Total No. of Printed Pages—7

23

ABP/CCM-9/XIV

2015

CHEMICAL ENGINEERING

FIRST PAPER

Full Marks : 200

Time : 3 Hours

The figures in the margin indicate full marks for the questions

Answer ***any ten*** *of the following questions :*

1. *(a)* In keeping with the definition of work use ">" or "<" to fill the following :

(i) W _____ O ; if work is done on system

(ii) W _____ O ; if work is done by system

(iii) Q _____ O ; for heat addition to system

(iv) Q _____ O ; for heat removal from system. 4

Contd.

(b) A gas initially at $1MPa$, $500°C$ is contained in a piston-cylinder arrangement of initial volume of $0{\cdot}1m^3$. The gas expands isothermally to a final pressure of $100kPa$. Determine the work. 6

(c) With the help of a schematic diagram describe Joule's experiment to show the interconvertability between two forms of energy-work and heat. 10

2. (a) Show that C_p and C_v of ideal gases are independent of pressure and volume. 5

(b) Using Gibbs-Duhem equation, show that in a binary solution, if the molar volume of one of the components increases with concentration, the molar volume of the other must decrease. 5

(c) Using the criteria of phase equilibrium, show that the change in entropy during phase change can be calculated from the latent heat of phase change and the absolute temperature as

$$\Delta S = \Delta H/T$$ 10

3. (a) Give the general procedure for integral method of analysis of data. 10

(b) Use Integral method for fitting the reaction $A \rightarrow$ products. 10

4. (a) Describe with the help of a neat diagram the 'fluidized bed catalytic cracking'. 10

(b) What are the different sources from where Ethylene and Acetylene are obtained? 5

(c) What are the different refinery processes which give propylene? Name *three* petrochemicals obtained from 'propylene'. 5

5. (a) Describe critically the process of ammonia production with reference to the following points —

(i) optimum process conditions

(ii) catalyst

(iii) types of reactors. 10

(b) What do you mean by 'Boiler Feed Water'? Discuss the problems that may arise in a boiler due to use of hard water. Suggest suitable solutions. 10

6. (a) Why do we need to go for size reduction of solids in process industries? What are the different ways or techniques used for size reduction? 3+4=7

(b) Define the terms 'sphericity' and 'angle of repose'. How do you measure angle of repose of a solid particle? 4+4=8

(c) State and explain the 'Bond's crushing law'. 5

7. (a) What are the various techniques available for polymer manufacturing? Discuss *any two* of them in details. 4+8=12

(b) What are soaps and detergents? What are the differences between the two? What is the basis of classification of surfactants? Name them. 1+2+1+4=8

8. (a) The activation energy of a certain chemical reaction is 52·42*kJ/mol*. If the reaction is carried out at 28°C; for what temperature rise the reaction rate will be doubled. 8

(b) What are the various methods for the determination of rate expression? Write down their merits and demerits. 7

(c) A liquid phase first order reaction is carried out in a batch reactor. It is observed that 40% of *A* is converted in 480 *seconds*. It is desired to have 80% conversion, how much time will be required? 5

9. (a) Write briefly on composition of petroleum. 10

(b) What is hydrogenation ? Why is it done ? Discuss the process in details with special reference to the catalyst used. 1+1+8=10

10. (a) Explain the working principle of an 'Electrostatic precipitator'. 5

(b) A falling ball viscometer operates by timing the fall of the ball (specific gravity 7·9) with a diameter 0·635*cm* through the fluid. Oil whose density is 0·88*g/cc* is introduced into the instrument. The steel ball falls a distance of 25·4*cm* through the oil. What is the viscosity of the oil if time for fall is 6·35*sec* ? 10

(c) What are the differences and similarities between mixing and agitation ? 5

11. (a) What are the different types of catalysts used in the chemical industries ? What do you mean by 'deactivation of catalyst' — explain in brief. 5+5=10

(b) When does unsteady state condition prevail in a CSTR operation.At what time a CSTR would reach steady state condition for a First order reaction. 4+6=10

12. *(a)* Give the method of screen analysis. 10

(b) What are the different types of filter media? What are the requirements a filter media should meet? 6

(c) What are the types of filter aids? 4

13. *(a)* What do you understand by 'refractories'? Describe the steps involved in pottery making. 2+8=10

(b) What do you understand by 'setting time of cement'?

Describe the 'Rotary Kiln' of a cement manufacturing unit and discuss about the various reactions occuring inside it. 2+8=10

14. *(a)* Consider a pure liquid and vapour in equilibrium in a reciprocating cycle and starting from the basic equation $dF = V \cdot dp - S\,dT$, derive the Clausis-Clapeyron equation. 10

(b) Calculate the fugacity of water at 1000*atm* and 25°*C* if the following data are given —

(i) Vapour pressure of water at 25°*C* is 23·75*mm Hg*.

(ii) Molal volume of water as a function of pressure is $V = 18 \cdot 07 - 8 \cdot 1 \times 10^{-4} p$ where V is in $cm^3/mole$ and p in atm. 10

15. (a) Classify the various products (industrial) manufactured by fermentation process. How have these products revolutionised the drugs and pharmaceutical sector, besides other uses for mankind ? 5+5=10

(b) What is synthesis gas ? Name the most important synthesis gas in terms of industrial production.

Discuss the process of production of any chemical from the synthesis gas stage (your own choice). 2+3+5=10
