MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)

(ISO/IEC -270001 – 2005 certified)

SUMMER -2019 EXAMINATION

Subject code: 22403 **Model Answer**

Important Instructions to examiners:

1) The answer should be examined by keywords 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 error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure 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 the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding

Q. No.	Question and Model Answers	Marks
Q. 1	**Attempt any FIVE of the following**	**10**
a)	**Write two merits of roadways over railways**	
	1. They provide door to door service. 2. In hilly or mountainous region, roads are the only means of conveyance. 3. They help to provide medical aid to remote places. 4. They transport men and material from one part to other speedily and easily. 5. A number of small units like rickshaw, cars, scooter etc are available for personalized transport. 6. The roads can be improved in terms of width and nature of surface as the demand of traffic grows. 7. Starting and destination points need not be necessarily defined.	**1 M each Any two**
b)	**List the types of rail gauge.**	
	1. Broad gauge = 1676 mm 2. Meter gauge 1000 mm 3. Narrow gauge = 762 mm 4. Light gauge =610 mm	**1/2 M each**
c)	**Define cant deficiency and negative cant.**	
	Cant deficiency: The difference between the equilibrium cant, necessary for maximum permissible speed on a curved railway track and the actual cant provided is known as cant deficiency. OR	**1 M each**

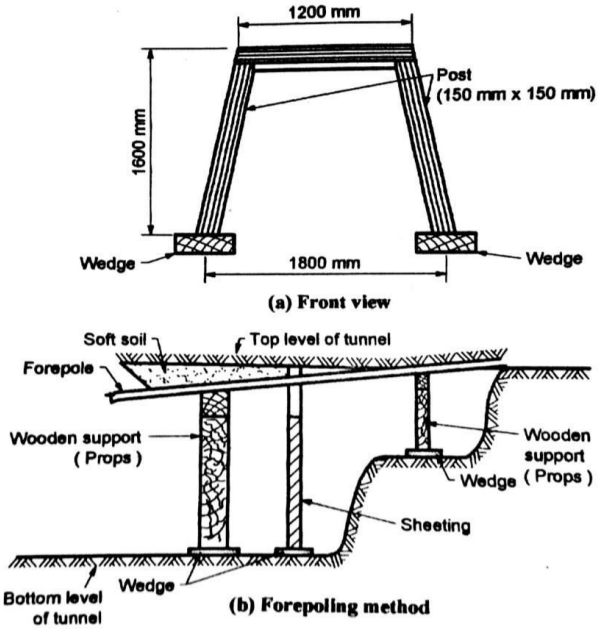
	Cant deficiency: is the amount by which the actual superelevation falls short of the equilibrium superelevation. **Negative cant:** The elevation of outer rail below the inner rail of a turnout or branch track at the place where it meets the main track on a curve is called as negative cant or negative super elevation.	
d)	**Give two purposes of station yard.**	
	I. Passenger bogie yards provide facilities for the safe movement of the passengers and vehicles for the passenger. II. Goods yard provide facilities for receiving, Loading, Unloading and delivery of goods and movement of goods vehicle. III. Marshalling yards provide facilities of receiving train and other loads, sorting out and forming new trains and their dispatch onwards. IV. Locomotive yards provide facilities for coaling, watering, repairing, oiling, cleaning etc for servicing and maintenance of locomotive.	**1 M each**
e)	**Write the necessity of temporary bridge.**	
	I. These bridges help in facilitating the construction of permanent bridges. II. When the bridges are required for shorter period or at the earliest time for temporary purpose. III. Temporary bridges are required under emergency conditions. IV. Temporary bridges are easy in construction and suitable for light traffic.	**1 M each**
f)	**List out the components of left hand turnouts.**	
	I. Stock rails II. Lead rails III. Check rails IV. Splice rails V. Tongue rails VI. Wing rails VII. Stretcher bar VIII. Point rails IX. Toes of switch X. Throw of switch XI. Nose of crossing XII. Main track XIII. Branch track XIV. Crossing angle.	**1/2 M each**
g)	**Classify tunnels based on its purpose.**	
	I. Railway tunnel II. Highway tunnel III. Navigation tunnel IV. Subway tunnel V. Pedestrian tunnel VI. Water supply tunnel VII. Sewer tunnel VIII. Hydro – electric power tunnel IX. Tunnels for industrial use. X. Tunnels for intake and conveying public utilities.	**1 M each (any two)**
Q. 2	**Attempt any <u>THREE</u> of the following.**	**12**
a)	Write the ideal requirements of permanent way. Ideal requirements of permanent way: I. The gauge should be uniform and correct. II. The alignment should be correct and the rails should be at the same level on	**1 M each**

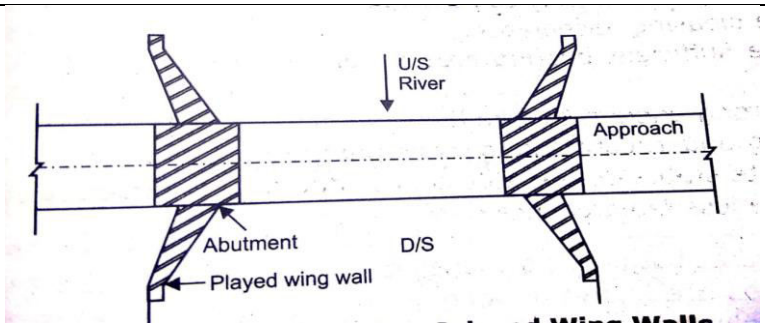
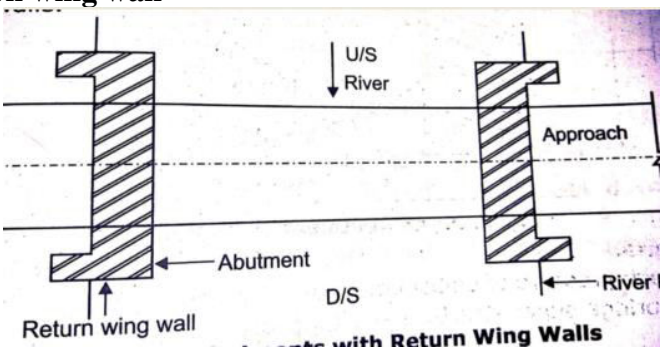
	straight portion. III. The track should be resilient. (i.e. there must be a certain amount of elasticity in the track) IV. The gradient should be uniform and any change in gradient should be followed by a smooth curve. V. The track should have enough lateral strength so that alignment is maintained. VI. Points and crossings and rail joints should be perfectly designed and maintained. VII. The radii and superelevation on curves should be properly designed and maintained. VIII. The drainage system must be perfect. IX. Fixtures and fastenings should be strong enough to withstand the stresses. X. It should not have excessive rail joints. XI. There should be adequate provision for easy renewals and replacements. XII. The load of the train should be distributed uniformly over the permanent way.	
b)	**Explain the functions of ballast.**	
	I. To distribute uniformly the load from the sleepers over a large area of formation or subgrade. II. To hold the sleepers in their correct position and preventing their lateral movements. III. To prevent the growth of weeds inside the track. IV. To drain off the rain water from the track quickly and to provide well drained foundation bed immediately below the sleepers. V. To provide cushion effect to the track since it acts as an elastic medium between the sleepers and the formation. VI. To provide a firm bed for the sleepers to rest upon. VII. To protect the top surface of formation. VIII. To provide an easy method for track adjustment and gradients without any disturbance to formation.	**1 M each**
c)	**Classify the bridges based on:** **I. Span of bridge** **II. Purpose of bridge**	
	Classification of bridges according to span. I. Culverts II. Minor bridges III. Major bridges IV. Long span bridge **Classification of bridges according to purpose:** I. Aqueducts II. Viaducts III. Foot Bridges IV. Highway Bridges V. Railway Bridges	**2 M** **2 M**
d)	**Discuss the factors affecting selection of rail gauge**	
	A. Cost of construction. There is little increase in the initial cost if we select a wider gauge (say B. G.) This is due to the following reasons: I. The cost of earthwork, ballast, sleepers, rails etc. would increase with increase in gauge width. II. There is little increase in the acquisition of land for permanent track with increase in gauge. III. The cost of rolling stock is independent of the gauge used. For the same volume of traffic.	**1 M each**

	B. Volume and nature of traffic It is evident with greater traffic volume and greater load carrying capacity, the trains should be run by a better traction technique or by better locomotive. **C. Development of the area** Narrow gauge can be used to develop the thinly populated areas by joining the poor developed areas with developed or urban areas. **D. Physical features of the country.** Use of narrow gauge is warranted in hilly regions where broad and meter gauge are not possible due to steep gradients and sharp curves. **E. Speed of movement** The speed of a train is almost proportion to the gauge. Speed is the function of diameter of wheel, which in turn is limited by the gauge. The wheel diameter is generally 0.75 times that of gauge. Lower speeds discourage the customers and so far maintaining high speeds, the broad gauge are preferred.	
Q.3.	**Attempt ANY THREE of the following**	
a)	**Factors affecting site selection for construction of bridge**	
	Following factors affect the selection of site for a bridge: **(1) Width of river: The** width of river indicates length of bridge. It is desirable to have well defined and a narrow channel at bridge site as far as possible which will help in providing least possible length of bridge. The smaller the width of river, the cheaper will be the bridge in its initial cost as well as maintenance cost. **(2) A straight reach :** The river should have straight reach over a reasonable long distance on upstream side and downstream side of the bridge site so that the utility of bridge can be maintained for the design period. On the other hand the curved reach of river is not desirable as it creates problems during construction and maintenance of bridge. **(3) Foundations :** The nature of soil at bridge site should be such that good sound foundations should be available at reasonable depth. Such type of bridge site will save expense, labour and time required. **(4) Connections with roads :** The bridge is constructed to connect the road on either side of a river. The bridge site should therefore form a proper link between the roads on either side of a river. The approaches at the bridge site should be such that the do not involve heavy expenditure. **(5) Firm embankments :** The embankment at bridge site should high, permanent, straight, solid and firm. Such embankments will not get disturbed at the time of heavy floods and they do not allow the course of stream toalter. **(6) Materials and labour :** The site of the proposed bridge should be such that labour, construction material should easily available nearby site. The transportation charges for material and labour at the bridge site should be minimum. This type of bridge site will provide economy in the overall cost of construction. **(7) Right angle crossing :** At bridge site, the direction of flow of water should benearly perpendicular to the	**1 Mark each**

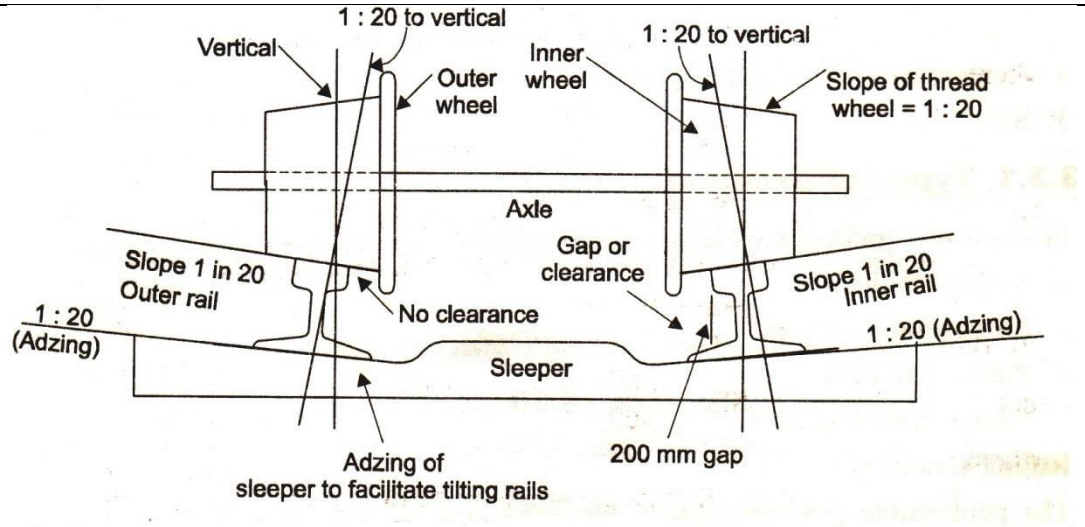
	centre-line of bridge. Such crossing is known as right angle crossing. This type of site will help in providing square alignment of bridge which will result in easy and economy in bridge construction. **(8) Velocity of flow :** The velocity of flow at bridge site should be between the range of non - silting and non-scouring. This type of site will result in minimum maintenance cost. **(9) Scouring and silting :** There should be no scouring and silting at bridge site, which will result in minimum maintenance cost. **(10) Minimum obstruction to water way :** There should be minimum obstruction to natural waterway at the site of bridge. **(11) Sound, economical and straight approaches :** The bridge site should provide sound, economical and straight approaches. In case of curved alignment, the bridge should be on the tangent and not on the curve, since it is difficult to construct and maintain a curved bridge. **(12) Free board :** Sufficient free board should be available for the passage of boats, ships under the bridge superstructure if the river is used for navigation	
b)	**Define the following** **a)Economic Span b) Afflux c) Scour Depth d) Freeboard**	
	a)Economic Span The span for which the total cost of the bridge is minimum is knownas economical span of a bridge. **b) Afflux** It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. Or The heading up of the water above its normal level while passing under the bridge is called afflux. **c) Scour Depth**:- The depth upto which a flowing stream erodes soil is known as scour depth **d) Freeboard**:- Its is the difference between the HFL after allowing the afflux, if anuy, and the lowest point on the under side of the bridge super structure is called free board.	**1 Mark each**
c)	**Explain the functions of the following** i) **Pier ii) Abutment iii) Bearing iv) Wing wall**	
	i) Functions of Pier: i) To divide the length of bridge into suitable number of spans. ii) To transfer the load from bridge superstructure to subsoil through foundations **ii) Functions of abutment :** 1. To retain the earth pressure of embankment of the approaches. 2. To support the bridge superstructure and to transmit the load from itto the subsoil lying underneath. 3. To finish up bridge so that it can be put for use./ To provide finalformation level to the bridge superstructure 4. To transmit the reaction of superstructure to the foundation	**1 Marka ny one** **1/2 Mark any two**

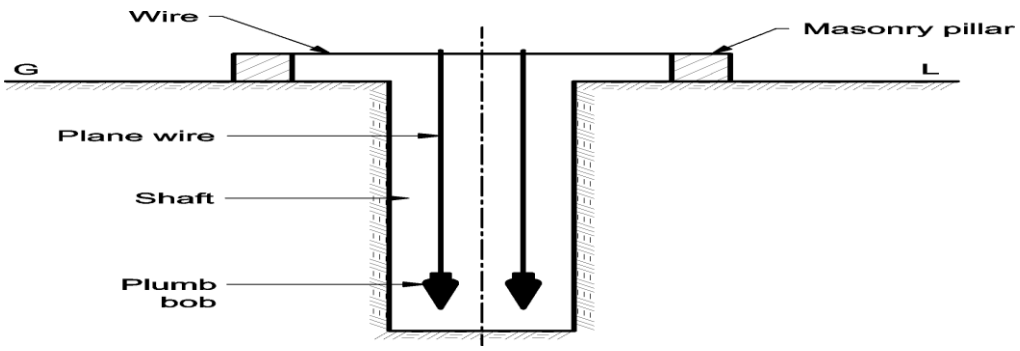
	iii)Functions of bearings: a. To distribute the load received over large area. b. To allow for longitudinal expansion or contraction due to changesin the temperature. c. To allow for angular movement at support due to deflection ofgirders. d. To allow for vertical movement due to sinking of supports. e. To transfer horizontal forces occurring due to application of brakesto the vehicle etc. f. To keep the compressive stress within safe limits. **iv)The functions of wing walls are as follows:** 1. To retain the earth banks of the river. 2. To protect the earth banks from the action of water.	**1/2 Mark any two** **1Mark any one**
d)	**Write the the function of bridge bearing. Also write its types.**	
	Function of bridge bearing: 1) To distribute the load received over large area. 2) To allow for longitudinal expansion or contraction due to changes in the temperature. 3) To allow for angular movement at support due to deflection of girders. 4) To allow for vertical movement due to sinking of supports. 5) To transfer horizontal forces occurring due to application of brakes to the vehicle etc. 6) To keep the compressive stress within safe limits. **Types of Bearing:** **A. Fixed Bearing:** 1. Fixed Plate Bearing 2. Deep Base Bearing 3. Rocker Bearing 4. Knuckle Bearing **B. Expansion Bearing:** 1. Sliding Plate Bearing 2. Deep cast with curve plate 3. Rocker bearing with curved base 4. Rocker & roller bearing	**1/2 Marks Any four** **1/2 Marks Any two** **1/2 Marks Any two**
Q.4.	**Attempt ANY THREE of the following**	**12M**
a)	**Write two advantages and two disadvantages of prestressed bridge.**	
	ADVANTAGES OF PRESTRESSED BRIDGE 1) have higher load carrying capacity 2) fewer expansion joints 3) Reduced deflection of girders. 4) Lighter construction. 5) More aesthetic appearance. 6) More effective use of precast members. 7) Better resistance to fatigue due elimination of cracking of its members under severe traffic loads. 8) Less cost of maintenance. **DISADVANTAGES OF PRESTRESSED BRIDGE** 1) Use of high tensile steel results in high cost 2) Skill supervision required. **3)** Special equipment are required.	**1/2 Mark any four** **1 Mark Any two**

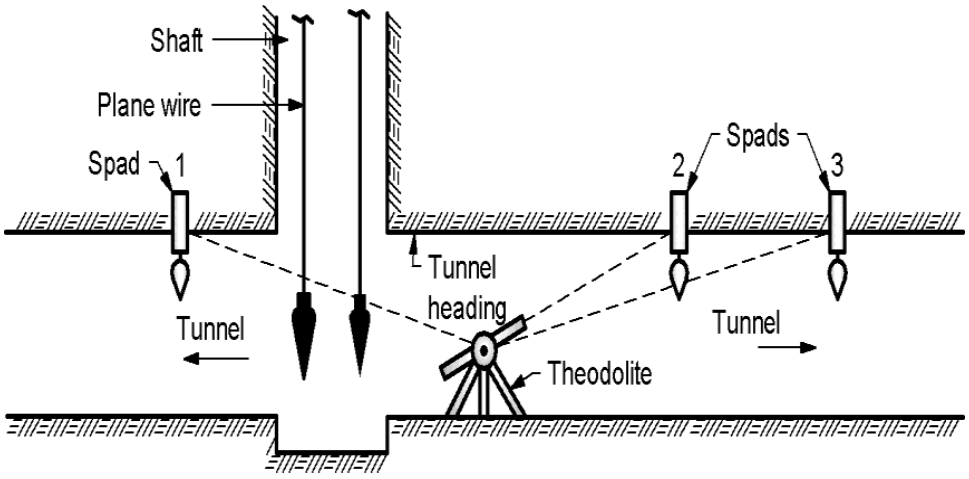
b)	**Explain the sequential steps involved in bridge construction.**	
	Following are the steps involved in bridge construction • Proposal:- Necessity of bridge hydraulic data collection • Site selection • Administrative approval • Technical sanction • Estimate • Sanctioned estimate • Design calculation • Details of estimate • Tendering process • Soil testing • Construction-substructure, super structure • Completion report • Open to traffic	**½ Mark each**
C)	**Describe fore-poling method of tunneling in soft rock.**	
	FORE-POLING METHOD It is an ancient method of tunneling, but now it has been replace by compressed air method. Thismethod needs large quantity of timber for supporting the ground. This method used for theconstruction of small dimensions tunnels required for laying sewers, gas, pipes etc. it is slowand tedious.In this method, a frame in the form of letter 'A' is prepared and placed near the face ofthe tunnel covered with suitable planks as shown in fig.The poles are then inserted at the top and continued to a depth upto which they can beeasily taken up.These poles are supported by verticals posts.Now excavation can be done under the forepoles.The excavations are also done on sides and are supported by suitable timbering.In this way the full section of the tunnel is excavated.  	**2M** **2M**

d)	**Draw the labelled sketches of the following** **i) Splayed wing wall** **ii) Return wing wall**	
	i) Splayed wing wall  **ii) Return wing wall**  	**2 Marks** **2 Marks**
e)	**Give the points to be observed during pre-monsoon and post monsoon inspection.**	
	Pre-Monsoon Inspection The inspection shall cover the following points • Foundation and substructure • Protective works • Superstructures • Detailed inspection of steel works of girder • Obstruction of water way • Inspection of drainage system • Development of cracks **Post Monsoon Inspection** The inspection shall cover the following points • Condition of slab girder, footpath, Drainage system • Condition of substructure, superstructure • Inspection of Development of cracks • Condition of Approaches of bridge	**1/2 Marks any four** **1 Marks Any two**
Q.5	**Attempt any <u>TWO</u> of the following**	**12M**
a)	**Explain the causes of creep of rail. Suggest preventive measures against it.**	
Ans	**Causes of creep:** **1. Wave action or Wave Theory:** Wave motion is set-up in a resilient track by the moving wheel loads. The train wheels causes depression under themselves forming lifts or crests. With movement of wheels, the lifts on front of the moving wheels are carried forward whereas the lifts at the rear of the moving wheels get back to their normal position. Thus, the rails are	

	pushed forward which causes creep in the forward direction. **2. Percussion Theory:** The rail creep is due to impact of wheels at the end of facing rail at each fish plate joint as shown in figure. When the wheel pass over such a rail joint the trailing rail depresses down and the wheel give impact to the end of facing rail, which results creep in forward direction. **3. Accelerating or Starting of a train:** At the time of accelerating or starting of a train, the engine wheels give a backward thrust which tends to push the rails backwards, causing creep in the backward direction. **4. De-accelerating or Stopping the train:** When the train is de-accelerated or stopped, the braking effect tends to push the rail forward. Thus, causing the creep in the forward direction. **5. Expansion and contraction of rails due to variation in temperature:** Creep may also be caused due to unequal expansion, contraction of rails due to variation in temperature. **6. Intensities of Traffic:** In a single line track, the creep will be resulted in the direction of heavy intensity of traffic. In a double line track, the creep occurs in both the tracks in the direction of movement of trains. **7. Alignment of the track:** Creep is greater on curved portion than on straight portion of the track. **8. Gradient of the track:** Creep is more on a track with steep gradient, particularly, if the trains move downwards with heavy loads. **Creep Prevention:** 1. Pulling back the rails. 2. Use of steel sleepers. 3. Using Anchors/Anti-creepers. 4. By increasing number of sleepers per rail length.	**1 mark each (any three)** **1 mark each (any three)**
b)	**Explain the necessity of tilting of rail with neat sketch**	
Ans	In case the rail of track are placed in vertical position ,the top surface will not come in full contact with the treads of wheels of a train due to coning of wheels and the pressure of wheels will always be exerted near the inner edges of the rails. Therefore, the rails will wear out quickly .To make full contact of top surface and thereby reducing the wear of rails in this way, these are placed at an inward slope of 1 in 20.which is known as tilting of rails**.** The tilting of rail is achieved by providing a cut in the wooden sleeper called as "Adzing". Canted bearing plates can also be used in wooden sleepers to provide tilting of rails. Steel, CI and PSC sleepers have in built slope on the bearing surface to provide tilting of rails.	**4Marks**

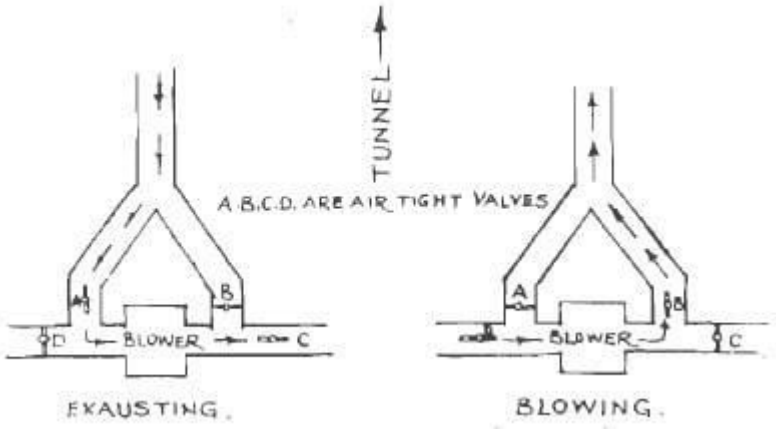
	 **Tilting of Rail**	**2Marks**
c)	**Explain the duties of following personnel's in rail track maintenance:** **(i) Permanent Way Inspector** **(ii) Gang Mate** **(iii) Key Man**	
Ans	**Duties of permanent way inspector -** 1. The duties of permanent way inspector are as follows; 2. The PWI is personally responsible for maintaining the track in good condition for the passage of trains. For this purpose, he travels over the track by push trolley and watches the defects of the track and arranges the repair of the defective track by his gang. 3. He is responsible to carry out the renewals of rails and sleepers. 4. He should maintain the record of wear of rails in his section. He should check out the programme for lubrication of rail joints in such a way that the entire rail joint are lubricated on a year during winter season. 5. He is responsible to maintain the correct gauge, super elevation on curves and removal of creep etc. 6. He should supervise the work of his gang regularly. 7. He should see the welfare of his gang man. 8. Level crossing under his charge must be maintained in perfect condition. During this visit to level crossing, he should check the working of gateman also. If necessary he should issue instructions to the gateman. 9. At the time of accident, he is responsible to store the traffic in the shortest possible time. He should also find out the causes of accident. 10. He should prepare the estimates of the maintenance work and should report the progress to his seniors. **Duties of gang mate-** 1. Gang mate means the person in charge of gang of work men employed on permanent way. 2. He is responsible for the maintenance of track. 3. It is his duty to arrange for tools and other requirement for his gang.	**½ M each for any four** **½ M each for any four**

	4. He has to allot duties to each of his gang man and to check their work. 5. He has to maintain record of work, reports of key man. **Duties of Keyman-** 1.The position of a Keyman in his gang is next to the Gangmate and hence, in his absence the Keyman is to perform his duties 2. He is responsible for the upkeep of all fastening and rail joints in the track of his section. 3. He is to walk on the whole section to inspect fastening and joints every day. 4. He is to tight all the fittings like fish bolts, spikes, sleepers, keys etc. found loose during his inspection. 5. He should grease fish plates and oil fish bolts. 6. He should open and refit all joints at least once in a year	**½ M each for any four**
Q.6	**Attempt any <u>TWO</u> of the following**	**12 M**
a)	**Describe the survey work required for proposed tunnel construction work.**	
Ans	The survey work involved following operations: **i) Locating centre line of the tunnel on ground :** • The initial procedure is to carry out a preliminary survey. • After fixing the route for the tunnel, its centre line (alignment) is accurately set out on the hills or ground. • When the length of tunnel is small; the centre line can be located by means of theodolite. • When the tunnel is long, and to be constructed under high mountains, the centre line is set out by triangulation preferably with the help of a micrometer transit theodolite. **ii) Constructing the shaft over the centre line :** After locating centre line, shaft constructed at suitable intervals for transferring the centre line to inside the tunnel **iii) Transferring the alignment to inside of the tunnel :** • After constructing the shafts, the alignment of the tunnel is to be transferred down the shafts. • Two plumb bobs are suspended inside the shaft by lowering both plumb bobs to the bottom of the shaft, two points are marked. • The line joining the points represents the centre line of the tunnel marked on the ground. • This line is further extended into the tunnel, as work advances, by theodolite placed in the shafts.  **Transferring the alignment (centre line) at the bottom of the shaft**	**1Mark any two** **1Mark** **1 Mark any two** **1M (any one dia.)**



Transferring the alignment to inside of the Tunnel

b)	**Discuss the purposes of tunnel lining.**	
Ans	**Purpose of tunnel lining :** 1. To provide the correct, desired shape to the tunnel. 2. To support the loosened rock pieces during blasting. 3. To increase the structural strength of soft places in the tunnel. 4. To improve the appearance of tunnel. 5. To prevent percolation of water inside the tunnel. 6. To reduce the maintenance cost of tunnel. 7. To house electrical fitting. 8. To withstand soil pressure when driven in soft rocks.	**1Mark any six**
c)	**Explain the tunnel ventilation using mechanical method.**	
Ans	**Mechanical method :** Mechanical ventilation is done by blowing fresh air into a tunnel or by exhausting the foul air or dust from the tunnel by any system listed below : **(1) Blowing process :** • In this method of mechanical ventilation, fresh air is forced by on e or two blowers through the ducts, provided in the tunnel. • By this method, positive supply of fresh air at the working place can be obtained. • But the disadvantage lies in that the foul air, smoke and dust slowly move out, fogging the atmosphere inside the tunnel, especially in long tunnels. • This method is also known as propulsion method. **(2) Exhausting process :** • In this method of mechanical ventilation, air is sucked by one or two exhaust fans installed near the tunnel heading. • This creates vacuum due to which fresh air enters inside the tunnel. • This method has the special advantage of quick removal of dust and smoke from the working face. • This method is also known as vacuum method.	**1 Mark any two** **1 Mark any two**

	(3) Combination of blowing and exhausting process : • In this method, blower and exhaust fans are provided for forcing fresh air in the tunnel and sucking foul air from the tunnel. • The blower and exhaust fans are installed in suitably spaced inlet and outlet shafts connected to the tunnel.  	**1Mark** **1Mark**