CLASS TEST

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HIGHWAY ENGINEERING

CIVIL ENGINEERING

Date of Test : 27/07/2026

ANSWER KEY

1.	(c)	7.	(a)	13.	(c)	19.	(c)	25.	(a)
2.	(a)	8.	(c)	14.	(a)	20.	(c)	26.	(d)
3.	(b)	9.	(d)	15.	(d)	21.	(d)	27.	(d)
4.	(a)	10.	(a)	16.	(b)	22.	(a)	28.	(c)
5.	(c)	11.	(a)	17.	(a)	23.	(a)	29.	(c)
6.	(b)	12.	(c)	18.	(d)	24.	(a)	30.	(d)

DETAILED EXPLANATIONS

1. (c)

Given: $V = 120$ kmph, $e = 0.07$ and $f = 0.15$

We know that, $$e + f = \frac{V^2}{127R}$$

$$\Rightarrow \quad 0.07 + 0.15 = \frac{120^2}{127R_{min}}$$

$$R_{min} = 515.40 \text{ m} \simeq 516 \text{ m}$$

2. (a)

Time taken during overtaking, $T = \sqrt{\frac{2(S_1+S_2)}{a}} = \sqrt{\frac{2(30+10)}{0.9}} = 9.428$ s

Speed of overtaken car,

$$V_b = V - 4.5 \text{ m/s}$$

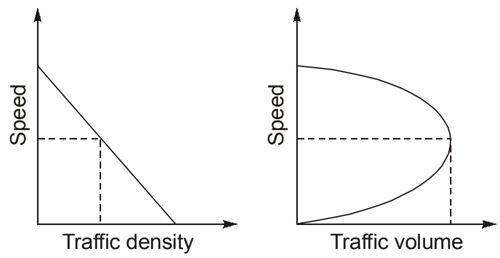
$$= \frac{90}{3.6} - 4.5 = 20.5 \text{ m/s}$$

$\therefore$ Distance travelled during overtaking, d_2

$$d_2 = V_b(T) + S_1 + S_2$$

$$= (20.5 \times 9.428) + 30 + 10 = 233.274 \text{ m} \simeq 234 \text{ m}$$

3. (b)



4. (a)

We know, $$\frac{\Delta}{2} = L\alpha\Delta T$$

$$\Rightarrow \quad \frac{2.5}{100 \times 2} = L \times 10 \times 10^{-6} \times 30$$

$$L = 41.67 \text{ m}$$

5. (c)

Hourly expansion factor $= \frac{25000}{5000} = 5$

6. (b)

Rulling gradient = 5%

Grade compensation $= \frac{30+R}{R} = \frac{30+50}{50} = 1.6\%$

Maximum limit of grade compensation $= \frac{75}{R} = \frac{75}{50} = 1.5\%$

$$\text{Compensated gradient} = 5 - 1.5 = 3.5\%$$

but it should not be less than 4%

$$\text{So, provided gradient} = 4\%$$

7. (a)

For bituminous concrete pavement,

$$\text{Cross slope} = 2\%$$

then, rise of crown with respect to edges

$$= \frac{7}{2} \times \frac{1}{50} = 0.07 \text{ m}$$

8. (c)

Psychological widening is given by

$$= \frac{V}{9.5\sqrt{R}} = \frac{80}{9.5\sqrt{250}} = 0.532 \text{ m}$$

9. (d)

$$\text{Density} = \frac{1000}{S} = \frac{1000}{40} = 25 \text{ vehicle/km}$$

$$u = 70 - 0.7 \times 25 = 52.5 \text{ km/hr}$$

11. (a)

With increase in bitumen content void content decreases.

12. (c)

$$\text{Space headway, } S = 0.278Vt + \frac{V^2}{254f} + L$$

$$= 0.278 \times 60 \times 2.4 + \frac{60^2}{254 \times 0.38} + 5$$

$$= 82.33 \text{ m}$$

$$\text{Capacity, } C = \frac{1000V}{S} = \frac{1000 \times 60}{82.33}$$

$$= 728.77 \simeq 728 \text{ vehicle/hour/lane}$$

13. (c)

Given: $h = 0.9$ m, $\beta = 1.2°$, $V = 90$ kmph, $f = 0.35$

$$N = |n_1 - n_2| = \left|\frac{1}{50} - \frac{1}{10}\right| = \frac{2}{25}$$

Assume $L > \text{HSD (or SSD)}$

$$\therefore \quad L = \frac{NS^2}{2h + 2S\tan\beta}$$

Now,

$$S = Vt + \frac{V^2}{2gf} = \frac{90}{3.6}(2.5) + \frac{\left(\frac{90}{3.6}\right)^2}{2 \times 9.81 \times 0.35} = 153.51 \text{m}$$

$$\therefore \qquad L = \frac{\frac{2}{25}\times(153.51)^2}{2(0.9A)+2(153.51)\tan 1.2^\circ} = 229.04 \text{ m}$$

$$\Rightarrow \qquad L \simeq 229 \text{ m} > \text{SSD } (= 153.51 \text{ m}) \qquad \text{(OK)}$$

14. (a)

$$V = 60 \text{ kmph} = 16.66 \text{ m/s}$$

We know that, SSD = 260 m

$$\therefore \qquad \text{SSD} = Vt + \frac{V^2}{2g(\eta_b \times f - n\%)}$$

$$\Rightarrow \qquad 260 = 16.66\times 2.5 + \frac{16.66^2}{2\times 9.81\times(\eta_b\times 0.4 - n)}$$

$$\Rightarrow \qquad 218.35 = \frac{16.66^2}{2\times 9.81\times(0.8\times 0.4 - n)}$$

$$\Rightarrow \qquad 0.32 - n = 0.064$$

$$\Rightarrow \qquad n = 0.256$$

$$\therefore \qquad n\,\% = 25.6\%$$

15. (d)

Overtaking criterion is not considered in horizontal transition curve design.

16. (b)

Given: SD = 400 m; L_c = 320 m; $SD > L_c$

$$\therefore \qquad \frac{\alpha}{2} = \frac{180}{\pi}\times\frac{L_c}{2(R-d)} = \frac{180}{\pi}\times\frac{320}{2(270-1.95)} = 34.2^\circ$$

$$\therefore \text{ Set back distance,} \qquad m = R-(R-d)\cos\frac{\alpha}{2} + \frac{S-L}{2}\sin\frac{\alpha}{2}$$

$$\Rightarrow \qquad m = 270-(270-1.95)\cos(34.2^\circ) + \frac{400-320}{2}\sin(34.2^\circ)$$

$$\Rightarrow \qquad m = 70.78 \text{ m}$$

$\therefore$ Set back distance from inner edge = 70.78 – 2(1.95) = 66.88 m

17. (a)

Assuming weight of specimen = W

Volume of specimen = V

$$\Rightarrow \qquad V = V_{CA} + V_{FA} + V_b + V_a$$

$$V = \frac{0.7W}{2.8} + \frac{0.24W}{2.66} + \frac{0.06W}{1} + 0.08\,V$$

$$0.92V = 0.25W + 0.0902W + 0.06\,W$$

$$\frac{W}{V} = 2.298$$

$$\therefore \qquad \frac{W}{V} = 2.298 \text{ gm/cm}^3$$

18. (d)
Space headway increases always but time headway first decreases and than starts increasing after an optimal value.

19. (c)

$$P(x) = \frac{e^{-\lambda t} \cdot (\lambda t)^x}{x!}$$

$$\lambda = \left(\frac{220}{60 \times 60}\right) \times \frac{\text{veh}}{\text{sec}} = 0.0611$$

$$t = 40 \text{ sec}; \quad x = 2$$

$$P(x = 2) = \frac{e^{-0.0611 \times 40} \times (0.0611 \times 40)^2}{2!} = 0.259$$

21. (d)

Normal flow on road A, q_a = 500 PCU/hr
Normal flow on road B, q_b = 300 PCU/hr
Saturation flow on road A, S_a = 1500 PCU/hr
Saturation flow on road B, S_b = 1000 PCU/hr
All red time, R = 16 sec
Number of phases, n = 2

$$y_a = \frac{q_a}{S_a} = \frac{500}{1500} = 0.33$$

$$y_b = \frac{q_b}{S_b} = \frac{300}{1000} = 0.3$$

$$Y = y_a + y_b = 0.33 + 0.3 = 0.63$$

Total lost time, $L = 2n + R = 2 \times 2 + 16 = 20$ sec.

Optimum cycle time, $C_o = \dfrac{1.5L + 5}{1 - Y} = \dfrac{1.5 \times 20 + 5}{1 - 0.63} = 94.59 \simeq 95 \text{ sec}.$

22. (a)
∴ Nothing is mentioned about dowel bars, therefore assuming dowel bars are not present.

∴ Spacing between contraction joints, $L_c = \dfrac{2S_c}{wf} \times 10^4$

⇒ $L_c = \dfrac{2 \times 0.8}{2400 \times 1.4} \times 10^4 = 4.76 \text{ m} \not> 4.50 \text{ m}$ (as per IRC)

23. (a)
Given: V = 100 kmph,
R = 400 m,
N = 150

Required superelevation,

⇒ $e = \dfrac{V^2}{225R} = \dfrac{100^2}{225 \times 400} = 0.11$

$e \leq 0.07$ for plain and rolling

Hence provide, $e = 0.07$

Since $R > 300$ m, extra widening is not required

Length of transition curve (L_t)= $\left(\dfrac{(w+w_e)eN}{2}\right)$ $\quad w_e = 0 \quad$ as R > 300 m

$$= \frac{(7 \times 0.07 \times 150)}{2} = 36.75 \text{ m}$$

24. (a)

Assume S is less than L

$$L = \frac{NS^2}{4.4}$$

$$N_1 = \frac{1}{50} = 0.02$$

$$N_2 = -\frac{1}{40} = -0.025$$

$$\therefore \quad N = N_1 - N_2 = 0.02 - (-0.025) = 0.045$$

$$\therefore \quad L = \frac{0.045 \times 180 \times 180}{4.4} = 331.36 \text{ m}$$

Hence assumption is correct.

Equation of parabola is,

$$y = \frac{Nx^2}{2L} = \frac{0.045x^2}{2 \times 331.36} = 6.79 \times 10^{-5} x^2$$

25. (a)

$$\text{The capacity of rotary, } Q_P = \frac{280w\left(1+\dfrac{e}{w}\right)\left(1-\dfrac{p}{3}\right)}{\left(1+\dfrac{w}{L}\right)}$$

$$w = 15 \text{ m}, p = 0.6, L = 75 \text{ m}, e = 5 \text{ m}$$

$$\Rightarrow \quad Q_p = \frac{280 \times 15 \times \left(1+\dfrac{5}{15}\right)\left(1-\dfrac{0.60}{3}\right)}{\left(1+\dfrac{15}{75}\right)} = 3733.33 \simeq 3733 \text{ PCU/hr}$$

26. (d)

As per Greenshield's model,

$$q_{max} = \frac{1}{4} U_o k_j$$

where,

$$k_J = \text{Jam density} = \frac{1000}{\text{Space headway}}$$

$$= \frac{1000}{L_v + S} = \frac{1000}{6.1 + 1.5} = 131.58 \text{ veh/km}$$

Put in equation (i),

$$\Rightarrow \quad 2200 = U_0 \times \frac{131.58}{4}$$

$$\Rightarrow \quad U_0 = 66.88 \text{ kmph}$$

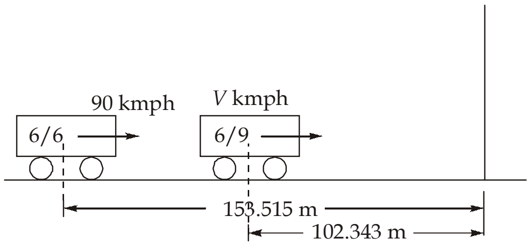
27. (d)

Safe stopping distance for 6/6 vision driver

$$SSD = vt + \frac{v^2}{2gf}$$

$$= \frac{90}{3.6}(2.5) + \frac{(90/3.6)^2}{2 \times 9.81 \times 0.35}$$

$$= 62.5 + 91.015 = 153.515 \text{ m}$$



For 6/9 vision driver, intersection will be visible, from 153.515 × 6/9 = 102.343 m

⇒ 6/9 vision driver will start reacting 102.343 m before intersection.

$$\Rightarrow \quad 102.343 = v(2.5) + \frac{v^2}{2 \times 9.81 \times 0.35}$$

$$\Rightarrow \quad 702.7894 = 17.1675v + v^2$$

$$\Rightarrow \quad v = 19.28 \text{ m/s}$$

$$\Rightarrow \quad V = 69.408 \text{ kmph} \simeq 70 \text{ kmph}$$

28. (c)

Design traffic is given by,

$$N = \frac{365 \times A\left[(1+r)^n - 1\right]}{r} \times \text{LDF} \times \text{VDF}$$

where, A = traffic in year of completion of construction in terms of CVD

r = annual growth rate

n = design life in years

LDF = lane distribution factor

VDF = vehicle damage factor

$$\therefore \quad N = \frac{365 \times 2100 \times \left[(1+0.08)^{16} - 1\right]}{0.08} \times 3 \times 0.75$$

$$N = 522.98 \times 10^5 \text{ standard axles}$$

29. (c)

Mean rate of arrival per unit time,

$$\lambda = \frac{100}{3600} = \frac{1}{36} \text{veh/second}$$

$$\text{Mean rate of service, } \mu = \frac{150}{3600} = \frac{1}{24} \text{veh/hour}$$

$$\text{Traffic intensity, } \rho = \frac{\lambda}{\mu} = \frac{\left(\frac{1}{36}\right)}{\left(\frac{1}{24}\right)} = \frac{24}{36} = \frac{2}{3}$$

Average time spent by the vehicle in the system,

$$\bar{d} = \frac{1}{\mu(1-\rho)} = \frac{1}{\frac{1}{24}\times\left(1-\frac{2}{3}\right)} = 72 \text{ seconds}$$

Average time spent by the vehicle in the queue,

$$\bar{w} = \frac{\rho}{\mu(1-\rho)} = \frac{\left(\frac{2}{3}\right)}{\frac{1}{24}\left(1-\frac{2}{3}\right)} = \frac{2}{3}\times 72 = 48 \text{ seconds}$$

Total time spent in the system and in queue = 72 + 48 = 120 seconds.

30. **(d)**

Plate correction, $k_1 a_1 = k_2 a_2$

$$\Rightarrow \quad 18\times\frac{60}{2} = k_2\times\frac{75}{2}$$

$$\Rightarrow \quad k_2 = 14.4 \text{ kg/cm}^3$$

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