Important Questions *for* GATE 2022

CIVIL ENGINEERING

MADE EASY

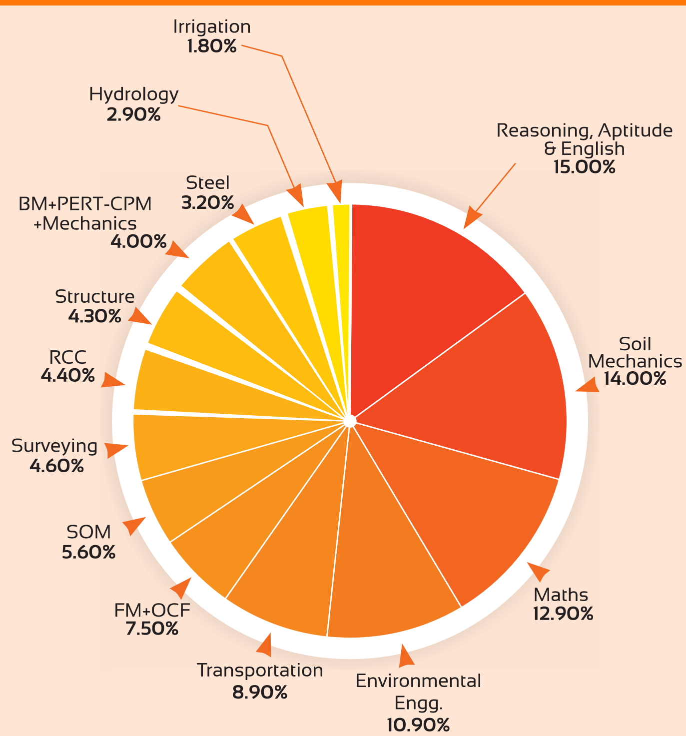
India's Best Institute for IES, GATE & PSUs

Day 2 of 8

Q.26 - Q.50 (Out of 200 Questions)

Irrigation Engineering + Engineering Mechanics + Transportation Engineering

SUBJECT-WISE WEIGHTAGE ANALYSIS OF GATE SYLLABUS



Subject	Average % (last 5 yrs)
Reasoning, Aptitude and English	15.00%
Soil Mechanics	14.00%
Engineering Mathematics	12.90%
Environmental Engineering	10.90%
Transportation Engineering	8.90%
Fluid Mechanics + OCF	7.50%
Strength of Materials	5.60%
Surveying Engineering	4.60%
Reinforced Cement Concrete	4.40%
Structural Analysis	4.30%
Building Materials+PERT-CPM+Mechanics	4.00%
Steel Structures	3.20%
Engineering Hydrology	2.90%
Irrigation Engineering	1.80%
Total	**100%**

Irrigation Engg. + Engg. Mechanics + Transportation Engg.

Q.26 A canal was designed to supply the irrigation needs of 1000 ha of land growing rice of 140 days base period and having a delta of 130 cm. If the canal water is also used to irrigate wheat of base period 119 days and having a delta of 50 cm, then the area (in ha) that can be irrigated is

(a) 452
(b) 904
(c) 1105
(d) 2210

Q.27 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I	**List-II**
A. In an aqueduct	**1.** the drainage water is carried in a trough supported on piers while their irrigation canal passes below with its FSL below the slab of the trough above.
B. In a level crossing	**2.** the drainage water is carried in a trough supported on piers while the irrigation canal passes below with its FSL above the slab of the trough above.
C. In a super-passage	**3.** the canal and the drain approach each other practically at the same level.
D. In a syphon	**4.** the irrigation canal is carried across the drain in a trough supported on piers with the canal bed level well above the HFL of the drain.

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	4	3	2	1
(c)	3	4	1	2
(d)	3	4	2	1

Q.28 The gross command area of an irrigation project is 1 lakh hectares. The culturable command area is 75% of gross command area. The intensities of irrigation for Kharif and Rabi are 50% and 55% respectively. The duties for Kharif and Rabi are 1200 hectares/cumec and 1400 hectares/cumec respectively, then the discharge (in cumecs) at the head of the canal, considering 20% provisions for transmission loss, overlap allowance, evaporation loss etc, is

(a) 29.46
(b) 36.82
(c) 39.06
(d) None of these

Q.29 A 200 gm/l solution of common salt was discharged into a hilly stream at a constant rate of 30 m^3/s. At a downstream observation section, the solution was completely mixed and an equilibrium concentration of 63 ppm was reached. If the background concentration was 13 ppm, then the discharge (in m^3/s) in the stream will be

(a) 120
(b) 150
(c) 180
(d) 240

Q.30 The time required to irrigate a strip of area 0.203 hectare by a stream discharge of 0.043 cumecs, to provide an average depth of 6.35 cm to the field is __________ min.
[Assume average rate of infiltration to be 5 cm/h]

Q.31 The concrete floor of a head regulator is level with the channel bed and is 13 m long. The depth of upstream and downstream cutoff wall is 2.5 m and 2.0 m. The upstream F.S.L. is 1.5 m above the floor level, then the value of x is (correct upto two decimal places) ___________.
[Use Khosla's theory]

Q.32 An elementary profile of a gravity dam, supporting 60 m height of reservoir water and full uplift, should have a minimum base width (in m) equal to
[Take specific gravity of solid particles = 2.4 and coefficient of friction = 0.7]
(a) 71.5
(b) 61.2
(c) 51.5
(d) 41.5

Q.33 In a pavement slab of thickness 20 cm the modulus of elasticity of concrete and Poisson's ratio are 3×10^5 kg/cm^2 and 0.16 respectively. Plate bearing test shown the pressure of 1.4 kg/cm^2 corresponding to 1.25 mm penetration. What is the radius of relative stiffness of pavement slab?
(a) 25.46 cm
(b) 47.78 cm
(c) 65.43 cm
(d) 79.48 cm

Q.34 What is the steepest gradient permissible on a 2° curve for BG line having a ruling gradient of 1 in 250?
(a) 1 in 275
(b) 2 in 625
(c) 2 in 675
(d) 1 in 185

Q.35 What is the gravel equivalent C - value of a three layer pavement section having individual C-values as given below?
[Use California resistance value method]

Materials	Thickness (cm)	C-Value
Bituminous concrete	16	80
Cement treated base	15	180
Gravel sub base	10	20

(a) 82.17
(b) 97.33
(c) 104.65
(d) None of these

Q.36 When the speed of traffic flow becomes zero, then the
(a) traffic density and traffic volume both attains maximum value.
(b) traffic density attains maximum value whereas traffic volume becomes zero.
(c) traffic density and traffic volume both becomes zero.
(d) traffic density becomes zero whereas traffic volume attains maximum value.

Q.37 For a cement concrete pavement, stresses are given below:

	Corner (kg/cm^2)	Edge (kg/cm^2)	Interior (kg/cm^2)
Wheel load stress	25	28	23
Warping stress (summer)	8	9	10
Warping stress (winter)	6	7	8
Frictional stress (summer)	0	5	5
Frictional stress (winter)	0	4	4

The most critical stress value of pavement is,

(a) 37 kg/cm^2
(b) 39 kg/cm^2
(c) 31 kg/cm^2
(d) 33 kg/cm^2

Q.38 A vehicle of weight 25 ton is moving on a road on which it is required to negotiate a curve of radius 250 m. If allowable speed on the road is 250 kmph and 30° banking is provided, then coefficient of side friction is

(a) 0.35
(b) 0.53
(c) 0.65
(d) 1.40

Q.39 While driving at a speed of 36 kmph, with available friction of 0.3, down the grade, the driver requires a braking distance twice that required for stopping the vehicle when he travels up the same grade. The grade is ___________ %.

Q.40 The average normal flow of traffic on cross roads *A* and *B* during design period are 600 and 400 PCU per hour; the saturation flow values on these roads are estimated as 1600 and 1200 PCU per hour respectively. The all red time required for pedestrian crossing is 12 sec. The optimum cycle time, for two phase traffic signal with pedestrian crossing is ___________seconds.

Q.41 Consider the following types of roads in the same rainfall region:

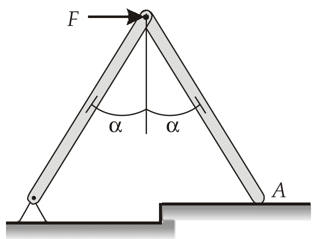
1. Water Bound Macadam roads
2. Cement Concrete roads
3. Bituminous high-speed roads
4. Gravel roads

The correct sequence of the descending order of steepness of camber of these roads is

(a) 4, 1, 2, 3
(b) 4, 1, 3, 2
(c) 1, 4, 3, 2
(d) 1, 4, 2, 3

Q.42 A rail road freight car weighs 1000 kN with wheels having a radius of 750 mm. If the rolling resistance of the rail road freight car is 30 N, then the coefficient of rolling resistance is _________ $\times 10^{-3}$ mm.

Q.43 Consider the bars as shown below. The coefficient of static friction between the right bar and the surface *A* is μ. Neglect the self weights of the bars. What is the magnitude of the friction force exerted at *A*? [Assume equal lengths for the bars]



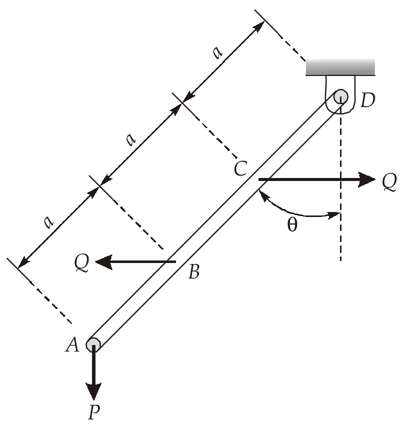
(a) $\dfrac{F}{2}$

(b) $\dfrac{F}{2\tan\alpha}$

(c) $2F$

(d) $\dfrac{F}{2}\tan\alpha$

Q.44 A rod *AD* is acted upon by a vertical force *P* at end *A* and by two equal and opposite horizontal forces of magnitude *Q* at points *B* and *C* as shown in the figure below. The value of *Q* required to maintain equilibrium of rod at any instant is



(a) $3P\cos\theta$

(b) $P\tan\theta$

(c) $3P\tan\theta$

(d) $P\cos\theta$

Q.45 A car starting from rest moves along a curved road of radius 500 m. The car attains a speed of 72 kmph in 20 seconds with uniform tangential acceleration. The ratio of tangential acceleration to normal acceleration after 10 seconds from start is __________.

Q.46 The resultant of two forces acting at a point at an angle 120° is perpendicular to the smaller of the two forces. If the greater force is 10 N then the smaller force is __________ N.

Multiple Select Questions (MSQ)

Q.47 Which of the following are the objectives for river training?

(a) High flood discharge may pass safely and quickly through the reach.

(b) To make the river course stable and reduce bank erosion to minimum.

(c) To check flow through canal.

(d) To provide a sufficient draft for navigation as well as good course for it.

Q.48 Consider the following statements:

(a) A regime channel will have side slopes of value 0.5 H : 1 V.

(b) Lacey's regime formula is applicable to regime channels with sediment concentration more than 5000 ppm

(c) For a Lacey regime channel the Manning roughness coefficient is estimated by Strickler's formula

(d) The mean velocity in a Lacey channel is proportional to $R^{2/3}$ where R = hydraulic radius.

Q.49 Which of the following factors are used for calculating temperature stress at the critical edge region in rigid pavement design?

(a) Maximum temperature difference between summer and winter

(b) Coefficient of thermal expansion of concrete

(c) Slab length

(d) Slab width

Q.50 Which of the following are the criteria associated with the design of sag vertical curve?

(a) Provision of minimum stopping distance during day time.

(b) Adequate drainage.

(c) Comfortable operation

(d) Pleasant appearance.

■■■■

Detailed Explanations

26. (d)

The discharge (Q) in canal remains same,

Duty for rice, $D_1 = \dfrac{1000}{Q}$ ha/cumecs

Duty for wheat, $D_2 = \dfrac{A_2}{Q}$ ha/cumecs

Since discharge is same

$$D = \frac{8.64B}{\Delta}$$

$$\frac{A}{Q} = \frac{8.64B}{\Delta}$$

$$\Rightarrow \quad \frac{AB}{\Delta} = \text{Constant}$$

Now, $$\frac{D_1\,\Delta_1}{B_1} = \frac{D_2\,\Delta_2}{B_2}$$

or, $$\frac{A_1\,\Delta_1}{B_1} = \frac{A_2\,\Delta_2}{B_2}$$

$$\therefore \quad A_2 = \frac{119}{140}\times\frac{130}{50}\times 1000 = 2210\,\text{ha}$$

27. (a)

28. (c)

Culturable command area $= 10^5 \times \dfrac{75}{100} = 75000$ hectares

for Kharif crop,Area under Kharif crop $= 75000 \times \dfrac{50}{100} = 37500$ hectares

Duty for Kharif crop = 1200 hectares/cumecs

Required discharge for Kharif crop $= \dfrac{37500}{1200} = 31.25$ cumecs

for Rabi crop, Area under Rabi crop $= 75000 \times \dfrac{55}{100} = 41250$ hectares

Duty for Rabi crop = 1400 hectares/cumecs

Required discharge for Rabi crop $= \dfrac{41250}{1400} = 29.46$ cumecs

Discharge of the canal at the head of the field should be 31.25 cumecs (as it is maximum).
Now, considering 20% provision for losses,
Required discharge at the head of canal = 31.25 /0.8 = 39.06 cumecs

29. (a)

$$C_1 = 13 \text{ ppm}$$
$$C_2 = 200 \text{ gm}/l = 200 \times 10^3 \text{ ppm}$$

$$C_3 = 63 \text{ ppm}$$
$$Q_2 = 30 \text{ m}^3/\text{s}$$
$$Q_1 = ?$$

Let, the discharge in the stream is 'x' m^3/s

$$Q_1C_1 + Q_2C_2 = QC_3$$
$$x \times 13 + 30 \times 200 \times 10^3 = (x+30)63$$
$$x = 119.96 \text{ m}^3/\text{s} \simeq 120 \text{ m}^3/\text{s}$$

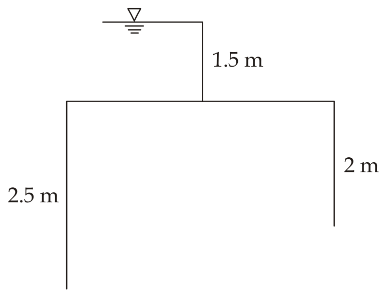
30. 81.25 (80 - 83)

$$t = 2.303\,\frac{y}{f}\log_{10}\left(\frac{Q}{Q - fA}\right)$$

where,
$$A = 0.203 \text{ ha} = 2030 \text{ m}^2$$
$$Q = 0.043 \text{ cumecs} = 0.043 \times 60 \times 60 \text{ m}^3/\text{h} = 154.8 \text{ m}^3/\text{h}$$
$$f = 5 \text{ cm/h} = 0.05 \text{ m/h}$$
$$y = 6.35 \text{ cm} = 0.0635 \text{ m}$$

$\therefore$
$$t = \left[2.303 \times \frac{0.0635}{0.05}\log_{10}\left(\frac{154.8}{154.8 - 0.05 \times 2030}\right)\right] \times 60$$
$$t = 81.25 \text{ min}$$

31. 8.15 (8.10 - 8.20)



Exit gradient,
$$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$$

where,
$$H = \text{Total head} = 1.5 \text{ m}$$
$$\lambda = \frac{1 + \sqrt{1 + \alpha^2}}{2}$$
$$d = \text{Depth of d/s cutoff} = 2 \text{ m}$$
$$\alpha = \frac{b}{d} = \frac{13}{2} = 6.5$$
$$\lambda = \frac{1 + \sqrt{1 + 6.5^2}}{2} = 3.79$$

$\therefore$
$$G_E = \frac{1.5}{2}\cdot\frac{1}{\pi\sqrt{3.79}}$$

$\Rightarrow$
$$G_E = 0.123 \text{ (1 in 8.15)}$$

32. (b)

As we know that,

$$B = \frac{H}{\sqrt{G - C}} = \frac{60}{\sqrt{2.4 - 1}} = 50.7 \text{ m} \quad \text{...(For full uplift, } C = 1)$$

and,
$$B = \frac{H}{\mu(G - C)} = \frac{60}{0.7(2.4 - 1)} = 61.22 \text{ m}$$

$\therefore$
$$\text{Width} = 61.22 \text{ m (maximum of above two)} \simeq 6.12 \text{ m}$$

33. (c)

Radius of relative stiffness,

$$l = \left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{\frac{1}{4}}$$

Modulus of subgrade reaction,

$$k = \frac{\text{Load}}{\text{Penetration}} = \frac{1.4}{1.25\times10^{-1}} = 11.2\ \text{kg/cm}^3$$

$$l = \left(\frac{3\times10^5\times20^3}{12\times11.2(1-0.16^2)}\right)^{\frac{1}{4}} = 65.43\ \text{cm}$$

34. (b)

Grade compensation of BG line

$= 0.04\%$ per degree of curve

∴ Grade compensation of 2° curve

$= 2 \times 0.04 = 0.08\%$

$$\text{Ruling gradient} = 1 \text{ in } 250 = \frac{1}{250}\times100 = 0.4\%$$

∴ Maximum allowable gradient = 0.4 – 0.08 = 0.32%

$$\frac{1}{100/0.32} = \frac{2}{625} = \frac{0.32}{100}$$

$= 1$ in $312.5 = 2$ in 625

35. (a)

The individual thickness of each layer is converted to their respective gravel equivalent.

We know that, $t \propto \dfrac{1}{C^{1/5}}$

For bituminous concrete,

$$\frac{t_g}{t} = \left(\frac{C}{C_g}\right)^{\frac{1}{5}}$$

$$\Rightarrow \quad \frac{t_g}{16} = \left(\frac{80}{20}\right)^{\frac{1}{5}}$$

$$\therefore \quad t_g = 21.11\ \text{cm}$$

For base course, $\dfrac{t_g}{15} = \left(\dfrac{180}{20}\right)^{\frac{1}{5}}$

$$\Rightarrow \quad t_g = 23.28\ \text{cm}$$

For sub-base course, $\dfrac{t_g}{10} = \left(\dfrac{C}{C_g}\right)^{\frac{1}{5}} = \left(\dfrac{20}{20}\right)^{\frac{1}{5}}$

$$\Rightarrow \quad t_g = 10 \text{ cm}$$

$$\text{Actual pavement thickness} = 16 + 15 + 10 = 41 \text{ cm}$$

This is equivalent to gravel thickness

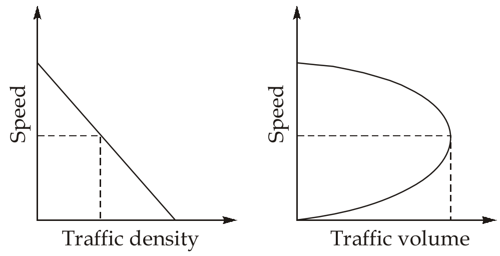
$$= 21.11 + 23.28 + 10 = 54.39 \text{ cm}$$

Therefore, C equivalent,
$$\frac{t_g}{t_{eq}} = \left(\frac{C_{eq}}{C_g}\right)^{\frac{1}{5}}$$

$$\Rightarrow \quad \frac{54.39}{41} = \left(\frac{C_{eq}}{20}\right)^{\frac{1}{5}}$$

$$\Rightarrow \quad C_{eq} = 82.17$$

36. (b)



37. (b)

	Corner (kg/cm²)	Edge (kg/cm²)	Interior (kg/cm²)
Wheel load	25 (T) 25 (C)	28 (T) 28 (C)	23 (C) 23 (T)
Warping stress (summer)	8 (C) 8 (T)	9 (C) 9 (T)	10 (C) 10 (T)
Warping stress (winter)	6 (T) 6 (C)	7 (T) 7 (C)	8 (T) 8 (C)
Frictional stress (summer)	0	5 (C)	5 (C)
Frictional stress (winter)	0	4 (T)	4 (T)

Tension is critical in concrete slab,

So, combinations are:

$$\text{At corner (top)} = 25 + 6 = 31 \text{ kg/cm}^2$$

$$\text{At edge (top)} = 28 + 7 + 4 = 39 \text{ kg/cm}^2$$

$$\text{at interior (bottom)} = 23 + 10 + 4 = 37 \text{ kg/cm}^2$$

$\because$ Warping stress depends on daily variation.

38. (c)

For vehicle negotiating on a curve,

$$\frac{P}{W} = \frac{e+f}{1-ef} = \frac{\tan\theta + f}{1 - \tan\theta \cdot f}$$

R = 250 m, V = 250 kmph = 69.44 m/s, θ = 30°, tanθ = 0.577

$$\therefore \quad \frac{mv^2}{R.(mg)} = \frac{0.577+f}{1-(0.577)f}$$

$$\Rightarrow \quad \frac{(69.44)^2}{9.81\times 250} = \frac{0.577+f}{1-0.577\times f}$$

$$\Rightarrow \quad (1.97)\ (1 - 0.577 \times f) = 0.577 + f$$

$$\Rightarrow \quad 1.97 - 0.577 = f\,(1 + 1.97 \times 0.577)$$

$$\Rightarrow \quad 1.393 = (2.14)f$$

$$\Rightarrow \quad f = 0.65$$

39. 10 (10 - 10)

Braking distance of vehicle for travelling upgrade,

$$S_1 = \frac{V^2}{254(f+0.01n)}$$

Braking distance of vehicle for travelling downgrade

$$S_2 = \frac{V^2}{254(f-0.01n)}$$

Given, $S_2 = 2S_1$

$$\Rightarrow \quad \frac{1}{(f-0.01n)} = \frac{2}{f+0.01n}$$

$$\Rightarrow \quad 2f - 0.02\,n = f + 0.01\,n$$

$$\Rightarrow \quad n = \frac{f}{0.03} = \frac{0.3}{0.03} = 10\%$$

40. 99 (98 to 101)

Normal flow on road A, q_a = 600 PCU/hr

Normal flow on road B, q_b = 400 PCU/hr

Saturation flow on road A, S_a =1600 PCU/hr

Saturation flow on road B, S_b =1200 PCU/hr

All red time, R = 12 sec.

Number of phases, n = 2

Critical flow ratio, $$y_a = \frac{q_a}{S_a} = \frac{600}{1600} = 0.375$$

$$y_b = \frac{q_b}{S_b} = \frac{400}{1200} = 0.333$$

$$Y = y_a + y_b = 0.375 + 0.333 = 0.708$$

Total lost time, $L = 2n + R = 2 \times 2 + 12 = 16$ sec.

Optimum cycle time, $$C_o = \frac{1.5L+5}{1-Y}$$

$$= \frac{1.5\times 16+5}{1-0.708} = 99.315 \text{ sec} \simeq 99 \text{ sec}$$

($\because$ Least count of any clock is one second)

41. (b)

Camber is provided to drain rain water from the surface of pavement. Therefore higher the absorbing capacity of surface, higher will be the camber required to drain water quickly. So correct sequence in order of steepness of camber is :

Cement Concrete roads < Bituminous high speed roads < WBM roads < Gravel roads.

42. 22.50 (22.00 - 23.00)

$\because$ Rolling resistance, $P = \dfrac{\mu W}{R}$

where, R = Radius of wheel, W = Weight of freight car

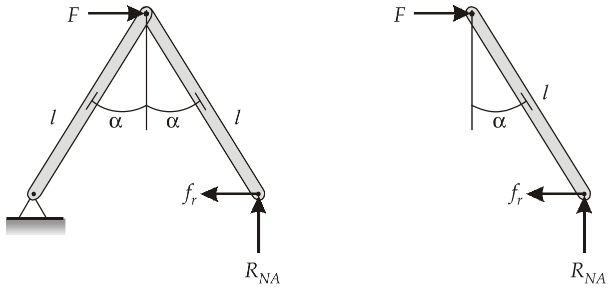
$\therefore$ Coefficient of rolling resistance,

$$\mu = \frac{PR}{W} = \frac{30 \times 750}{1000 \times 10^3} = 0.0225 \text{ mm}$$

$$= 22.5 \times 10^{-3} \text{ mm}$$

43. (a)

Note that the condition of impending slip does not necessarily apply. The moments about the left pin support must be zero.



$$\Sigma M = 0,$$

$$\Rightarrow -Fl\cos\alpha + 2R_{NA}\, l\sin\alpha = 0$$

$$\Rightarrow R_{NA} = \frac{F}{2\tan\alpha} \quad \text{...(i)}$$

Isolate the right bar and take moments about the upper pin joint:

$$\Sigma M = 0,$$

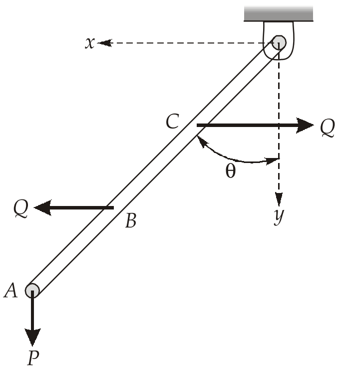
$$\Rightarrow R_{NA}\, l\sin\alpha - f_r\, l\cos\alpha = 0$$

$$\Rightarrow f_r = R_{NA}\tan\alpha$$

Substituting R_{NA} from equation (i), we get

$$f_r = R_{NA}\tan\alpha = \frac{F\tan\alpha}{2\tan\alpha} = \frac{F}{2}$$

44. (c)



We have $x_c = a\sin\theta$

$\delta x_c = a\cos\theta\,\delta\theta$

$$\left.\begin{aligned} x_B &= 2a\sin\theta \\ \delta x_B &= 2a\cos\theta\,\delta\theta \end{aligned}\right\}$$

$$\left.\begin{aligned} y_A &= 3a\cos\theta \\ \delta y_A &= -3a\sin\theta\,\delta\theta \end{aligned}\right\}$$

Virtual work: We note that P tends to increase y_A and Q at B tends to increase x_B, while Q at C tends to decrease x_c. From principle of virtual work, work done by external forces is equal to change in internal energy of the system.

$$\therefore \quad \delta U = P\,\delta y_A + Q\delta x_B - Q\delta x_C = 0$$

$$\Rightarrow \quad -P(3a\sin\theta\,\delta\theta) + Q(2a\cos\theta\,\delta\theta) - Q(a\cos\theta\,\delta\theta) = 0$$

$$\Rightarrow \quad Q\cos\theta = 3P\sin\theta$$

$$\Rightarrow \quad Q = 3P\tan\theta$$

Alternatively,

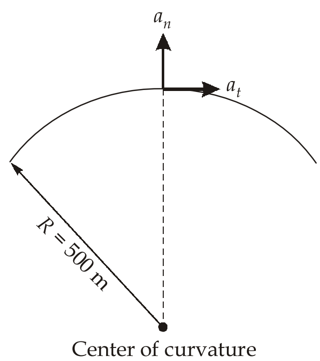
$$\Sigma M_D = 0 \qquad (\because \text{ End } D \text{ is hinged})$$

$$\Rightarrow P(3a\sin\theta) + Q(a\cos\theta) = Q(2a\cos\theta)$$

$$\Rightarrow \quad 3P\sin\theta = Q\cos\theta$$

$$\Rightarrow \quad Q = 3P\tan\theta$$

45. **5 (5 - 5)**



$$\text{Speed after 20 sec} = \frac{72}{3.6} = 20 \text{ m/s}$$

$$\text{Initial speed} = 0 \text{ m/s}$$

$$\therefore \quad \text{Tangential acceleration, } a_t = \frac{20-0}{20} = 1 \text{ m/s}^2$$

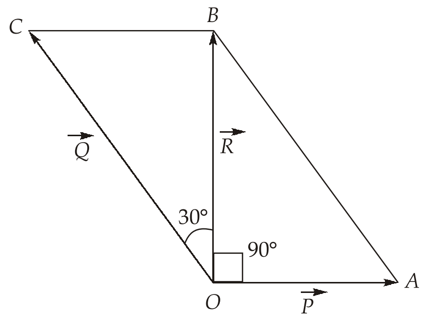
Now speed after 10 sec from start = 10 × 1 = 10 m/s

$$\text{Normal acceleration, } a_n = \frac{V^2}{R}$$

$$= \frac{10^2}{500} = 0.2 \text{ m/s}^2$$

$$\therefore \quad \text{Required ratio, } \frac{a_t}{a_n} = \frac{1}{0.2} = 5$$

46. **5 (5 to 5)**



In the triangle OCB,

$$\cos 30° = \frac{R}{Q} = \frac{R}{10}$$

$$\Rightarrow \quad R = 10\cos 30°$$

$$\sin 30° = \frac{P}{Q}$$

$$\Rightarrow \quad P = Q \sin 30°$$

$$\Rightarrow \quad P = 5 \text{ N}$$

47. (a, b, d)

Objectives of river training are high water training: So that high flood discharge may pass safely.

Mean water training : To have efficient disposal of sediments.

Low water training : To provide sufficient depth of navigation during low weather season.

To reduce bank erosion and make the river course stable.

48. (a, d)

Although a channel in true regime attain semi-elliptical cross-section, its equation is not provided by lacey. Thus for design purpose we may assume channel to be trapezoidal with side slopes 0.5H : 1V.

49. (b, c, d)

For calculating temperature stress factors considered are:

(i) Maximum temperature difference between top and bottom of slab

(ii) Slab width

(iii) Slab length

(iv) Coefficient of thermal expansion of concrete per degree Celsius

(v) Modulus of elasticity of concrete

(vi) Poisson's ratio

50. (b, c, d)

The criteria for sag vertical curve are:

(i) Comfort condition

(ii) Head light sight distance

(iii) Drainage at lowest point

(iv) Aesthetic consideration

■■■■