperature?

A. Molality

B. Weight fraction of solute

C. Fraction of solute present in water

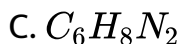
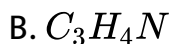
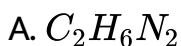
D. Mole fraction

**Answer: C**



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3. A compound of carbon, hydrogen, and nitrogen contains the three elements in the respective ratio of 9:1:3.5 Calculate the empirical formula. If the molecular weight of the compound is 108, what its molecular formula?



**Answer: C**



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4. What volume of  $H_2$  at  $273K$  and 1 atm will be consumed in obtaining 21.6g of elemental boron (atomic mass of  $B = 10.8$ )

from the reduction of  $BCl_3$  with  $H_2$ .

A. 44.8L

B. 22.4L

C. 89. L

D. 67.2L

**Answer: D**



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5.  $6.02 \times 10^{20}$  molecules of urea are present in 100mL solution.

The concentration of urea solution is:

A. 0.1M

B. 0.01M

C.  $0.02M$

D.  $0.001M$

**Answer: B**



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6. Two solutions of a substance (non-electrolyte) are mixed in the following manner  $480mL$  of  $1.5M$  of first solution with  $520mL$  or  $1.2M$  of second solution. The molarity of final solution is:

A.  $1.20M$

B.  $1.50M$

C.  $1.344M$

D.  $2.70M$

**Answer: C**



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7. If  $1/6$ , in place of  $1/12$ , mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will:

- A. Decrease twice
- B. Increase two folds
- C. Remain uncharges
- D. Be a function of the molecular mass of element

**Answer: C**



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8. How many mole of magnesium phosphate  $Mg_3(PO_4)_2$  will contain 0.25mole of oxygen atoms?

A. 0.02

B.  $3.125 \times 10^{-2}$

C.  $1.25 \times 10^{-2}$

D.  $2.5 \times 10^{-2}$

**Answer: B**



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9. Density of 2.05M solution of acetic acid in water is  $1.02g/mL$ . The molality of same solution is:

A.  $1.14molkg^{-1}$

B.  $3.28 \text{ mol kg}^{-1}$

C.  $2.28 \text{ mol kg}^{-1}$

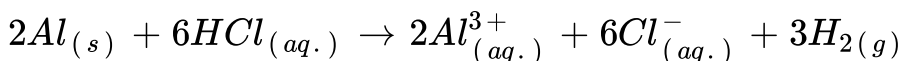
D.  $0.44 \text{ mol kg}^{-1}$

**Answer: C**



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**10.** In the reaction:



A. 6 litre  $HCl_{(aq.)}$  is consumed for every 3L  $H_{2(g)}$  produced

B. 33.6 litre  $H_{2(g)}$  is produced regardless of temperature and pressure for every mole  $Al$  that react

C. 67.2 litre  $H_{2(g)}$  at *STP* is produced for every mole *Al* that reacts

D. 11.2 litre  $H_{2(g)}$  at *STP* is produced for every mole  $HCl_{(aq.)}$  consumed

**Answer: D**

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11. Calculate the density (in  $\text{gm L}^{-1}$ ) of a 3.60 M sulphuric acid solution that is 29 %  $H_2SO_4$  by mass (molar mass =  $98 \text{ g mol}^{-1}$ )

A. 1.64

B. 1.88

C. 1.22



D. 1.45

**Answer: C**



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12. How many moles of electrons weigh one kilogram?

A.  $6.023 \times 10^{23}$

B.  $\frac{1}{9.108} \times 10^{23}$

C.  $\frac{6.023 \times 10^{54}}{9.108}$

D.  $\frac{1}{9.108 \times 6.023} \times 10^8$

**Answer: D**



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13. Which of the following has the maximum number of atoms?

A.  $24gC(12)$

B.  $56gFe(56)$

C.  $27gAl(27)$

D.  $108gAg(108)$

**Answer: A**



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14. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator.

The number of moles of Mohr's salt required per mole of dichromate is:

A. 3

B. 4

C. 5

D. 6

**Answer: D**



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**15.** Given that the abundance of isotopes  ${}^{54}\text{Fe}$ ,  ${}^{56}\text{Fe}$ , and  ${}^{57}\text{Fe}$  is 5%, 90% and 5% respectively. The atomic mass of  $\text{Fe}$  is

A. 55.85

B. 55.95

C. 55.75

D. 56.05

**Answer: B**



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16.  $25\text{mL}$  of a solution of barium hydroxide on titration with  $0.1\text{molar}$  solution of hydrochloric acid give a titre value of  $35\text{mL}$ . The molarity of barium hydroxide is:

A. 0.28

B. 0.35

C. 0.07

D. 0.14

**Answer: C**



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17. To neutralize completely  $20\text{mL}$  of  $0.1\text{M}$  aqueous solution of phosphorous ( $\text{H}_3\text{PO}_3$ ) acid the volume of  $0.1\text{M}$  aqueous  $\text{KOH}$  solution required is:

A.  $60\text{mL}$

B.  $20\text{mL}$

C.  $40\text{mL}$

D.  $10\text{mL}$

**Answer: C**

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18. The normality of  $0.3\text{M}$  phosphorous acid  $\text{H}_3\text{PO}_3$  is:

A. 0.1

B. 0.9

C. 0.3

D. 0.6

**Answer: D**



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19. An aqueous solution of  $6.3g$  oxalic acid dihydrate is made up to  $250mL$ . The volume of  $0.1N NaOH$  required to completely neutralise  $10mL$  of this solution is

A.  $40mL$

B.  $20mL$

C.  $10mL$

D.  $4mL$

**Answer: A**



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20. Dissolving  $120g$  of urea ( $Mw = 60$ ) in  $1000g$  of water gave a solution of density  $1.15gmL^{-1}$ . The molarity of solution is:

A.  $1.78M$

B.  $1.02M$

C.  $2.05M$

D.  $0.50M$

**Answer: C**



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## Exercise 6 (INTEGER ANSWERS TYPE PROBLEMS)

1. How many  $g$ -atom are in  $84g$  of carbon?

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2. How many moles are in  $96gO_2$ ?

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3. How many  $g$ -atom of  $S$  are present in  $196g$  of  $H_2SO_4$ ?

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4. The measured density at *NTP* of *He* is  $0.1784\text{gL}^{-1}$ .

Calculate the weight of 1mole of *He*.



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5. Calculate the number of moles of water in  $610\text{gBaCl}_2 \cdot 2\text{H}_2\text{O}$



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6. Haemoglobin contains 0.312 % iron by weight. The molecular weight of haemoglobin is 89600. Find the number of iron atoms per molecular of haemoglobin.



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7. A solid element is specific heat  $1Jg^{-1}K^{-1}$ . If equivalent weight of an element is 9, find its valence.



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8. An element has atomic mass 31. Mass of 1.12 litre at *STP* of vapours of this element weighs 6.2g. Find the atomicity of this element.



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9. On heating 1.763g of hydrated  $BaCl_2$  to dryness, 1.505g of anhydrous salt remained, What is the formula of hydrate?



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10. A gaseous alkane was exploded with oxygen. The volume of  $O_2$  for complete combustion to  $CO_2$  formed was in the ratio of 7: 4. The molecular formula of alkane is:

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11. A branded tooth paste contains 0.754g sodium in form of sodium monofluoroortho phosphate ( $Na_3PO_4F$ ) in 100mL solution. Calculate the amount of  $Na_3PO_4F$  present in 100mL of solution.

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12. Find the molality of  $H_2SO_4$  solution whose specific gravity is  $1.98mL^{-1}$  and 93 % by volume  $H_2SO_4$

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13. Calculate the degree of hardness of a sample of water containing  $6\text{mg}$  of  $\text{MgSO}_4$  per kg of water.

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14. Find the number of  $g$ -molecules of oxygen in  $6.023 \times 10^{24} \text{CO}$  molecules.

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15. Calculate the mass of  $\text{CaO}$  that shall be obtained by heating  $20\text{kg}$  of  $80\%$  pure limestone ( $\text{CaCO}_3$ ).

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16.  $H_2O_2$  is marked 22.4 volume. How much of it is required to oxidise  $3.5gH_2S$  gas?



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17. Calculate the weight of  $NaOH$  in 75 mill-equivalents.



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18. Calculate the normality of  $0.74gCa(OH)_2$  in  $10mL$  of solution.



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19. What is the strength in  $g/L$  of a solution of  $H_2SO_4$ ,  $14mL$  of which neutralized  $20mL$  of  $N/10NaOH$  solution?



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20. Find the weight of  $H_2SO_4$  in  $919mL$  of a solution of  $0.2N$  strength.



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21. Calculate the volume of a solution of  $HCl$  containing  $80.5g$  of acids per litre would suffice for the exact neutralization of  $NaOH$  obtained by allowing  $0.46g$  of metallic sodium to act upon water?



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22. 1g of an acid  $C_6H_{10}O_4$  is completely neutralised by 0.768g  $KOH$ . Calculate the number of neutralizable protons in acid.



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23. 0.9698g of an acid are present in 300mL of a solution. 10mL of this solution requires exactly 20mL of 0.05N  $KOH$  solution. If the *mol. wt.* of acid is 98, calculate the number of neutralizable protons.



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24. On being heated in oxygen,  $3.120g$  of a metal  $M$  convert to  $4.560g$  of oxide. Find the valency of metal ( at.wt. of metal = 52 ).



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25.  $3.150g$  of oxalic acid  $[(COOH)_2 \cdot xH_2O]$  are dissolved in water and volume made up to  $500mL$ . On titration  $28mL$  of this solution required  $35mL$  of  $0.08N NaOH$  solution for complete neutralization. Find the value of  $x$ .



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26. Find the concentration of  $1.6N$  solution of  $H_2O_2$  in terms of volume.



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27. The equivalent weight of an element is 4. Its chloride has a vapour density 59.25. Find the valency of element.

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28.  $2.68 \times 10^{-3}$  moles of solution containing anion  $A^{n+}$  require  $1.61 \times 10^{-3}$  moles of  $MnO_4^-$  for oxidation of  $A^{n+}$  to  $AO_3^-$  in acidic medium. What is the value of  $n$ ?

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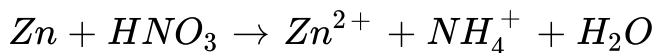
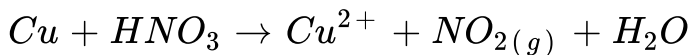
29. What is the molality of acetic acid solution containing 6g of acetic acid in 100g water?

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30. A bottle is labelled 122.5 % oleum. 22.7mL of  $Ca(OH)_2$  is unknown molarity are used to completely neutralise 1g oleum. Find the normality of  $Ca(OH)_2$ .

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31. 15g sample of an alloy containing  $Cu$  and  $Zn$  reacts completely with  $3MHNO_3$  as,



The liberated  $NO_{2(g)}$  was found to be 4.647litre at 1atm and 300K. Find the amount of zince ( to the closest value) in alloy. ( $Cu - 63.6, R = 0.0821$ )

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**32.** What is the ' $n$ ' factor or valency factor of ozone during the change:  $2O_3 \rightarrow 3O_2$ ?

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**33.** A student performs a titration with different burettes and finds titre values of  $25.2\text{mL}$ ,  $25.25\text{mL}$ , and  $25.0\text{mL}$ . The number of significant figures in the average titre value is .....

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**34.** The volume (in  $\text{mL}$ ) of  $0.1\text{M AgNO}_3$  required for complete precipitation of chloride ions present in  $30\text{mL}$  of  $0.01\text{M}$  solution of  $[Cr(H_2O)_5Cl]Cl_2$ , as silver chloride is close to:

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35. 29.2 % ( $w/w$ )  $HCl$  stock, solution has a density of  $1.25\text{gmL}^{-1}$ . The molecular weight of  $HCl$  is  $36.5\text{gmol}^{-1}$ . The volume ( $mL$ ) of stock solution required to prepare a  $200\text{mL}$  solution of  $0.4\text{MHCl}$  is :

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## Exercise 7 Comprehension based objective problems

1. The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in  $g$  and its molecular weight. 1mole of a gaseous compound occupies  $22.4\text{litre}$  at  $NTP$  and contains  $6.023 \times 10^{23}$  molecules of gas.

weight of 1atom of hydrogen is:

A.  $1.66 \times 10^{-24}$  amu

B.  $3.32 \times 10^{-24}$  g

C.  $1.66 \times 10^{-24}$  g

D.  $3.32 \times 10^{-24}$  amu

**Answer: C**



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2. How many years it would take to spend Avogadro's number of rupees at the rate of 10 lakh rupees per second?

A.  $1.91 \times 10^{10}$  year

B.  $2.91 \times 10^{10}$  year

C.  $3.91 \times 10^{10}$  year

D.  $4.91 \times 10^{10}$  year

**Answer: A**



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3. The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in  $g$  and its molecular weight.

1mole of a gaseous compound occupies 22.4litre at  $NTP$  and contains  $6.023 \times 10^{23}$  molecules of gas.

The amount of sulphur required to produce 100mole of  $H_2SO_4$

is:

A.  $3.2 \times 10^3 g$

B.  $32.65g$

C.  $32g$

D. 3.2g

**Answer: A**



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4. The vapour density of a mixture containing  $NO_2$  and  $N_2O_4$  is 38.3 at  $27^\circ C$ . Calculate the mole of  $NO_2$  in 100 mole mixture.

A. 33.48

B. 32.65g

C. 32g

D. 3.2g

**Answer: A**



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5. The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in  $g$  and its molecular weight.

1mole of a gaseous compound occupies 22.4litre at  $NTP$  and contains  $6.023 \times 10^{23}$  molecules of gas.

A substance contains 3.4% sulphur. If it contains two molecules of sulphur per molecule the minium molecular weight of substance will be:

A. 941

B. 1882

C. 470.5

D. 1411.5

**Answer: B**



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6. Calculate the residue obtained on strongly heating  $2.76g Ag_2CO_3$ .

A. 0.02mole

B. 1mole

C. 0.01mole

D. 2mole

**Answer: A**



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7. The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in  $g$  and its molecular weight.

1mole of a gaseous compound occupies 22.4litre at  $NTP$  and

contains  $6.023 \times 10^{23}$  molecules of gas.

The volume of air needed to burning 12g carbon completely at *STP* is:

A. 22.4litre

B. 112litre

C. 44.8litre

D. 50litre

**Answer: B**



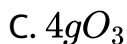
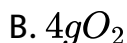
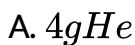
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**8.** The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in *g* and its molecular weight.

1mole of a gaseous compound occupies 22.4litre at *NTP* and

contains  $6.023 \times 10^{23}$  molecules of gas.

The maximum number of atoms present are in:



**Answer: A**



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**9.** The term mole first used by Ostwald in 1896 refers for the ratio of mass of a substance in  $g$  and its molecular weight.

1mole of a gaseous compound occupies 22.4litre at  $NTP$  and

contains  $6.023 \times 10^{23}$  molecules of gas.

The hydrated salt  $Na_2SO_4 \cdot nH_2O$  undergoes 56% loss in weight on heating and becomes anhydrous. The value of  $n$  will be:

- A. 5
- B. 3
- C. 7
- D. 10

**Answer: D**



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**10.** The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The

molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by weight terms.

Number of oxalate ions in  $100\text{mL}$  of  $0.1N$  oxalic acid is:

A.  $\frac{N_A}{100}$

B.  $\frac{N_A}{20}$

C.  $\frac{N_A}{200}$

D.  $\frac{N_A}{1000}$

**Answer: C**



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11. The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by weight terms.

Volume of water required to convert  $100\text{mL } 0.5\text{MNaOH}$  solutions to  $0.2\text{MNaOH}$  solution is:

- A.  $250\text{mL}$
- B.  $150\text{mL}$
- C.  $100\text{mL}$
- D.  $400\text{mL}$

Answer: C

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12. The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by weight terms.

The normality of  $0.3NH_3BO_3$  is:

A.  $0.3N$

B.  $0.15N$

C.  $0.6N$

D.  $0.9N$

**Answer: C**

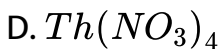
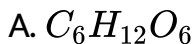


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**13.** The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by weight terms.

Which is not a molecular formula?



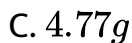
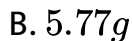
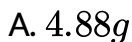


**Answer: D**



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14. What weight of  $AgCl$  will be precipitated when a solution containing  $4.77gNaCl$  is added to a solution of  $5.77g$  of  $AgNO_3$ .



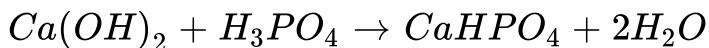
D. None of these

**Answer: A**



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15. Find out the equivalent weight of  $H_3PO_4$  in the reaction:



A. 49

B. 32.66

C. 98

D. None of these

**Answer: A**



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16.  $20\text{mL}$  of  $0.2\text{MAl}_2(\text{SO}_4)_3$  is mixed with  $20\text{mL}$  of  $0.6\text{MBaCl}_2$ . Calculate the concentration of each ion in solution.

A.  $0.6\text{N}$ ,  $0.6\text{N}$

B.  $0.2\text{N}$ ,  $0.6\text{N}$

C.  $0.6\text{N}$ ,  $0.2\text{N}$

D.  $0.2\text{N}$ ,  $0.2\text{N}$

**Answer: A**



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17. A  $6.90\text{M}$  solution of  $\text{KOH}$  contains 30% by weight of  $\text{KOH}$ .

Calculate the density of the solution.

A.  $1.288g/mL$

B.  $12.88g/mL$

C.  $0.1288g/mL$

D. None of these

**Answer: A**



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**18.** Find the weight of  $H_2SO_4$  in  $1200mL$  of a solution of  $0.2N$  strength.

A.  $11.76g$

B.  $5.83g$

C.  $16.42g$

D. 2.92g

**Answer: A**



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**19.** The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by weight terms.

The weight of  $Na_2CO_3$  sample of 95% purity required to neutralise 45.6mL of 0.235N acid is:

A. 0.60g

B. 0.80g

C. 0.40g

D. 0.20g

**Answer: A**



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**20.** The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by

weight terms.

Two litre of  $NH_3$  at  $30^\circ C$  and  $0.20\text{atm}$  is neutralised by  $134\text{mL}$  of acid ( $H_2SO_4$ ). The molarity of  $H_2SO_4$  is:

A. 0.12

B. 0.24

C. 0.06

D. 0.03

**Answer: B**



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21. How much  $BaCl_2$  would be needed to make  $250\text{mL}$  of a solution having same concentration of  $Cl^-$  as the one containing  $3.78\text{g}$  of  $NaCl$  per  $100\text{mL}$ .

A. 8.40g

B. 16.80g

C. 25.20g

D. 4.20g

**Answer: B**



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**22.** The concentration of solutions can be expressed in number of ways such that Normality, Molarity, Molality, Mole fractions, Strength, % by weight, % by volume and % by strength. The molarity of ionic compound is usually expressed as formality because we use formula weight of ionic compound. Addition of water to a solution changes all these terms, however increase in temperature does not change molality, mole fraction and % by



weight terms.

Molecular weight of  $O_3$  in the reaction,  $2O_3 \rightleftharpoons 3O_2$  is:

A. 8

B. 16

C. 24

D. 48

**Answer: A**



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**23.** The domestic water supply is treated by bleaching powder to remove unhygienic species in water and to make it safe for drinking water. However, this given rise to  $Ca^{2+}$  and  $Cl^-$  ion contamination in water. Both these ions are also injurious for

health if a minimum concentration is crossed. The chloride ions are tested by a kit provided by many companies having  $AgNO_3$  solution that is added drop by drop to  $23mL$  of water sample to which an indicator has been added. When sufficient silver nitrate is added to remove  $Cl^{-1}$  ions as  $AgCl$  solid, the solid turns orange. The colour change is noticed by addition of  $AgNO_3$  having molar concentration such that each drop ( $0.05mL$ ) of  $AgNO_3$  converts  $12.5mg$  of  $Cl^{-}$  ions  $AgCl$ .

If 12 drops of  $AgNO_3$  solution are used to reach the colour point, what mass of chloride ion is present in one litre sample?

- A.  $6.52g$
- B.  $7.150g$
- C.  $5.125g$
- D.  $1.25g$

**Answer: A**



24. The domestic water supply is treated by bleaching powder to remove unhygienic species in water and to make it safe for drinking water. However, this gives rise to  $Ca^{2+}$  and  $Cl^{-}$  ion contamination in water. Both these ions are also injurious for health if a minimum concentration is crossed. The chloride ions are tested by a kit provided by many companies having  $AgNO_3$  solution that is added drop by drop to  $23mL$  of water sample to which an indicator has been added. When sufficient silver nitrate is added to remove  $Cl^{-}$  ions as  $AgCl$  solid, the solid turns orange. The colour change is noticed by addition of  $AgNO_3$  having molar concentration such that each drop ( $0.05mL$ ) of  $AgNO_3$  converts  $12.5mg$  of  $Cl^{-}$  ions as  $AgCl$ .

The molar concentration of  $Cl^{-}$  in the sample of water used is:

A.  $3.225 \times 10^{-3} M$

B.  $2.225 M$

C.  $1.521 M$

D.  $0.1837 M$

**Answer: D**



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**25.** The domestic water supply is treated by bleaching powder to remove unhygienic species in water and to make it safe for drinking water. However, this gives rise to  $Ca^{2+}$  and  $Cl^{-}$  ion contamination in water. Both these ions are also injurious for health if a minimum concentration is crossed. The chloride ions are tested by a kit provided by many companies having  $AgNO_3$  solution that is added drop by drop to  $23 mL$  of water sample

to which an indicator has been added. When sufficient silver nitrate is added to remove  $Cl^{-1}$  ions as  $AgCl$  solid, the solid turns orange. The colour change is noticed by addition of  $AgNO_3$  having molar concentration such that each drop ( $0.05mL$ ) of  $AgNO_3$  converts  $12.5mg$  of  $Cl^{-}$  ions  $AgCl$ .

The molar concentration of  $AgNO_3$  solution if one drop of  $AgNO_3$  measure  $0.05mL$  is:

A.  $6.04 \times 10^{-3} M$

B.  $7.04 \times 10^{-3} M$

C.  $150M$

D.  $3.52M$

**Answer: B**



**Watch Video Solution**

26. The domestic water supply is treated by bleaching powder to remove unhygienic species in water and to make it safe for drinking water. However, this gives rise to  $Ca^{2+}$  and  $Cl^{-}$  ion contamination in water. Both these ions are also injurious for health if a minimum concentration is crossed. The chloride ions are tested by a kit provided by many companies having  $AgNO_3$  solution that is added drop by drop to  $23mL$  of water sample to which an indicator has been added. When sufficient silver nitrate is added to remove  $Cl^{-}$  ions as  $AgCl$  solid, the solid turns orange. The colour change is noticed by addition of  $AgNO_3$  having molar concentration such that each drop ( $0.05mL$ ) of  $AgNO_3$  converts  $12.5mg$  of  $Cl^{-}$  ions to  $AgCl$ .

Assuming that concentration of  $Ca^{2+}$  ions in solution is equal equivalence ratio to chloride ions, the hardness of water is:

A.  $9.185 \times 10^3$  ppm

B.  $6.185 \times 10^3$  ppm

C.  $1.185 \times 10^3$  ppm

D.  $4.185 \times 10^3$  ppm

**Answer: A**



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**27.** Chemical reactions involve interaction of atoms and molecules. A large number of atoms / molecules (approximately  $6.023 \times 10^{23}$ ) are present in a few grams of any chemical compound varying with their atomic / molecular masses. To handle such large numbers conveniently, the mole concept was introduced. This concept has implications in diverse areas such as analytical chemistry, biochemistry, electrochemistry, and radiochemistry. The following example illustrates a typical case, involving chemical / electrochemical

reaction, which requires a clear understanding of the mole concept.

A  $4.0M$  aqueous solution of  $NaCl$  is prepared and  $500mL$  of this solution is electrolyzed. This leads to the evolution of chlorine gas at one of the electrodes ( atomic mass of  $Na$  is 23 and  $Hg$  is 200)( $1F = 96500C$ ).

The total number of moles of chlorine gas evolved is

- A. 0.5
- B. 1.0
- C. 2.0
- D. 3.0

**Answer: B**



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**28.** Chemical reactions involve interaction of atoms and molecules. A large number of atoms / molecules (approximately  $6.023 \times 10^{23}$ ) are present in a few grams of any chemical compound varying with their atomic / molecular masses. To handle such large numbers conveniently, the mole concept was introduced. This concept has implications in diverse areas such as analytical chemistry, biochemistry, electrochemistry, and radiochemistry. The following example illustrates a typical case, involving chemical / electrochemical reaction, which requires a clear understanding of the mole concept.

A  $4.0M$  aqueous solution of  $NaCl$  is prepared and  $500mL$  of this solution is electrolyzed. This leads to the evolution of chlorine gas at one of the electrodes ( atomic mass of  $Na$  is 23 and  $Hg$  is 200)( $1F = 96500C$ ).

If the cathode is an  $Hg$  electrode, the maximum weight ( $\in g$ ) of amalgam formed from this solution is

A. 200

B. 225

C. 400

D. 446

**Answer: D**



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**29.** Chemical reactions involve interaction of atoms and molecules. A large number of atoms / molecules ( approximately  $6.023 \times 10^{23}$  ) are present in a few grams of any chemical compound varying with their atomic / molecular masses. To handle such large numbers conveniently, the mole concept was introduced. This concept has implications in diverse areas such as analytical chemistry, biochemistry,

electrochemistry, and radiochemistry. The following example illustrates a typical case, involving chemical / electrochemical reaction, which requires a clear understanding of the mole concept.

A  $4.0M$  aqueous solution of  $NaCl$  is prepared and  $500mL$  of this solution is electrolyzed. This leads to the evolution of chlorine gas at one of the electrodes ( atomic mass of  $Na$  is 23 and  $Hg$  is 200)( $1F = 96500C$ ).

The total charge ( coulomb ) required for complete electrolysis is

A. 24125

B. 48250

C. 96500

D. 193000

**Answer: D**



**30.** Bleaching powder and bleach solution are produced on a large scale and used in several household products. The effectiveness of bleach solution is often measured by iodometry.

$25\text{mL}$  of household bleach solution was mixed with  $30\text{mL}$  of  $0.50\text{MKI}$  and  $10\text{mL}$  of  $4\text{N}$  acetic acid. In the titration of the liberated iodine,  $48\text{mL}$  of  $0.25\text{NNa}_2\text{S}_2\text{O}_3$  was used to reach the end point. The molarity of the household bleach solution is :

A.  $0.48\text{M}$

B.  $0.96\text{M}$

C.  $0.24\text{M}$

D.  $0.24\text{M}$

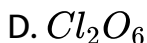
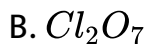
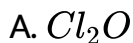
**Answer: C**



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**31.** Bleaching powder and bleach solution are produced on a large scale and used in several household products. The effectiveness of bleach solution is often measured by iodometry.

Bleaching powder contains a salt of an oxoacid as one of its components. The anhydride of that oxoacid is:



Answer: A



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## Exercise 8 Statements: Explanation type problems

1. Statement The atomic weight of an element is given by

Dulong Petit's law:  $at. wt. \times sp. heat (cal / mole) \cong 6.4$ .

Explanation The formula is valid for metals only and not for all elements.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of

$S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: B**



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2. Statement  $1\text{mole } O_3 = N\text{molecule } O_3 = 3N$  atoms of  $O = 48g$

Explanation A mole is the amount of matter that contains as many as objects as the amount of atoms exactly in  $12gC^{12}$ .

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: C**



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3. Statement The volume of 1mole of an ideal gas at 1bar pressure at  $25^{\circ}C$  is 24.78litre.

Explanation:  $1\text{bar} = 0.987\text{atm}$

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .



D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: D**



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4. Statement Equivalent weight of a species can be written as molecular weight of species divided by valence factor.

Explanation Valence factor represents valence in element, acidity in bases, basicity in acids and total charge on cation or anion in an ionic compound.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: D**



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5. Statement  $H_3PO_3$  is a dibasic acid and its salt  $Na_2PO_3$  does not exist.

Explanation Being dibasic nature, only two  $H$  are replaceable.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: C**



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6. Statement  $H_3BO_3$  is monobasic Lewis acid but its salt  $Na_3BO_3$  exist.

Explanation  $H_3BO_3$  reacts with  $NaOH$  to give  $Na_3BO_3$ .

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: A**



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7. Statement Addition of water to a solution containing solute and solvent changes its normality or molarity only.

Explanation The milli-equivalent and milli-moles of solutes are not changed on dilution.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: D**



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**8.** Statement On increasing the temperature the milli-moles of solute, milli-equivalent of solute, molality, mole fraction of solute and % by weight does not change.

Explanation Each of these involves only weights of solute and solvent.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: C**



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9. Statement 1 equivalent of  $K_2Cr_2O_7$  has 1 equivalent of  $K$ ,  $Cr$  and  $O$  each.

Explanation Equivalent and milli-equivalent reacts in equal number to give same eq.or meq. of product.

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: C**



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**10.** Statement  $109\% H_2SO_4$  represent a way to express concentration of industrial  $H_2SO_4$ .

Explanation It represents that  $9gH_2O$  reacts with  $40gSO_3$  to produce  $49gH_2SO_4$  in addition to  $100gH_2SO_4$ .

A.  $S$  is correct but  $E$  is wrong.

B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: D**



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11. Statement Equivalent weight of an element may have different value.

Explanation Equivalent weight depends upon the nature of chemical reaction shown by that element.

A.  $S$  is correct but  $E$  is wrong.



B.  $S$  is wrong but  $E$  is wrong.

C. Both  $S$  and  $E$  are correct and  $E$  is correct explanation of  $S$ .

D. Both  $S$  and  $E$  are correct but  $E$  is not correct explanation of  $S$ .

**Answer: C**



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## Exercise 9 Advanced numerical problems

1. A polystyrene, having formula  $Br_3C_6H_2(C_8H_8)_n$ , was prepared by heating styrene with tribromobenzoyl peroxide in

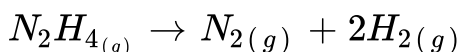
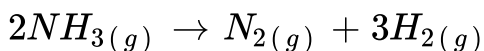
the absence of air. If it was found to contain 10.46% bromine by weight, find the value of  $n$ .

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2. Calculate the % of free  $SO_3$  in oleum ( a solution of  $SO_3$  in  $H_2SO_4$ ) that is labelled 109 %  $H_2SO_4$  by weight.

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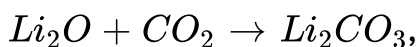
3. A mixture of  $NH_3(g)$  and  $N_2H_4(g)$  is placed in a sealed container at  $300K$ . The total pressure is  $0.5atm$ . The container is heated to  $1200K$ , at which time both substances decompose completely according to the equations:



After decomposition is complete, the total pressure at  $1200K$  is found to be  $4.5\text{atm}$ . Find the amount (mole) per cent of  $N_2H_{4(g)}$  in the original mixture.

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4. Chemical absorbents can be used to remove exhaled  $CO_2$  of space travellers in short space flight.  $Li_2O$  is one of the most efficient in terms of absorbing capacity per unit weight. If the reaction is:



What is the absorption efficiency of pure  $Li_2O$  in litre  $CO_2(STP)$  per kg?

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5. Copper forms two oxides. For the same amount of copper, twice as much oxygen was used to form first oxide than to form second one. What is the ratio of the valencies of copper in first and second oxides?

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6.  $105\text{mL}$  of pure water at  $4^\circ\text{C}$  saturated with  $\text{NH}_3$  gas yielded a solution of density  $0.9\text{gmL}^{-1}$  and containing 30%  $\text{NH}_3$  by mass. Find out the volume of  $\text{NH}_3$  solution resulting and the volume of  $\text{NH}_3$  gas at  $4^\circ\text{C}$  and  $775\text{mm}$  of  $\text{Hg}$ , which was used to saturate water.

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7.  $50\text{mL}$  of dry ammonia gas was sparked for a long time in an eudiometer tube mercury. After sparking, the volume becomes  $97\text{mL}$ . After washing the gas with water and drying, the volume becomes  $94\text{mL}$ . This was mixed with  $60.5\text{mL}$  of oxygen and the mixture was burnt. After the completion of the combustion of  $\text{H}_2$ , the volume of the residual gas was  $48.75\text{mL}$ . Derive molecular formula of ammonia.



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8. The mass of one litre sample of ozonised oxygen at  $NTP$  was found to be  $1.5\text{g}$ . When  $100\text{mL}$  of this mixture at  $NTP$  were treated with turpentine oil, the volume was reduced to  $90\text{mL}$ . Hence calculate the molecular mass of ozone.

(Turpentine oil absorbs ozone)



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9. A sample of gaseous hydrocarbon occupying 1.12 litre at *NTP*, when completely burnt in air produced  $2.2gCO_2$  and  $1.8gH_2O$ . Calculate the weight of hydrocarbon taken and the volume of  $O_2$  at *NTP* required for its combustion.

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10. A  $5.0g$  sample of a natural gas consisting of  $CH_4$ ,  $C_2H_4$  was burnt in excess of oxygen yielding  $14.5gCO_2$  and some  $H_2O$  as product. What is weight percentage of  $CH_4$  and  $C_2H_4$  in mixture?

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**11.** Determine the formula of ammonia from the following data:

(i) Volume of ammonia =  $25\text{mL}$ .

(ii) Volume on addition of  $O_2$  after explosion =  $71.2\text{mL}$ .

(iii) Volume after explosion and reaction with  $O_2$  on cooling  
=  $14.95\text{mL}$ .



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**12.**  $0.05\text{g}$  of a commercial sample of  $KClO_3$  on decomposition liberated just sufficient oxygen for complete oxidation of  $20\text{mLCO}$  at  $27^\circ\text{C}$  and  $750\text{mm}$  pressure. Calculate % of  $KClO_3$  in sample.



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13. Igniting  $MnO_2$  in air converts it quantitatively to  $Mn_3O_4$ . A sample of pyrolusite is of the following composition:  $MnO_2 = 80\%$ ,  $SiO_2$  and other inert constituents = 15%, and rest bearing  $H_2O$ . The sample is ignited to constant weight. What is the percent of  $Mn$  in the ignited sample?

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14. A granulated sample of aircraft alloy ( $Al$ ,  $Mg$ ,  $Cu$ ) weighing  $8.72g$  was first treated with alkali and then with very dilute  $HCl$ , leaving a residue. The residue after alkali boiling weighed  $2.10g$  and the acid insoluble residue weighed  $0.69g$ . What is the composition of the alloy?

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15. A hydrated sulphate of metal contained 8.1 % metal and 43.2 %  $SO_4^{2-}$  by weight. The specific heat of metal is  $0.24 \text{ cal/g}$ .

What is hydrated sulphate?



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16. A saturated solution is prepared at  $70^\circ C$  containing  $32.0 \text{ g } CuSO_4 \cdot 5H_2O$  per  $100 \text{ g}$  solution. A  $335 \text{ g}$  sample of this solution is then cooled to  $0^\circ C$  so that  $CuSO_4 \cdot 5H_2O$  crystallises out. If the concentration of a saturated solution at  $0^\circ C$  is  $12.5 \text{ g } CuSO_4 \cdot 5H_2O$  per  $100.0 \text{ g}$  solution, how much of  $CuSO_4 \cdot 5H_2O$  is crystallised?



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17. In a gravimetric determination of  $P$ , an aqueous solution of dihydrogen phosphate ion  $[H_2PO_4^-]$  is treated with a mixture of ammonium and magnesium ions to precipitate magnesium ammonium phosphate,  $[Mg(NH_4)PO_4 \cdot 6H_2O]$ . This is heated and decomposed to magnesium pyrophosphate  $[Mg_2P_2O_7]$ , which is weighed. A solution of  $H_2PO_4^-$  yielded 1.054g of  $Mg_2P_2O_7$ . What weight of  $NaH_2PO_4$  was present originally? ( $Na = 23, H = 1, P = 31, O = 16, Mg = 24$ )



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18. A mixture contains  $NaCl$  and unknown chloride  $MCl$ .

(a) 1g of this is dissolved in water, excess of acidified  $AgNO_3$  solution is added to it, so that 2.567g of white *ppt.* is obtained.

(b) 1g of original mixture is heated to  $300^\circ C$ . Some vapours come out which are absorbed in  $AgNO_3$  (acidified) solution.

1.341g of white precipitate is obtained.

Find the mol.wt. of unknown chloride.

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19. A precipitate of  $AgCl$  and  $AgBr$  weighs 0.4066g. On heating in a current of chlorine, the  $AgBr$  is converted to  $AgCl$  and the mixture loses 0.0725g in weight. Find the % of  $Cl$  in original mixture.

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20. What weight of  $Na_2CO_3$  of 95% purity would be required to neutralize 45.6mL of 0.235N acid?

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21. What volume of water is required to make  $0.20N$  solution from  $1600mL$  of  $0.2050N$  solution?



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22. How much  $BaCl_2 \cdot 2H_2O$  and pure water are to be mixed to prepare  $50g$  of  $12.0\%$  (by wt.)  $BaCl_2$  solution?



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23. A piece of  $Al$  weighing  $2.7g$  is titrated with  $75.0mL$  of  $H_2SO_4$  (specific gravity  $1.8mL^{-1}$  and  $24.7\%$   $H_2SO_4$  by weight). After the metal is completely dissolved, the solution is diluted to  $400mL$ . Calculate the molarity of free  $H_2SO_4$  solution.



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24. To 50L of 0.2N  $NaOH$ , 5L of 1N  $HCl$  and 15L of 0.1N  $FeCl_3$  solution are added. What weight of  $Fe_2O_3$  can be obtained from the precipitate? Also report the normality of  $NaOH$  left in the resultant solution.



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25. Chloride samples are prepared for analysis by using  $NaCl$ ,  $KCl$ ,  $NH_4Cl$  separately or as mixtures. What minimum volume of a 5.0% by weight  $AgNO_3$  Solution (Density = 1.04) must be added to a sample weighing 0.3 g in order to ensure complete precipitation of chloride in every possible cases?



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26. A sample of water has its hardness due to only  $CaSO_4$ . When this water is passed through on anion exchange resin,  $SO_4^{2-}$  ions are replaced by  $OH^-$ . A  $25.0\text{mL}$  sample of water so treated requires  $21.58\text{mL}$  of  $10^{-3}\text{MH}_2\text{SO}_4$  for its titration. What is the hardness of water expressed in terms of  $CaCO_3$  in ppm? Assume density of water  $1.0\text{g/mL}$ .



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27.  $250$  mL of  $x$  M solution and  $500$  mL of  $y$  M solution of a solute are mixed and diluted to  $2\text{L}$  to produce a final concentration of  $1.6\text{M}$ . If  $x : y = 5 : 4$ , calculate  $x$  and  $y$ .

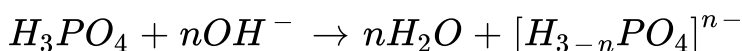


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28. The cupric salt ( i.e.,  $Cu^{2+}$ ) of a monobasic acid contains 3 molecules of water of hydrogen per atom of  $Cu$ . One gram of hydrated salt yielding on strong heating 0.3306g of  $CuO$ . What is the equivalent weight of anhydrous acid?

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29. 25mL of 0.107M  $H_3PO_4$  was titrated with 0.115M solution of  $NaOH$  to the end point identified by indicator bromocresol green. This required 23.1mL. The titration was repeated using phenolphthalein as indicator. This time 25mL of 0.107M  $H_3PO_4$  required 46.2mL of the 0.115M  $NaOH$ . What is the coefficient of  $n$  in this equation for each reaction?



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30. How many  $mL$  of a  $0.1M HCl$  are required to react completely with  $1g$  mixture of  $Na_2CO_3$  and  $NaHCO_3$  containing equimolar amounts of two?



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31. A solution of specific gravity  $1.6gmL^{-1}$  is  $67\%$  by weight. What will be the  $\%$  by weight of the solution of same acid if it is diluted to specific gravity  $1.2gmL^{-1}$ ?



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32.  $0.5 g$  of fuming sulphuric acid ( $H_2SO_4 + SO_3$ ), called oleum, is diluted with water. Thus solution completely



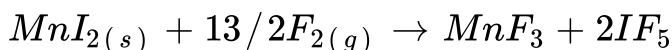
neutralised 26.7 mL of 0.4 M  $NaOH$ . Find the percentage of free  $SO_3$  in the sample solution.

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**33.** A sample of  $Mg$  metal containing some  $MgO$  as impurity was dissolved in 125 mL of 0.1  $NH_2SO_4$ . The volume of  $H_2$  evolved at  $27.5^\circ C$  and 1 atm was 120.0 mL. The resulting solution was found to be 0.02  $N$  with respect to  $H_2SO_4$ . Calculate the weight of sample dissolved and the % by weight of pure  $Mg$  metal in sample. Neglect any change in volume.

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**34.** Manganese trifluoride can be prepared by the reaction:



What is the minimum amount of  $F_2$  that must be used to react with 12g of  $MnI_2$  if only 75 %  $F_2$  is utilized to convert all of  $MnI_2$  to  $MnF_3$ ?



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35. A natural gas sample contains 84 % ( by volume) of  $CH_4$ , 10 % of  $C_2H_6$ , 3 % of  $C_3H_8$  and 3 %  $N_2$ . If a series of catalytic reactions could be used for converting all the carbon atoms into butadiene,  $C_4H_6$ , with 100 % efficiency, how much butadiene could be prepared from 100g of the natural gas?



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36. 1.5g sample of  $P_2O_3$  and some impurity was dissolved in water and warmed gently till  $P_2O_3$  disproportionated

quantitatively to  $PH_3$  and  $H_3PO_4$ . The solutions was then boiled to get rid off  $PH_3(g)$  and then cooled finally to room temperature and diluted to  $100mL$ .  $10mL$  of this solution was mixed with  $20mL$  of  $0.3MNaOH$ . Now  $10mL$  of this solution required  $3.6mL$  of  $0.05MH_2SO_4$  for back titration. Determine % by weight of  $P_2O_3$  in sample.



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**37.** In presence of fluoride ion  $Mn^{2+}$  can be titrated with  $MnO_4^-$  both reactants being converted to a complex of  $Mn(II)$  in presence of  $F^-$  ions. A  $0.545g$  of sample containing  $Mn_3O_4$  was dissolved and all manganese was converted to  $Mn^{2+}$ . The titration in presence of fluoride ion consumed  $31.1mL$  of  $KMnO_4$  that was  $0.117N$  against oxalate.

(a) Write balanced chemical equation of titration was assuming

that the complex is  $MnF_4^-$ .

(b) What was the % of  $Mn_3O_4$  in sample?

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**38.** What volume of  $0.20M H_2SO_4$  is required to produce  $34.0g$  of  $H_2S$  by the reaction?



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**39.** A drop ( $0.05mL$ ) of  $12MHCl$  is spread over a thin sheet of aluminium foil ( thickness  $0.10mm$  and density of  $Al = 2.70g/mL$ ). Assuming whole of  $HCl$  is used to dissolve  $Al$ , what will be maximum area of hole produced in foil ?

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**40.** A solution of palmitic acid in benzene contains 4.24g of acid per litre. When this solution is dropped on water surface, benzene gets evaporated and palmitic acid forms a unimolecular film on surface. If we wish to cover an area of  $500\text{cm}^2$  with unimolecular film, what volume of solution should be used? The area covered by one palmitic acid molecule may be taken as  $0.21\text{nm}^2$ . Mol.wt. of palmitic acid is 256.



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**41.** 11.2g carbon reacts completely with 19.63 litre of  $O_2$  at *NTP*. The cooled gases are passed through 2litre of 2.5N  $NaOH$  and  $Na_2CO_3$  in solution.  $CO$  does not react with  $NaOH$  under these conditions.



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**42.** 20litre of air containing  $CO_2$  at *STP* passed through 100mL of 0.12N solution of  $Ca(OH)_2$ . The filtrate obtained after the reaction required 50mL of a solution of  $HCl$  of specific gravity  $1.25gmL^{-1}$  containing 0.35% by weight of acid. Find the amount of  $CO_2$  present in the volume of air as well as the percentage by volume of  $CO_2$  in air.

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**43.** 1.0 gallon pure octane (density  $2.65kg/gallon$ ) on combustion produces 11.53kg  $CO$ ,  $CO_2$  and  $H_2O$ .  $CO$  is formed partially due to combustion of octane which is responsible to decrease the efficiency of engine. If complete combustion of octane to  $CO_2$  and  $H_2O$  provide 100%

efficiency to engine, calculate efficiency of engine in the above case.



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**44.** 11.2g of carbon reacts with 21.1 litres of oxygen at  $18^{\circ}C$  and 750mm of Hg. The cooled gases are passed through 2 litre of 2.5N NaOH. Determine the concentration of NaOH remaining in solution which is not converted to  $Na_2CO_3$ . Assume that CO does not react with NaOH:

a. What is the mole fraction of CO in the gases?

b. What is the concentration of NaOH which is not converted to  $Na_2CO_3$  in the remaining solution?



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45.  $5\text{mL}$  of a gaseous hydrocarbon was exposed to  $30\text{mL}$  measure  $25\text{mL}$  of which  $10\text{mL}$  are absorbed by  $\text{NaOH}$  and the remainder by pyrogallol. Determine molecular formula of hydrocarbon. All measurements are made at constant pressure and temperature.



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46. The gases produced when  $18\text{g}$  carbon reacts with  $5\text{litre}$  of oxygen at  $18^\circ\text{C}$  and  $5\text{atm}$  pressure are treated with  $0.5\text{litre}$  of  $2\text{MNaOH}$ . Calculate the concentration of sodium carbonate and sodium bicarbonate produced by the reaction of  $\text{CO}_2$  with  $\text{NaOH}$ .  $\text{CO}$  has no reaction under these conditions.



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47. The molecular mass of an organic acid was determined by the study of its barium salt.  $4.290g$  of salt was quantitatively converted to free acid by the reaction with  $21.64mL$  of  $0.477MH_2SO_4$ . The barium salt was found to have two mole of water of hydration per  $Ba^{2+}$  ion and the acid is mono-basic. What is molecular weight of anhydrous acid?

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48.  $1g$  of a mixture containing equal no. of moles of carbonates of two alkali metals, required  $44.4mL$  of  $0.5NHCl$  for complete reaction. The atomic weight of one metal is 7, find the atomic weight of other metal. Also calculate amount of sulphate formed on quantitative conversion of  $1.0g$  of the mixture in two sulphates.

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**49.** What would be the molality of a solution obtained by mixing equal volumes of 30 % by weight  $H_2SO_4$  ( $d = 1.218gmL^{-1}$ ) and 70 % by weight  $H_2SO_4$  ( $d = 1.610gmL^{-1}$ ) ? If the resulting solution has density  $1.425g/mL$ , calculate its molarity.



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**50.** A sample of fuming sulphuric acid containing  $H_2SO_4$ ,  $SO_3$  and  $SO_2$  weighing  $1.0g$  is found to require  $23.47mL$  of  $1.0N$  alkali for its neutralisation. A separate sample shows the presence of 1.5 %  $SO_2$ . Find the percentage of free  $SO_3$ ,  $H_2SO_4$  and combined  $SO_3$  in the sample.



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51. Calculate the ionic strength of a solution containing  $0.2MNaCl$  and  $0.1MNa_2SO_4$ .



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52.  $200mL$  of a solution of mixture of  $NaOH$  and  $Na_2CO_3$  was first titrated with phenolphthalein and  $N/10HCl$ .  $17.5mL$  of  $HCl$  was required for the end point. After this methyl orange was added and  $2.5mL$  of same  $HCl$  was required for next end point. Find out amounts of  $NaOH$  and  $Na_2CO_3$  in mixture.



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53. Two drops of phenolphthalein was added to  $40$  mL of  $HCl$  solution. When  $30$  mL of  $0.1$  M  $NaOH$  was added, part of the

the solution turned pink, but colour disappeared on mixing the solution. Addition of NaOH was continued drop-wise until a one-drop addition produced a lasting pink colour, and the volume of NaOH added was 32.56 mL. Calculate

- (a). The concentration of HCl solution.
- (b). The concentration of HCl solution when 30 mL base was added.
- (c). The pH of solution when 30 mL base was added.
- (d). The pH of solution when 32.56 mL base was added



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**54.** A sample supposed to be pure  $CaCO_3$  is used to standardise a solution of  $HCl$ . The substance really was a mixture of  $MgCO_3$  and  $BaCO_3$ , but the standardisation of  $HCl$  was accurate. Find the percentage of  $BaCO_3$  and  $MgCO_3$  in mixture.



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55.  $100\text{mL}$  sample of hard water is passed through a column of the ion exchange resin  $RH_2$ . The water coming off the column requires  $15.17\text{mL}$  of  $0.0265\text{MNaOH}$  for its titration. What is the hardness of water as ppm of  $Ca^{2+}$ ?



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56. A sea water sample has density of  $1.03\text{g/cm}^3$  and  $2.8\%$   $NaCl$  by mass. A saturated solution of  $NaCl$  in water is  $5.45\text{MNaCl}$ . How much water would have to be evaporated from  $10^6$  litres of sea water before  $NaCl$  would precipitate?



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57. One litre of a mixture containing  $BaF_2$  and  $H_2SO_4$  was taken for analysis.  $25mL$  of this mixture was added to  $100mL$  of  $0.05NK_2CO_3$  solution and precipitate was filtered off. The filtrate required  $12mL$  of  $0.025M$  oxalic acid solution using phenolphthalein as indicator. Find the strength of  $BaF_2$  and  $H_2SO_4$  in mixture.



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58.  $5g$  of  $CuSO_4 \cdot 5H_2O$  is intended to be prepared by using  $CuO$  and four times the stoichiometric amount of  $H_2SO_4$ . Assuming that  $10\%$  of the material is lost in crystallisation, what weight of oxide should be taken and how many litre of  $mL$  of a  $5MH_2SO_4$ ?



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**59.** A mixture contains  $20g$  of caustic soda,  $20g$  of sodium carbonate and  $20g$  of sodium bicarbonate in one litre. What will be the titre value if  $55mL$  of this mixture is used for titration against  $1NHCl$  if ?

- (a) First titrated with phenolphthalein.
- (b) Methyl orange added after first end point.
- (c) Methyl orange added from the very beginning.



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**60.** The reaction,  $Zn + CuSO_4 \rightarrow Cu + ZnSO_4$  goes to completion. In one experiment,  $10g$  of metallic zinc was added to  $200mLCuSO_4$  solution. After all the  $Cu$  was precipitated, it was found that not all the zinc has dissolved. After filtration, the total solid at the end of reaction was  $9.81g$ . Calculate the

weight of  $Cu$  deposited and molarity of  $CuSO_4$  in original solution.

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**61.** A sample of green crystals of nickel (II) sulphate heptahydrate was heated carefully to produce the bluish-green nickel (II) sulphate hexahydrate. What are the formulas of the hydrates? If  $8.753g$  of the heptahydrate produces  $8.192g$  of the hexahydrate, how many grams of anhydrous nickel (II) sulphate could be obtained?

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