WINTERER-18 EXAMINATION

Model Answer

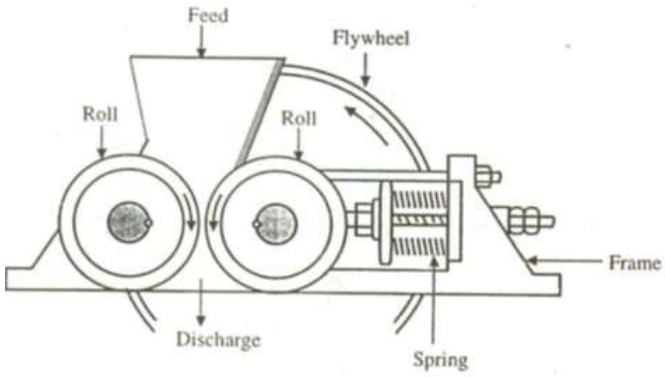
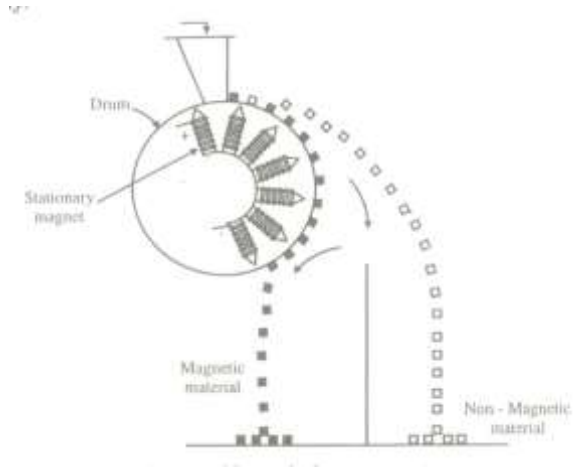
Subject Title: Mechanical Operation | Subject code: 22313 |

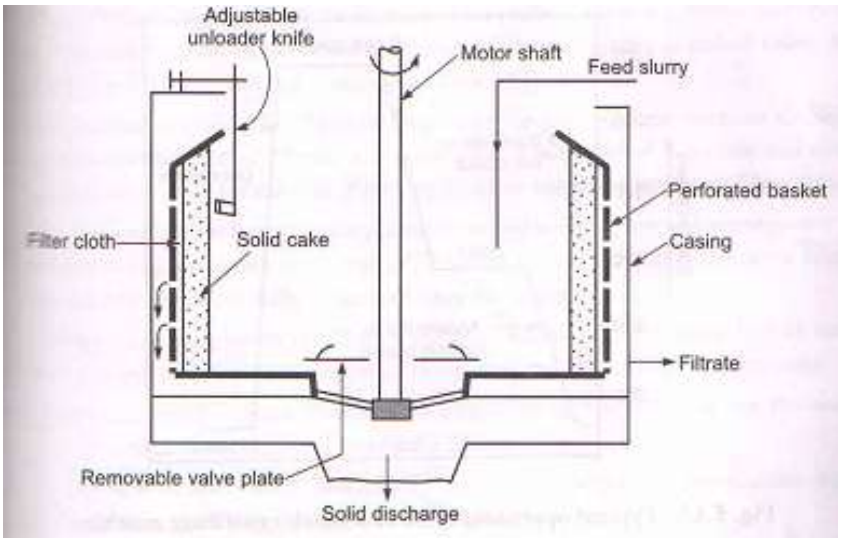
Important Instructions to examiners:

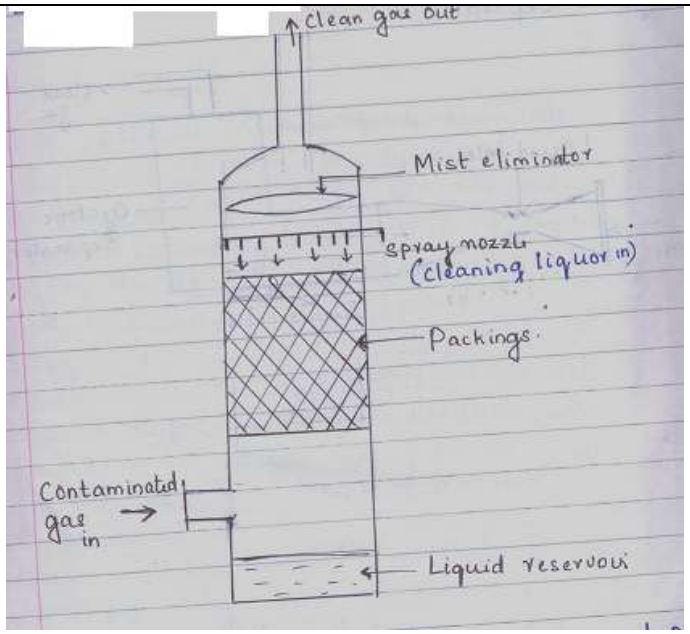
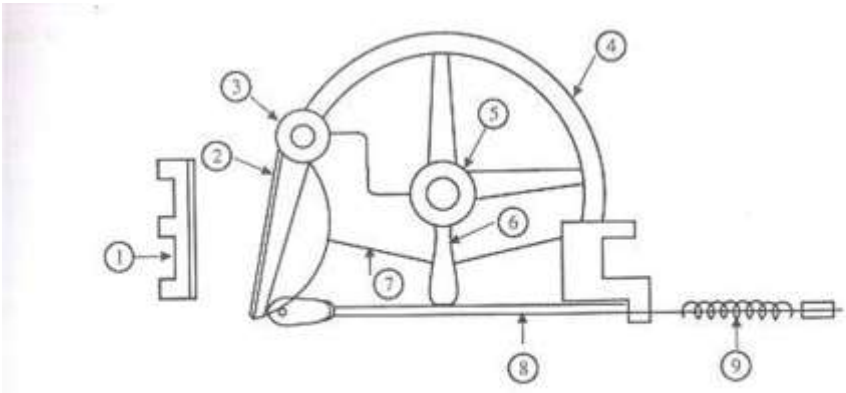
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q No.			Marks
1		**Attempt any FIVE of the following**	**10**
1	a	**Sphericity:** **Definition:** Sphericity(φ_s **)** is the ratio of surface-volume ratio for a sphere of diameter Dp to the surface–volume ratio for the particle whose nominal size is Dp. (OR) It is the ratio of surface area of sphere of same volume as particle to surface area of particle **Equation:** For spherical particle $\varphi_s = 1$ And for non-spherical particle $\varphi_s = \frac{6/Dp}{Sp/Vp}$ whereDp is the normal diameter of the particle, Sp is the surface area of one particle Vp is the volume of one particle.	1 1
1	b	**Kicks law** **Statement:** Kick's law states that the work required for crushing a given mass of material is the log of ratio of initial particle size to final particle size. **Equation:** $\frac{P}{\dot{m}} = K_k \ln\frac{D}{d}$	1 1
1	c	**Definition:** **Capacity:** It is the mass of material that can be fed to unit area of screen in unit time. **Mesh number:** It is the number of openings per linear inch counting from the center of any wire to a point exactly one inch distant.	1 1
1	d	**Terminal settling velocity:** As the particle falls, its velocity increases and will continue to increase until the	

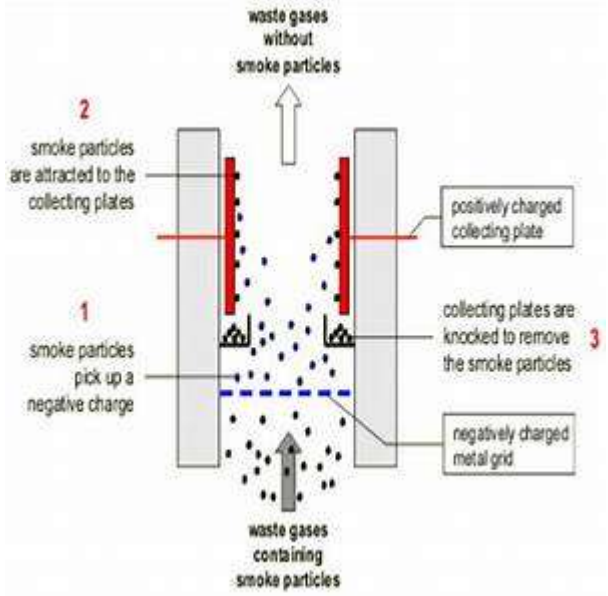
		resisting force and the accelerating force (force of gravity) are equal. When this point is reached, the particle will fall at a definite constant velocity during remainder of the fall. This velocity is termed as terminal settling velocity.	2
1	e	**Working principle of fabric filter:** The contaminated gas under suction or pressure enters the lower portion i.e. hopper of the bag filter. The gas travels through the filter bag, which retains the dust particles on the surface of the bag, and the clean gas passes through the outlet of the bag filter.	2
1	f	**Importance of transportation in industry:** Good and efficient transportation 1. Permits smooth and continuous production flow. 2. Reduces production cycle time 3. Promotes better working condition 4. Gives less fatigue to the operator	1 mark each for any two points
1	g	**Different types of mixing equipments:** Sigma mixer, ribbon blender, muller mixer, pug mill, Banbury mixer, tumbling mixer etc	1 mark each for any two
2		**Attempt any THREE of the following**	**12**
2	a	**Smooth roll crusher:** **Construction:** Two heavy smooth faced metal rolls turning towards each other on parallel horizontal axis are the working elements of the roll crusher. They have relatively narrow faces and large in diameter. To allow unbreakable material to pass through without damaging the machine, at least one roll must be spring mounted.	2

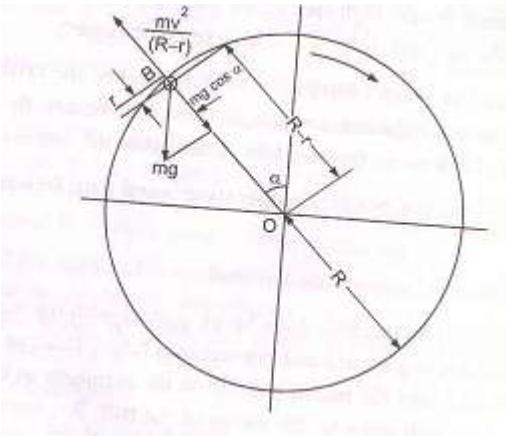
		 **Working:** Particles of feed caught between the rolls are broken in compression and drop out below. The rolls turn towards each other at the same speed. The particle size of the product depends on the spacing between the rolls and the capacity of the machine.	2
2	b	**Magnetic drum separator:** **Construction:** It consists of a rotating drum incorporating a stationary magnet assembly. The magnet arc covers approximately 165^0 towards the discharge side of the drum.  **Working:**	2

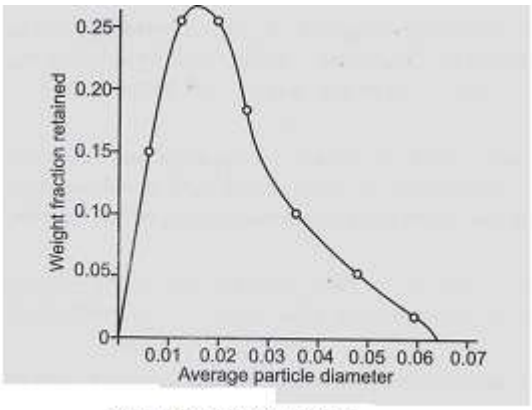
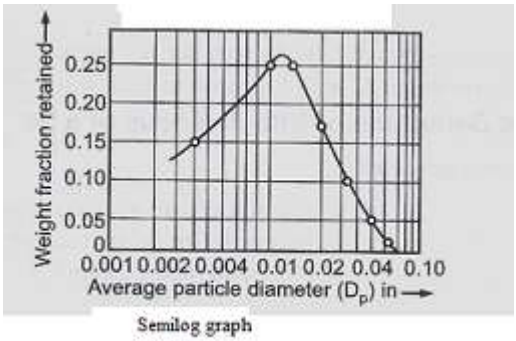
		The feed (mixture of magnetic & non-magnetic materials) is admitted at the top & is allowed to fall on the rotating drum. The non-magnetic material is discharged in a normal manner. The magnetic material adheres to the drum & falls off underside when the drum loses the contact of the magnet assembly.	2
2	c	**Basket centrifuge** **Diagram**  **Construction:** It consists of a basket with perforated sides. Basket is held at the lower end of a free swinging vertical shaft. Shaft is driven by electric motor. Basket is surrounded by a casing. Inside of the basket is covered by filter medium.	2 2
2	d	**Working of wet scrubber:** The contaminated air is drawn through a packing zone filled with suitable packing which are irrigated with cleaning liquor. The impurities come in good contact with the absorbing liquor and hence a high cleaning efficiency is obtained. A mist eliminator following the packing zone removes any entrained liquid particles, leaving the exhaust air containing less than 2% of the original contaminant	4

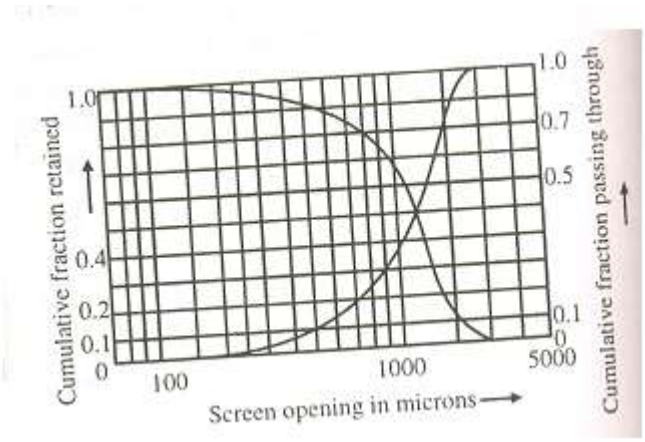
		 .	
3		**Attempt any THREE of the following**	**12**
3	a	**Diagram of Blake Jaw crusher:**  (1) Fixed jaw, (2) Movable jaw, (3) Shaft, (4) Fly wheel, (5) Eccentric, (6) Pitman, (7) Toggle, (8) Tie rod, (9) Spring	2 marks for diagram and 2 marks for labeling
3	b	**Derivation for finding out the effectiveness of a screen:** Let feed consists of material A & B,where A is the oversize & B is the undersize	

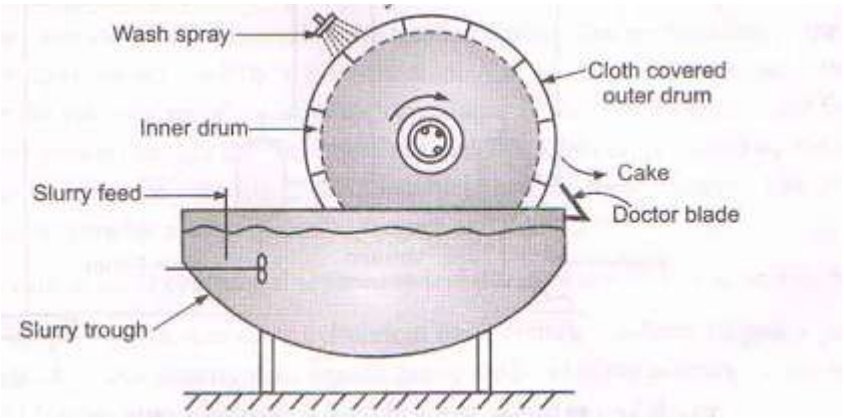
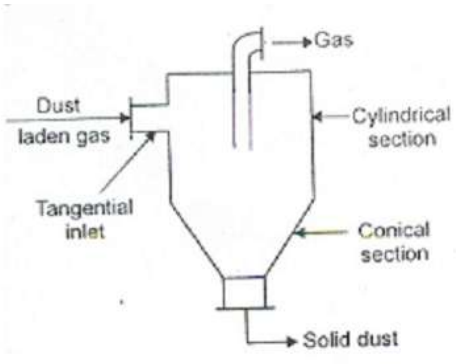
		material. Let *F*, *D*, and *B* be the mass flow rates of feed, overflow, and underflow, respectively, and x_F, x_D, and x_B be the mass fractions of material A in the feed, overflow and underflow respectively. **Screen effectiveness based on the oversize material A (E_A)** is the ratio of oversize material A that is actually in the overflow to the amount of A in the feed. Thus $E_A = \frac{Dx_D}{Fx_F}$ **Screen effectiveness E_B based on the undersize material** is the ratio of undersize material B that is actually in the under flow to the amount of B in the feed $E_B = \frac{B(1-x_B)}{F(1-x_F)}$ **Overall effectiveness is** $E = E_A E_B = (DX_D / FX_F) / (B[1- X_B] / F[1- X_F])$ But $\frac{B}{F} = \frac{xD - xF}{xD - xB}$ and $\frac{D}{F} = \frac{xF - xB}{xD - xB}$ $E = E_A E_B = \frac{(x_F - x_B)(x_D - x_F)x_D(1-x_B)}{(x_D - x_B)^2(1-x_F)x_F}$	2 2
3	c	**Working of electrostatic precipitator:** A high voltage is applied to the discharge wires to form an electric field between the wires and the collecting plates and also ionizes the gas around the discharge wires to supply ions. When the gas that contains an aerosol (dust,mist) flows between the collecting plates and the discharge wires, the aerosol particles in the gas are charged by the ions. The Coulomb force caused by the electric field causes the charged particles to be collected on the collecting plates, and the gas is purified.	4

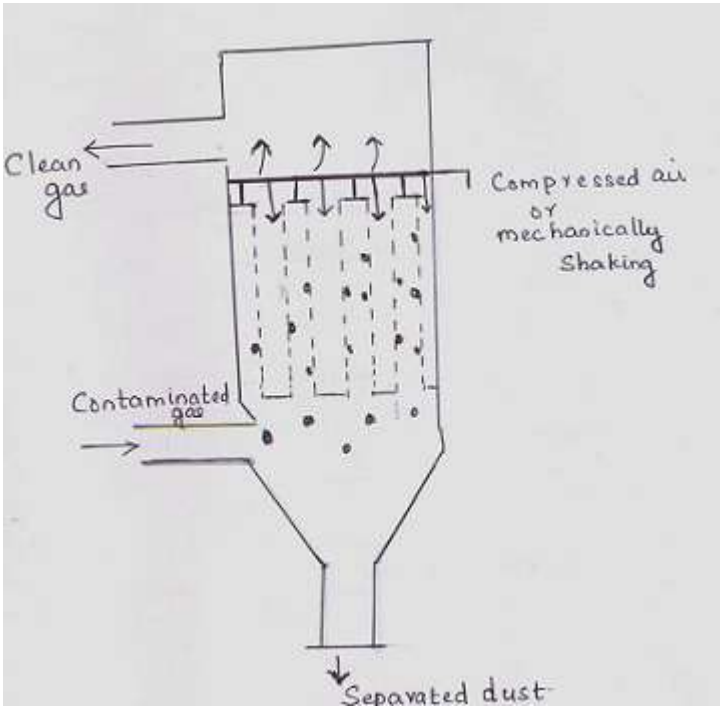
			
3	d	Data: Radius of Ball mill = R = D/2 = 1000 /2 = 500 mm =0.5 m Radius of Ball = d/2 = 70 /2 = 35 mm =0.035 m The critical speed of Ball mill is $N_c=1/2\pi\sqrt{\frac{g}{R-r}}$ $N_c=1/2\pi\sqrt{\frac{9.81}{0.5-0.035}}$ = 0.7314rps N_c =0.7312 *60=**43.884 rpm** Operating speed of Ball mill = 50 to 75 % of the critical speed = **21.942 to 32.913 rpm**	2 1 1

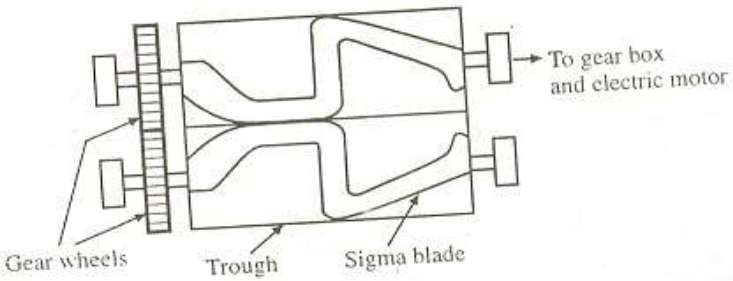
4		**Attempt any THREE of the following**	**12**
4	a	**Derivation for calculating critical speed of ball mill** The minimum speed at which centrifuging occurs is known as critical speed.  Consider the ball at point B on the periphery of the ball mill. Let R – radius of mill, r- radius of ball R-r - distance between the center of ball and axis of the mill. Let α be the angle between OB and vertical through the point O. The forces acting on the ball are 1. Force of gravity - mg 2. The centrifugal force - $mv^2/(R-r)$ The component of gravity opposing the centrifugal force is mgcosα As long as the centrifugal force exceeds the component force of gravity, particle will not lose contact with the wall. When the above opposing forces are equal, ball is ready to fall down from the wall. For grinding to take place, $mg\cos\alpha = mv^2/(R-r)$ $\cos\alpha = v^2/(R-r)g$ The relationship between the peripheral speed and speed of rotation is	2

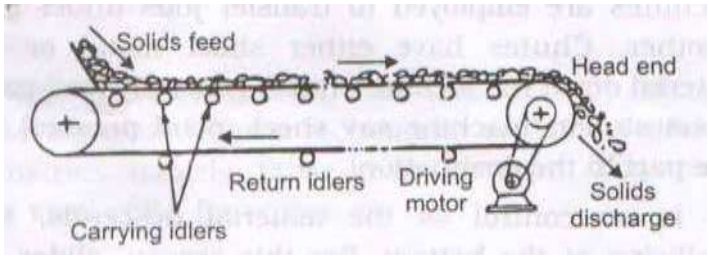
		v= 2 πN(R-r) Putting value of v, cos α = 4 π^2N^2 (R-r)/g At critical speed α=0, And cosα=1 and N=N_c Cos α=1= 4 $\pi^2N_c^2$ (R-r)/g N_c^2 = g/4 π^2 (R-r) $N_c=1/2\pi\sqrt{\frac{g}{R-r}}$	2
4	b	**Differentiate cumulative and differential screening operation:** **Differential analysis**: The screen analysis in which weight fraction of retained material on each screen is reported in a tabular or a graphical form as a function of a mesh number is differential analysis.  Ordinary graph paper  Semilog graph paper **Cumulative screen analysis:**	2

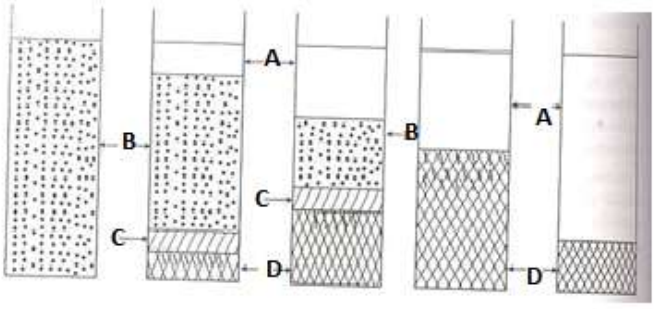
		It is obtained by adding cumulatively the individual weight fraction retained on each screen and plotting the cumulative sums against the screen opening of the retaining screen. It can also be reported by incorporating cumulative fraction passing through screen 	2
4	c	**Meaning of 1-2-3-2-1-2-3…… in filtration equipment** For quick identification & proper assembling, it is common practice to cast buttons on sides of plates & frames. No. of buttons on non-washing plate : 1 No. of buttons on frame : 2 No. of buttons on washing plate : 3 The press is assembled in the following order- non-washing plate, frame & then washing plate .ie 1-2-3-2-1-2-2-3-2-1.	4
4	d	**Rotary drum vacuum filter:** **Construction:** It consists of a cylindrical sheet metal drum mounted horizontally. Outer surface of drum is made up of a perforated plate. Filter medium (canvas cloth) covers the drum which turns at 0.1 to 2 rpm in an agitated slurry trough. Inside the outer drum is a smaller drum with a solid surface. Annular space between two drums is divided into	2

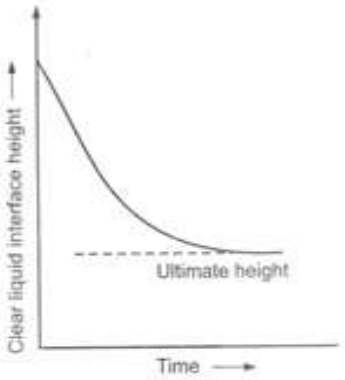
		compartments by radial partitions. As the drum rotates, vacuum & air are alternately applied to each compartment. **Diagram:**  	2
4	e	**Cyclone separator:** **Diagram**  **Working:** The dust laden gas is introduced tangentially into a cylindrical vessel at a high velocity (30 m/s). Centrifugal force throws the solid particles out against the wall of the vessel and they drop into a conical section of the cyclone and removed from the bottom opening. The clean gas is taken out through a central outlet at the top.	2 2

5		Attempt any TWO of the following	12
5	a	**Fabric filter:** **Diagram:**  **Construction :** The simplest one consists of a number of filter bags assembled together in a bag house. The filter medium is in the form of a woven textile fabric, which may be arranged as a tube or supported on a suitable frame work. The individual textile fibres with a diameter of 5-10 micrometer crisscross the aperture and form effective impingement target. **Working:** The dust laden gas passes through the filter, then a loose floc builds up on the fabric surface and it is this which provides the effective filter for the removal of fine particles. The filter cloth requires cleaning from time to time by compressed air or by mechanical shaking to avoid excessive build up of solids which give rise to high pressure drop	2 2 2

5	b	**Sigma Mixer:** **Diagram**  **Construction:** It consists of a short rectangular trough with saddle shaped bottom. Two counter rotating heavy blades are incorporated in the trough. Blades are so placed and so shaped that the material turned up by one blade is immediately turned under adjacent one. The edges of the blades may be serrated to give a shredding action The blades are driven by a gear mechanism provided at either ends. The trough may be open or closed and may be jacketed for heating or cooling. The machine can be emptied through a bottom valve. **Working:** The material to be kneaded is dropped into the trough. The blades turn towards each other at the top, drawing the mass downward, then shearing it between the wall and blades of the trough. It is mixed for about 5 to 20 minutes or longer. The trough is then unloaded by tilting it.	2 2 2
5	c	**Belt conveyor:** **Construction:** Belt conveyor consists of an endless moving belt of flexible material, stretched between two drums / pulleys and supported at intervals on idler rollers. The pulley that drives conveyor belt rotating is called drive pulley or transmission drum; the	2

		other one only used to change conveyor belt movement directions called bend pulley. Drive pulley is driven by the motor through reducer. The drive pulleys are generally installed at the discharge end in order to increase traction and be easy to drag. Proper idlers are selected and appropriately located to prevent belt sagging. Idlers are placed fairly close at the feed point and then farther apart and uniformly for the rest of the conveyor. **Working:** Material is fed on the feed-side and landed on the rotating conveyor belt, then rely on the conveyor belt friction to be delivered to discharge end. A clean discharge is vital for good belt life. On the return run, the carrying side of the belt is in contact with the return rollers and any material adhering to it is deposited on the roller. A belt cleaning device in the form of a revolving brush or rubber scraper blades is used for extremely sticky materials. **Diagram:** 	2 2
6		**Attempt any TWO of the following**	**12**
6	a	**Any two industrial application of:** **(i) Cyclone separator** Used in oil refineries, feed and grain processing, mineral processing, paper and textile industry, wood working industry etc. **(ii) Electrostatic separator** Used in ore dressing, for removing ash from mined coal, recycling of plastic waste etc	1 mark each 1 mark each

		(iii) Wet scrubber Used in pulp and paper industry, oil refineries, steel, metal and glass industry, fertilizer and mining industry, waste incinerators etc	1 mark each
6	b	**Batch sedimentation:**  A- clear liquid B- Original slurry C- transition zone D- settled solids Prepare slurry of uniform concentration. The particles begin to settle and attain terminal settling velocity under hindered settling conditions. The heavier faster settling particles settled at the bottom are indicated by zone D. Above zone D forms another layer called zone C, which is a transition layer, the solid content of which varies from that in the original pulp to that in zone D. Above zone C is zone B which has the same concentration as the original pulp. Above zone B is zone A, which is a zone of clear liquid. As sedimentation continues, the depth of zone A and D increases, that of zone C remains constant and zone B decreases. After further settling, zone B and C disappear and all the solids are in zone D. Then a new effect called compression begins. In compression, a portion of the liquid which has accompanied the solids into the zone D is expelled and the thickness of this zone decreases. After some time, the sludge reaches ultimate height. The entire process is called sedimentation.	2 2 2

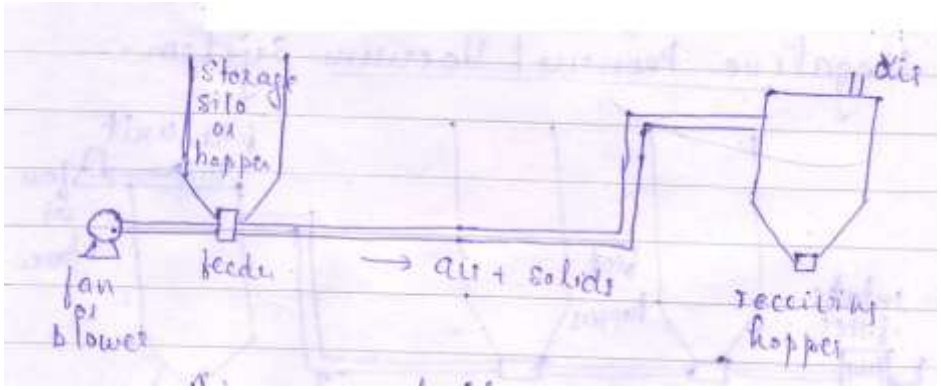


6 c **Pneumatic conveyor:** 2

Principle:

It works on the principle of using a stream of air or gas for the transportation of dry granular solids through a pipe line.

Construction and working:



Air or suitable gas is blown along a pipeline, which carries the bulk solid to be conveyed. Fan or blower is used to deliver air into the pipeline. Feeders are used to introduce the material into the pipeline against the conveying gas pressure. Gas/ solid disengaging device are used at the discharge end of the pipeline, which 4

		separates the conveyed bulk solid from the conveying air stream. The cyclone separator or bag filter units are used for this purpose. The clean gas/ air coming out from these devices is fed back for conveying purpose. These systems are useful for picking up solid from one point band delivering them to various discharge points. They are used for free flowing materials up to ¼ inch size. But it is unsuitable for multiple pick up points on account of excess air leakage.	