Important Instructions to examiners:

1) The answers should be examined by key words 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 errors such as grammatical, spelling errors should not be given more importance. *(Not applicable for subject English and Communication Skills).*
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures 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 some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

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|---|---|
| 1. a) Attempt **any SIX** of the following | **12** |
| i) State the function of front axle. | 02 |
| Answer: **The functions of front axle : (***Any 02***)**<br>1) It supports the weight of front part of the vehicle.<br>2) It facilitates steering.<br>3) It absorbs shocks which are transmitted due to road surface irregularities.<br>4) It withstands cornering forces and braking torque etc.<br>5) If front axle is live, it transmits engine torque.<br>6) If front axle is live, it withstands torque reaction, driving thrust. | 02 |
| ii) State the function of drop arm and drag link. | 02 |
| Answer: **The functions of drop arm and drag link :**<br>When the steering wheel is turned, the swinging action of the drop arm imparts a near linear movement to the link rod. This movement is transmitted through the link rod arm to the knuckle arm and stub axle so as to turn the front wheel. | 02 |
| iii) What is brake fade? | 02 |
| Answer: **Brake fade**:<br>Brake fade is indication of the partial or total loss of braking power used in a vehicle brake system. It occurs when the brake pad and the brake rotor no longer generate sufficient mutual friction to stop the vehicle at its preferred rate of deceleration. Number of severe stops, holding the brakes on a long down hilling results into brake fading. | 02 |
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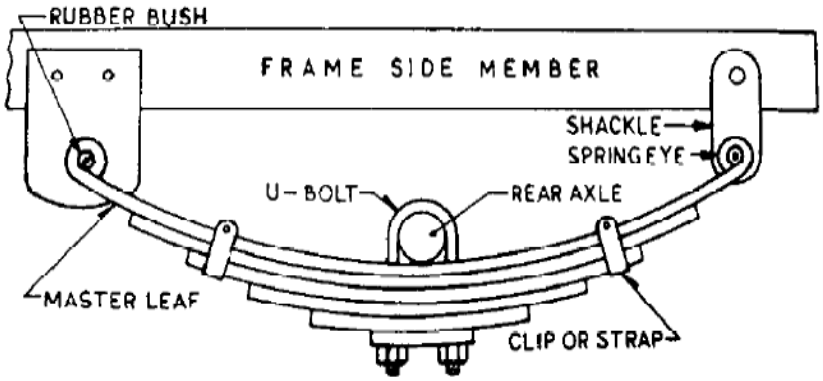
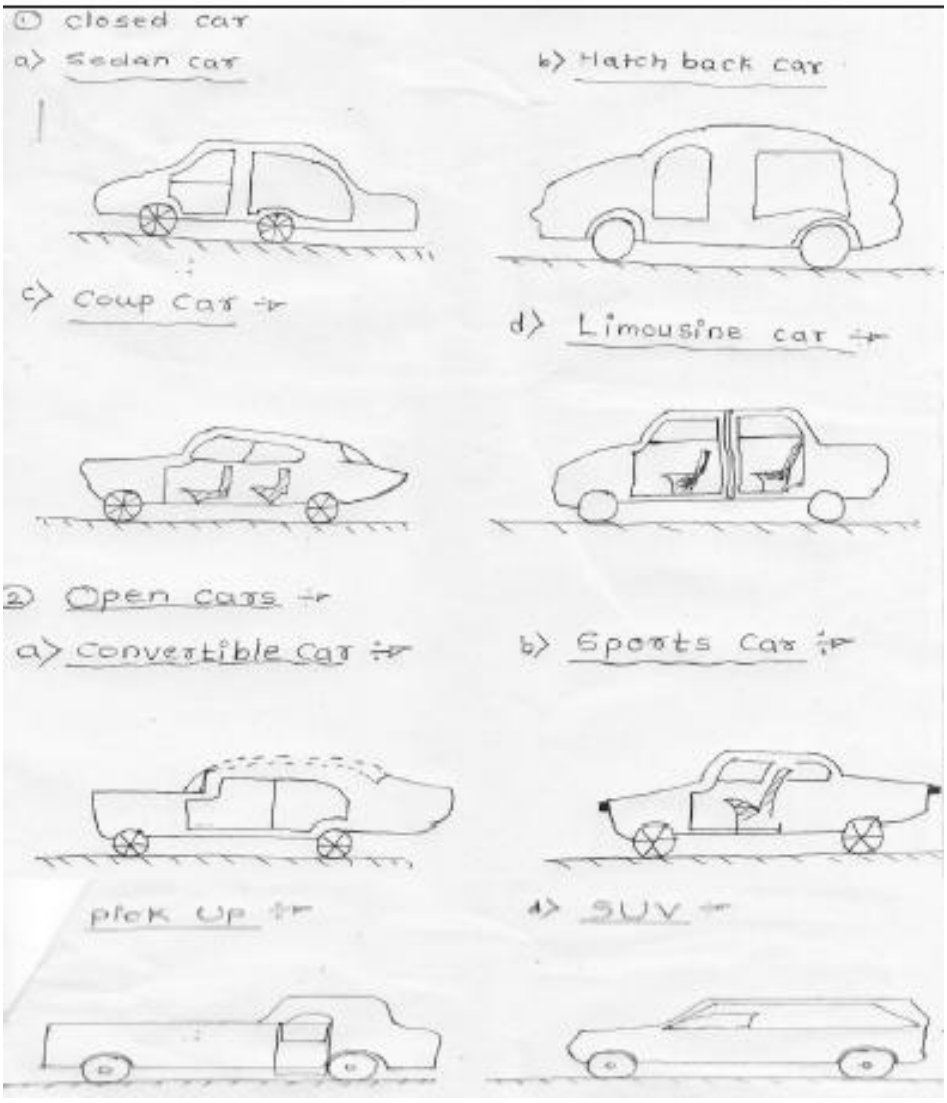
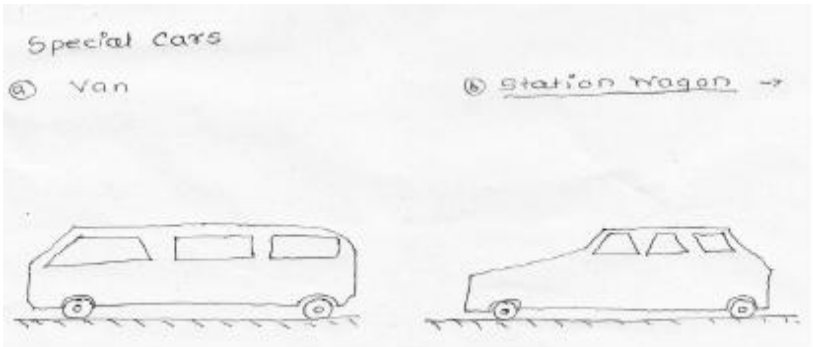
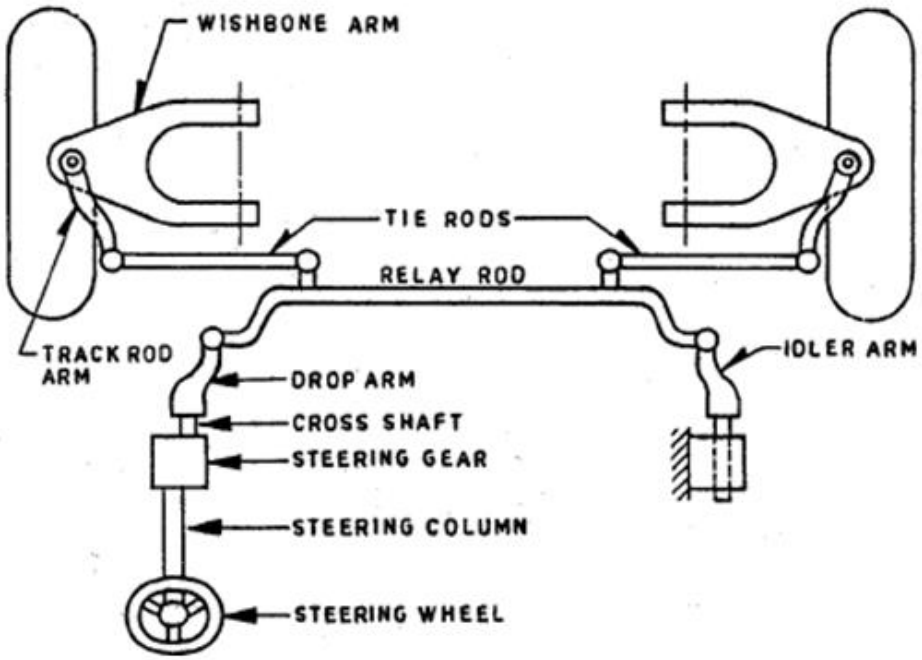
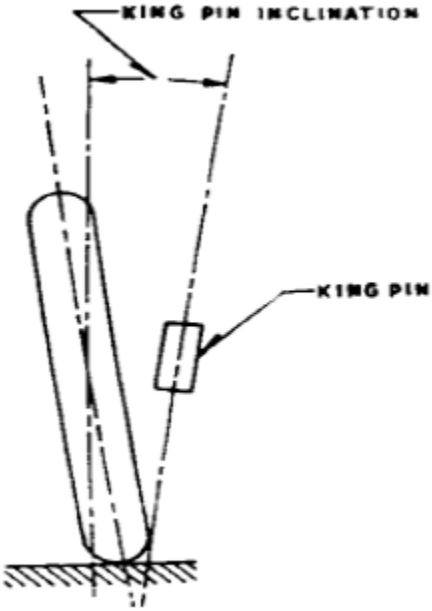
iv) State necessity of car air - conditioning system.	02
Answer: **Necessity of car air - conditioning system:** Due to varying conditions of heating, ventilating, cooling and dehumidification in the atmosphere at various places, the air conditioning of automobiles is very essential. To maintain human comfort & improve internal atmosphere in an enclosed space, proper control of freshness, temperature, humidity & cleanliness of the air is required.	02
v) Define gradient resistance and write its expression.	02
Answer: **Gradient Resistance:** It is force that opposing forward motion of vehicle on the gradient. It is expressed as $$R_g = W.G = mg.G = W.\sin\theta$$ Where, Rg = Gradient resistance in N W = mg = Weight of the vehicle in N. G = Gradient θ = Angle of gradient	01 01
vi) State any four components of hydraulic braking system.	02
Answer: **The components of hydraulic braking system are: (***Any 04- ½ mark each***)** 1) Brake pedal. 2) Master cylinder. 3) Oil reservoir. 4) Steel pipe lines, unions and flexible hoses 5) Wheel cylinder. 6) Brake shoe. 7) Disk or Drum brake.	02
vii) Draw a neat sketch of semi elliptical leaf spring and label it.	02
Answer:  Figure: Multileaf semi-elliptical leaf spring	02
viii) State requirements of steering system.	02
Answer: **Requirements of steering system**: (*Any 02*) 1. It should be very accurate and easy to handle. 2. It should provide directional stability. 3. It should multiply the turning effort applied on the steering wheel by the driver. 4. It should be irreversible to a certain degree so that the shocks of the road surface encountered by	02

the wheels are no transmitted to the driver's hands. 5. The mechanism should have self – righting effect so that when the driver releases the steering wheel after negotiating the turn, the wheel should try to achieve straight ahead position.	
1. b) Attempt **any TWO** of the following	**08**
i) Draw any four body styles used for cars.	04
Answer: **Body styles: (***Any 04-1mark each***)**   	04

ii) Describe aluminium and plastics as body materials.	04
Answer: **Aluminium :** Aluminium is used as a body material because of its better formability, lightness and anti rusting qualities, though its main disadvantage is lesser stiffness and rigidity. e. g. Pillars, frame work and paneling are all made out of aluminium sections and sheets. **Plastic:** Plastic is also popular material in body work. Thermoplastics are often used for components like boot coves, grills etc., where as thermosetting plastics are used for the body shells. The latest type of plastic used for body work is reinforced carbon fiber which is stronger that steel.	02 02
iii) Define : 1. Air resistance 2. Rolling resistance	04
Answer: 1) **Air resistance:** It is resistance offered by air to the forward movement of vehicle. This resistance has an influence on performance, ride and stability of the vehicle. Wind or air resistance depends upon speed, shape of the vehicle body and wind velocity. 2) **Rolling resistance:** It is resistance caused by friction between road and tyres which opposes the motion of the vehicle. The magnitude of rolling resistance depends mainly on the nature of road surface, the types of tyres, the weight of the vehicle and the speed of the vehicle.	02 02
2. Attempt **any <u>FOUR</u>** of the following	16
a) Describe parallelogram type steering linkage with neat sketch.	04
Answer: **Parallelogram type steering linkage:**  **Figure: Parallelogram type steering linkage.**	02

In this tie rods are mounted parallel to the lower control arms In case of rigid axle suspension, the main axle beam ensures the movement of stub axle in the horizontal plane only. Therefore, there is no vertical deflection of the suspension and hence there is no change in effective track rod length. However, in case of parallelogram type suspicion the two stub axles can move up or down independent of each other due to which distance between ball joint ends of the two track rods and arm is continuously varying. This type of steering linkage is used on most pickups and rear wheel drive cars.	02
b) Describe king pin inclination with neat sketch.	04
Answer: **King pin inclination**:  Figure: King pin inclination. It is the angle between vertical line and centre line of king pin or steering axis when viewed from the front of the vehicle. King pin inclination helps the straight ahead recovery of steering wheel, thus providing directional stability. It also reduces tyre wear. It is normally about 7^0 to 8^0 .	02 02
c) State at least four advantages of power steering.	04
Answer: **Advantages of power steering:** (*Any 04- 1 mark each*) 1) Power steering reduces the effort needed to turn the steering wheel 2) Higher degree of steering response is achieved 3) Hydraulic system also absorbs road shocks, thereby archiving comfort driving. 4) It reduces driver's fatigue. **5)** Higher control over the vehicle is possible which leads to greater safety of vehicle.	04
d) State use of caliper in disc brake and state any two disadvantages of disc brake.	04
Answer: **Use of caliper in disc brake:** In disc brake system, caliper houses the brake pads and pistons. When the brakes are applied, hydraulically actuated pistons move the friction pads to contact with disc. The friction between the pad and rotating disc retards the speed.	02

Disadvantages of disc brake: (*Any 02*) 1) Initial cost is more. 2) Disc brakes are much more prone to noise. 3) Disc brakes are not self-energizing; they need higher clamping forces, which require a power booster.	02
e) State painting procedure for new vehicles.	04
Answer: **Procedure of painting:** *(Note: Credit shall be given to any other suitable Procedure)* 1) Thoroughly wash the vehicle. 2) Carryout protective and anticorrosive treatment. 3) Spray a thin coat of primer. Allow to dry for 15 min. 4) Apply three full coats of surfacer allowing 10 – 15 minutes between the coats. 5) Allow it to dry for 1 hour. Then wet flat with P 600 grade paper. 6) Apply stopper (putty) wherever necessary allowing 15 to 20 minutes between the layers. 7) Allow to dry for 1 to 1½ hours. 8) Spray surfacer to stop-up areas and flat with P 600 grade paper. 9) Blow off vehicle with air gun and tack off. 10) Spray finishing material, apply one coat and allow it to dry for 15 to 30 minutes. Then apply second coat. 11) Allow overnight drying. Wet flat with P 800 grade paper and dry with air gun. 12) Spray double header coat.	04
f) State function of brake and classify brakes.	04
Answer: **Functions of brakes:** *(Any 02)* 1) To stop or slow down the vehicle in the shortest possible distances in emergencies. 2) It is used to control the vehicle while descending along the hill. 3) To park the vehicle and held it in stationary position without the presence of driver. The brakes are classified according to following consideration: *(Any 02)* 1) With respect to purpose: a) Primary brake or Service brake b) Parking brake or Secondary brake 2) With respect to application: a) Foot brake b) Hand brake 3) With respect to number of wheels: a) Two- wheeler brakes b) Four-wheeler brakes 4) With respect to the method of braking contact: a) Internal expanding brakes b) External contracting brakes 5) With respect to the method of applying the braking force: a) Single acting brakes b) Double acting brakes 6) With respect to construction: a) Drum brake b) Disc brake	02 02

7) With respect to method of actuation:
   a) Mechanical brakes
   b) Hydraulic brakes
   c) Air brakes
   d) Vacuum brakes
   e) Electric brakes
8) With respect to speciality:
   a) Engine exhaust gas operated brake
   b) Pneumatic-hydro brake
   c) Hill-holding brake

3. Attempt **any FOUR** of the following:. 16

a) Distinguish between air brakes and hydraulic brakes. (any four points) 04

Answer: **Distinguish between air brakes and hydraulic brakes:** (*Any 04- 1 mark each*) 04

Air brakes	Hydraulic brakes
1. Compressed air is used as a working substance.	1. Hydraulic oil is used as a working substance.
2. Air brake has more powerful than hydraulic brake.	2. Hydraulic brake has less powerful than air brake.
3. Components: Air compressor, unloader valve, brake valve, brake chamber.	3. Components: Master cylinder, wheel cylinder, oil reservoir.
4. Air brake system is used in trucks, buses, trains etc.	4. Hydraulic oil brake system is used for light vehicles such as cars, light duty trucks etc.
5. Air compressor uses a certain amount of engine power.	5. No engine power is used.
6. It is not self lubricating.	6. Hydraulic brakes are self lubricating.

b) Describe any two essential properties of brakes fluid. 04

Answer: **Properties of brakes fluid:** (*Any 02- 2 marks each*) 04

1) **Boiling point:** Boiling point of fluid must be high because due to continue operation of brakes, generates the heat inside the drum, which increases the temperature of fluid in the wheel cylinder and lastly generates the vapour, which decreases the effectiveness of brakes. Therefore the boiling point should be high i.e. 2500 C to 3000 C.
2) **Viscosity:** Viscosity of brake fluid should be such that the fluid should not lose its fluidity in any atmospheric condition. i.e., too cold or too hot temperature. Therefore, it is necessary that the viscosity of brake fluid should change adequately with the change in temperature to maintain its fluidity.
3) **Lubrication properties:** The brake fluid should provide proper lubrication to the pistons in the master cylinder, wheel cylinder. Otherwise these components wear out quickly.
4) **Effect on rubber:** A number of rubber seals are used in the hydraulic braking system, therefore the brake fluid should not have any effect on these seals. Otherwise it leads to leakage of fluid, loss of pressure in lines.
5) **Corrosive action:** The brake fluid should not corrode the metal components with which it comes into contact.

6) **Storage stability:** Brake fluid should have sufficient stability at least 3 years. During this period the fluid should not be spoiled.

c) Compare wishbone type suspension with Macpherson strut type suspension. — 04

Answer: **Comparison between wishbone and Macpherson strut type suspension**: — 04

Wishbone type suspension	Macpherson strut type suspension
1. In this type upper & lower wishbones are used.	1. In this type only lower wishbones are used
2. It has less space for engine compartment.	2. It has more space for engine compartment
3. It is complicated is construction	3. It is simpler in construction
4. Applications: Honda Accord, Mercedez Benz etc.	4. Applications: Maruti 800, Volkswagen Jatta, Passat cars etc.

Note: Suitable credit shall be given if diagrams are drawn for comparison.

d) State role of dehydrator and evaporator in Air-conditioning system. — 04

Answer: **Role of dehydrator :** — 02

The refrigerant is stored under pressure in receiver-drier. The refrigerant is passed through dehydrator that removes any traces of moisture present in the system to avoid freezing of moisture at low temperature and thus clogging the lines.

Role of evaporator: — 02

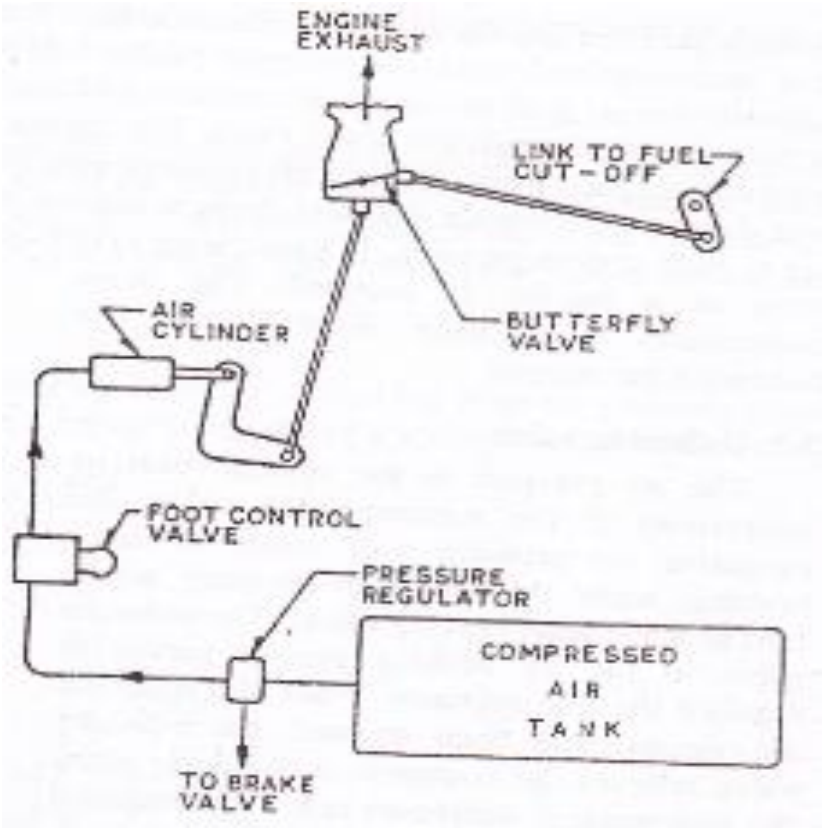
The evaporator unit where the cooling effect is obtained is usually located inside the passenger compartment below the dash board. A high capacity blower circulates the air in the car interior across the evaporator coils, and this drops the temperature of the air inside the passenger compartment. It also helps in dehumidification, as warmer air travels through the evaporator coil, the moisture containing the air condenses on its surface.

e) Describe working of exhaust brake with neat sketch. — 04

Answer: **Exhaust brake:**

This is an auxiliary brake (a non –service brake) used to work when the vehicle is either moving on a long downhill gradient, or in busy traffic where has to slow down continuously over a large distance. It consists of pressure regulator, Foot control valve, Air cylinder, Butterfly valve and Linkages. In it, the pressure regulator is common with the air (service) brake

When the exhaust gas brake is to be applied, the driver presses upon the control valve by his foot. This allows flow of compressed air from the air cylinder, which in turn operates the linkage to close the butterfly valve at the exhaust manifold. It prevents exit of the exhaust gas into atmosphere and diverts it to apply the brakes. As soon as the foot is taken- off the foot control valve, the brake is released. In this way, this type of brake effect fuel economy of vehicle. — 02



02

f) State any two advantages and two dis -advantages of central locking system. 04

Answer: **Advantages of central locking system:** *(Any 02)*

1) All the doors and luggage compartments can be locked or unlocked simply by operating one key.
2) It Indicates open door with flash
3) Locking/ unlocking can be done by remote
4) In case of failure of electronic system, the manual locking is still possible.

02

Disadvantages of central locking system: *(Any 02)*

1) It is not convenient in case of accident because occupant may not open the door in emergency since all doors are centrally locked.
2) It's initial and maintenance cost is high.

02

4. Attempt **any <u>TWO</u>** of the following. 16

a) State caster, camber, toe in – toe out and turning radius with neat sketch. 08

Answer:

Caster:

It is the angle between the king pin centre line & the vertical, in the plane of the wheel, when viewed from the side is called the caster angle. 01

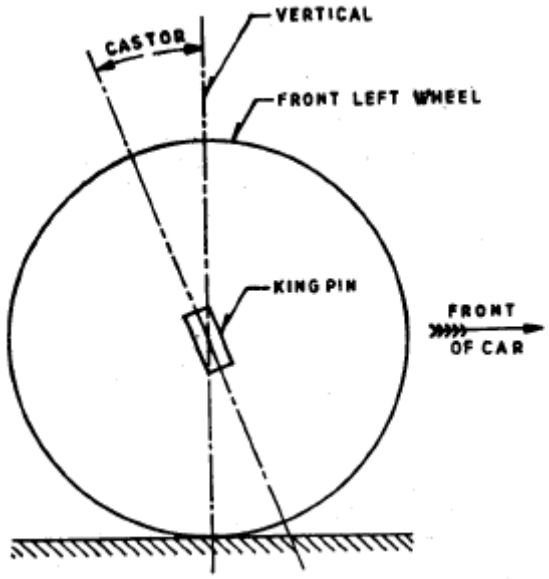


Fig. Caster

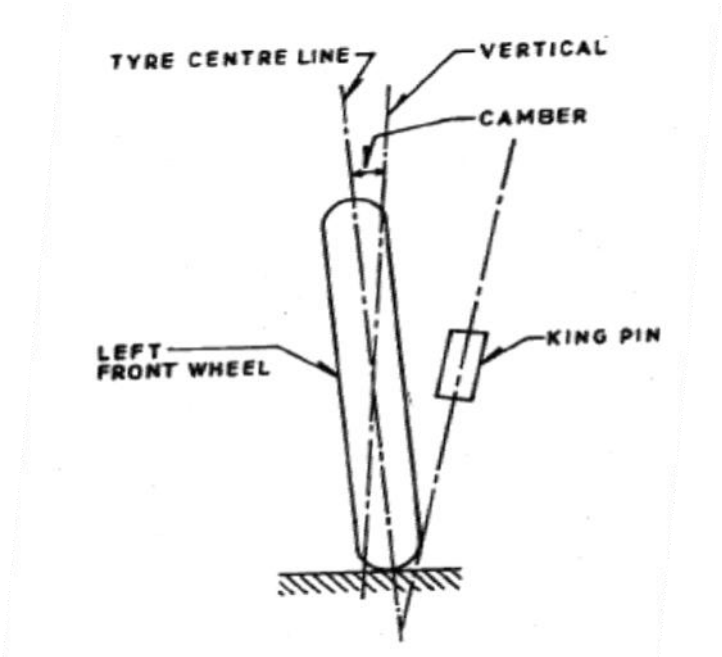
01

Camber:

It is the angle between centre line of tyre and vertical line when viewed from front of the vehicle.

OR

Camber is the tilt of the car wheels from the vertical, when viewed from the front of the vehicle. 01



01

01

Fig. Camber

Toe-in: It is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary.

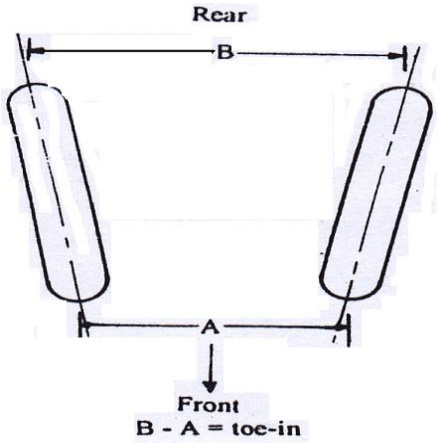


Fig. Toe-in when viewed from the top. 01

Toe-out: - The front wheels may be set closer at the rear than at the front in which case the difference of the distances between the front wheels at the front and at the rear is called as toe-out.

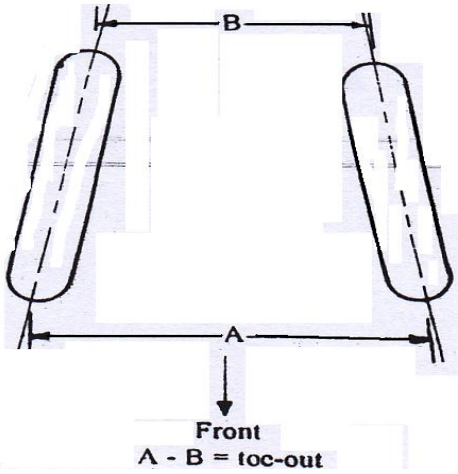


Figure. Toe-Out when viewed from the top. 01

Turning radius: It is the radius of circle on which the outside front wheel moves when the front wheels are turned to their extreme outer position. Here OA indicates the turning radius.

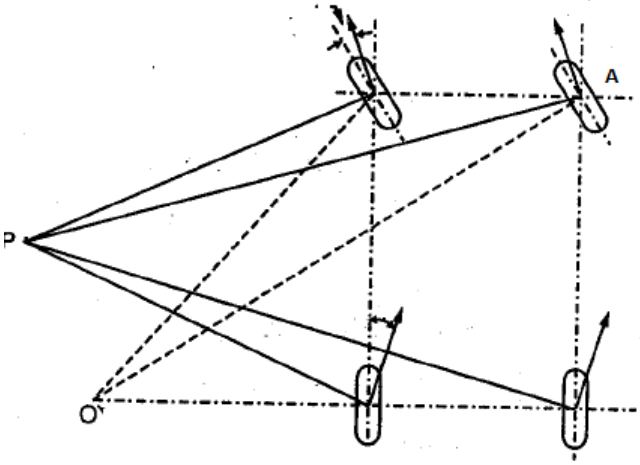
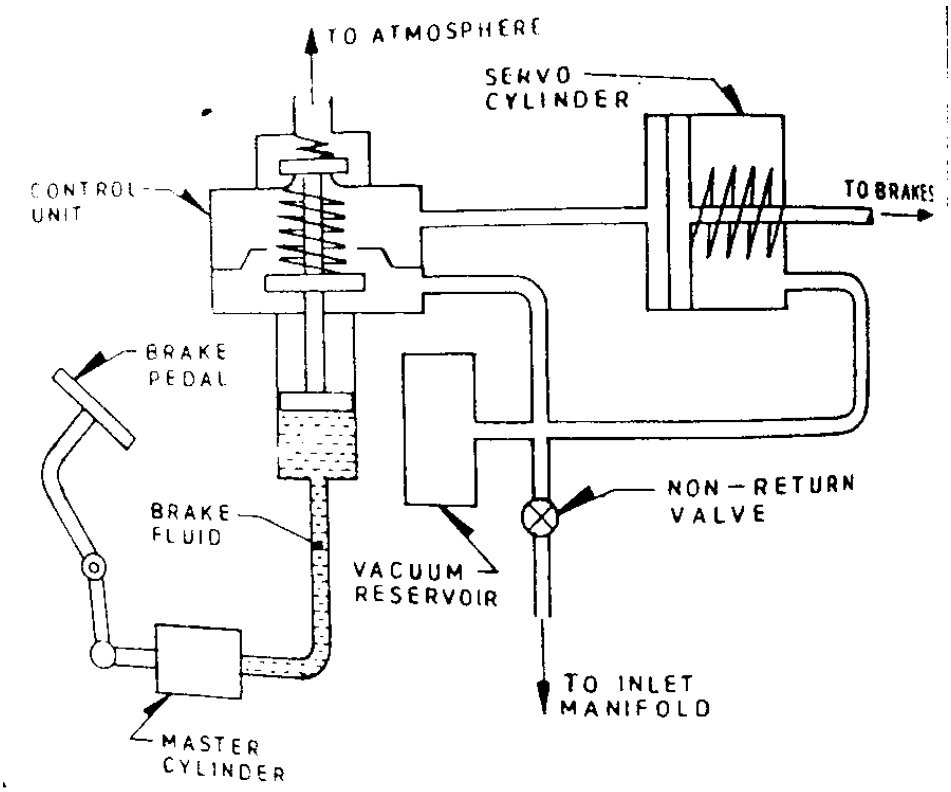


Figure. Turning Radius 01 01

b) Describe working of servo master cylinder with neat sketch.	08
Answer: **Servo master cylinder:**  Figure: Working of Servo Master Cylinder. **Working:** When brake pedal is free, upper valve in the control unit is closed and lower is opened. Thus both side of piston is exposed to engine vacuum. However when brake pedal is pressed to apply brake, the lower valve is closed and upper is opened. This causes atmospheric air to apply pressure on left side of piston causing servo piston moves to right causing movement of master cylinder piston thereby applying brake. When pedal is released both side of servo piston is once again exposed to vacuum.	04 04
c) Draw neat labeled lay out of air suspension and state the advantages of air suspension.	08
Answer: Air suspension system: **Advantage of air suspension:** 1) A variable space for wheel deflection is put to optimum use by virtue of the automatic control devices 2) Because the vehicle altitude is also constant, changes in head lamp alignment due to varying loads are avoided. 3) The spring rate varies much less between the laden and unladen conditions, as compared with that of conventional steel spring. It reduces the dynamic loading. 4) The improved standard of ride comfort and noise reduction attend with air springs reduces both driver and passenger fatigue.	04

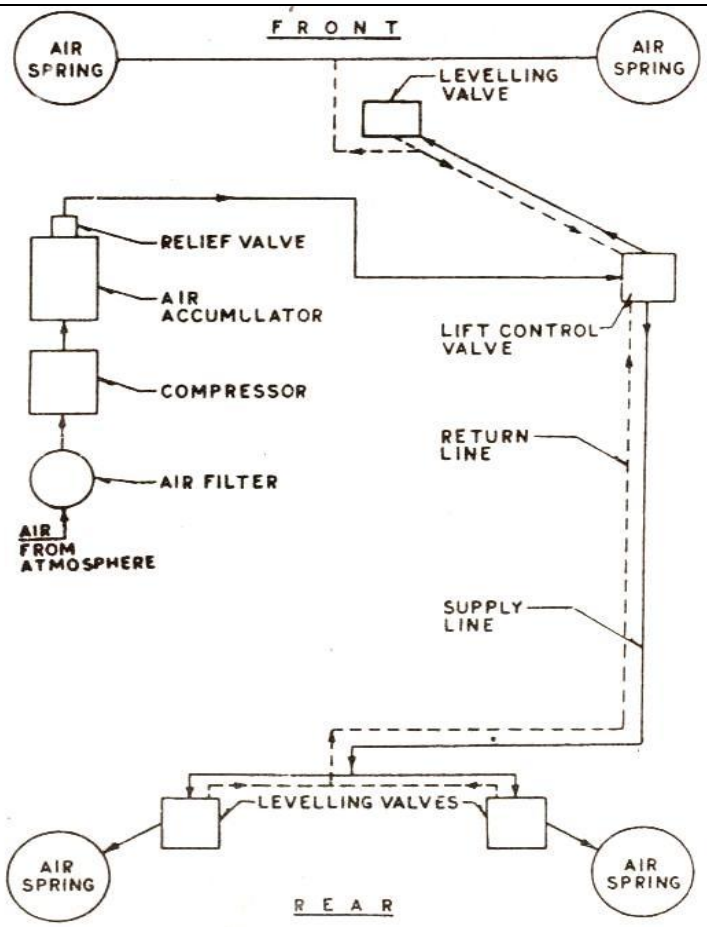


Fig.: Schematic diagram showing the layout of an air suspension system. — 04

5. Attempt **any FOUR** of the following **:** — 16

a) State any four advantages of rack and pinion type steering gear. — 04

Answer: Advantages of rack and pinion type steering gear: (*Any 04-1 mark each*) — 04

1) It is simple, light and it uses minimum linkages parts.
2) It is more responsive and easier to control
3) Repairing a rack and pinion steering system tends to be easier than a traditional system
4) It occupies very small space.
5) Rack-and-pinion steering is more precise.

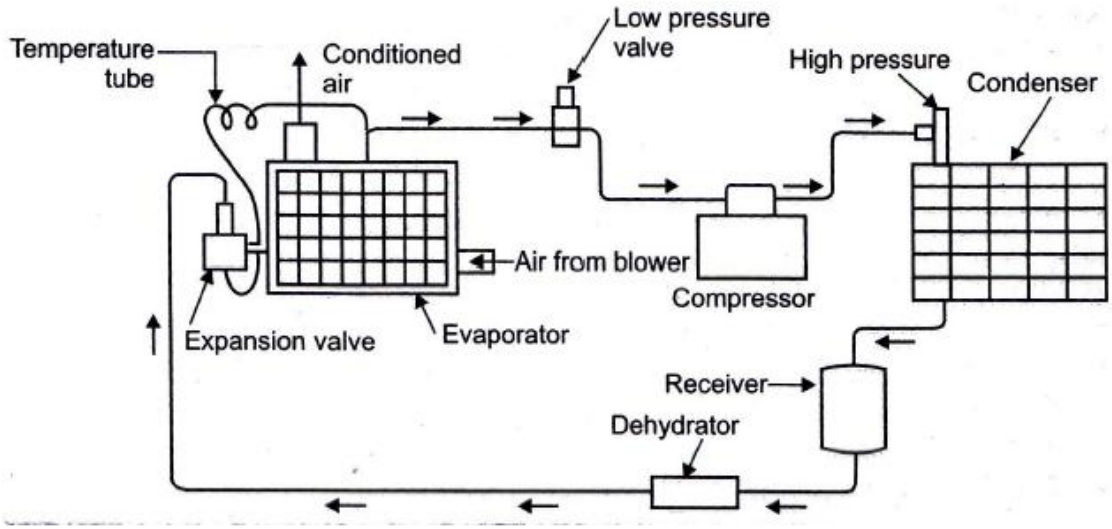
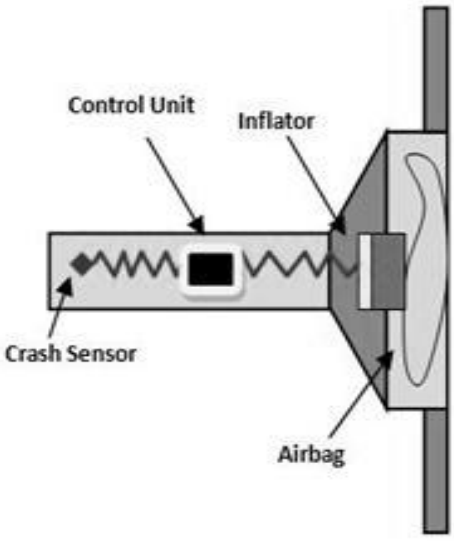
b) State importance of collapsible steering and state its types. — 04

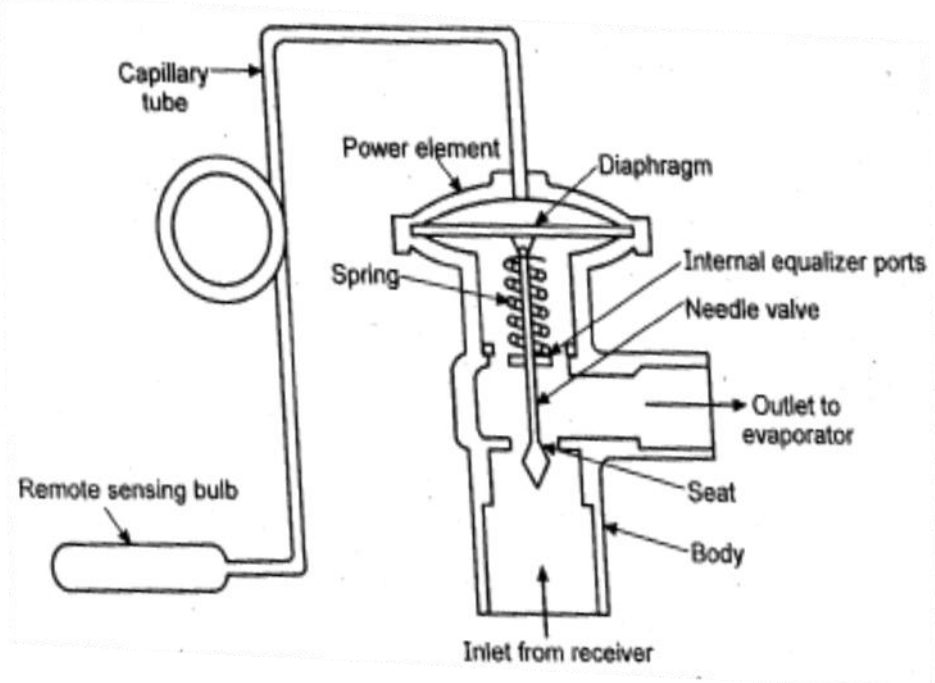
Answer: — 02

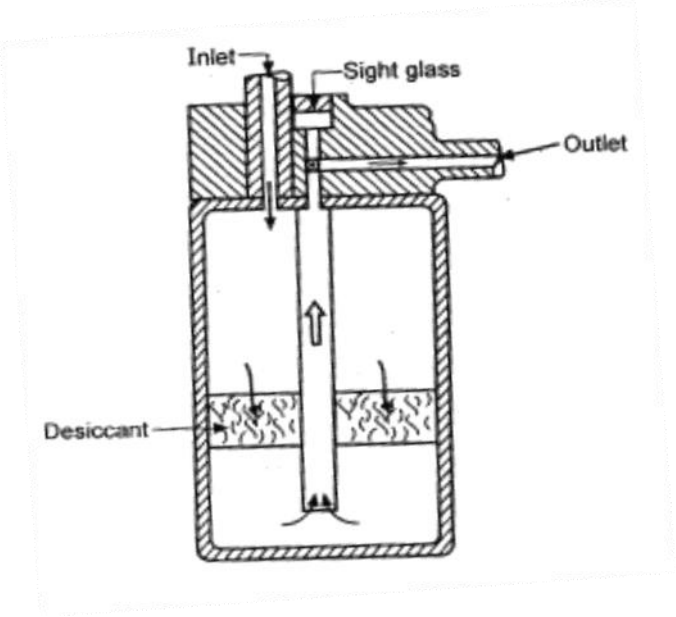
Collapsible steering-

The design of these columns is such that they collapse due to impact forces caused during head-on collision of the vehicle. The collapsing columns ensure greater safety to the driver by minimizing or avoiding a direct severe impact to him.

Types of collapsible steering: (*Any 04*) 1) Mesh type jacket column. 2) Ball type jacket column. 3) Corrugated deformable section type column, 4) Telescopic type column. 5) Hooks joint type column.	02
c) State two advantages and two disadvantages of torsion bar.	04
Answer: **Advantages of torsion bar:** **1)** The main advantages of a torsion bar suspension are durability, easy adjustability of ride height, and small profile along the width of the vehicle **2)** It takes up less of the vehicle's interior volume than coil springs **Disadvantages of torsion bar:** **1)** A disadvantage is that torsion bars, unlike coil springs, usually cannot provide a progressive spring rate **2)** Torsion bar does not control oscillation so it is necessary to use shock absorbers along with them.	02 02
d) State any four desirable properties of refrigerant.	04
Answer: **Properties of ideal refrigerant:** *(Any 04)* 1) The refrigerant should have low freezing point. 2) It must have high critical pressure and temperature to avoid large power requirement. 3) It must have low specific heat and high latent heat. 4) It should have low specific volume to reduce the size of the compressor. 5) It must have high thermal conductivity to reduce the areas of heat transfer in evaporator and condenser. 6) It should be non-inflammable, non-explosive, non-toxic and non-corrosive. 7) It should give high C.O.P. in the working temperature range. This is necessary to reduce running cost of the system. 8) It must be readily available and it must be cheap also.	04
e) State the function and types of shock absorbers.	04
Answer: **Function of shock absorber:** The shock absorber is a part of suspension system used as springing device to compromise between flexibility and stiffness. It absorbs the energy of shock converted into the vertical movement of the axle by providing damping and dissipating the same in to heat. **Types of shock absorbers:** 1) Mechanical. 2) Hydraulic: (i) Vane type (ii) Piston type : a) Single acting b) Double acting (iii)Telescopic type	02 02

f) Draw a labeled layout of HVAC	04
Answer: *(Diagram: 02 Marks & Correct Labeling : 02 Marks)*  **Fig. Car Air Conditioning**	04
6. Attempt any TWO of the following.	16
a) Describe working of Air- bag as a safety device also state function, material and locations of air bags in an automobile.	08
Answer : **Working of air bag:** *(Note: Credit shall be given to any other suitable diagram)*  Figure: Air bag. As vehicle comes across the impact, the sensor detects it and triggers the inflator. Once the electrical circuit has been turned on by the sensor, a pellet of sodium azide (NaN_3) is ignited. A rapid reaction occurs, generating nitrogen gas (N_2). This gas fills a nylon or polyamide bag at a velocity of 150 to 250 miles per hour. This process, from the initial impact of the crash to full inflation of the airbags, takes only about 40 milliseconds. Thus minimizing the injury to the passenger or driver. When N_2 generation stops, gas molecules escape the bag through vents. The pressure inside the bag decreases and the bag	02 03

deflates slightly to create a soft cushion. By 2 seconds after the initial impact, the pressure inside the bag has reached atmospheric pressure. **Function*:*** *(Any 01)* 1) To provide an additional level of protection in the event of a car accident. 2) Air bags supplement the safety belt by reducing the chance that the occupant's head and upper body will strike some part of the vehicle's interior. 3) It help reduce the risk of serious injury by distributing crash forces more evenly across the occupant's body	01
Material: Nylon or polyamide bag	01
Location: 1. Front air bag- In steering wheel & in dashboard 2. Side Air bag: In doors.	01
b) How temperature and humidity is controlled in car air conditioning.	08
Answer: **Control of temperature :**  The expansion valve is placed at the evaporator inlet tube. It is used to control refrigerant flow into the evaporator. The expansion valve contains a variable orifice that is controlled by a sensing bulb placed inside the evaporator cooling fins. The sensing bulb is a sealed tube containing a small amount of refrigerant. The changes in temperature of the evaporator cause the refrigerant inside the sensing bulb to expand or contract. The action of the internal pressure of the sensing bulb controls the amount of refrigerant that flows through the expansion valve by varying the size of the orifice. **Control of humidity:**	02 02



02

Liquid refrigerant enters through the inlet. Any dirt is filtered by the filter pads and moisture is absorbed from the refrigerant by the desiccant. Any refrigerant vapor that does not liquefy in the condenser, is trapped and held until it condenses. Finally, clean and dry liquid refrigerant leaves the receiver dehydrator and goes to expansion valve.

Evaporator also helps in dehumidification, as warmer air travels through the aluminum fins of cooler evaporator coil, the moisture content in the air condenses on its surface.

02

c) Define Rolling, Pitching, Bouncing, Yawing and state effect of each on automobile. 08

Answer: *(Note: Definition 01 mark, Effect 01 mark)*

1. Rolling:

While cornering, the centrifugal force produces a movement of the vehicle about a longitudinal axis through centre of gravity and is known as rolling. 02

Effect: The left hand side spring expands as the right hand spring compress (or Vice-versa) which results in the body of the vehicle moving up and down from side to side in relation to the centre of vehicle. This will result into lack of steering control and driving inconvenience.

2. Pitching:

It is rotating action about a transverse axis through center of gravity parallel to ground is known as pitching.

OR

It is rocking chair action or rotating action about a transverse axis through the vehicle parallel to ground is known as pitching. 02

Effect: The front springs extend simultaneously as the rear spring compresses, a continuous motion results in the body of vehicle oscillating up and down at the front and back in a fore and aft direction. This will cause discomfort to the passengers and may lead to failure of mechanical components in severe situations.

3. Bouncing: It is the vertical movement of the complete body. When the body of the vehicle rises up and down, it is known as bounce or bouncing. There may be front end or rear end bounce. OR It is the vertical movement of the complete body. When the body of the vehicle rises up and down, it is known as bounce or bouncing. There may be front end or rear end bounce. **Effect:** As the whole body moves up and down, this may result into passenger discomfort, lack of steering control and directional instability.	02
4. Yaw: It is the turning movement of the body around the center point of the vehicle. Yaw occurs as the vehicle corners if the cornering speed is too high, the transfer of weight can cause the vehicle to spin. **Effect:** Due to transfer of weight, The driver may loose the steering control during cornering and the vehicle may go off the road causing severe accident.	02