



KEEPING MOBILE PHONE/SMART WATCH, EVEN IN "OFF" POSITION, IS TREATED AS EXAM MALPRACTICE

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. A chemist is interested in preparing 500 ml of 1 M and 3 N solution of H_2SO_4 from a 98% (by weight) H_2SO_4 stock solution. If the density of the stock H_2SO_4 is 1.075 g/ml, calculate the volume of the stock H_2SO_4 required to prepare these solutions. Molecular weight of H_2SO_4 is 98 g/gmole.
2. a) If mass ratio of A (MW =30) and B (MW= 50) is 2. Calculate i) weight percentage of A ii) mole ratio iii) mole percentage of A. [5]
b) 1000 calorie of energy is spent in moving an object by 500 ft. What is the mass of the object if the acceleration imparted on the body is 10000 ft/min^2 ? [5]
1 cal = 0.0039 BTU; 1 cal = 4.1868 J; 1 ft = 0.3048 m
3. Pressure of a tank containing air at 292 K is 102 kPa. A block of dry ice (solid CO_2) with a mass of 15.7 kg is dropped into the tank, which is then sealed. After sublimation of the entire mass of solid CO_2 to gaseous CO_2 , the pressure of the tank reaches a value of 3822 kPa. Molecular weight of air is 28.84 g/gmole and that of CO_2 is 44 g/gmole.
 - a) How many moles of air did the tank contain initially?
 - b) What is the final density of the gas in the tank?
4. Air at 288 K and 100 kPa contains 1 kg of water vapour. Water is completely removed by adsorbing on silica gel. The dry air after adsorption measures 1000 m^3 at 108 kPa and 293 K. What was the relative humidity of air before adsorption? The vapour pressure of water at 288 K is 1.7 kPa.
5. 200 kg of 15% and 100 kg of 5% solutions of sodium sulphate by weight are mixed in a mixing tank. This solution is sent to a crystallizer where 50 kg of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ crystals are formed. Compute the composition of the magma. Molecular weight of Na_2SO_4 is 142.
6. It is desired to make a 24% solution (by mass) of caustic soda (NaOH). Due to the very high heat of dissolution of caustic soda in water, the above solution is prepared by a two-step process. First, in a dissolution tank, caustic soda is dissolved in water to produce 50% (by mass) solution. After complete dissolution and cooling, the solution is taken to dilution tank where some more water is added to produce 24% solution. The two-step process is shown in the below figure 1. Assuming no evaporation loss in the dissolution tanks, calculate mass ratio W_1/W_2 .

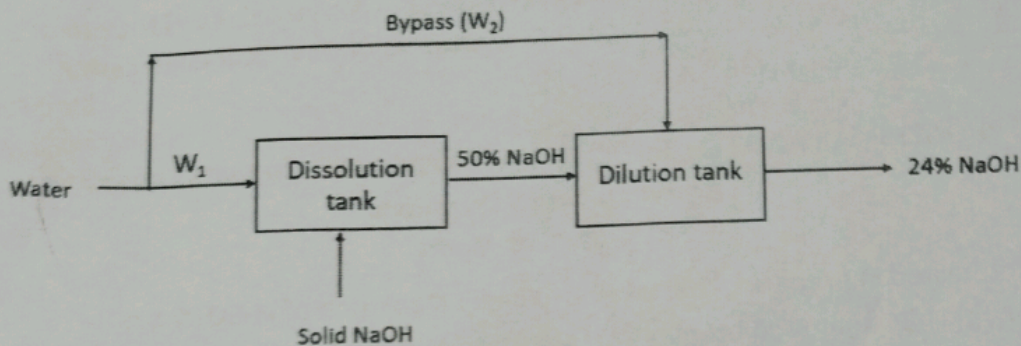


Figure 1

7. Heat of combustion of ethanol is -1368 kJ/mol. 500 gmole of ethanol is combusted and the percentage conversion of the reaction is 55%. The heat of the combustion reaction is used to generate steam at 100 °C. Find the amount of steam that can be generated from water available at 30°C. Assume latent heat of vaporization of water as 2261 kJ/kg and specific heat capacity of water is given by $C_p = 26.54 + 42.454 \times 10^{-3} T$ (C_p is in kJ/kgmole K and T is in °C).
8. Give a detailed description on
 - a) Different types of energy that a body can possess
 - b) Different forms in which the energy possessed by a body can be exchanged with the surroundings.
9. By using Buckingham's method of dimensional analysis, obtain an expression for the drag force (F) in N, on a partially submerged body moving with a relative velocity (u) in a fluid in m/s; the other variables being the linear dimension (L) in m, surface roughness (e) in m, fluid density (ρ) in kg/m³ and gravitational acceleration (g) in m/s².
10. State Newton's law of viscosity and elaborate on the classification of fluids based on viscosity.
11. A U-tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is open to atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main line, if the difference in level of mercury between the limbs of the U-tube is 10 cm and the free surface of mercury is in level with the centre of the pipe. If the pressure of water in pipe line is reduced to 9810 N/m², calculate the new difference in the level of mercury. Sketch the arrangements in both cases.
12. Detail how Bernoulli's equation can be used to measure volumetric flow rate of liquids.