SUMMER-16 EXAMINATION

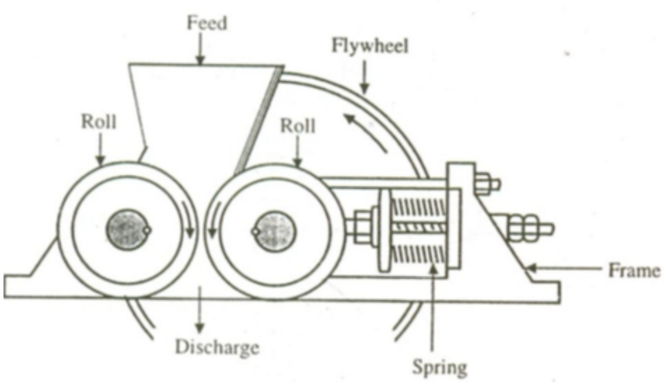
Model Answer

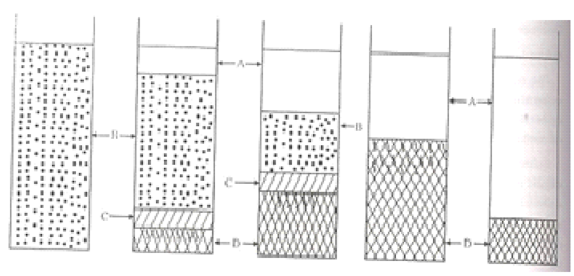
Important Instructions to examiners:

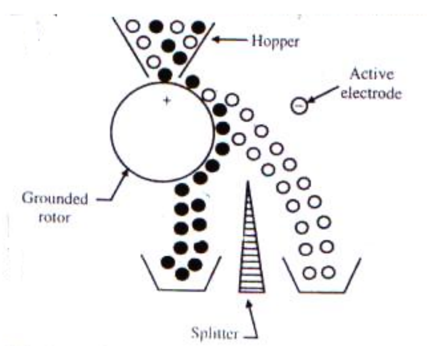
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.	Answer	marks	Total marks
1	**Attempt any TEN of the following**		**20**
1-A	**Work index** Work index is defined as the gross energy requirement in KWH/ ton of feed needed to reduce very large feed to such a size that 80% of the product passes a 100µm screen	2	2
1-B	**Mesh:** It is the number of openings per linear inch counting from the center of any wire to a point exactly one inch distant.	2	2
1-C	**Industrial importance of vibrating screen:** 1. They are used in industry where large capacity and high efficiency is required 2. Low operating and maintenance cost per unit of material handled. 3. Lesser blinding of screen openings 4. Requires less space.	1 mark each for any two	2
1-D	**Physical properties of solid material** Odour, colour, volume, density, melting point, boiling point, heat capacity, hardness etc	1/2 mark each for any 4 points	2
1-E	**Constant Pressure Filtration:** The method of filtration in which the pressure drop over the filter is held constant throughout the run so that the rate of filtration is maximum at the start of filtration and decreases continuously towards the end of the run is called Constant pressure filtration	2	2
1-F	**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	2	2

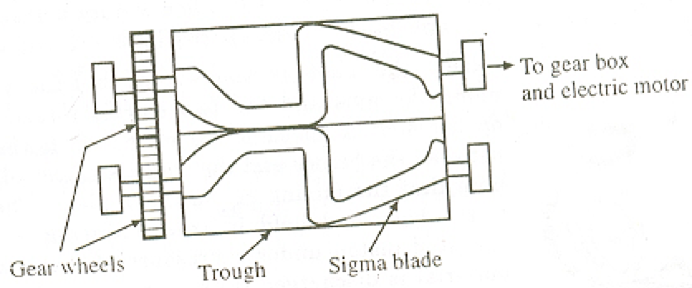
	point is reached, the particle will fallat a definite constant velocity during remainder of the fall. This velocity is termed as terminal settling velocity.		
1-G	**Industrial uses of vacuum filters:** 1. Dewatering slurries of food, pulp, pharmaceuticals. 2. Treatment of waste water. 3. Metallurgical industry.	1 mark each for any two	2
1-H	**Sedimentation:** It is the process of separating solids from suspension in liquid by gravity settling.	2	2
1-I	**Types of impellers:(any two)** Propellers, paddles and turbines	1 mark each	2
1-J	**Industrial importance of ribbon blender** 1. It is used for mixing thin pastes 2. For mixing powders that do not flow readily.	2	2
1-K	**Kick's law:** 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. $\frac{P}{\dot{m}} = K_k \ln\frac{\bar{D}_{sa}}{\bar{D}_{sb}}$	2	2
1-L	**Centrifugal force:** The outward force (acting away from the center of rotation) created due to rotation is known as centrifugal force.	2	2
1-M	**SI unit of** **Cake resistance:** m / kg **Filter medium resistance:** m^{-1} or / m	 1 1	2
1-N	**Industrial application of sedimentation:(any four)** 1. Mineral processing	1/2 mark each for	2

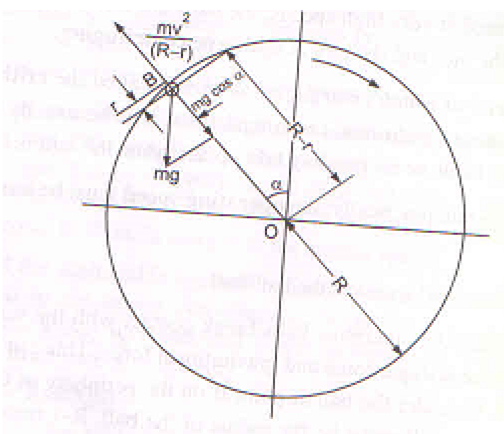
	2. Treatment of gold and diamond cyanide slimes, 3. Sewage treatment. 4. Water purification 5. Treatment of pulp and paper waste. 6. Treatment of lime stone slurry.	any 4 points	
2	**Attempt any FOUR of the following**		**16**
2-A	**Roll crusher:** **Construction:**  Two heavy smooth faced metal rolls 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. **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	4

2-B	$x_F = 0.87$ $x_D = 0.95$ $x_B = 0.55$ 1)Mass ratio of overflow to feed = – = ——— = ————= **0.8** 11)Mass ratio of underflow to feed = – = ———= ———— = **0.2** 111) effectiveness of screen = $E = E_A E_B$ = —— * ——— = ———————————— = **0.604** or $E = E_A E_B = \frac{(x_F - x_B)(x_D - x_F)x_D(1 - x_B)}{(x_D - x_B)^2(1 - x_F)x_F}$ = ———————————————————— = **0.604**	1 1 2	4
2-C	**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	4	4

	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-D	**Electrostatic precipitator**: **Construction**: It consists of rotating drum, a hopper for feed, an active electrode & collecting bin  **Working:** The charged particles fed on drum from hopper. Conductive particles assume potential of drum, opposite to that of active electrode, hence attracted towards active electrode. Non-conductive particles get repelled by electrode ,attracted by drum, falls straight in collecting bin due to gravity.	2 2	4

2-E	**Expression for batch filter for constant rate filtration:** As the equation for overall pressure drop is ΔP = Pressure drops over filter medium & cake ΔP = ΔPc + ΔPm eq.I The differential rate of filtration per unit area of filtering surface (which is the ratio of pressure drop to the product of viscosity of filtrate & the sum of cake resistance & filter medium resistance) is as follows $$\frac{dV}{dtA} = \frac{\Delta P}{\mu\left[\frac{c\alpha V}{A} + R_m\right]} \quad eq.2$$ Where $\alpha = specific\ cake\ resistance$ $\mu = viscosity\ of\ filtrate$ $A = Area\ of\ filter\ surface$ C =mass of particles deposited For constant rate filtration , filtrate flows at a constant rate, linear velocityU is constant and U = $\frac{dV}{dtA} = \frac{V}{tA}$ But $Specific\ cake\ resistance\ \alpha = \frac{\Delta P_{C\ A}}{\mu U M_C}$ $$\frac{\Delta P_C}{\alpha} = \frac{\mu U M_C}{A}$$ But $M_{C} =$ CV and U = $\frac{V}{tA}$ $$\frac{\Delta P_C}{\alpha} = \frac{\mu VCV}{tA*A} = \frac{\mu C}{t}\left(\frac{V}{A}\right)^2$$	2 2	4
2-F	**Application of different mixers.** **Muller Mixer :** 1) It is used for handling batches of pastes.	4	4

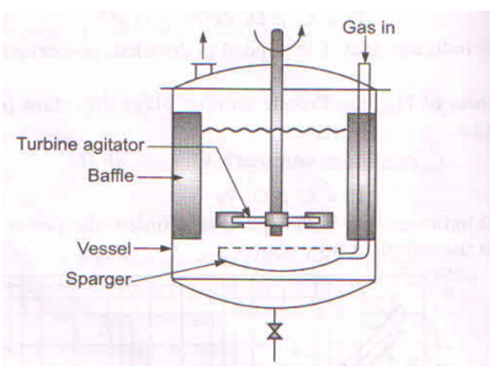
	2) It is used for handling batches of heavy solids. 3) It is used for uniform coating the particles of granular solids with a small amount of liquid. **Sigma mixer:** 1. It is used for sticky materials 2. for heavy plastic mate 3. It is used to disperse powder or liquids into plastic or to rubbery masses **Banbury Mixer** 1) It is used mainly in plastic and rubber industries **Ribbon blender:** 1. It is used for mixing thin pastes 2. For mixing powders that do not flow readily.		
3	**Attempt any FOUR of the following**		**16**
3-A	**Sigma mixer:** **Diagram**  **Construction:** It consists of a short rectangular trough with saddle shaped bottom. Two counter rotating 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	2 2	4

	adjacent one. The blades are driven by through 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.		
3-B	**Derivation for calculating critical speed of ball mill** The minimum speed at which centrifuging occurs is 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 centre 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 mxg 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 centrifugal component of force of gravity, particle will not loose contact with the wall. Unless the speed crosses the critical value the above opposing forces are equal and ball is ready to fall away from the wall.	2	4

	The angle at which the said phenomenon occurs is found out by equating the two opposing forces $mg\cos\alpha = mv^2/(R-r)$ $\cos\alpha= v^2/(R-r)g$ The relationship between the peripheral speed and speed of rotation is $v= 2\pi N(R-r)$ Putting value of v, $\cos\alpha = 4\pi^2N^2(R-r)/g$ At critical speed $\alpha=0$, And $\cos\alpha=1$and $N=N_c$ $\cos\alpha=1= 4\pi^2N_c^2(R-r)/g$ $N_c^2 = g/4\pi^2(R-r)$ $N_c=1/2\pi\sqrt{\frac{g}{R-r}}$	2	
3-C	**Difference between filtration and sedimentation.** (see table below)	1 mark each for any 4 points	4

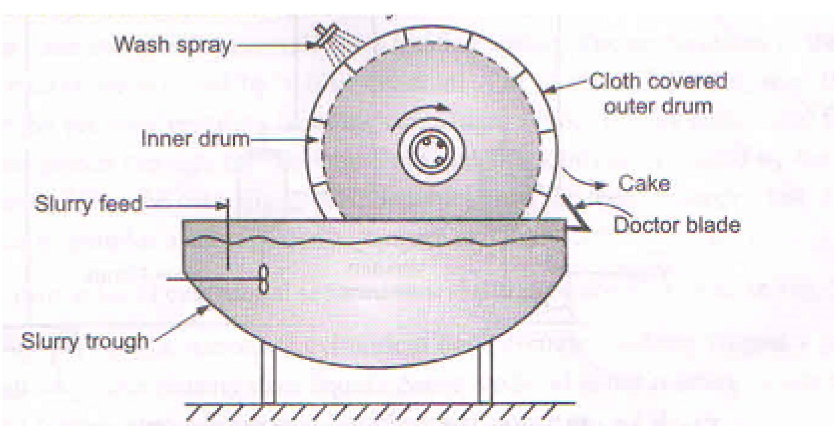
Sr.No.	Basis	Filtration	Sedimentation
1	Principle	Separation of solids from suspension using a porous medium which retains solids & allows liquid to pass.	Removal of solids by settling under gravity
2	Driving force	Pressure difference across filter medium	Gravitational force is responsible
3)	Use of filter medi um	Required	Not required
4)	Concentratio	Very large quantities	Low concentration of

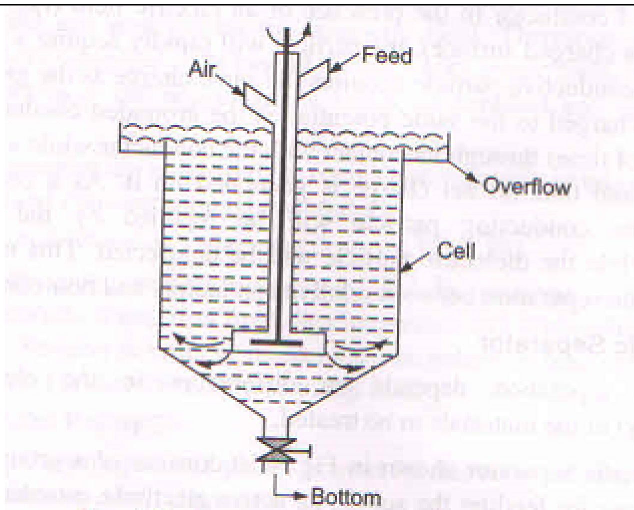
	n of solids	of solids in cake filtration	solids
5)	Product	Wet cake of solids	Clear liquid
6)	Equipment	Filterpress, rotary drum filter	Sedimentation basins,thickners

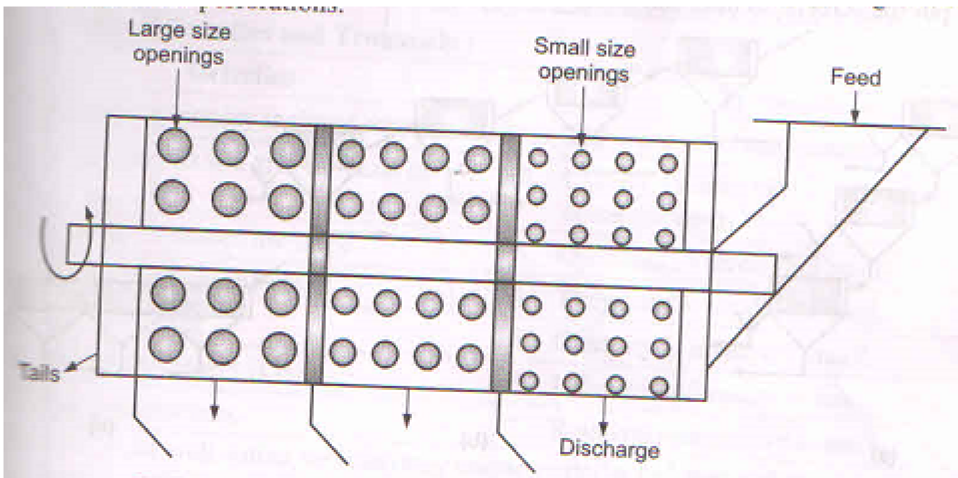
3-D	**Mechanical agitated vessel:** Mixing of gases with liquids is accomplished by spraying a gas under a flat blade turbine near the bottom of a cylindrical vessel.The equipment used consists of a baffled vertical vessel incorporating a flat blade turbine agitator.The diameter of turbine is 1/3rd of the tank diameter.The depth of a pool of liquid is same as the tank diameter.A ring shaped sparger is mounted below the impeller with the holes on the top.The diameter of sparger is less than or equal to diameter of impeller.The gas is introduced from the top and injected in a pool of liquid in the form of fine bubbles through the sparger .  	2 2	4
3-E	**Screen analysis:** It is carried out by using testing sieves .A set of standard screens is arranged serially in a stack in such a way that the coarsest of the screens is at the top and the finest is at the bottom. Analysis is carried out by placing the sample on the top screen and shaking the stack in a definite manner,(manually or	2	4

	mechanically) ,for a definite length of time. The material retained on each screen is removed and weighed. The screen analysis of sample is reported in tabular or a graphical form Methods for reporting screen analysis 1) **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 average mesh size is differential analysis. 2**) Cumulative analysis**: The screen analysis in which cumulative weight fraction of retained material(cumulative oversize) or passing through (cumulative undersize)each screen is reported in a tabular or a graphical form as a function of a mesh size is cumulative analysis	 1 1	
3-F	**Derivation for finding out effectiveness of screen** Let feed consists of material A &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 streams overflow, and underflow. The mass fractions of material B in the feed, overflow, and underflow are 1- x_F, 1- x_D and 1- x_B Overall material balance: Feed = Overflow + Underflow $F = D + B$ *eq. 1* *Material balance of A over a screen* $x_F.F = x_D.D + x_B.B$ *eq.2* *As* $F-B = D$ *eq.3* *Putting value of D from eq.3 into eq.2,we get* $x_F.F = x_D(F-B) + x_B.B$	 3	4

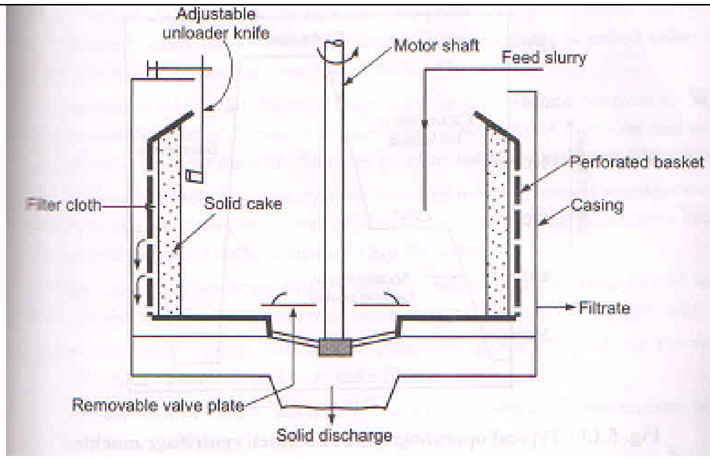
	Elimination of B from the above equations gives $$x_F.F = x_D.F - x_D.B + x_B.B$$ $$(x_D - x_F)F = (x_D - x_B).B$$ $$\frac{B}{F} = \frac{(x_D - x_F)}{(x_D - x_B)}$$ Similarly,elimination of B from eq.2 and 3 gives $$\frac{D}{F} = \frac{(x_F - x_B)}{(x_D - x_B)}$$ Effectiveness based on oversize material = $\frac{Quantity\ of\ oversize\ in\ overflow}{Quantity\ of\ oversize\ in\ feed}$ $$E_A = \frac{D.x_D}{F.x_F}$$ Based on the undersize materials is given by $$E_B = \frac{B(1 - x_B)}{F(1 - x_F).}$$ A combined overall effectiveness can be defined as the product of the two $E = E_A E_B$ Therefore $E = \frac{(x_F - x_B)(x_D - x_F)x_{D(1-x_B)}}{(x_D - x_B)^2(1 - x_F)x_F}$ **Different types of standard screens used.** IS16014 IS 1566 IS4948 IS3310	1	
4	**Attempt any FOUR of the following**		**12**
4-A	**Rotary vacuum filter:** **Construction**: 1) It consists of a cylindrical sheet metal drum (dia. 50-400cm,length: 50-		4

	800 cm)mounted horizontally. 2) Outer surface of drum is made up of a perforated plate. 3) Filter medium (canvas cloth) covers drum which turns at 0.1 to 2 rpm in agitated slurry trough. 4) Inside outer drum, a smaller drum with a solid surface. 5) Annular space between two drums is divided into compartments by radial partitions and separate connection is made & a rotating valve. 6) Drum rotates; vacuum & air are alternately applied to each compartment. **Working** Filter drum is immersed in slurry,vacuum applied to filter medium causes cake to deposit on the outer surface of drum.The drum is divided into segments,each segment connected to rotating valve through which vacuum is applied and filtrate,wash &air is removed. 	2 2	
4-B	**Froth flotation operation:**	4	4

	 It is the operation in which one solid is separated from another by floating one of them at or on the liquid surface. **Construction**The mechanically agitated cell consists of a tank having square or circular cross-section with an agitator.The air from a compressor is introduced into the system through a downpipe surrounding the impeller shaft. Overflow and underflow outlets bare provided for the removal of froth and tailings. **Working:** 1. Water is taken into the cell; material is feed to the cell. 2. The promoters and frothers are added. 3. Agitations are given and air is bubbled in the form of fine bubbles. 4. Air-avid particles due to reduction in their effective density will rise to the surface and be held in the froth before they are discharged from the overflow.Hydrophilic particles will sink to the bottom and removed from the discharge for tailing.		
4-C	**Working of trommel:** The material to be screened is at the upper end and gradually moves down the screening surface towards the lower end.The material passes over the apertures of gradually increasing size(as single cylinder is provided with perforations	3	4

	from finest desired at feed end to the coarsest at discharge end) For example, if single cylinder is provided with screen having three different size perforations, we get four fractions.The finest material is collected as underflow in compartment near to feed end and the coarsest is collected from discharge end.  **Industrial application(any two)** 1.Treatment of municipal and industrial waste 2. Mineral processing 3. Food industry	1/2 mark each for any 2	
4-D	**Power consumption in mixing.** Electric power is used to drive the impellers in stirred tanks.The power requirement of the impeller is a function of geometrical details of the impeller and vessel,viscosity density of liquid & rotation speed of impeller. An empirical correlation that can be obtained for a given system from dimensional analysis is of the following form: $$\frac{P}{N^3 D_a^5 \rho} = F\left(\frac{N.D_{a.\rho}^2}{\mu}, \frac{N^2.D_a}{\rho}\right)$$		4

	Where Np (Power no.) = $\frac{P}{N^3 D_a^5 \rho}$ N_{Re}(ImpellerRaynolds no.) = $\frac{N.D_a^2.\rho}{\mu}$ N_{Fr} (Froude number) = $\frac{N^2.D_a}{\rho}$ N = speed of rotation (rps) D_a = Diameter of impeller When N_{Re} >10000,turbulent flow,when N_{Re}<10 laminar flow, N_{Re} in between 10 to 10000,flow is in transition in which flow is turbulent at impeller & laminar in remote parts of vessel. Np = f (N_{Re},N_{Fr}) For N_{Re}<300, absence of vortex . N_{Re} accounts for viscous forces. Therefore Np = f (N_{Re}) At lower N_{Re} , equation becomes Np = $N_p = \frac{C_o}{N_{Re}}$ where $C_o = constant\ for\ a\ impeller$ Rearranging we get Np. N_{Re} = C_o Putting values of Np and N_{Re} P = $C_o.\mu.D_a^3.N^2$ For higher values of Reynolds no., N_{Fr} plays an important part. Therefore Np = constant = C' P = C'. $\rho D_a^5.N^3$	2 1 1	
4-E	**Centrifuge** **Diagram**		4

	 **Explanation:** Construction: It consists of abasket 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 having covered by filter medium from inside. Working: Slurry is fed to rotating basket,forced against basket sides by centrifugal force,the liquid passes through the filter medium into casing and out a discharge pipe,while the solids form a filter cake against the filter medium.Cake is washed by spraying wash liquid to remove soluble material.It leaves the centrifuge through discharge pipe.After washing, cake is spun at higher speed.	2 2	
4-F	**Different types of settling:** Free settling is the settling of the particle unaffected by other particle and the boundary of the container. It occurs when the concentration of the slurry is less than 1%. Hindered settling is the settling of particles affected by other particles and by the boundary of the container. Hindered settling takes place in sedimentation **Importance of settling in sedimentation:**	2	6

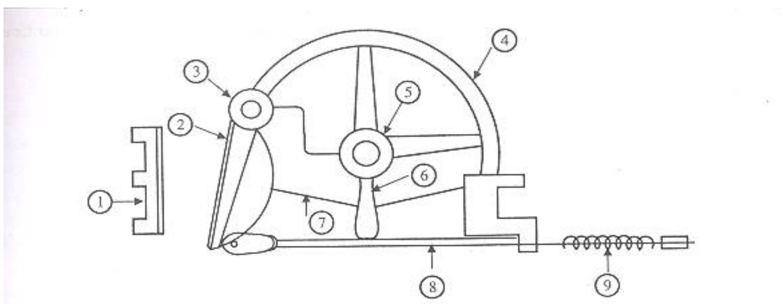
	1. To remove coarse dispersed phase. 2. To remove coagulated and flocculated impurities. 3. To remove precipitated impurities after chemical treatment. 4. To settle the sludge (biomass) after activated sludgeprocess / tricking filters.	2	
5	**Attempt any FOUR of the following**		**16**
5-A	**Difference between closed circuit and open circuit grinding:** (see table below)	1 mark each	4

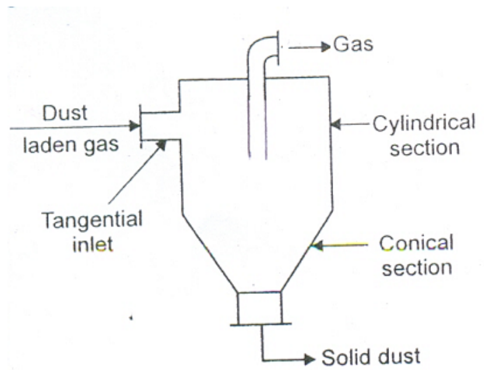
Closed Grinding	Open Grinding
1. In this grinding, oversize material is returned to machine for reground.	1. In this grinding, material is passed only once through machine.
2. Closed circuit grinding is useful for any size grinding.	2. Open circuit grinding is useful for coarse size grinding.
3. Closed circuit required less energy.	3. Open circuit required more energy.
4. It is most value in reduction to fine and ultrafine sizes.	4. It is most value in reduction to coarse size.

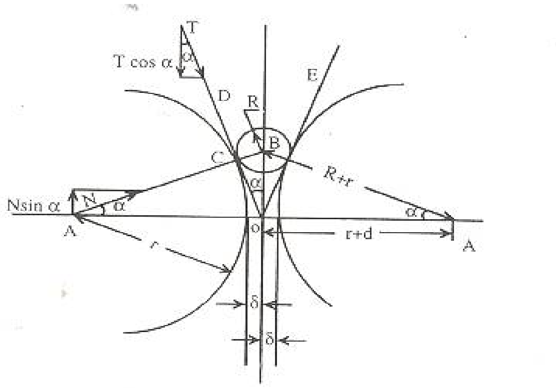
5-B	**Filter aids:** A filter aid is granular or fibrous material which packs to form a bed of very high voidage. Because of this, they are capable of increasing the porosity of the filter cake.	1	4
	Example : 1. Diatomaceous earth 2. Asbestos Fibers.	1	
	Characteristics of good filter media. 1.It should retain the solid to be filtered 2. It should not plug or blind	1/2 mark each to any 4 points	

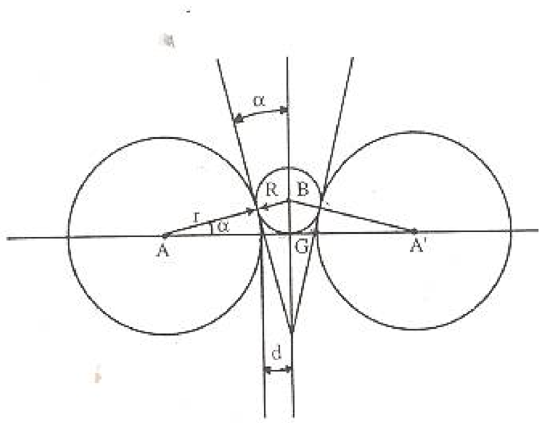
	3. It should be resistant to the corrosive action of fluid. 4. It should offer as little resistance as possible to the flow of filtrate. 5. It should be cheap. 6. It should have long life.		
5-C	D = 2 ft= 0.6096 m N = 92 rph = 0.0256rps ρ = 1498 kg / m^3 μ = 12 cp = 0.012 Pa.s NRe = $ND^2\rho / \mu$ = 0.0256 *0.6096^2 *1498 / 0.012 = 1187.57 At low values of NRe, N_pNRe= Co where Co is constant for a given impeller. N_p = Co / NRe= Co / 1187 ***Due consideration should be given if students have assumed any value for Co and calculated Power number***	 2 1 1	4
5-D	P = the power required = 12KW $\dot{m}$ = mass flow rate = 15ton / hr $\bar{D}_{sa}$ = Volume surface mean diameter of feed = 20mm = 0.02m $\bar{D}_{sb}$ = Volume surface mean diameter of product = 10mm = 0.01m $\frac{P}{\dot{m}} = K_r\left(\frac{1}{\bar{D}_{sb}} - \frac{1}{\bar{D}_{sa}}\right)$ $\frac{12}{\dot{15}} = K_r\left(\frac{1}{0.01} - \frac{1}{0.02}\right)$ K_r is Rittinger's constant = **0.016** $\dot{m}$ = 10 ton / hr $\frac{P}{\dot{m}} = K_r\left(\frac{1}{\bar{D}_{sb}} - \frac{1}{\bar{D}_{sa}}\right)$ $\frac{P}{\dot{10}} = 0.016\left(\frac{1}{0.01} - \frac{1}{0.02}\right)$ = **8 KW**	 2 2	4

<table>
<tr><td>5-E</td><td>Specific cake resistance:
During filtration, the solids are retained in the form of cake through which the filtrate must flow. The resistance offered by the cake is the specific cake resistance.
specific cake resistance α can be defined by the equation
$$\alpha = \frac{\Delta P_c \, A}{\mu \, u \, m_c}$$
where ,
ΔP_c = Pressure drop over cake
A = filter area perpendicular to the direction of flow
u = linear velocity of filtrate based on the filter on the filter area.
μ = viscosity of the filtrate
mc = total mass of solids in cake .</td><td>4</td><td>4</td></tr>
<tr><td>5-F</td><td>Difference between sedimentation and centrifugation:
<table>
<tr><th>Sedimentation</th><th>Centrifugation</th></tr>
<tr><td>1. Separation of solids from a suspension in a liquid by gravity settling is called sedimentation.
2. Industrially sedimentation is carried out in equipment known as thickener.
3. The degree of suspended impurities depends upon the length of retention period.
4. Sedimentation is one of the</td><td>1. Separation of solids from a suspension in a liquid by centrifugal force is called centrifugation.
2. Industrially centrifugation. is carried out in equipment known as centrifuge.
3. The degree of suspended impurities depends upon the concentration of slurry.
4. Centrifugation is widely</td></tr>
</table></td><td>1 mark each</td><td>4</td></tr>
</table>

	most widely used processes in treatment of water. | used process in Sugar refining.		
6	**Attempt any TWO of the following**		**16**
6-A	**Jaw crusher:** **Principle:** It works on the principle of compression . **Construction:**  (1) Fixed jaw, (2) Movable jaw, (3) Shaft, (4) Fly wheel, (5) Eccentric, (6) Pitman, (7) Toggle, (8) Tie rod, (9) Spring 1. It has a fixed jaw and a movable jaw which is pivotaed at the top. 2. The jaws are set to form a V open at the top. 3. The movable jaw which reciprocates in a horizontal plane usually makes an angle of 20 to 30 ^{O} with fixed jaw 4. The jaws are usually made of manganese steel. 5. The faces of the jaw are usually corrugated for concentrating the pressure on relatively small areas. **6.** It also consist of pitman, toggles, flywheel, eccentric shaft. Toggles act as fuse to the machine. **Working:** 1. The material to be crushed is admitted between two jaws from the top. 2. The material caught between the upper parts of the jaws is crushed to a	2 2	8

	smaller size during forward motion by compression. 3.The crushed material then drops into narrower space below during the backward motion. **Application:** It is used in Coal mines, Ore processing, Cement Industry, Chemical Industry.	2 2	
6-B	**Cyclone separator:** **Diagram**  **Explanation:** **Principle:** A cyclone separator is essentially a settling chamber in which the gravitational separating force is replaced by a much stronger centrifugal separating force. **Construction:** 1. It consists of a tapering cylindrical vessel. 2. A cylindrical vessel consisting of a top vertical section and lower conical section terminating in an apex opening. 3. It is provided with a tangential feed inlet nozzle in the cylindrical section near the top and an outlet for the gas , centrally on the top. 4. The Outlet is provided with a downward extending pipe to prevent the gas short circuiting directly from the inlet to the outlet and for cutting the vortex.	3 5	8

	Working: 1.The dust laden gas is introduced tangentially into a cylindrical vessel at a high velocity (30 m/s) 2.Centrifugale force throws the solid particles out against the wall of the vessel and drop into conical section 3. Then removed from the bottom. 4. The clean gas is taken out through a central outlet at the top		
6-C	**Criteria for selection of crushing roll:** In selecting the rolls for a certain duty, it is necessary to known the size of the feed and the size if the product. **Derivation for angle of nip:** Consider a feed particle being caught between the rolls.  If we neglect the force of gravity, the two forces acting at the point C are vertical component of tangential force and vertical component of radial force. The vertical components of forces T and N are opposed. Force Nsinα tends to expel the particle from the rolls and force Tsinα tends to draw the particle between the rolls. If the particle is to be drawn between the rolls and crushed, $T\sin\alpha \geq N\sin\alpha$ T and N are related through,	1 3	8

	$T = \mu N$ $\mu N \sin\alpha \geq N \sin\alpha$ $\mu \geq \tan\alpha$  Let R be the radius of the feed particle, r the radius of the roll and 2d the distance between the rolls. Then in triangle ABG, the angle BAG is α,AG is r+d and AB is r+R.Then ,from the simple geometry of figure $\cos\alpha = \frac{r+d}{r+R}$ Where, α=angle of nip **Industrial application:** 1. Used for crushing oil seeds 2. Gun powder industry	2 2	