



7279

BOARD DIPLOMA EXAMINATION, (C-20)  
OCTOBER/NOVEMBER—2023  
DCHPP - THIRD SEMESTER EXAMINATION  
MASS AND ENERGY BALANCE

Time : 3 Hours ]

[ Total Marks : 80

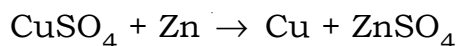
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**PART—A**

3×10=30

- Instructions :** (1) Answer **all** questions.  
(2) Each question carries **three** marks.  
(3) Answers should be brief and straight to the point and shall not exceed five simple sentences.

1. Convert volumetric flow rate of  $2 \text{ m}^3/\text{s}$  to liter/s.
2. Define the terms (a) normality and (b) Dalton's law of partial pressures.
3. Define the terms (a) Define relative humidity and (b) Dry bulb temperature.
4. What are the terms involved in a general material balance equation?
5. Define the terms (a) yield and (b) selectivity.
6. 1,274 g of copper sulfate ( $\text{CuSO}_4$ ) reacts with excess zinc metal to yield 0.392 g of copper according to the reaction,

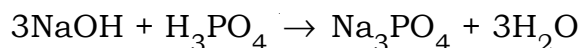


Calculate % yield of Cu.

Atomic weight of species are

Cu-63.5; S-32; O-16; Zn-65

7. Sodium hydroxide reacts with phosphoric acid to form sodium phosphate according to the reaction,



If 35.6 g of NaOH is reacted with 30.8 g of  $\text{H}_3\text{PO}_4$ , identify the limiting reactant.

Molecular weight of NaOH	=	40
Molecular weight of $\text{H}_3\text{PO}_4$	=	98
Molecular weight of $\text{Na}_3\text{PO}_4$	=	164

8. Define latent heat of fusion. Write units of latent heat in SI system.
9. Distinguish between proximate and ultimate analysis.
10. Define calorific value. Write the calorific values of any two fuels.

### PART—B

8×5=40

- Instructions :** (1) Answer **all** questions.  
(2) Each question carries **eight** marks.  
(3) Answers should be comprehensive and criterion for valuation is the content but not the length of the answer.

11. Iron metal weighing 500 lb occupies a volume of 29.25 L. Calculate the density of iron in  $\text{kg/m}^3$ .

**(OR)**

Stainless steel, type 304, has a thermal conductivity “K” of 16.2 BTU/hr.ft.°F. Convert this value of thermal conductivity into SI units.

12. An aqueous solution of soda ash ( $\text{Na}_2\text{CO}_3$ ) is prepared by dissolving 20 g  $\text{Na}_2\text{CO}_3$  in 100 g water at 20 °C .The density of the solution is measured to be 1.09 g/cc. Find the molarity, normality and molality of the solution.

**(OR)**

A flue gas has the following composition by volume :

$\text{CO}_2 = 13.1\%$ ,  $\text{O}_2 = 7.7\%$ ,  $\text{N}_2 = 79.2\%$ . Calculate—

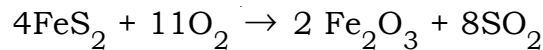
- (a) density of flue gas at STP.  
(b) specific gravity of the flue gas at STP.

13. The spent acid from a nitrating process contains 33%  $\text{H}_2\text{SO}_4$ , 36%  $\text{HNO}_3$  and 31% water by weight. This acid is to be strengthened by the addition of concentrated sulfuric acid containing 95%  $\text{H}_2\text{SO}_4$  and concentrated nitric acid containing 70%  $\text{HNO}_3$ . The strengthened mixed acid is to contain 40%  $\text{H}_2\text{SO}_4$  and 43%  $\text{HNO}_3$ . Calculate the quantities of spent and concentrated acids that should be mixed together to yield 3000 kg of desired mixed acid.

(OR)

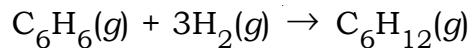
A sample of coal is found to contain 63% carbon and 24% ash on weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate the percentage of the original carbon unburnt in the refuse.

14. Calculate the composition of gases obtained by burning pure  $\text{FeS}_2$  with 60% excess air. Assume that the reaction occurs in the following manner and goes to completion.



(OR)

Gaseous benzene ( $\text{C}_6\text{H}_6$ ) reacts with hydrogen in the presence of Ni catalyst as per the reaction,



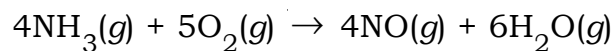
30% excess hydrogen is used above that required by the above reaction. Conversion is 50% and yield is 90%. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane produced.

15. Calculate the heat required to raise the temperature per kmol of pure  $\text{SO}_2$  from 300 K to 1000 K. Data :

$$C_p^\circ = 43.458 + 10.634 \times 10^{-3} T - 5.945 \times 10^{-5} T^2.$$

(OR)

Calculate the standard heat of reaction of the following reaction.



Data :

Component	$\Delta H_f^\circ$ kJ/mol at 298.15 K
—	—
$\text{NH}_3(g)$	-45.94
$\text{NO}(g)$	90.25
$\text{H}_2\text{O}(g)$	-241.82

## PART—C

10×1=10

- Instructions :** (1) Answer the following question.  
(2) The question carries **ten** marks.  
(3) Answer should be comprehensive and the criterion for valuation is the content but not the length of the answer.

- 16.** A solution containing 55% benzene, 28% toluene and 17% xylene by weight is in contact with its vapour at 373 K. Calculate the total pressure and molar composition of the liquid and vapour.

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