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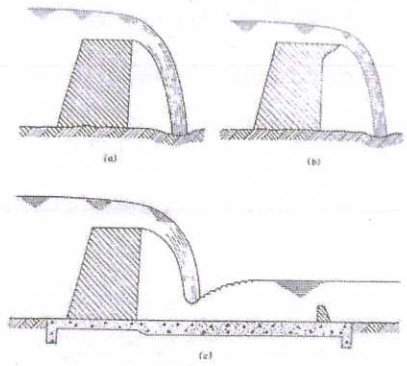
SCHEME OF VALUATION

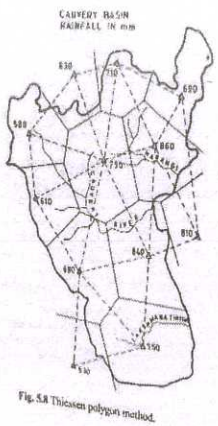
(Scoring indicators)

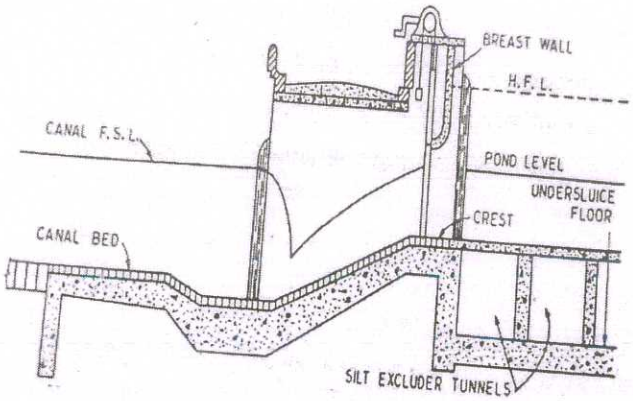
	Revision: 2015	Course code:4012	IRRIGATION ENGINEERING		
		Course Title:			
Q.No.	Scoring Indicator		Split up	Sub Total	Total
I 1	Crop period is defined as the total time that elapses between the sowing of the crop and its harvesting		2	2	2
2	(i) Rabi (ii) Kharif		1+1	2	2
3	Groynes are the structures constructed transverse to the river flow. They extend from the bank into the river		2	2	2
4	Water in reservoir is stored upto a level known as FTL (full tank level) or FRL (full reservoir level). Usually the crest of spillway is kept at this level.		2	2	2
5	A berm is a narrow strip of land left at the ground level between the top edge of cutting and the inner toe of the bank.		2	2	2
II 1	The yield from an agricultural land depends upon several factors but the most important factor is that the crops get adequate water at the various stages of the growth of the plants. Thus the factors which necessitate irrigation are as indicated below..				
	1) Inadequate rainfall. When the rainfall at a place is inadequate to meet the crop requirements, then it would be necessary to use irrigation. In such cases water may be conveyed from the places where it is available in abundance to the places of deficiency		2	6	6
	(2) Uneven Distribution of Rainfall. The total rainfall in a region may be adequate but it may be unevenly distributed over time as well as place. The entire rainfall for any region may occur only during some period of the year and for the rest of the period there may be no rains. The rainfall may also show considerable variation from year to year. Further in some part of the region there may be excessive rains and the remaining part may have very little or almost no rains. The water may be collected during the period of rainfall and it may be utilised for irrigation when there are no rains. Most of the irrigation projects in India are based on this premise.		2		
	(3) Growing a Number of Crops during a Year. The rainfall in a region may be sufficient to grow only one crop in a year for which no irrigation may be required. However, in the same region if more number of crops are to be grown during the same year it would be possible only if irrigation facilities are available		1		
	(4) Growing Superior Crops:There are several superior or high-priced crops which need frequent application of large quantity of water and for growing such crops irrigation is necessary.		1		

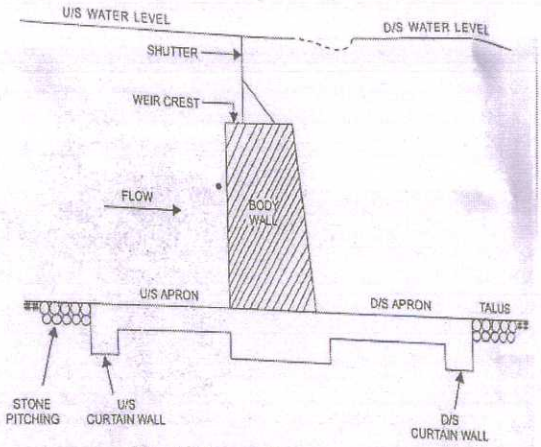
2	Flow irrigation system is that system of irrigation in which the irrigation water is available at such a level that it is conveyed to the land to be irrigated by gravity flow. The flow irrigation system can be further classified on the basis of the source from which the irrigation water is obtained as follows. (a) Direct irrigation system. (b) Reservoir or Tank or Storage irrigation system.	3	6	6
	Lift irrigation system is that system of irrigation in which the irrigation water is available at a level lower than that of the land to be irrigated, and hence the water is lifted up by pumps or other mechanical devices for lifting water and then conveyed to the land to be irrigated by gravity flow. The irrigation practised in this system of irrigation is known as lift irrigation. Irrigation from wells is an example of lift irrigation system.	3		
3	The various components of a diversion headworks are as follows. (1) Weir or Barrage (2) Divide wall or Divide groyne (3) Fish ladder (4) Pocket or Approach channel,(5) Undersluices or Scouring sluices (6) Silt excluder (7) Canal head regulator 8) River training works, such as Marginal bunds and Guide bunds.	6	6	6
4	Diversion head works are suitable in Deltaic tract when the river is perennial and flows on a mild gradient and sufficient supplies are available in the river. Since the delta tract is a plain country a little amount of rise in the water level will be enough to divert water into the canals. Since the river does not flow through a valley it is not possible and not necessary to go for a storage work. Storage Head works are more suitable when the perennial river has a steep gradient, flows through a valley and where storage in the form of a reservoir is possible. After the canals enter the plain country some the water is supplied to the fields by gravity causes the water from the reservoir being at a commandble height is used for generating electricity	6	6	6
5	The various forces acting on a gravity dam are as follows. (1) Water pressure. (2) Weight of the dam. (3) Uplift pressure. (4) Earthquake (or Seismic) forces. (5) Silt pressure (6) Wave pressure (7) Ice pressure (8) Wind pressure.	6	6	6
6	A free overfall or straight drop spillway is the one for which the control structure is a low height narrow crested weir having its downstream face vertical or nearly vertical. The overflowing water drops as a free jet clearly away from the downstream face of the spillway. As such occasionally the crest of this spillway is extended in the form of an overhanging lip (Fig. b) to direct small discharges away from the downstream face of the overfall section. The underside of the nappe is ventilated sufficiently to prevent pulsating or fluctuating jet. In order to protect the stream bed from scouring, an artificial pool may be created by constructing a low auxiliary dam downstream of the main structure or by excavating a basin which is then provided with a concrete apron. However, if tailwater depths are sufficient, a hydraulic jump will form when the jet falls freely from the crest, in which case a sufficiently long flat apron may be provided.	4	6	6

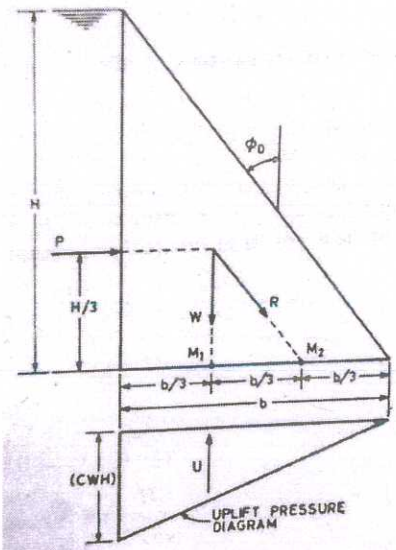
	 Fig. 12.1. Straight drop spillway (a) without downstream protection; (b) with overhanging lip ; (c) with downstream protection work.	2		
7	A Drop/fall is a structure constructed across a channel to permit lowering down of its water level. When the natural slope of the ground over which channel is to be constructed is greater than the designed bed slope of the channel, the difference in the slopes is adjusted by providing vertical falls or drops in the bed of the channel at suitable intervals.	3	6	6
	An escape is a structure constructed on an irrigation channel for the disposal of surplus water from the channel.	1		
	Surplus water may result at any point in an irrigation channel in the followingcircumstances. (i) Mistake or difficulty in regulation at the head of a channel. (ii) Heavy rainfall in upper reaches of a channel. (iii) Sudden closure of outlets by cultivators due to sudden cessation of demand. (iv) Sudden closure of any offtaking channel due to breach	2		
III a	The duty of water mainly depends on the following factors. (1) Type of crop, (2) Climatic condition of the area, (3) System of irrigation,(4) Method of irrigation,(5) Quality of irrigation water,(6) Method of cultivation,(7) Time of irrigation and frequency of cultivation,(8) Type of soil and sub-soil of the irrigated field,(9) Type of soil and sub-soil of the area through which canal passes,(10) Canal conditions,(11) Method of assessment of irrigation water rate,(12) Skill of the cultivator,(13) Topography of land,(14) Base period of crop	Any 8 factor	8	8
b	(1) Characteristics of precipitation:he precipitation may occur either in the form of rain or snow. If the precipitation occurs in the form of rain, it will immediately produce the runoff, but if the precipitation occurs in the form of snow, it will produce the runoff much later, only when the snow will melt due to rise in the temperature. The runoff increases with the increase in the intensity of the rainfall.On the other hand a mild rainfall extending over a longer duration would produce less runoff. Further a greater areal extent of the rainfall over the drainage basin and also the rainfall for a longer duration would produce greater runoff.	2	7	7

	(2) Characteristics of drainage basin. The runoff is considerably affected by the characteristics of the drainage basin such as size, shape, surface, orientation, altitude, topography and geology of the drainage basin.Larger the drainage basin greater will be the runoff, but it may not be always true. Even for a smaller drainage basin with intense rainfall, uniformly spread over the entire basin, greater runoff rate may be produced.A fan-shaped drainage basin produces a greater runoff rate than a fern-shaped drainage basin. A bare surface gives more runoff as compared with a surface having vegetal covering. Similarly a paved surface also produces a greater runoff.For the drainage basin located on the windward side of the mountains heavy precipitation occurs and hence greater runoff is produced. Similarly the drainage basins located at higher altitude receive more precipitation and hence yields greater runoff. A steeply sloping drainage basin produces greater runoff because a steep slope helps quicker drainage	2		
	(3) Meteorological characteristics:Higher temperature and higher wind velocity cause more losses due to evaporation and transpiration and hence reduce the runoff. On the other hand, greater humidity decreases evaporation and transpiration losses, resulting in greater runoff. The variation of the pressure in the atmosphere helps the movement of storms causing the precipitation. If the direction of the storm is same as the direction of flow of water in the drainage basin, then water will remain in the basin for lesser period and hence more runoff will be produced in a short duration as compared to the case when the storm is moving in the opposite direction.	2		
	(4) Storage characteristics:If a drainage basin has a larger number of natural depressions, pools, lakes etc., which will store a part of the precipitation and the same will not appear as runoff, then the runoff at the out-flow point of the basin will be reduced. Similarly the creation of artificial reservoirs or tanks will also increase the storage capacity of a drainage basin, resulting in the reduction of the runoff. However, if from these surface storages of the basin, water is released subsequently, it will appear in the form of delayed runoff. Further for drainage basins having pervious deposits, large ground water may be created, which may also appear in the form of delayed runoff	1		
IV a	Relation between duty of water in hectares per cumec and delta Let D be the duty of water on the field in hectares per cumec, A be the delta or the total depth of water in metres supplied to a crop growing on the field during the entire base period and B be the base period of the crop in days. For a field of area D hectares corresponding to the depth of water Δmetres the total quantity of wate supplied for growing a crop on the field =Dx Δ hectare-metre =DxΔx10000 cubic metre	2	8	8

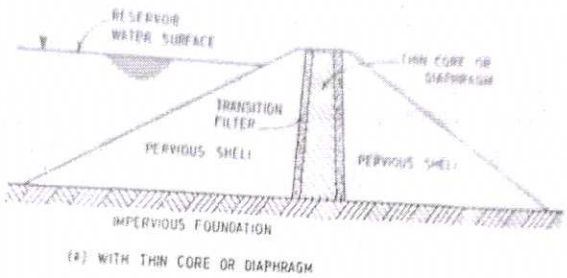
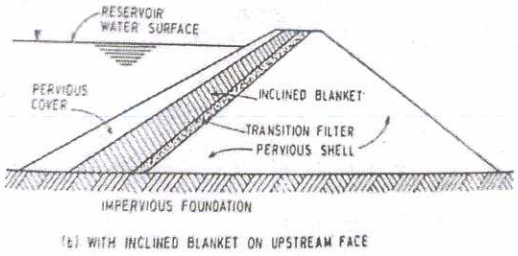
	Further for the same field of area D hectares for growing a crop on it if the water is supplied at the arte of 1 cumec for the entire base period of B days, then the total quantity of water supplied to the field $= 1 \times B \times 24 \times 60 \times 60$ cubic metre $= 8.64 \times 10^4 \times B$ cubic metre Equating (*i*) and (*ii*), we get $D \times \Delta \times 10^4 = 8.64 \times 10^4 \times B$ $D = \frac{8.64 \times B}{\Delta}$	3		
	$D = \frac{8.64 \times B}{\Delta}$	1		
	=(8.64*120/.90)= 1152 hectares/cumec	2		
b	Thiessen polygon method:In this method the adjacent rain gage stations are joined by straight lines thus dividing the entire area into a series of triangles as shown in Fig. On each of these lines perpendicular bisectors are erected, thereby forming a series of polygons, each containing only one rain gage station.	3	8	8
	If P1, P2, P3..... Pn represent the depths of rainfall recorded at the rain gage stations enclosed by polygons, the areas of which are respectively A1, A2, A3, ... An	Eqn-2		
	$P = \frac{P_1A_1 + P_2A_2 + P_3A_3 + ...P_nA_n}{A}$ $= \frac{\sum_{i=1}^{i=n} P_i A_i}{A}$ where $A_1 + A_2 + A_3 + ... + A_n = A$  Fig. 5.8 Thiessen polygon method.	Fig-3		
V a	The canal headworks may be classified into the following two types. (1) Storage headworks (2) Diversion headworks.	2	8	8

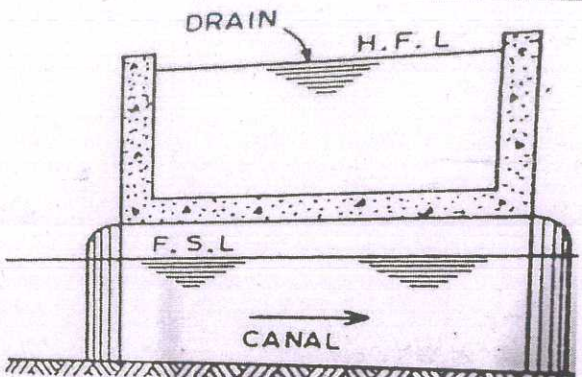
	A storage headworks consists of a dam constructed across the river to create a reservoir in which water is stored during the period of excess flow in the river. From the reservoir water is supplied to the canal in required quantity as per the demand. Thus a storage headworks stores water in addition to its diversion into the canal.	3		
	A diversion headworks serves to raise the water level in the river and divert the required quantity into the canal. The various purposes served by a diversion headworks are as follows. 1)It raises the water level in the river so that the commanded area is increased. 2) It regulates the supply of water into the canal. 3) It controls the entry of silt into the canal. 4) It provides some storage of water for a short period. 5) It reduces the fluctuations in the level of supply in the river.	3		
b	A canal head regulator is a structure constructed at the head of a canal taking off from the upstream of a weir or a barrage.	1	7	7
	Functions of canal head regulator A canal head regulator serves the following functions. (1) It regulates the supply of water into the canal (2) It controls the entry of silt into the canal. (3) It completely excludes the high flood from entering into the canal	3		
	 Fig. 13.23 Canal head regulator.	3		
VI a	Body of the Weir: It's function is to raise the water level on the upstream side. It should be sufficiently strong to resist the water pressure and the uplift pressure from beneath the foundations.	1	8	8
	Upstream Apron : It protects the main body of the weir during floods from erosive forces. The length of this apron depends upon the discharge in the river and the weir length. It must be strong enough to withstand the downward water pressure and also to prevent any leakage in the subsoil.	1		
	Upstream Curtain Wall: It is provided to reduce the uplift pressure. The length of the curtain wall depends on the nature of the soil.	1		

	Downstream Apron: When water falls from a height it produces Kinetic energy which will erode the downstream bed of the river. This apron is provided to dissipate the Kinetic energy.	1		
	Downstream Curtain Wall: It protects the downstream floor from uplift pressure. It should also be strong to resist the falling energy of water.	1		
	Crest: The top of the weir is called crest. It must be sufficiently strong enough as it has to resist the excessive water pressure during floods.	0.5		
	Shutter: This is provided on the crest of the weir, in order to rise the water level of the river on the upstream side and divert it into the canal. This can be rised or laid flat on the crest during floods	0.5		
	 Fig. 2.5 Component Parts of a Weir	2		
b	Scour : Scour has a bad effect on any irrigation work. Since a weir is constructed on a permeable foundation it has to give scope for the percolating water to flow under it's foundations also. If proper length of creep and the relevant protective works are not provided under the weir floor the water percolating may try to re-appear at any point. Since this Percolating water has certain amount of pressure it's re-appearance may cause scour. The effect of this scour would be to carry away the particles of soil and if left unchecked for a longer time would undermine the foundations of the weir itself.	4	7	7
	Percolation: When a column of water is standing against the face of any irrigation structure and if the structure happens to be one constructed on permeable foundations the water starts moving under the foundations with certain amount of pressure. This movement of water is called as 'Percolation'.	3		
VII a	Storage Dam or Impounding Dam: A storage dam is constructed to create a reservoir to store water during the period when the flow in the river is in excess of the demand, for utilisation later on during the period when the demand exceeds the flow in the river	2	8	8
	Detention Dam:A detention dam is primarily constructed to temporarily detain all or part of the flood waters of a river and to gradually release the stored water at controlled rates so that the entire region on the downstream side of the dam may be safeguarded against the possible damage due to floods.	2		

	Diversion Dam:A diversion dam is constructed for the purpose of diverting part or all of the water from a river into a conduit or a channel.	2		
	Coffer Dam:A coffer dam is a temporary dam constructed to exclude water from a specific area. Such a dam is invariably constructed on the upstream side of the site where actual dam is to be constructed so that the site for the constructional work is rendered dry	1		
	Debris Dam:A debris dam is constructed to catch and retain debris such as sand, gravel, silt and drift wood flowing along with water in the river	1		
b	If a gravity dam is subjected to only water pressure, uplift pressure and its self weight, then the stability conditions can be satisfied by a right angled triangular section having zero width at the water surface in the reservoir where water pressure is zero and a base width b at the bottom where the water pressure is maximum. The right angled triangular section of a dam will also provide maximum possible stabilising force against overturning without causing tension at any point in the base for the reservoir empty condition. This is so because when the reservoir is empty the only force acting on the dam is its self weight which acts at a distance of b/3 from the upstream face of the dam, and hence satisfies the middle third rule. The right angled triangular section of a dam is known as the elementary profile of gravity dam.	4	7	7
	 Fig. 9.18 Elementary profile	3		
VIII a	Various causes of failure of earth dams may be grouped into the following three broad categories. (a) Hydraulic failures (b) Seepage failures (c) Structural failures	2	8	8

	Hydraulic failures. The hydraulic failures include the failure of earth dams on account of the following causes.• Overtopping: The earth dams may get overtopped if the design flood is underestimated or if the spillway is of insufficient capacity.• Erosion of upstream slope by waves: upstream slopes of most of the earth dams are provided with protective covering to safeguard against wave erosion. The protective covering is laid on a filter bed to prevent the soil mass of the dam to be washed out.if the protective covering is not heavy enough to resist the hydraulic forces generated by the waves it may be washed out. With the displacement of the protective covering the upstream slope may be eroded which may lead to the failure of the dam• Erosion of downstream slope by wind and rain:The rain water flowing down the slope may result in the formation of gullies on the downstream slope thus damaging the dam which may generally lead to partial failure of the dam and also to its complete failure in some cases.• Erosion of downstream to: If the downstream toe of an earth dam is not properly protected it may be eroded due to two reasons:(a) presence of tail water, and (b) the cross currents produced from the water discharging from the spillway.	2
	Seepage failures. The seepage failures include the failure of earth dams on account of the following causes. (1) **Piping through dam and its foundation**:Piping is the progressive backward erosion which may be caused through an earth dam or its foundation by the water seeping through the dam or its foundation. (2) **Conduit leakage**:Conduit leakage may cause the failure of an earth dam in the following two ways:(1) seepage along the conduit wall; and (2) seepage through cracks developed in the conduit. **(3) Sloughing:** Sloughing may be defined as the falling away of the soil mass of an earth dam. The sloughing may take place when under the full reservoir condition most of the downstream portion of the dam becomes saturated and continuously remains in the same state due to which the soil mass in the downstream portion of the dam gets softened.The sloughing begins when a small amount of softened soil mass at the downstream toe is eroded and produces a small slump or miniature slide.	2
	Structural failures:The structural failure includes the failure of earth dams due to the following (1) Sliding of upstream and downstream slopes. (ii) Flow slides due to spontaneous liquefaction (or liquefaction slides). (iii)Damage caused by burrowing animals. (iv) Damage caused by water soluble materials. (v) Damage caused by earthquake	2

b	In a diaphragm type earth dam the bulk of the dam is constructed of pervious material (sand, gravel or rock) and a thin core usually known as diaphragm of impermeable material is provided to check seepage. As such these dams are also sometimes known as thin core dams. The position of the diaphragm may vary from a central vertical core to a blanket directly on the upstream face of the dam and in between these extreme positions there may be several intermediate positions of the diaphragm in which an inclined diaphragm sloping upstream may be provided. The diaphragm may consist of impervious soil, cement concrete, bituminous concrete or any other suitable material. If the core or blanket is of impervious soil it is considered to be a 'diaphragm' if its horizontalthickness at any elevation is less than 3 m or less than the height of the dam above the corresponding elevation in the dam.A diaphragm type earth dam is usually constructed where there is an ample supply of pervious material but there is only a limited supply of soil suitable for an impervious core. However, the construction of an internal diaphragm of impervious soil with the necessary filters requires a high degree of precision and control.	5	7	7
	 (a) WITH THIN CORE OR DIAPHRAGM	any one fig- 2		
	 (b) WITH INCLINED BLANKET ON UPSTREAM FACE Fig. 11.3 Diaphragm type earth dams.			
IX a	1. Ridge canal or Watershed canal 2. Contour canal 3. Side slope canal	2	6	6
	Ridge canal or Watershed canal:A ridge or watershed canal is the one which is aligned along the ridge or the natural watershed line. When the canal runs on a watershed it can irrigate areas on both sides and hence a large area can be brought under cultivation i.e., the canal has a higher command area. Further no drainage can intersect a ridge line or watershed, as all the drainage flows away from the ridge line. Thus ridge canals are quite economical.	2		

	Contour canal.:A contour canal is the one which is aligned nearly parallel to the contours of the country. It can irrigate areas only one one side. As the ground level on the other side is higher it is not necessary to construct a bank on that side.	2		
	A side slope canal is the one which is aligned at right angles to the contours of the country. Thus it is neither on the watershed nor in the valley but it is somewhere in between the two along the slope. As this canal is nearly parallel to the natural drainage of the country it does not intercept drainage and hence cross-drainage works are not required. It can also irrigate areas only on one side as in the case of a contour canal.	2		
b	Since the canals are earthen channels either in embankment or in cutting, the water that flows in the canals is subject to certain losses. The soil being made up will be having voids and the water percolates or being absorbed into the natural banks and gets collected on the sides of the canals making some area water logged. The losses of water by percolation and absorption are called seepage losses.To control the seepage losses and make good use of valuable irrigation water it is necessary that the bed and sides of a canal is given an impervious layer which is called "lining".	3	7	7
	Lining has following advantages:1. Saves water for extending irrigation.2. Water logging can be avoided.3. Reduces the cost of maintenance of canals.4. Permits water to flow at higher velocities.5. Checks growth of weeds on the canal bed.6.Prevents canal breaches	4		
X a	A super passage is also just like a bridge in which the natural drain is carried over the canal. Thus a super passage is reverse of an aqueduct. The canal water flows under the drain such that there is sufficient headway available between the full supply level of the canal and the underside of the drain trough. The canal therefore flows at atmospheric pressure under the work. In this case it is however not possible to provide an inspection road along the canal	5	8	8
	 (b) SUPER PASSAGE	3		

b	The causes of soil erosion are: (i) natural (ii) artificial (or) man made. **(i) Natural causes:** Some portion of soil gets eroded naturally and carried away by the action of water and wind. There are two kinds of erosion by natural agencies. (b) Wind erosion. (a) Water erosion Water erosion: Water erosion is due to beating of rain water flowing high velocity on the land surface.There are two types of water erosion. (i) sheet erosion (ii) gully erosion. wind erosion :Coarse sand particles are lifted and carried elsewhere on to good cultivable land. This layer of infertile sand dunes makes the land unfit for cultivation	3	7	7
	Artificial causes of soil erosion: The following are the some of the causes of man made soil erosion.(a) Deforestration and over grazing. (b) Faulty method of cultivation.(a) Deforestration: Trees, plants and grass protect the land from direct impact of rain fall and surface flow. Also the roots of plants bind the soil particles together and make the soil stable. When a forest is destroyed the land is exposed to erosion. Due to over grazing of animals like goats, sheep, buffaloes etc. The top fertile soil is transported from one place to another place by the foot of animals.(b) Faulty methods of cultivation : Some of the faulty methods of cultivation are:(i) Improper rotation (or) no rotation of crops.(ii) Inadequate precautions when crops are grown on the steep slopes and the water flowing down carries with soil	4		