



(d) Explain the working principle of a Pitot tube. What is meant by stagnation pressure?

3 + 4 + 3 + 2 =

7.(a) Write down the relations between pump head, capacity and rpm for centrifugal pump.

(b) A centrifugal pump has the following dimensions: Inlet diameter = 160 cm; Outlet diameter = 320 cm; width of the impeller at the inlet = 5 cm; Vane angle at the inlet (ϕ_1) = 0.45 radians; and vane angle at the outlet (ϕ_2) = 0.25 radians; width at inlet (B_1) = 5 cm; width at the outlet (B_2) = 5 cm.

Assuming shockless entry, determine the discharge and the head developed by the pump when the impeller rotates at 850 r.p.m.

5 + 7 =

Group - E

8.(a) A water softener consists of a vertical tube of 100 mm diameter and packed with height of 0.5 m with ion-exchange resin particles. The particles may be considered spherical with a diameter of 1.3 mm. Water flows over the bed because of gravity as well as a pressure difference at a rate of 200 mL/s. The bed has a porosity of 0.4. Calculate the pressure gradient.

(b) Briefly describe the different types of fluidization. Explain what is meant by minimum fluidization velocity. Mention the different applications of fluidization.

(c) Estimate the terminal velocity for limestone particles of diameter 0.08 mm (density 2800 kg/m³) falling in water at 30 °C. The viscosity of water is 10⁻³ Pascal sec.

(d) Explain the significance of void fraction during flow of fluid through packed bed.

3 + 4 + 3 + 2 =

9.(a) Explain the significance of the concept of Prandtl's mixing length theory in case of turbulent flow and obtain an expression for the mixing length.

(b) The air is flowing over a cylinder of diameter 50 mm and infinite length with a velocity of 0.1 m/s. Find the total drag, shear drag and pressure drag on 1 m length of the cylinder if the total drag coefficient is equal to 1.5 and shear drag coefficient equal to 0.2. Take density of air as 1.25 kg/m³.

Time Allotted : 3 hrs

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A

(Multiple Choice Type Questions)

10 x 1 = 10

Choose the correct alternatives for the following:

(i) Coal with higher volatile matter content has
(a) Higher calorific value (b) Higher ignition temperature
(c) Higher tendency of spontaneous oxidation (d) None of these.

(ii) Coal demand in India is maximum for
(a) Thermal power Industry (b) Steel Industry
(c) Cement Industry (d) Brick Industry.

(iii) Which process among the following is a thermal cracking process?
(a) Hydrocracking (b) Catalytic reforming
(c) Hydrotreating (d) Visbreaking.

(iv) Which type of compound has the highest octane number?
(a) Paraffins (b) Olefins
(c) Aromatics (d) Napthenes.

(v) For a controlled nuclear reaction, the multiplication factor must be
(a) <1 (b) >1
(c) =1 (d) None of these.

(vi) Volatile matter in coal is determined by heating the coal sample in muffle furnace
(a) at 800°C for 10 min (b) at 850°C for 9 min
(c) at 900°C for 8 min (d) at 925°C for 7 min.

(vii) Cetane number is highest for
(a) Aromatics (b) Paraffins
(c) Napthenes (d) Olefins.

(viii) The cold weather performance of a fuel is indicated by its
(a) Calorific value (b) Pour point
(c) Flash point (d) Smoke point.

- (ix) Which of the following has the highest calorific value?
 (a) Coke oven gas (b) Natural gas
 (c) Carburetted water gas (d) Bio gas.

- (x) A solar cell converts solar energy to
 (a) Chemical energy (b) Electrical energy
 (c) Heat energy (d) None of these.

Group - B

- 2.(a) What do you mean by washing of coal? What are the objectives of coal washing? What is the working principle of a Jig washer? What are the advantages of a jig washer? What are the advantages of a jig washer? What are the advantages of a jig washer?
 washed coal?

- (b) The following data are available from a coal washery using Indian coal:
 Ash in feed coal = 21%
 Ash in clean product = 18.7%
 Ash in sink = 41%
 If the theoretical recovery is 91.5% for a product of same ash level, calculate the performance of the washery.

(2 + 2 + 3 + 3)

- 3.(a) Describe how coal is carbonized in a by-product slot type coke oven.

- (b) With a neat flow diagram describe how valuable by-products are recovered from a coke oven gas.

Group - C

- 4.(a) Why is vacuum distillation of crude oil required? State the products from a vacuum distillation unit in a refinery.

- (b) With respect to Fluid Catalytic Cracking process state the following:
 i) Feedstock used
 ii) Catalyst used
 iii) Process conditions
 iv) Regeneration of catalyst
 v) Draw the flow-sheet of the process.

(1+3)

- 5.(a) What is catalytic reforming? Describe the main chemical reactions that occur in catalytic reforming. State the operating conditions of a typical reforming process.

- (b) Write a short note on visbreaking.

(2+4+2)

Group - D

- (a) Describe the operation of an anaerobic digester for producing bio-gas.

- (b) What is coke oven gas? How is it produced?

6+(1+5) = 12

- (a) Write a note on Integrated gasification combined cycle.

- (b) Compare the properties of blast furnace gas and water gas. State the uses of natural gas.

6+(3+3) = 12

Group - E

- (a) Explain the principle of operation of flat plate solar collectors. What is tracking?

- (b) What are heliostats? How do they work?

(5+3) + (1+3) = 12

- (a) Explain the concept of Ocean thermal Energy Conversion.

- (b) Describe the operation of a breeder reactor.

6 + 6 = 12