

Road Traffic Engineering (315318)

Model Question Paper — Set A · Model Answers

Q.1

a) Define traffic engineering.

2 M

Traffic engineering is that phase of engineering which deals with the planning, geometric design and traffic operation of roads, streets and highways, their networks, terminals, abutting lands and their relationship with other modes of transportation, for achieving **safe, efficient and convenient movement** of persons and goods.

(Correct definition 2 M)

b) Four factors affecting reaction time.

2 M

1. **Physical condition of driver** — fatigue, sleepiness, illness and poor eyesight increase reaction time.
2. **Alcohol and drugs** — slow down perception and judgement; reaction time increases considerably.
3. **Age and experience** — young inexperienced and elderly drivers generally react slower; experience reduces reaction time.
4. **Complexity of the situation** — more choices / more objects to watch (busy intersections) need more time to decide.

(Any four, ½ M each)

c) Traffic volume and its units.

2 M

Traffic volume is the number of vehicles crossing a section of road per unit time at any selected period. It is expressed as vehicles per hour or vehicles per day; for mixed traffic it is converted into **Passenger Car Units (PCU)** per hour or per day.

Units: vehicles/hour, vehicles/day (ADT, AADT); for mixed traffic PCU/hour or PCU/day.

(Definition 1 M, units 1 M)

d) Methods of O-D survey.

2 M

1. Road-side interview method
2. Licence-plate method
3. Return post-card method
4. Tag on car method
5. Home interview method
6. Work-spot interview method

(Any four, ½ M each)

e) Parking accumulation and turnover.

2 M

i) Parking accumulation: the number of vehicles parked in the study area at a particular instant of time. It is shown by the accumulation curve (accumulation vs time).

ii) Parking turnover: the ratio of the number of vehicles parked during the study period (parking volume) to the number of parking bays available; i.e. how many vehicles use one bay in that period.

(1 M each)

f) Foot-candle and lumen.

2 M

Foot-candle: unit of illumination (illuminance). It is the illumination on a surface placed at one foot distance from a uniform point source of one candle power (candela); it equals **one lumen per square foot**. 1 foot-candle = 10.764 lux (lux = lumen/m²).

Lumen: unit of luminous flux — the light flux emitted in a unit solid angle by a uniform point source of one candela.

(1 M each)

g) Four causes of road accidents.

2 M

1. Over-speeding and rash driving.
2. Drunken driving / fatigue of driver.
3. Defects in vehicle — brake failure, tyre burst, poor lights.
4. Bad road conditions — slippery surface, potholes, sharp curves, poor sight distance.
5. Bad weather — fog, heavy rain.
6. Careless pedestrians, stray animals, improper parking.

(Any four, ½ M each)

Q.2

a) PIEV theory with sketch.

4 M

PIEV theory: According to PIEV theory, the total reaction time of a driver is split into four parts:

1. **Perception (P):** time taken to see / sense the object or situation through the eyes and to transmit the sensation to the brain.
2. **Intellection (I):** time required to understand and identify the situation by comparing with past experience (new thoughts and ideas).
3. **Emotion (E):** time spent in emotional sensation and judgement — fear, anger, superstition, impatience — before reaching a decision (whether to stop, swerve or horn).
4. **Volition (V):** time for the will to act — the final action such as applying the brake or turning the steering wheel.

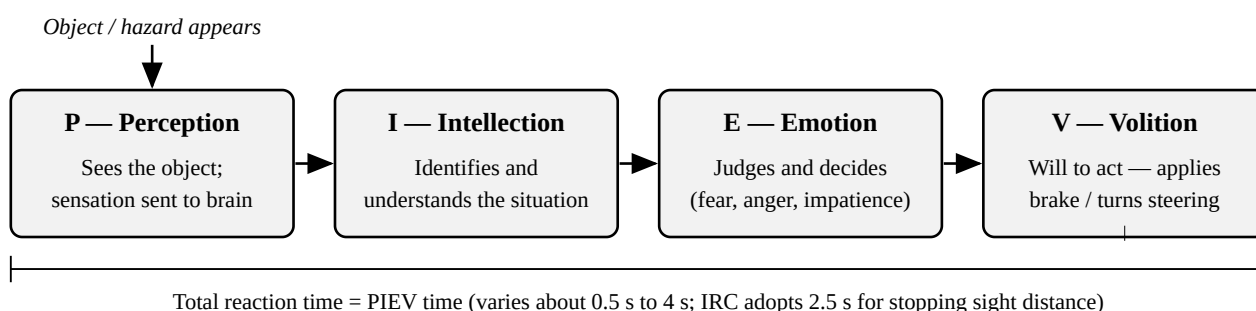


Fig.: PIEV theory — sequence of driver reaction

Total PIEV time varies from about 0.5 s to 4 s depending on the driver and situation. For design of stopping sight distance, IRC adopts a total reaction time of **2.5 s**.

(Explanation of four stages 2 M, sketch 1 M, value of reaction time 1 M)

b) Purposes of traffic volume study.

4 M

1. To find the relative importance of a road and decide priority of improvement and classification of the road.
2. To decide the number of lanes, width of carriageway and other geometric design elements (design hourly volume).
3. To design intersections — channelisation, rotaries, signal timing and turning lanes (from turning-movement counts).
4. For structural (pavement) design — number of commercial vehicles per day.
5. To study traffic trends and forecast future traffic for planning and economic studies.
6. To find capacity and level of service of a road and identify congested sections.

(Any four purposes, 1 M each)

c) Necessity of O-D study; road-side interview method.

4 M

Necessity:

- To plan a new road network and decide the most suitable routes (desire lines) of travel.
- To decide whether existing roads are adequate or need improvement.
- To plan bypasses, ring roads and expressways (to separate through traffic from local traffic).
- To locate terminals, parking facilities, bus stops and bus routes.

Road-side interview method:

1. The study area is divided into zones and a cordon line is drawn; interview stations are set up on the roads crossing the cordon.
2. Vehicles are stopped (a sample, at random) with the help of police, and trained interviewers ask the driver the **origin, destination, purpose of trip, route, type of vehicle and number of passengers**.
3. Information is recorded on printed forms; counts of total traffic are taken simultaneously to expand the sample.
4. Data are analysed into an O-D matrix and shown by desire lines. The method is quick and reliable, but causes delay to traffic.

(Necessity 2 M, method 2 M)

d) Ill effects of on-street parking.

4 M

1. **Congestion:** parked vehicles reduce the effective width of carriageway and the capacity of the road; traffic speed reduces and delays increase.
2. **Accidents:** vehicles coming out of / going into parking, opening of doors, pedestrians emerging suddenly from behind parked vehicles cause accidents; parked vehicles near junctions block sight distance.
3. **Obstruction to emergency vehicles:** fire tenders and ambulances cannot reach buildings in time; fire hydrants get blocked.
4. **Environmental effects:** searching for parking, frequent stop-start and idling increase fuel consumption, air and noise pollution.
5. **Obstruction to pedestrians:** vehicles parked on footpaths force pedestrians to walk on the carriageway.

(Any four, 1 M each)

Q.3

a) Spot speed study; use of percentile speeds.

4 M

Spot speed is the instantaneous speed of a vehicle at a specified location (spot) of the road. A spot speed study gives the speed distribution of the traffic stream at that point.

Methods of measurement:

- **Stop-watch (long base) method:** a known base length (about 30 m to 90 m) is marked; time taken to cover it is noted with a stop-watch; speed = distance / time.
- **Enoscope (mirror box):** an L-shaped mirror box makes the start of the base visible to the observer at the other end, so the time is recorded accurately.
- **Pressure contact tubes / detectors:** two road tubes or loops at a short distance record the time difference automatically.
- **Radar / laser speed meter:** direct reading of instantaneous speed using the Doppler principle.

The data are presented as a frequency table, histogram and cumulative speed distribution curve.

Use of percentile speeds:

- **85th percentile speed:** 85 % of vehicles travel at or below this speed — used as the upper (safe) speed limit.
- **98th percentile speed:** used for the **geometric design** speed of the road.
- **15th percentile speed:** used as the **minimum speed limit** on expressways / high-speed roads (lower limit).
- **Modal speed:** the speed range in which the largest number of vehicles travel.

(Description with methods 2 M, use of percentile speeds 2 M)

b) Applications of ITS in traffic management.

4 M

Intelligent Transportation System (ITS) is the application of advanced information, communication, sensor, electronics and computer technologies to roads and vehicles, in order to

improve the **safety, efficiency, mobility and environmental performance** of the transportation system.

1. **Advanced Traffic Management System (ATMS):** adaptive (area) traffic signal control, incident detection, CCTV surveillance, ramp metering.
2. **Advanced Traveller Information System (ATIS):** variable message signs, real-time route guidance, travel-time information on mobile apps.
3. **Advanced Public Transport System (APTS):** GPS tracking of buses, passenger information at stops, smart cards.
4. **Electronic Toll Collection (ETC):** RFID based FASTag at toll plazas — vehicles pay without stopping.
5. **Commercial Vehicle Operation (CVO):** fleet tracking, weigh-in-motion to check overloading, e-way bills.
6. **Advanced Vehicle Control System (AVCS):** collision warning, adaptive cruise control, lane-departure warning.

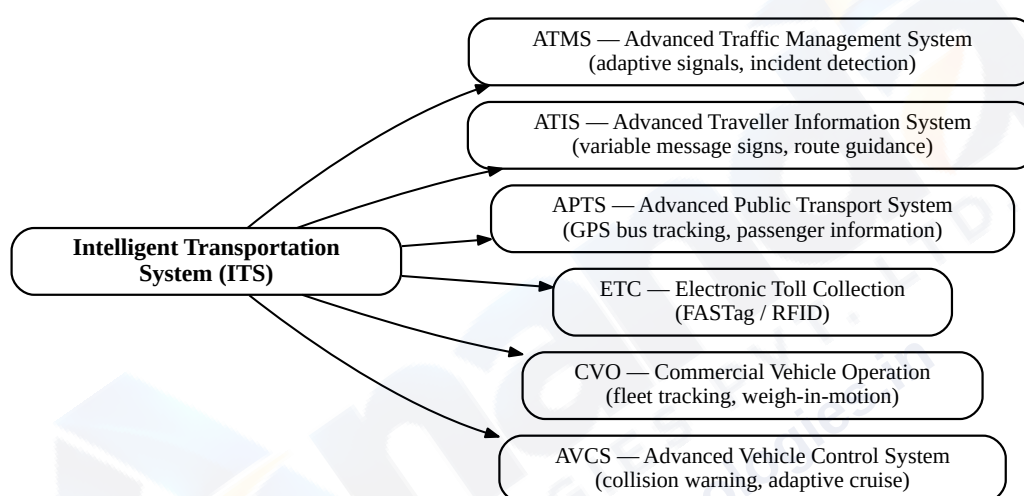


Fig.: Components / applications of Intelligent Transportation System (ITS)

(Any four applications, 1 M each)

c) Parking space requirement as per IRC.

4 M

IRC:SP:12-2015 (Guidelines for Parking Facilities in Urban Areas) recommends parking spaces according to occupancy (land use) and the population of the city:

Recommended parking: one car space (ECS) for every ... (IRC:SP:12-2015, Table 7.1 — source NBC 2005 / MPD 2021)

Occupancy / city population →	< 50,000	50,000 – 2 lakh	2 – 10 lakh	10 – 50 lakh	> 50 lakh
Business offices (private)	300 m ²	200 m ²	100 m ²	50 m ²	25 m ²
Public / semi-public offices	500 m ²	300 m ²	200 m ²	100 m ²	50 m ²
Hospitals (private)	20 beds	25 beds	10 beds	5 beds	2 beds
Hospitals (public)	30 beds	25 beds	15 beds	10 beds	5 beds
Cinema / assembly halls	120 seats	80 seats	25 seats	15 seats	10 seats

Restaurants	60 seats	40 seats	20 seats	10 seats	5 seats
-------------	----------	----------	----------	----------	---------

Example: in a city of 10 to 50 lakh population — one car space per 50 m² of private office floor area, per 5 beds of a private hospital, per 15 seats of a cinema and per 10 seats of a restaurant. Size of one car parking stall = 2.5 m × 5.0 m. Other vehicles are converted into equivalent car spaces (ECS): two-wheeler 0.25, auto-rickshaw 0.5, bicycle 0.1, truck/bus 2.5.

(Any four occupancies with correct values 4 M)

d) Street lighting — definition and necessity.

4 M

Street lighting is the artificial illumination of roads and streets at night by lamps (luminaires) mounted on poles, so that road users can see the road, obstacles, vehicles and pedestrians quickly, clearly and comfortably.

Necessity:

1. Reduces night-time accidents by improving visibility of obstacles, pedestrians and road edges.
2. Increases speed and comfort of night driving; drivers feel confident.
3. Increases the night-time capacity of roads.
4. Reduces crime (theft, robbery) and gives a sense of security to pedestrians.
5. Helps in identifying junctions, curves, signs and house numbers.

(Definition 1 M, any three points of necessity 3 M)

Q.4

a) Essential road characteristics.

4 M

- **Gradient:** Steep gradient reduces the speed of heavy vehicles going up, increases braking distance and accident risk going down; ruling gradients are fixed according to terrain.
- **Curves (horizontal and vertical):** Sharp curves reduce safe speed and sight distance; proper radius, super-elevation, extra widening and transition curves are required.
- **Design speed:** All geometric elements (sight distance, curve radius, super-elevation, gradient) depend on the design speed of the road.
- **Friction between road and tyre:** Skid resistance of the pavement surface decides stopping distance and safe speed on curves; wet, smooth or oily surfaces reduce friction.

Other characteristics: width of carriageway, pavement surface condition, sight distance, camber and lighting.

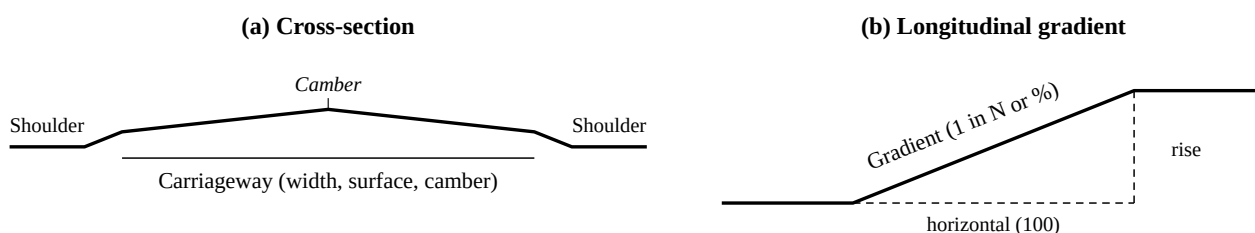


Fig.: Road characteristics — cross-section and longitudinal gradient

(Any four characteristics, 1 M each)

b) Factors affecting visibility at night.

4 M

1. **Amount and distribution of light:** uniform illumination of the road surface is needed; dark patches hide objects.
2. **Brightness contrast:** an object is seen mainly by **silhouette** — dark object against a bright road background; poor contrast reduces visibility.
3. **Glare:** from headlights of opposite vehicles and badly designed lamps reduces the ability to see.
4. **Size, colour and reflectivity of object:** small, dark coloured objects and pedestrians in dark clothes are difficult to see.
5. **Reflection characteristics of road surface:** wet and dark bituminous surfaces reflect less light towards the driver.
6. **Speed of vehicle:** less time is available to see and react at high speed.

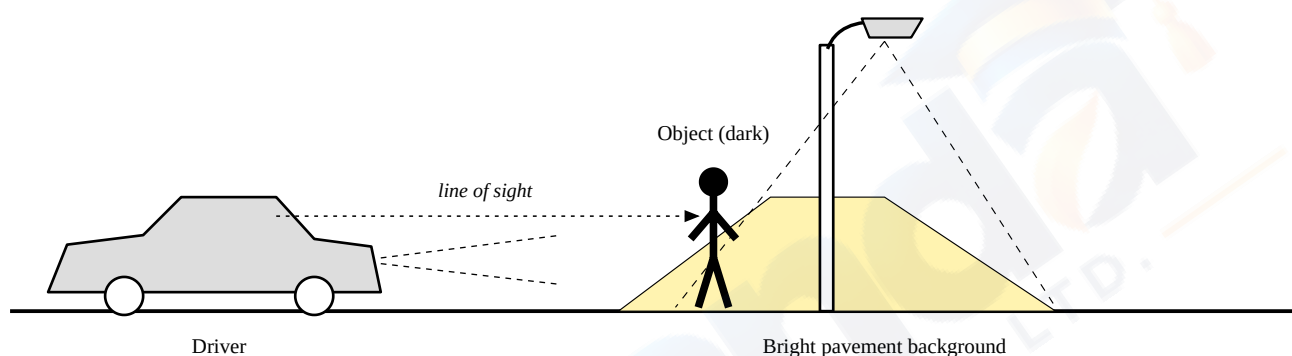


Fig.: Discernment by silhouette — dark object seen against bright road surface

(Any four factors, 1 M each)

c) Arboriculture — definition and objectives.

4 M

Arboriculture is the science and art of planting, cultivating, protecting, maintaining and managing trees, shrubs and other woody plants — here, the systematic plantation and care of trees along roads.

Objectives:

1. To provide shade and comfort to road users and pedestrians, and to protect the pavement from extreme heat.
2. To reduce air pollution (absorb dust and gases) and traffic noise.
3. To improve the beauty (aesthetics) of the road and surroundings.
4. To guide drivers along the alignment, especially at night and in fog.
5. To reduce headlight glare when planted on the median; act as wind-breaks.

(Definition 1 M, any three objectives 3 M)

d) Need and types of parking regulations.

4 M

Need:

- To keep the carriageway free for moving traffic and maintain road capacity.

- To improve safety — prohibit parking near intersections, bus stops, pedestrian crossings, curves and bridges.
- To distribute limited parking space fairly among users and increase turnover (more short-term parkers).
- To discourage long-term parking and private vehicle use in the central business district; encourage public transport.

Types:

1. **No-parking / prohibited zones** — near junctions, bus stops, bridges, hospitals, fire stations.
2. **Time-limited parking** — e.g. maximum 1 hour, or no parking during peak hours.
3. **Pay-and-park / metered parking** — charges increase with duration.
4. **Alternate-side (odd-even day) parking** — parking on one side on odd dates and other side on even dates.

(Need 2 M, any four types 2 M)

e) Sketches of types of collision.

4 M

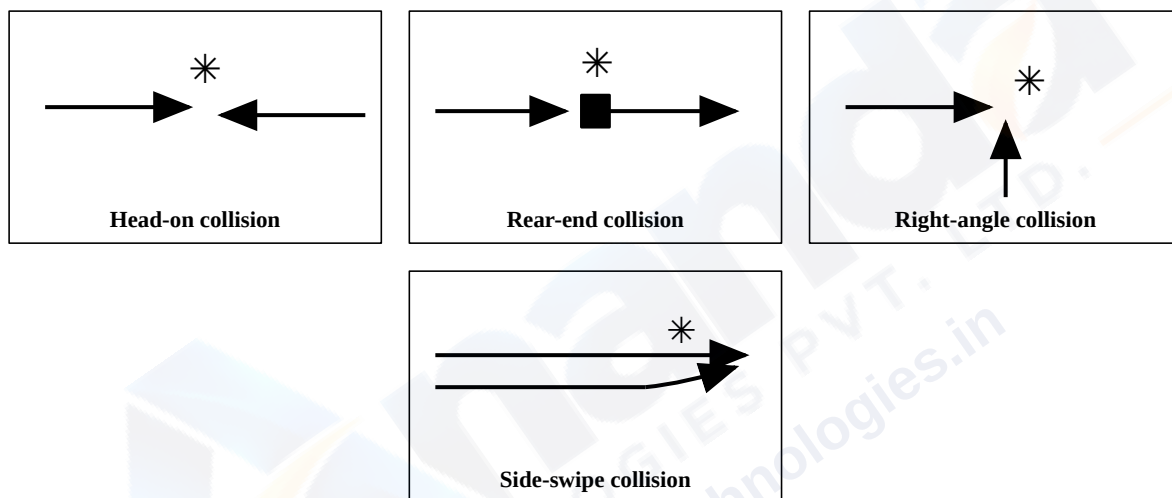


Fig.: Head-on, rear-end, right-angle and side-swipe collisions

- **Head-on collision:** vehicles moving in opposite directions hit front to front — usually during wrong overtaking on two-lane roads.
- **Rear-end collision:** a vehicle hits another vehicle from behind — due to sudden braking, inadequate gap.
- **Right-angle collision:** vehicles from two crossing roads collide at an intersection.
- **Side-swipe collision:** vehicles moving side by side touch each other while overtaking / lane changing.

(Each sketch with label 1 M)

Q.5

a) On-street parking facilities and layouts.

6 M

On-street (kerb) parking means parking of vehicles on the carriageway along the kerb of the street. It is cheap and convenient for short-term parkers, but reduces the road width available for moving traffic.

1. **Parallel parking:** vehicles parked along the kerb, one behind another. Needs the least width of road (about 2.5 m) but the largest kerb length per car (about 5.9 m). Least obstruction and safest for moving traffic.
2. **Angle parking (30°, 45°, 60°):** vehicles parked at an angle with the kerb. More cars per unit kerb length than parallel parking, but needs more road width; backing out into traffic is a hazard.
3. **Right-angle (90°) parking:** vehicles parked perpendicular to the kerb. Maximum number of cars per kerb length (2.5 m per car) but needs the greatest width (about 5 m) and is most hazardous on through roads.

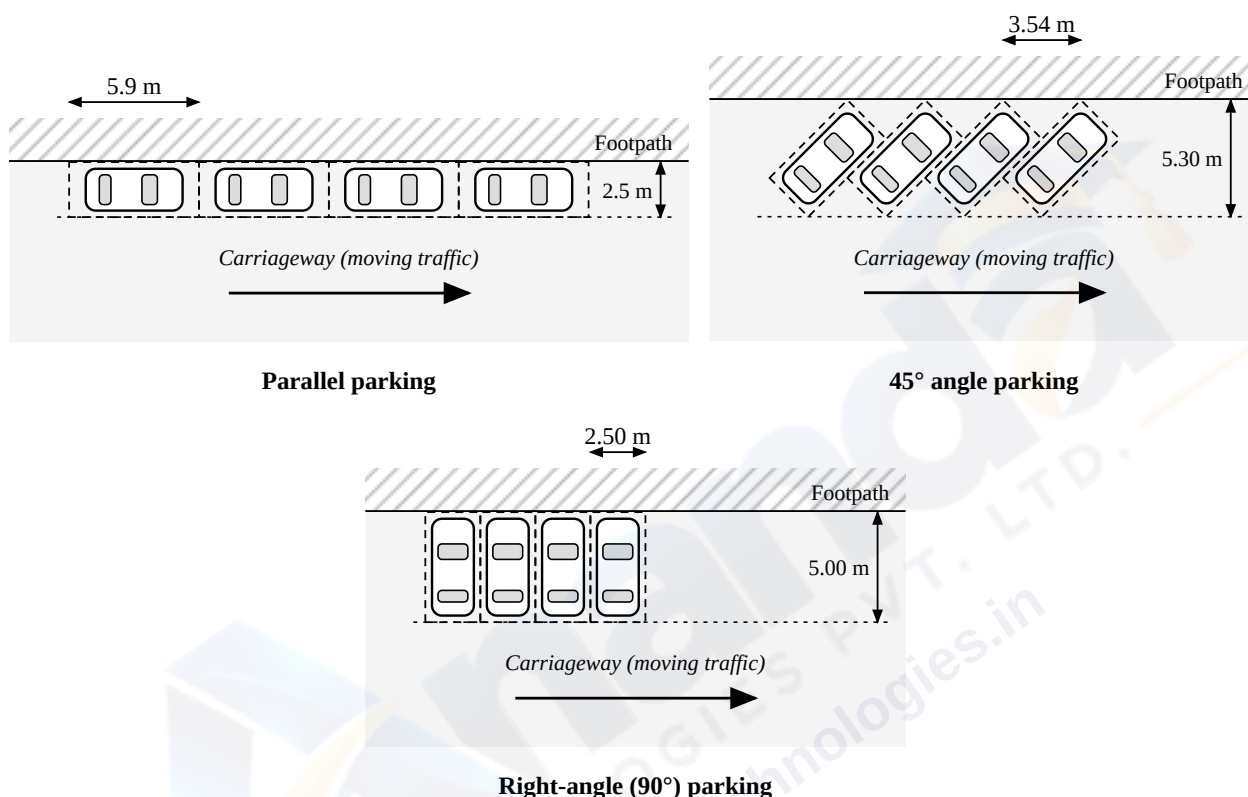


Fig.: Parallel, 45° and 90° on-street parking (dimensions per car, stall 2.5 m × 5.0 m)

Type	Kerb length per car (m)	Width occupied from kerb (m)	Cars per 100 m of kerb
Parallel	5.90	2.50	16.9
30°	5.00	4.67	20.0
45°	3.54	5.30	28.3
60°	2.89	5.58	34.6
90°	2.50	5.00	40.0

Computed for car stall 2.5 m × 5.0 m: kerb length = $2.5 / \sin \theta$, width = $5.0 \sin \theta + 2.5 \cos \theta$ (parallel parking: 5.0 m + manoeuvring space ≈ 5.9 m).

(Description 2 M, three layouts 3 M, kerb lengths 1 M)

b) Off-street parking methods with sketches.

6 M

Off-street parking is provided away from the carriageway in separate areas or buildings, so that the full road width is available for moving traffic.

1. **Surface car parks (parking lots):** open ground near the business area with marked stalls and aisles; cheapest and simplest.
2. **Multi-storey car parks:** ramp type (vehicles driven up ramps) or mechanical / automated (lifts, stack or puzzle systems); large capacity on small land area in CBD.
3. **Underground / basement parking:** below buildings, parks and plazas; saves surface land but needs ventilation, lighting and fire safety.
4. **Roof-top parking:** on roofs of large buildings and shopping malls with ramps or lifts.

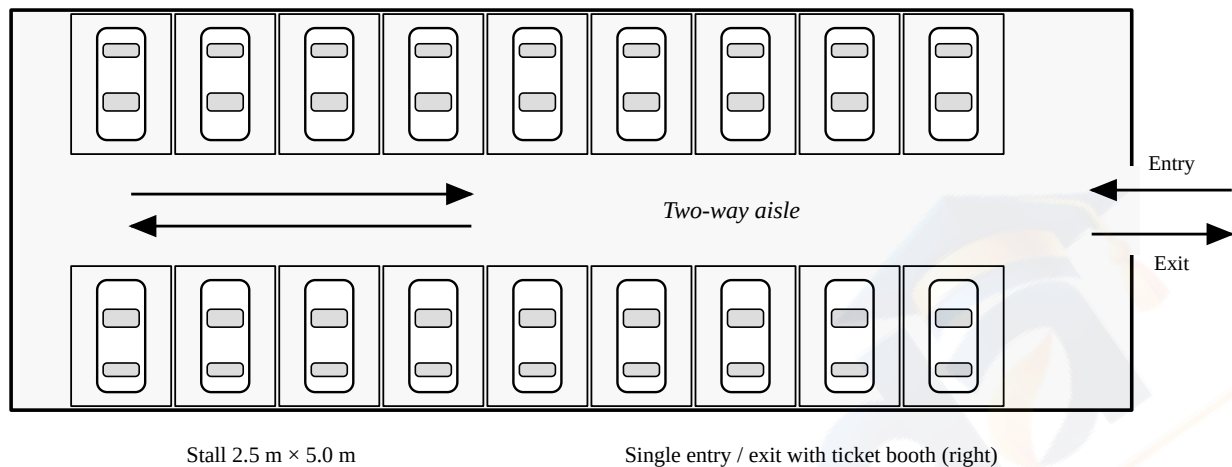


Fig.: Off-street surface car park (90° stalls on both sides of a two-way aisle)

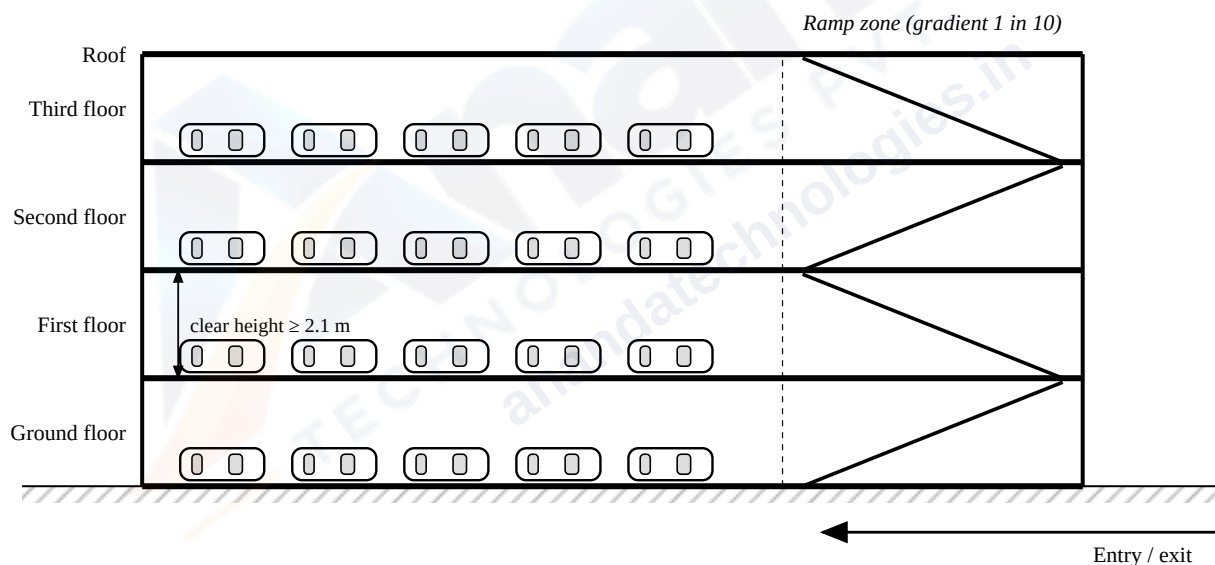


Fig.: Multi-storey car park (ramp type) — sectional elevation

(Any three methods 3 M, sketches 3 M)

c) Factors affecting selection of roadside trees.

6 M

1. **Climate and soil:** species suitable to local rainfall, temperature and soil should be selected.
2. **Root system:** deep, non-spreading roots which do not damage the pavement, drains and footpaths.
3. **Height and spread of crown:** should give good shade without obstructing sight distance, signs, lights or overhead wires; high clear trunk.

4. **Evergreen nature:** evergreen / semi-evergreen trees give shade throughout the year and less leaf litter.
5. **Strength of branches:** branches should not be brittle and should not break easily in storms.
6. **Rate of growth and life span:** fast growing in early years and long life.
7. **Nature of fruits and thorns:** trees with heavy fruits, thorns or attracting animals/people (fruit plucking) are avoided.
8. **Resistance:** resistant to pests, diseases, drought and pollution; low water requirement.
9. **Aesthetic value and availability:** attractive flowers / foliage; seedlings easily available locally.

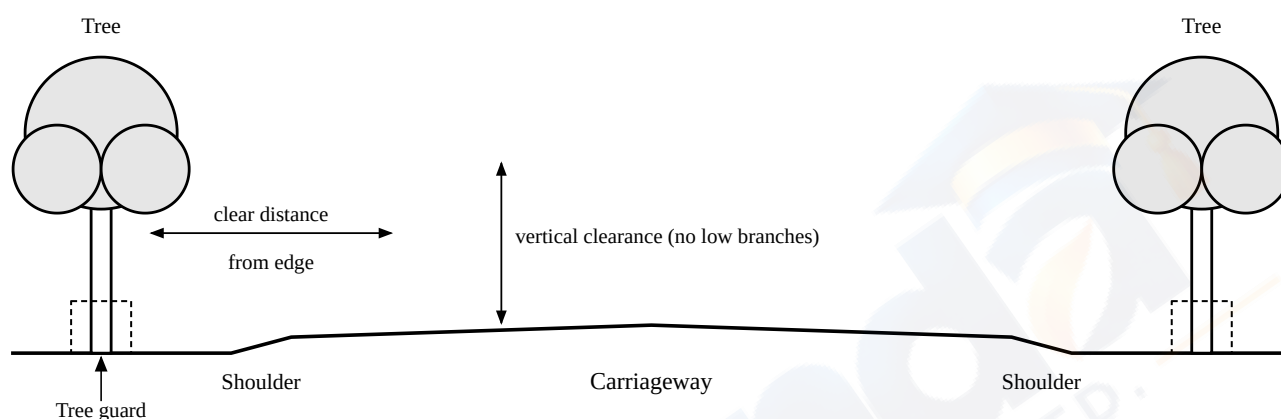


Fig.: Roadside tree plantation — typical cross-section (generic, not to scale)

(Any six factors, 1 M each)

Q.6

a) **Spot speed — cumulative curve, percentile speeds and mean.**

6 M

Step 1 — Cumulative frequency table: Mid speed = (lower + upper limit)/2; % frequency = $f / N \times 100$; cumulative % is plotted against the **upper limit** of each class.

Speed range (km/h)	Mid speed v (km/h)	No. of vehicles f	% frequency	Cumulative f	Cumulative %	f × v
20 – 30	25	7	4.38	7	4.38	175
30 – 40	35	16	10.00	23	14.38	560
40 – 50	45	38	23.75	61	38.12	1710
50 – 60	55	52	32.50	113	70.62	2860
60 – 70	65	30	18.75	143	89.38	1950
70 – 80	75	13	8.12	156	97.50	975
80 – 90	85	4	2.50	160	100.00	340
Total		160	100.00			8570

Step 2 — Mean (average) spot speed = $\Sigma(f \cdot v) / N = 8570 / 160 = 53.56 \text{ km/h}$. Modal class = 50 – 60 km/h (maximum frequency 52).

Step 3 — Cumulative speed distribution curve: plot cumulative % (Y-axis) against upper speed limit (X-axis) and join the points by a smooth curve. Draw horizontal lines from the required percentages to meet the curve and read the speeds on X-axis.

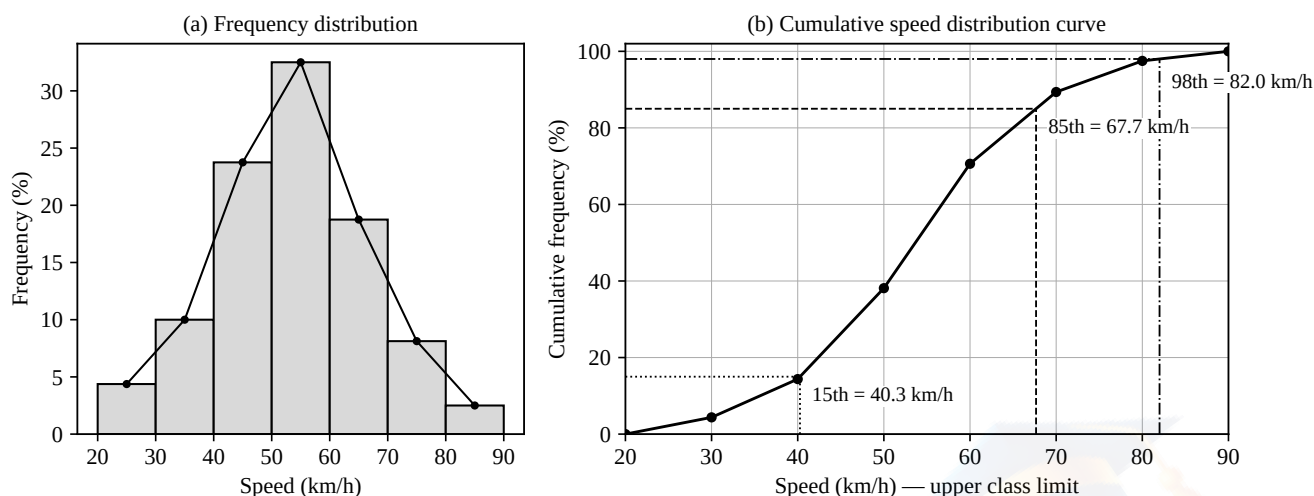


Fig.: Spot speed — frequency histogram and cumulative speed distribution curve

Step 4 — Values read from the curve (checked by linear interpolation between plotted points):

- **15th percentile speed:** 15 % lies between 14.38 % (40 km/h) and 38.12 % (50 km/h) → $V_{15} = 40 + (15 - 14.38) \times (50 - 40) / (38.12 - 14.38) = 40.26 \text{ km/h}$
- **85th percentile speed:** 85 % lies between 70.62 % (60 km/h) and 89.38 % (70 km/h) → $V_{85} = 60 + (85 - 70.62) \times (70 - 60) / (89.38 - 70.62) = 67.67 \text{ km/h}$
- **98th percentile speed:** 98 % lies between 97.50 % (80 km/h) and 100.00 % (90 km/h) → $V_{98} = 80 + (98 - 97.50) \times (90 - 80) / (100.00 - 97.50) = 82.00 \text{ km/h}$

Result: 85th percentile speed $\approx 67.7 \text{ km/h}$; a speed limit of about 70 km/h (rounded to the nearest 5 km/h) can be adopted for this section.

(Table 2 M, curve 2 M, percentile speeds and mean 2 M)

b) Collision diagram and condition diagram.

6 M

Collision diagram: A schematic diagram (not to scale) of the accident location on which each accident is shown by standard symbols — arrows indicate the paths of the vehicles / pedestrians involved, and symbols show the type of collision and severity (fatal, injury, property damage), with date, time and weather. It shows the **pattern of accidents** (e.g. many right-angle or rear-end collisions) at the location.

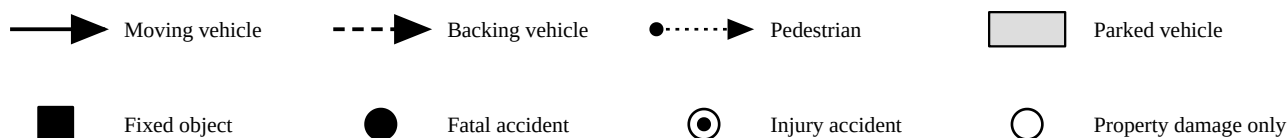


Fig.: Symbols commonly used in a collision diagram

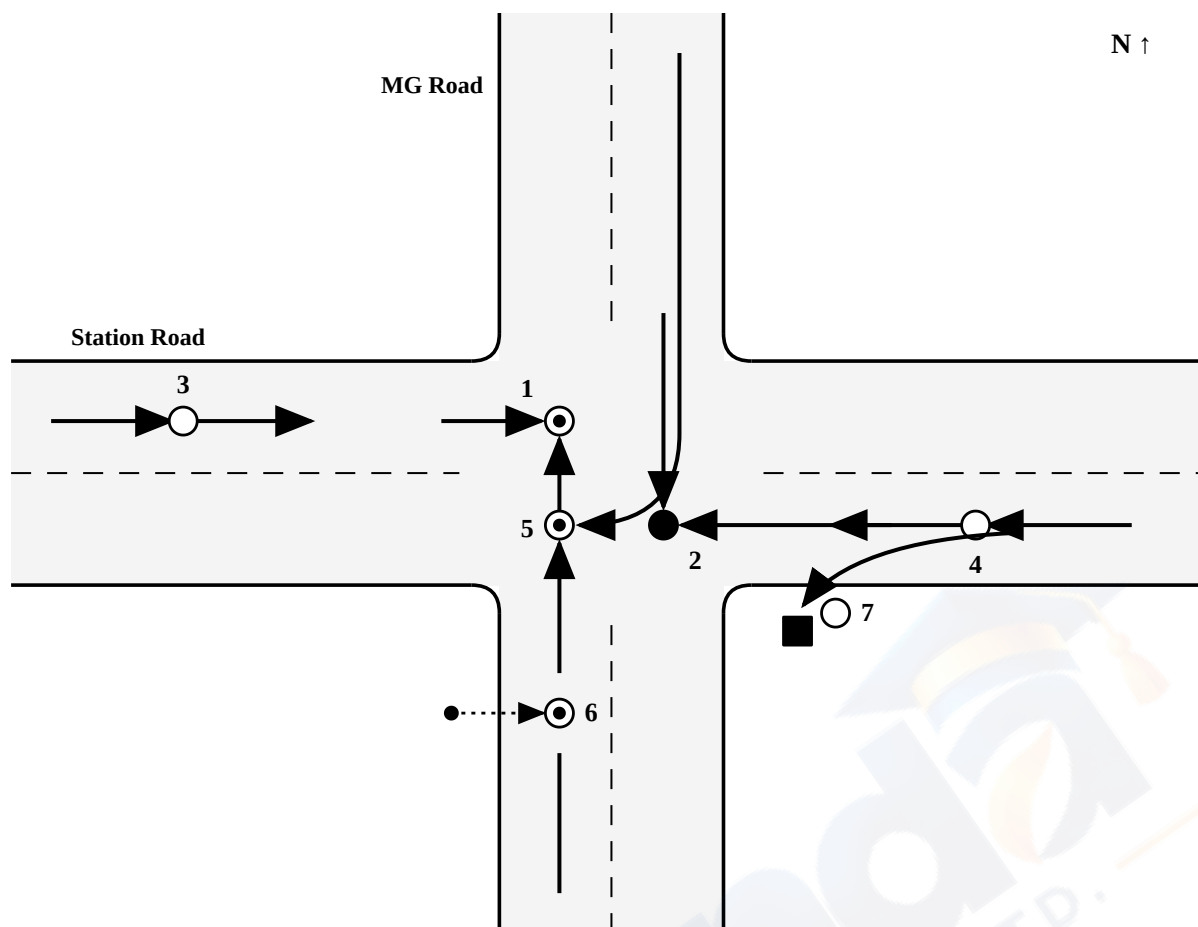


Fig.: Collision diagram — accidents 1 to 7 plotted at an intersection (schematic)

No.	Type of accident	Severity
1	Right-angle (eastbound × northbound)	Injury
2	Right-angle (westbound × southbound)	Fatal
3, 4	Rear-end on approaches	Property damage
5	Right-turn vs. through vehicle	Injury
6	Pedestrian hit on crossing	Injury
7	Hit lamp post (fixed object)	Property damage

Condition diagram: A drawing **to scale** of the accident location showing all the important **physical features** — carriageway and kerb lines, widths, footpaths, islands, traffic signs, signals, markings, street lights, bus stops, parking, driveways, buildings, trees and other obstructions to view, and surface condition.

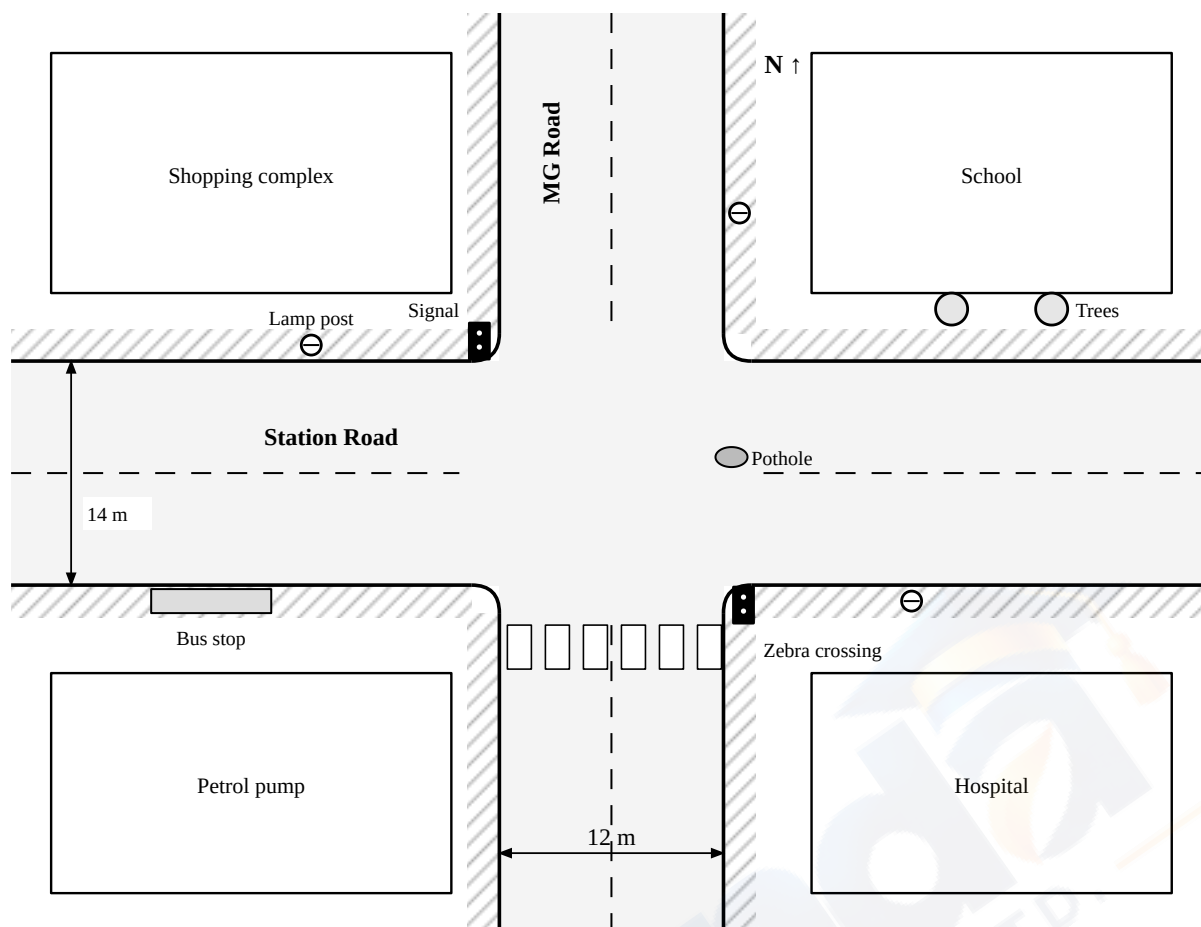


Fig.: Condition diagram of the same intersection (drawn to scale on site; sketch)

Use:

- Both diagrams are studied together to find the probable causes of repeated accidents at the location (accident-prone or "black spot").
- They help to select corrective measures — e.g. signal installation for right-angle collisions, skid-resistant surface for rear-end collisions, removal of sight obstructions.
- They are used to compare the accident pattern before and after improvements.

(Collision diagram 3 M, condition diagram 3 M)

c) Legislation, enforcement and education.

6 M

Road accidents are reduced by the combined action of the 3 E's — **Engineering, Enforcement and Education**. Legislation provides the legal basis for enforcement.

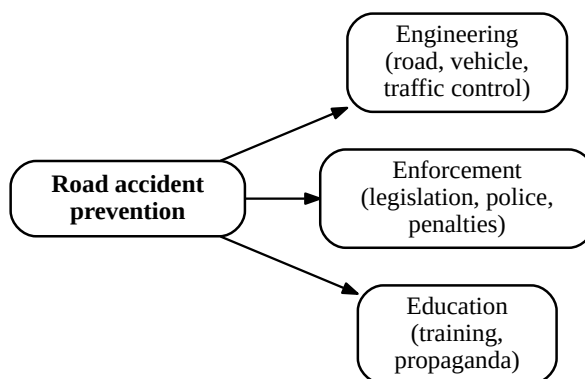


Fig.: The "3 E's" of road safety

1) Legislation: Motor Vehicles Act, 1988 (amended 2019) and Central Motor Vehicles Rules, 1989 lay down rules for driving licences, registration, fitness of vehicles, insurance, speed limits, helmets, seat belts, drunk driving, overloading and penalties. State rules and municipal bye-laws control parking and local traffic.

2) Law enforcement:

- Traffic police check speed (radar guns, cameras), drunk driving (breath analyser), helmets and seat belts.
- Strict tests before issue of driving licence; cancellation/suspension of licence of offenders.
- Periodic fitness checks of vehicles and control of overloading.
- CCTV and ANPR based e-challan for signal jumping and over-speeding; heavy fines act as deterrent.

3) Education and propaganda:

- Road safety education in schools and colleges (rules, signs, safe crossing).
- Training of drivers at driving schools; refresher courses for heavy vehicle drivers.
- Propaganda through TV, radio, newspapers, social media, posters, hoardings and films.
- Observing Road Safety Week / Month, campaigns and competitions.

(Legislation 2 M, enforcement 2 M, education 2 M)

Note: This is a **model question paper prepared by Ananda Technologies** only for practice and exam preparation, based on the pattern of previous MSBTE question papers and the K-scheme syllabus. It is **not an official MSBTE paper**, and it does **not** mean that these questions will come in the exam. Answers follow standard textbook points; marks shown are indicative. Free for students — anandatechnologies.in