Type: DES

Q1. Explain the various methods of screen analysis for the determination of average particle size and specific surface area of the materials in the feed mixture with its suitable assumptions and which method is more reliable to determine the above parameters. (3)

Q2. Distinguish between Fins and Tails (any 2 points). What are the various factors affecting the effectiveness (E) of the screen? (2)

Q3. Define cut point diameter (D_{pc}) and what is its significance. Finely divided spherical particles of copper oxide-reduced graphene oxide (CuO-rGO) nanocomposites are used as a photocatalyst for the degradation of pollutants from industrial effluent. The nanocomposite particle has a density of 262.197 lb/ft^3 and the screen analysis data is given below

A	4	8	20	35	48	65	100	150	200
B	4.699	2.362	0.833	0.417	0.295	0.208	0.147	0.104	0.074
C	3.18	8.67	21.83	16.125	8.00	6.50	7.42	10.08	18.195

where A = Mesh no; B = Screen opening (mm); C = Weight percentage of particle retained on the screen. (gm) Calculate the average particle size and specific number of photocatalyst particles in the sample mixture using differential analysis. (5)

Q4. The commercial pigment fine powders are produced by a pilot-scale ball mill. Explain the principle, construction, and working operation of the same equipment with a suitable sketch. (3)

Q5. The following experimental results were obtained by crushing iron ore material in a Jaw crusher. The weight of the feed is 2 kg, average size of the feed is 15 mm. Energy meter reading is 3600 rev= 1 kw-hr. Under no load condition (before adding the feed) the disc takes 50 sec per revolution. The crushing duration of the disc is 30 sec per revolution and the total time required for both crushing and empty running is 150 sec. Calculate the Rittinger's law constant in kJ-m/kg for the power required for crushing. The screen analysis data is given in the following table:

I	12.5	8.75	6.25	4.35	3.10	2.15	1.50	1.05	0.75
II	503	1114	115	62	49	70	22	15	50

where I: Average particle size on each mesh (mm) II: Mass of the particle retained on the screen (gm). (5)

Q6. Compare and contrast between open and closed-circuit grinding operations with a suitable sketch. (2)

Q7. Develop an expression to determine the terminal settling velocity (U_t) of solid particles settling in a fluid medium in a transition region with its suitable assumptions. (4)

Q8. With a neat sketch, explain the principle, construction, and working operation of a cyclone separator with its advantages. (3)

Q9. Urea pellets are made by spraying melted urea with cold air at the top of the tall tower and allowing the material to solidify as it falls. The pellets are 6 mm in diameter and made to fall from a 25 m height tower containing the air at 15˚C. The density of urea pellets and air is 1330, and 1.2056 kg/m^3 respectively. The viscosity of air is 0.017 mPa-sec. Calculate the settling time of the urea pellets assuming that the particles settle under free-settling conditions. (3)

Q10. Write the effect of various factors on the rate of filtration with appropriate mathematical representation. Develop an equation to determine the time required for washing (t_w) in a rotary drum vacuum filter. (4)

Q11. Feed slurry of crystals is filtered at constant pressure through a filtration medium consisting of a screen support mounted across the end of a Pyrex pipe. The resistance of the filter medium is negligible and the following data in a laboratory test is given below

Weight of crystals	:	62 gm
Pressure of filtration	:	15 psi
Filter diameter	:	5.08 cm
Filtrate volume	:	253 cm^3
Filtration time	:	163 min

Evaluate $\frac{\mu\alpha}{2\rho_0}$ in the laboratory test data. The cake is essentially incompressible. Based on the laboratory test data, predict the number of frames (30-inch x 30-inch x 1-inch thickness) needed for a plate and frame filter press. Estimate the time required to filter the slurry for 63 kg crystal formed on the filter medium. In this calculation, assume that the feed pump will deliver 10 psi and that the filtrate from the press is to be reduced to 6.5 psi. (1 psi = 6.894 x 10^3 N/m^2). (4)

Q12. Write the significance of the centrifugation coefficient. List out the possible ways to increase the settling velocity of solid particles in a centrifugal separation. (2)

Q13. A batch sedimentation test was carried out on calcium carbonate ($CaCO_3$) slurry with water. The initial concentration of the solid slurry was 1.9083 lb/ft^3 and the settling data is given below. Determine the maximum cross-sectional area of continuous thickener to handle 227. 1984 lit/sec of feed to a final concentration of 20% by weight. The density of $CaCO_3$ was 2.63 g/cc. Assume that the density of water is 1 g/cc.

Z (cm)	30	24	21	18	16	13	11.2	8.7	7.0	6.2
ϴ (sec)	0	159	244	332	396	502	600	840	1080	1200

where Z= Height of settling interface (cm); ϴ = settling time (sec). (5)

Q14. Fine particles are to be separated from a feed solution. Assume that the particles are spherical with a diameter of 5 μm and a density of 1.06 g/cc. viscosity of the feed solution is 1.36 mpa-sec. At the temperature of separation, the density of the suspending fluid is 0.997 g/cc. 500 liters of feed solution must be treated every hour for a suitably sized disc stack centrifuge. The small size and low density of fine particles are disadvantages of centrifugation. If instead of fine particles, silica particles of diameter 0.1 mm and specific gravity 2.0 are separated from the liquid, by how much percentage (%) of the sigma factor 'Σ' is reduced? (3)

Q15. Explain the importance of (a) cake compressibility factor "S" and (b) filter aids during a filtration operation. (2)