M.Sc. 1st Semester Examination, 2011

CHEMISTRY

PAPER—CEM-104

Full Marks : 40

Time : 2 hours

Answer any **four** questions

The figures in the right-hand margin indicate marks

1. (*a*) Explain the terms 'emissivity', 'monochromatic emissivity' and 'gray body'. State the Stefan -Boltzmann law for blackbody radiation.

(*b*) Derive an expression for heat flux through compound resistances in series. 1 + 1 + 1 + 2 + 5

2. (*a*) Discuss about the factors that affect technical nitrations.

(*b*) Define the terms 'D. V. S.' and nitric ratio.

(*c*) Deduce an expression for the rate constant of a self-catalysed polyesterification reaction.

4 + (1 + 1) + 4

3. (*a*) Define ideal and real fluid.

(*b*) Explain why pseudoplastic fluid is called shear thinning fluid.

(*c*) Write examples of Bingham plastic fluid.

(*d*) What do you mean by single column manometers ? How are they used for the measurement of pressure ?

(*e*) What is the difference between U-tube differential manometers and inverted U-tube manometers ? Where are they used ?

2 + 2 + 2 + 2 + 2

4. (*a*) State and explain the Bernoulli's theorem for steady flow of an incompressible fluid.

(*b*) What is a venturimeter ? Derive an expression for the discharge through a venturimeter. 3 + 7

5. A flat plate fuel element for a nuclear reactor is 7 mm thick and is clad on each face with aluminium 2 mm thick. The rate of heat generation is uniform within

the element and has a magnitude of 3×10^4 W/kg of uranium. Determine the temperatures at the free surface of the aluminium, the aluminium/uranium interface, and at the centre of the fuel element. The coolant temperature is 413 K. 10

Additional data :

Density of uranium	$= 18{\cdot}9 \times 10^3$ kg/m^3
Thermal conductivity of uranium	$= 24{\cdot}3$ W/mK
Thermal conductivity of aluminium	$= 2{\cdot}1 \times 10^2$ W/mK
The heat transfer coefficient at the aluminium/coolant interface	$= 2{\cdot}84 \times 10^4$ W/m^{2}K.

6. (*a*) 2000 kg of wet solids containing 70% solids by weight are fed to tray drier where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight. Calculate

(*i*) kg of water removed from the wet solids

(*ii*) kg of product obtained.

(*b*) For carrying out nitration reaction, it is desired to have a mixed acid containing 39% HNO_3, 42% H_2SO_4 and 19% H_2O (by weight). Nitric acid of 68·3% (by weight) is readily available. Calculate (*i*) required strength of H_2SO_4 to obtain the above mixed acid, (*ii*) the weight ratio of HNO_3 to H_2SO_4 to be mixed. 4 + 6

7. (*a*) NH_3 is produced by following reaction :

$$N_2 + 3H_2 = 2NH_3$$

Calculate (*i*) the molal flow rate of H_2 corresponding to N_2 feed rate of 25 kgmole/hr if they are in stoichiometric proportion, (*ii*) the kg of NH_3 produced if % conversion is 25 and N_2 feed rate is 25 kgmol/hr.

(*b*) 1000 kg/hr of a fluid is to be indirectly heated in a heater from 300 K to 550 K. Calculate the heat load on the heater in kW. The heat capacity of the fluid

$$C_p = 1{\cdot}436 + 0{\cdot}00218\ T$$

Where C_p is in kJ/kgK and T is in K. 5 + 5

8. (*a*) Write a note on the concentration of ore using physical methods.

(*b*) Write the principles of froth flotation. 5 + 5