# MANILA REVIEW INSTITUTE, INC.

**3F Consuelo Building, 929 Nicanor Reyes St. (formerly Morayta), Manila**
**Tel. No. 8-736-MRII (6744)**
**www.manilareviewinstitute.com**

## CHEMICAL ENGINEERING REFRESHER COURSE

## UNIT OPERATIONS 2 PART 2

1. Formation of large crystals is favored by
   a. a low nucleation rate
   b. a high degree of supersaturation
   c. a high magma density
   d. a low magma density

2. A sphere having a diameter of 0.042 m is held in a small wind tunnel, where air at 37.8°C and 1.0 atm abs. and various velocities is forced past it, at this condition density is 1.137 kg/m$^3$ and viscosity is $1.9 \times 10^{-5}$ kg/m-s. Assuming Stokes' law, the force on the sphere for a velocity of $2.3 \times 10^{-4}$ m/s is
   a. $1.729 \times 10^{-9}$ N
   b. $1.831 \times 10^{-8}$ N
   c. $2.971 \times 10^{-8}$ N
   d. $2.135 \times 10^{-9}$ N

3. The wire diameter of a screen of mesh size TBC (tensile bolting cloth) 94 is
   a. 0.0055 in
   b. 0.004 in
   c. 0.0035 in
   d. 0.0026 in

4. A mixture of galena (ρ = 7500 kg/m$^3$) and silica (ρ= 2650 kg/m$^3$) having a size range between 0.025 mm to 0.08 mm is separated by elutriation using water. Assume the density and viscosity of water to be 1000 kg/m3 and 1.0 cp respectively. The velocity of water needed to obtain a pure galena product, assuming Stokes' law applies is
   a. 0.06 m/s
   b. 0.045 m/s
   c. 0.57 m/s
   d. 0.0056 m/s

5. The viscosity of ethyl benzene is ____cp at 60°C
   a. 0.24
   b. 0.56
   c. 0.14
   d. 0.44

6. An available crusher has been accepting hard rock with a volume-surface mean diameter of 0.069 m and providing a product with a volume-surface mean diameter of 5 x 10-3 m. The power required for crushing 10,000 kg/h of this specific rock is 6.35 kW. Assume that the mechanical efficiency of the unit will remain unchanged. The power consumption using Bond's law if the capacity were reduced to 9000 kg/h with the same feed characteristics but with a reduction in the volume surface mean diameter of the product to 4 x 10-3 m is
   a. 7.35 kW
   b. 7.0 kW
   c. 6.64 kW
   d. 8.64 kW

7. A mixture of particles in packed bed contains the following volume percent of particles and sizes: 15%, 10 mm; 25%, 20 mm; 40%, 40 mm and 20%, 70 mm. The effective mean diameter, Dpm if the shape factor is 0.74 is
   a. 23.43 mm
   b. 16.81 mm
   c. 12.38 mm
   d. 18.34 mm

8. A laboratory test was conducted with a small, tubular-bowl centrifuge on a fermentation broth. At the operating conditions, a sigma value of 7400 $ft^2$ was computed, with a measured volumetric flow rate of 0.11 gal/min. For the commercial plant that will process the same broth, the largest tubular bowl centrifuge available has the following characteristics: bowl speed = 15000 rpm, $r_2$ = 5 cm, $r_1$ = 2 cm, and bowl depth = 100 cm. Using the sigma scale-up theory, the volumetric flow rate of this unit can process is

    a. 0.92 gal/min                  c. 0.47 gal/min
    b. 0.37 gal/min                  d. 0.59 gal/min

9. What is the bowl diameter of a disc type sedimenting centrifuge with the following specifications and performance characteristics: speed = 4,000 rev/min, liquid throughput rate = 20 – 200 gal/min and typical motor size = 7.5 Hp?

    a. 7.0 in                         c. 24 in
    b. 13 in                         d. 10 in

10. A phenomena called choking, limits the flow rate of solids that occur when solids can no longer be carried upward. Use equation 21-92 page 21-46 Perry ChE HB 9the edition to calculate the choking velocity of a 10-micron particle with a solid conveying rate of 7500 kg/h through a 100 mm inner tube inside diameter. The conveying gas is air at 22°C and 150 kPa. The terminal velocity for the 10-micron particle is 0.0028 m/s and viscosity of 1.84 x $10^{-5}$ kg/m-s. The choking velocity is

    a. 1.85 m/s                  c. 4.2 m/s
    b. 14.7 m/s                  d. 1.57 m/s

11. A crushing and grinding equipment that is used in chemical industry for processing brittle-heat sensitive materials into very fine powders with a narrow size distribution is

    a. Roll Press                  c. Pan Crushers
    b. Jet Mill                     d. Tumbling Mill

12. An extractor that can facilitate a liquid-liquid extraction process by reducing diffusion path lengths and increasing the driving force for liquid-liquid phase separation. It can achieve a very high specific throughput with very low liquid residence time.

    a. Rotary Disc Contractor (RDC)          c. Centrifugal extractor
    b. Karr Column                 d. Static Extraction Column

13. Zinc is to be recovered from an ore containing zinc sulfide. The ore is first roasted with oxygen to produce zinc oxide, which is then leached with aqueous sulfuric acid to produce water soluble zinc sulfate and an insoluble, worthless residue called gangue. The decanted sludge of 20,000 kg/h contains 5 weight % water, 10 weight % zinc sulfate and the balance as gangue. This sludge is to be washed with water in a continuous countercurrent washing system to produce an extract, called a strong solution, of 10 weight % zinc sulfate in water with a 98 % recovery of the zinc sulfate. Assume that the underflow from each washing stage contains, by weight, two parts of water (sulfate-free basis) per part of gangue, the number of stages required is

    a. 4                            c. 7
    b. 6                            d. 10

14. With the lowering of equilibrium pressure at a given temperature, the amount of adsorbate on adsorbent

    a. increases                  c. decreases
    b. remains the same         d. may increase or decrease

15. The terminal settling velocity in water at 70°F of a particle with a specific gravity of 5.0 and diameter of 100 microns is _____ ft/s

    a. 0.135                    c. 0.081
    b. 0.014                    d. 0.028

16. Partition ratios can be particularly sensitive to temperature when mutual solubility between the feed and extraction solvent involves hydrogen bonding. An interesting example is the extraction of citric acid from water using 1-butoxy-2-propanol as a solvent. Its partition ration at a temperature of 80°C is

    a. 0.65                     c. 0.35
    b. 0.40                     d. 0.20

17. The following equilibrium relationship was obtained during the treatment of an aqueous solution of a valuable solute by decolorizing carbon for removal of coloring impurities: $Y = 8.91 \times 10^{-5} X^{1.66}$
    where X = adsorbate concentration per kg of carbon and Y = equilibrium color units per kg of solution measured on an arbitrary scale proportional to the concentration of the colored impurity.
    It is proposed to reduce the color of the solution to 20% of its original value of 9.0. The quantity of fresh carbon required per 100 kg of the solution in single stage operation is
    - a. 4.18 kg
    - b. 5.6 kg
    - c. 7.2 kg
    - d. 1.84 kg

18. The average work index of $CaSO_4\,2H_2O$ in kWh/ton is
    - a. 13.11
    - b. 8.16
    - c. 25.17
    - d. 45.03

19. A crusher is fed with limestone having particles of 2.0 cm median equivalent diameter and discharges a product consisting of particles of 0.50 cm median equivalent diameter. The feed particles can be considered very coarse and so Kick's law would be the most appropriate. The equipment operates at a capacity of $1.2 \times 10^4$ kg/h consuming a power of 10 Hp. If the requirements of the process demand a finer size of the product (0.4 cm of median equivalent diameter) decreasing the capacity to $1.0 \times 10^4$ kg/h, the theoretical power consumption under the new conditions is
    - a. 5.3 kW
    - b. 7.2 kW
    - c. 6.2 kW
    - d. 8.6 kW

20. The solubility of strontium acetate in water at 0°C is _____parts per 100 parts water.
    - a. 53.5
    - b. 33
    - c. 25.4
    - d. 36.9

21. For a solid spherical particle of 0.80 mm in diameter and a density of 2600 kg/m3 that is immersed in a fluid of density 1200 kg/m3 and a viscosity of one centipoise, the unhindered terminal velocity is
    - a. 0.975 m/s
    - b. 0.0975 m/s
    - c. 0.0795 m/s
    - d. 0.0579 m/s

22. The mutual solubility of two salts can be plotted on the X and Y axes with temperatures as isotherm lines. If both solid-phase KCl and NaCl are present, the solution composition at equilibrium can only be represented by the invariant point (at constant pressure). The solubility ratios in parts per 100 parts water of KCl and NaCl at 40°C are:
    - a. 34.3 and 27
    - b. 20.4 and 28.4
    - c. 35 and 27.5
    - d. 22.6 and 31.4

23. The average pore diameter and surface area of polyacrylic ester for purification of pulping wastewaters and antibiotics recovery are
    - a. 0.3-0.6 and 0.5-20
    - b. 10-25 and 0.15-0.4
    - c. 2-4 and 0.9-1.2
    - d. 4-20 and 0.3-0.7

24. It is desired to recover lead from an ore containing 10% lead sulfide (PbS) and the balance assumed to be silica, 500 tons of ore being treated per 24 hr-day. It is assumed that the concentrate from a single cell is of acceptable purity but the tailings are to be retreated in scavenger cells with return of scavenger concentrate to the rougher. Laboratory findings indicate that if the water to solids ratio L/S = 2.0 and the contact time is 8 min in the rougher and L/S = 4.0 for 15 min in scavenger with mechanically agitated machines of the Denver type. The following compositions will be found for the various products:

| | PbS | $SiO_2$ |
|---|---|---|
| Feed | 10% | 90% |
| Final Concentrate | 80% | 20% |
| Rougher Tailings | 2% | 98% |
| Scavenger Concentrate | 11% | 89% |
| Final Tailings | 0.5% | 99.5% |

The densities of PbS and $SiO_2$ are 7.5 and 2.65 g/cc respectively.
The volume needed in the scavenger is
    - a. 750 ft³
    - b. 570 ft³
    - c. 680 ft³
    - d. 840 ft³

25. The step in mineral ore flotation where low concentrated product is returned for repeated flotation.
    a. scavenger concentrate
    b. scavenger flotation
    c. rougher flotation
    d. final concentrate

- END -