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.

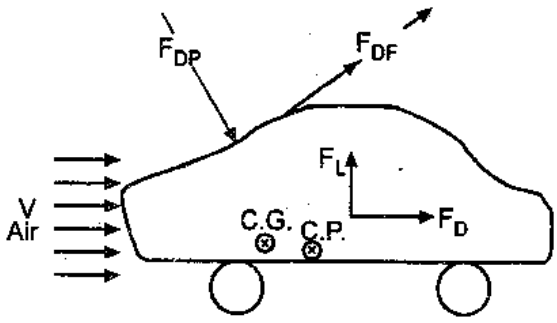
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

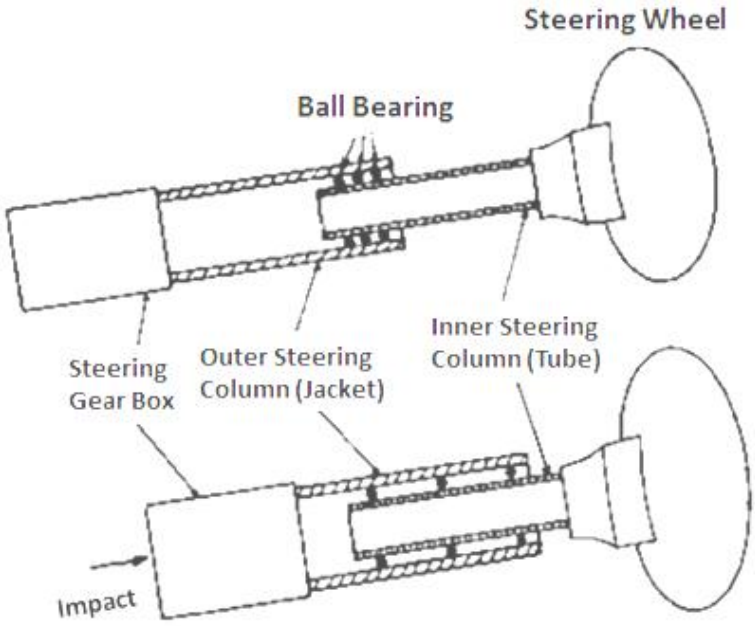
7) For programming language papers, credit may be given to any other program based on equivalent concept.

……

	Marks
1. a) Attempt any **SIX** of the following :	**12**
i) Define understeering and oversteering.	02
Answer: During turns, centrifugal force acts on the wheels. Two cases can arise: **i) Understeering:** When the slip angles of the front wheels are greater than those for the rear wheels, radius of the turn is increased. This means that the vehicle will turn less sharply than it should for a given rotation of the steering wheel. This condition is called understeering**.** **ii) Oversteering:** When the slip angles of the front wheels are less than those of the rear wheels, radius of the turn is decreased. This means that the vehicle will turn more sharply than it should for a given rotation of the steering wheel. This condition is called oversteering.	01 01
ii) List main parts of a power steering system.	02
Answer: Parts of power steering system:*(Any 04- ½ mark each)* 1. Hydraulic pump 2. Hydraulic control valve 3. Fluid reservoir 4. Rack & pinion gear box 5. Steering shaft 6. Steering wheel 7. Steel pipe lines, unions and flexible hoses 8. Electronic control unit 9. Torque sensor 10. Rotation sensor 11. Electric motor	02

<table>
<tr><td>iii) State friction materials used for brake shoes.</td><td>02</td></tr>
<tr><td>Answer: Friction materials used for brake shoes: (Any 04 - ½ mark each)
Generally, brake linings are made from fiber metallic mixed with brass, lead, plastics etc. and formed under heat.
1. Asbestos fiber
2. Zinc wires
3. Cotton fiber
4. Copper or bronze wire
5. Rubber compound
6. Ferodo</td><td>02</td></tr>
<tr><td>iv) State the purpose of compressor and condenser used in car air conditioner.</td><td>02</td></tr>
<tr><td>Answer:
Purpose of Compressor: The purpose of compressor is to draw the low pressure and low temperature vapor from the evaporator and compress this vapor into high-temperature, high pressure vapor. Also to circulate the refrigerant through the AC system.
Purpose of Condenser: The purpose of condenser is to condense the high pressure, high temperature vapor coming from the compressor into liquid.</td><td>01
01</td></tr>
<tr><td>v) Define gradability and draw bar pull.</td><td>02</td></tr>
<tr><td>Answer:
Gradeability: It is the maximum percentage grade which a vehicle can negotiate with a full rated condition.
Drawbar pull: If the extra load attached to the vehicle is pulled by fully utilizing the excess power, then, maximum drawbar pull = Tractive effort – Road resistance.</td><td>01
01</td></tr>
<tr><td>vi) Give four main differences between a drum brake and disc brake.</td><td>02</td></tr>
<tr><td>Answer: Difference between drum-brake and disc brake: (Any 04-01 mark each)
<table>
<tr><th>Sr. No.</th><th>Drum brake</th><th>Disc Brake</th></tr>
<tr><td>01</td><td>Friction occurs on the internal surfaces, therefore heat dissipated only by conduction through the drum.</td><td>Friction surfaces are directly exposed to the cooling air.</td></tr>
<tr><td>02</td><td>Curved friction linings are used.</td><td>Flat friction pads are used.</td></tr>
<tr><td>03</td><td>Non uniform wear of friction linings.</td><td>There is uniform wear of friction pads.</td></tr>
<tr><td>04</td><td>There is loss of efficiency due to expansion.</td><td>There is no loss of efficiency due to expansion.</td></tr>
<tr><td>05</td><td>Comparatively higher weight.</td><td>Weight is less so saving upto 20 % is possible.</td></tr>
<tr><td>06</td><td>Comparatively poor anti-fade characteristics.</td><td>Disc brakes have comparatively better anti-fade characteristics.</td></tr>
<tr><td>07</td><td>Complicated design.</td><td>Simple in design.</td></tr>
<tr><td>08</td><td>Removal and replacement of brake linings is difficult and consumes more time.</td><td>Comparatively easy to remove and replace friction pads.</td></tr>
<tr><td>09</td><td>More frictional area</td><td>Less frictional area</td></tr>
<tr><td>10</td><td>Pressure intensity is less</td><td>Pressure intensity is more</td></tr>
</table></td><td>04</td></tr>
</table>

vii) Mention different types of a front axle.	02
Answer: Types of front axle: **1. Live front axle:** It is axle which contains differential mechanism through which the engine power flows towards the front wheels. **2. Dead front axle:** It has no connection with engine means it is dead and will not carry the engine power.	01 01
viii) Write the application of a torsion bar.	02
Answer: Application of a torsion bar: Torsion bar is used with leaf springs on chrysler cars, Santro with coil spring and alone with Volkswagon cars and Racings cars, buses, trailers and HCVs to avoid the tendency of rolling.	02
b) Attempt any **TWO** of the following:	08
i) Explain the repainting procedure of a old vehicle body.	04
Answer: Repainting procedure of a old vehicle body: 1. Remove dent using denting tools and dent removing procedure. 2. Preparing the Surface: Begin by sanding the car's surface with a dual action sander and 120 grit sandpaper to remove old paint and primer. 3. Carryout any necessary masking so that paint remover may not fall on the finished surface. 4. Wipe the surface down with a proprietary sprit. 5. Primer coat: Spray a coat of primer on the entire car and allow it to dry for 30 minutes. Use a long block sander and 120 grit sandpaper to slowly sand the entire car, keeping the sanding block flat and level. Repeat the primer and block sanding steps until the body is smooth. 6. Painting: Wipe the car with wax and grease remover. Spray the car with automotive spray paint, starting at the roof and work your way to the hood, trunk and then the sides of the car. Spray a total of four thin coats of paint on the car, allowing 30 minutes of dry time between each coat. 7. Polishing: Inspect the painted finish for runs and other imperfections. Use 800 grit sandpaper and water to sand the entire car. Once the car is sanded and looks dull use a mildly abrasive liquid rubbing compound and a dual action orbital polisher to polish the car. Use circular and back and forth motions until the entire car has been polished.	04
ii) Explain the concept of streamline shape of a vehicle body.	04
Answer: Concept of streamlining: When the vehicle moves along the road, it faces various forces applied by the air, known as aerodynamic forces. The major effects of these aerodynamic forces on vehicle performance are: Aerodynamic Drag (Induced drag, Profile drag, Friction drag) and Aerodynamic Lift. **The various aerodynamic forces acting on the vehicle body are shown in Fig.**  F_L = Lift forces F_D = Drag forces F_{DP} = Pressure drag force in normal direction F_{DF} = Friction drag force in tangential direction C.G. = Centre of gravity C.P. = Centre of pressure	04

To reduce the air resistance during running, the body of motor vehicle is so shaped that is streamlined. An arbitrary shape body of vehicle experiences a large air resistance. This leads to loss of power required for propulsion. This implies a need of aerodynamic considerations for designing a body. So the profiling or shaping of the vehicle body to reduce air resistance as vehicle moves forward is called streamlining.	
iii) Explain the working of a collapsible steering.	04
Answer: Collapsible steering:  Figure: Arrangement of a ball type collapsible steering column in normal mode and in collapsed condition. **Working:** 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. This type of column consists of inner tube and outer tube. Ball bearing is provided between the two overlapping tubes. The inner tube is attached on the steering wheel while the outer jacket is fitted over the brackets (not shown in figure) on the body or on the frame. In case of a collision, the inner tube collapses by sliding inside the outer jacket and thus saves the driver from severe impact.	02 02
2. Attempt any **FOUR** of the following	16
a) Describe a front wheel assembly with a neat sketch.	04
Answer: Front wheel assembly: The figure shows the front wheel mounted on stub axle. Two taper roller bearings are mounted on the stub axle on which wheel hub is fitted. The brake back plate is bolted to the stub axle. The brake shoe assembly along with the wheel cylinder is mounted on this back plate. Oil seals are also provided to prevent the leakage of lubricant from the bearings. The adjusting nut is provided to adjust or positioning the front wheel.	02

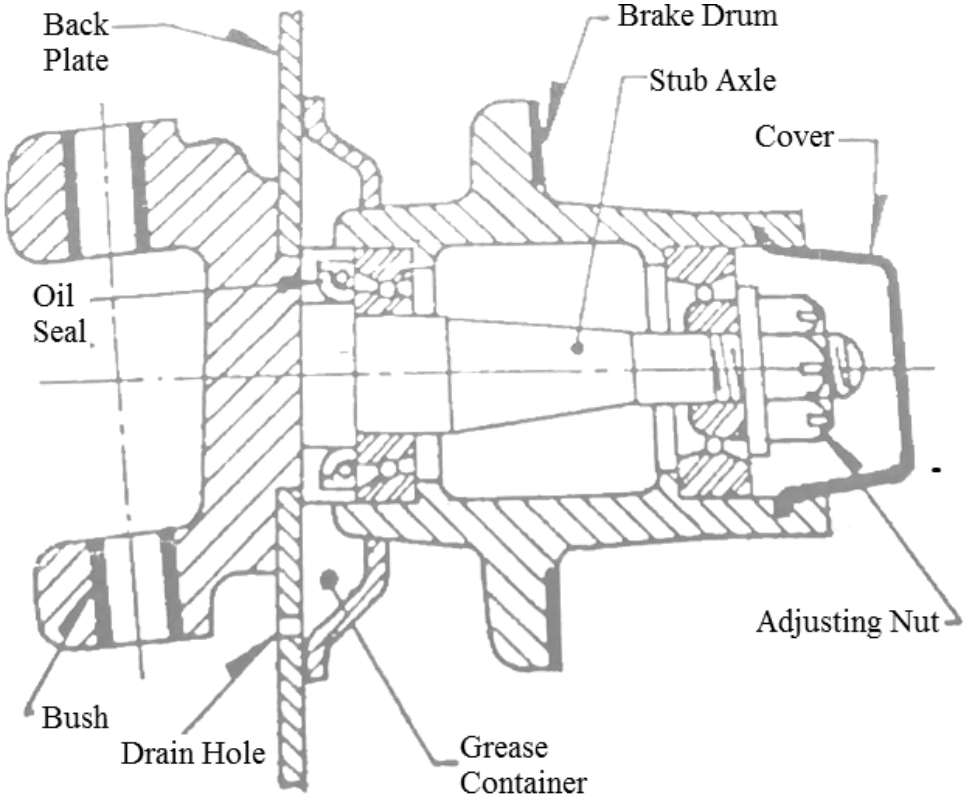


Figure: Front Wheel Assembly. 02

b) Explain correct steering angle and turning radius. 04

Answer:

Correct steering angle: Equation for correct steering is

$$\cot\varnothing - \cot\theta = b/l$$

Where,

Ø = angle between line passing through front outer wheel center and instantaneous center and rear wheel and instantaneous center. 02

θ = angle between line passing through front inner wheel center and instantaneous center and rear wheel and instantaneous center.

b = distance between the pivots of front axle.

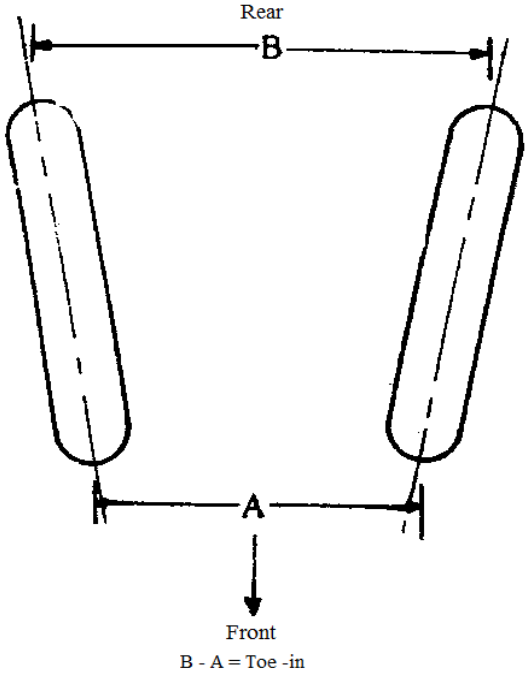
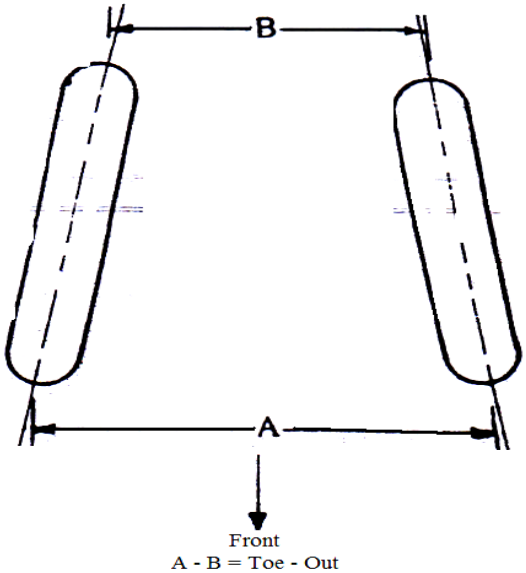
l = wheel base

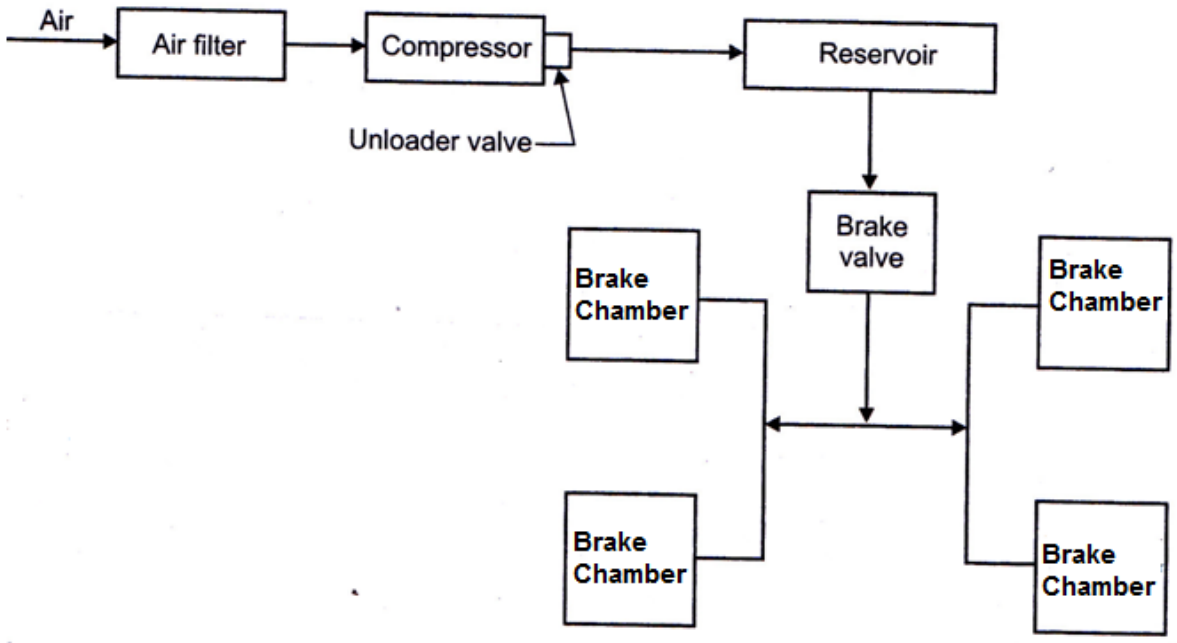
The value of $\cot\varnothing - \cot\theta$ corresponds to the position when steering is correct. There are three values of angle θ which give correct steering of the vehicle, first while it is turning to right, second while it is turning to left and third while it is running straight.

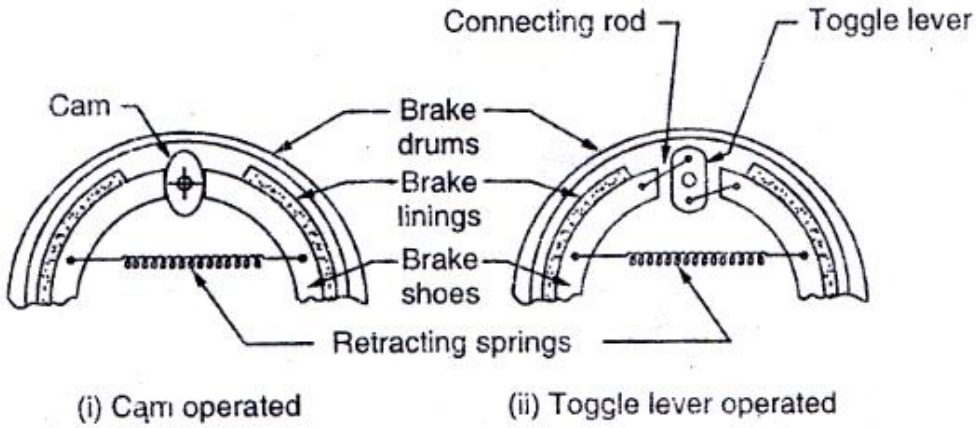
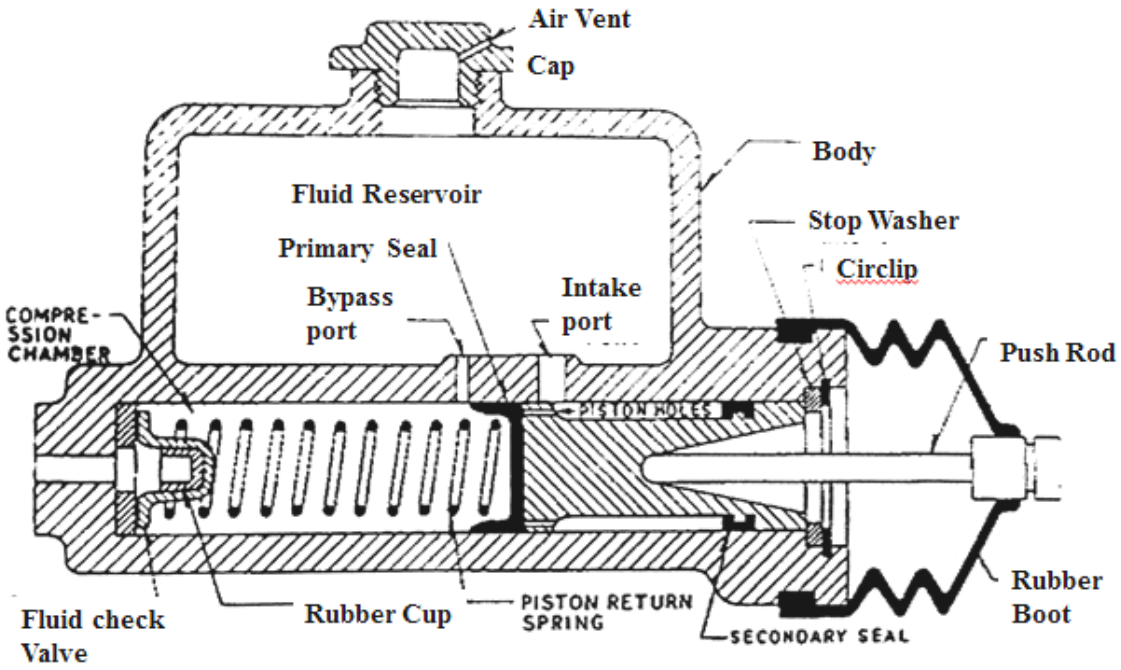
Turning radius: 02

It is the radius of circle on which the outside front wheel moves when the front wheels are turned to their extreme outer position.

Cars have turning radius from 5.38 to 7.85 m whereas in the case of trucks it is as high as 13.85m.

c) Explain toe-in and toe-out stating its necessity.	04
Answer: **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. The amount of toe-in is usually 3 to 5mm.  Figure: Toe-in when viewed from the top. **Necessity of Toe-in:** The toe-in is provided to ensure parallel rolling of the front wheels, to stabilize steering and prevent side slipping and excessive tyre wear. It also serves to offset the small deflections in the wheel support system which comes out when the car is moving forward. **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 01 01

Necessity of Toe-out: The steering system is designed to turn the inside wheel through a larger angle than the outside wheel when making a turn. This condition causes the wheels to toe-out on turns, due to the difference in their turning angles.	01
d) Draw a neat sketch of air braking system and state its working principle.	04
Answer: Air braking system:  Figure: Air braking system. **Working principle:** As shown in the figure, in the air brakes the compressed air (around 700 kPa) is used to actuate the brake mechanism. When the brake pedal is depressed, compressed air from the reservoir is transmitted through pipes equally in all directions to the brake chambers through brake valve which further applies the brake.	03 01
e) Explain painting procedure of a new vehicle in brief.	04
Answer: Procedure of painting of a new car: 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 how a mechanical brake system works with the help of a neat sketch.	04
Answer: Mechanical braking system: **Working:** When the brake pedal is depressed, the cam or toggle is turned and operates the brake shoes. It means that the brake shoes are expanding against the spring force and come to contact with brake drum, so brake is applied. When brake pedal is released, due to spring tension the brakes shoes are comes to its original position. So drum is free from the brake shoes, thus brakes is released. Usually this type of brakes used for the two wheelers.  Figure: Mechanical braking system. *(Note: Equivalent credit shall be given to any other suitable sketch if drawn)*	02 02
3. Attempt any **FOUR** of the following:	16
a) Describe construction and working of a master cylinder.	04
Answer: Master Cylinder:  Figure: Master Cylinder. *(Note: Equivalent credit shall be given to schematic diagram if drawn)*	02

Construction:

There are two main chambers viz. the fluid reservoir and compression chamber in which the piston operates. There are rubber seals on both ends of the piston in the compression chamber. The reduced diameter region of the piston is always surrounded by the fluid. A rubber boot covers the push rod end of the master cylinder to prevent the dust from entering inside. Towards the brake line side of the compression chamber, there is a fluid check valve with a rubber cup inside. — 01

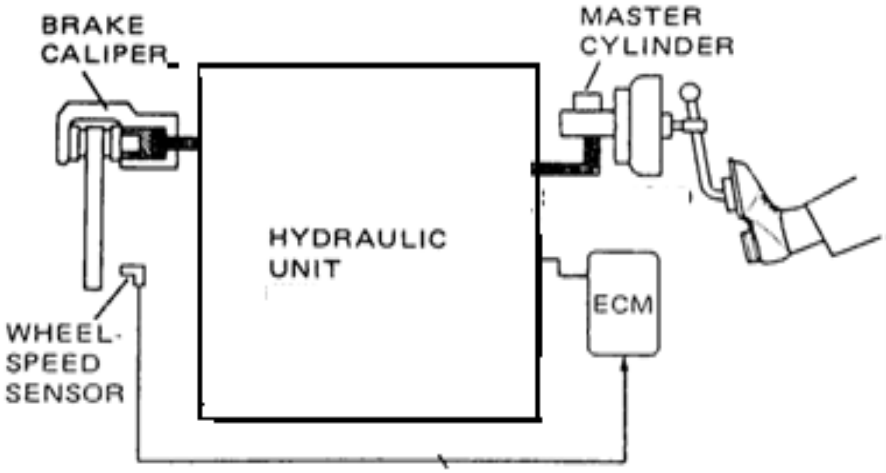
Working:

The push rod is operated with the foot brake pedal through linkage. As the pedal is pressed, push rod moves the piston to the left against the force of the spring till it covers the bypass port. Further movement f the push rod causes building up of pressure in the compression chamber. Finally, when sufficient pressure has built up, the inner rubber cup of the fluid check valve is deflected, forcing the fluid under pressure in the lines. This fluid enters the wheel cylinder or the caliper and moves the piston thereby applying the brakes. — 01

b) State concept and working of antilock braking system. — 04

Answer:

Concept: Antilock braking system is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to the driver inputs. While braking preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. — 01



— 01

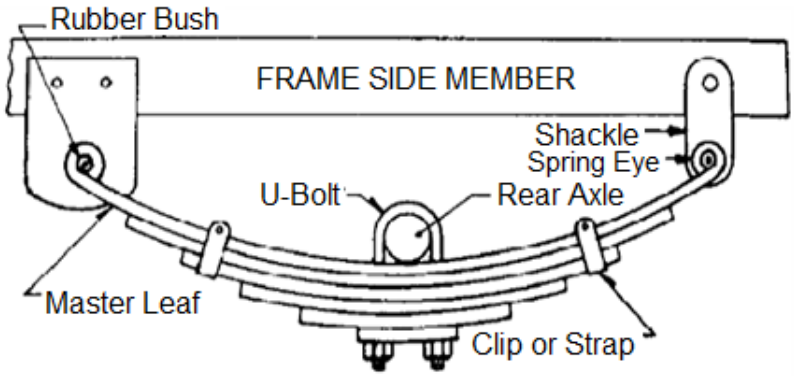
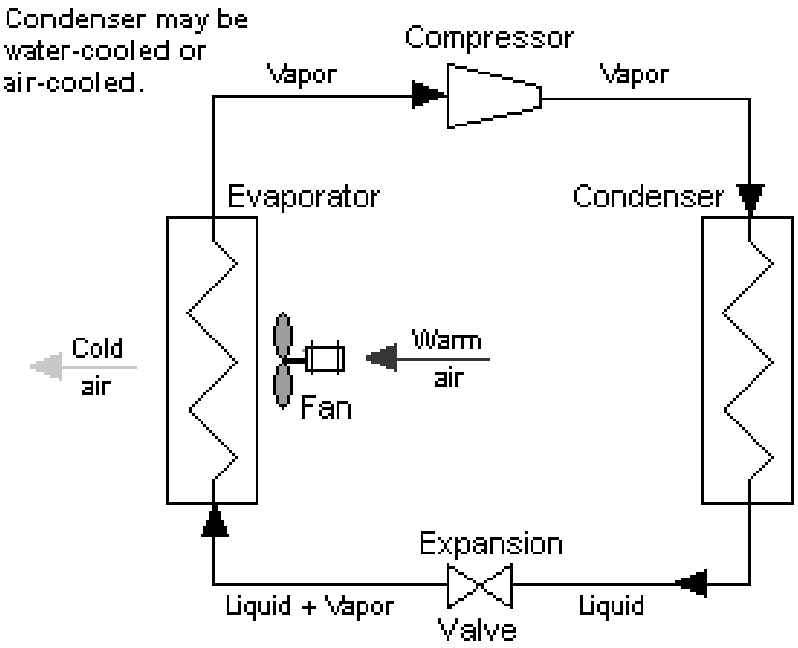
Figure: Antilock braking system.

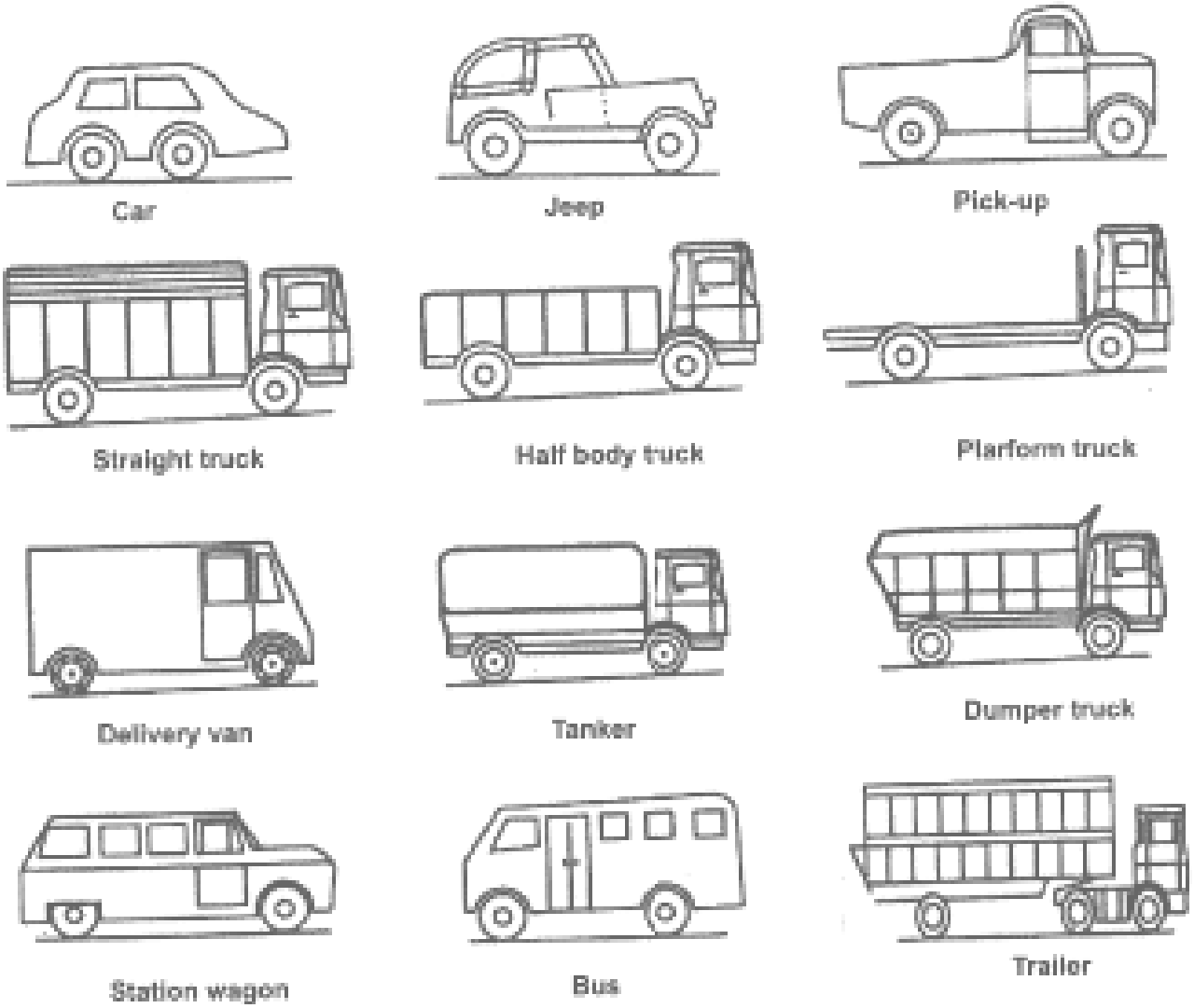
(Note: Any other suitable sketch may be considered.)

Working:

Figure shows block diagram of the antilock braking system. Typically it includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves (hydraulic unit or actuator) and pump. The brake lines from master cylinder connect to hydraulic unit or actuator. Lines from the actuator connect to the wheel brakes. — 02

The actuator is controlled by ECU. Wheel speed sensors at each wheel continuously send rotational wheel speed information to the ECU. If it detects a wheel rotating slower than the others, it means there is tendency of wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster.

c) Explain with a neat sketch a semielliptical leaf spring used in a heavy vehicle.	04
Answer: Semielliptical leaf spring used in a heavy vehicle:  Figure: Semielliptical leaf spring. It consists of number of leaves called blades. The blades vary in length. The lengthiest blade has eyes on its ends called master leaf. All the leaves are bounded together by means of steel straps. The spring is supported on the axle, front or rear by means of a U – bolt. One end of the spring is mounted on the frame with a simple pin, while on the other end; the connection is made with a shackle. When the vehicle comes across a projection on the road surface, the wheel moves up deflecting the spring. This changes the length between the spring eyes.	02 02
d) Give description of vapour compression cycle with its components.	04
Answer: Vapour compression cycle:  Figure: Vapour compression cycle. In Vapor compression cycle working medium is liquid refrigerant, (i.e. R12 or R 134 a) which is pressurized by using compressor. It consists of compressor, condenser, evaporator, receiver and expansion valve.	02

In compressor during suction stroke low pressure vapor in dry state is sucked from evaporator. It is then compressed to high pressure and temperature. These vapors are then passed into condenser where heat is removed by cooling medium which converts vapor into liquid. The liquid is stored into receiver. The liquid from receiver is then passed to evaporator through expansion valve. Expansion valve reduces pressure. The low pressure liquid refrigerant enters evaporator, where it absorbs the heat from the body to be cooled. Due to heat absorption, liquid refrigerant gets converted into vapor and these vapors are passing to compressor.	02
e) Explain types of vehicle bodies.	04
Answer: Types of vehicle bodies: *(Any 04 - 01 mark each)*  Figure: Types of vehicle body. *(Note: Suitable diagram of vehicle body types shall be given credit)*	04

1. **Car:** The car bodies have great resistance to air. The streamlining is the process for shaping the body to reduce air resistance. A car body is formed by a number of pressed steel panels welded together. 2. **Jeep:** It is a car suitable for traveling over rough terrain and a small, durable, general-purpose motor vehicle with four-wheel drive and a quarter-ton capacity 3. **Pick up:** It is light truck with an open body and low sides. 4. **Open Truck:** It does not have roof. It consists of surrounding side only. The rear side is only a half panel which may be opened down for loading and unloading. 5. **Delivery van:** It consists of only eight passenger seats. 6. **Tanker:** It is a truck constructed to transport liquids, such as oil, in bulk. 7. **Dumper:** It is a truck whose contents can be emptied without handling; the front end of the platform can be pneumatically raised so that the load is discharged by gravity 8. **Station wagon:** It is having an extended interior with a third seat or luggage platform and a door or tailgate at the back. 9. **Bus:** It is passenger carrying type of vehicle body. It provides large space for luggage. 10. **Trailer:** It is a road vehicle, usually two-wheeled, towed by a motor vehicle: used for transporting boats, vehicles etc.	
f) Explain the importance of exhaust brake and emergency brake.	04
Answer: **Importance of exhaust brake system:** 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 it has to slow down continuously over a large distance.This type of brake effects fuel economy of vehicle. **Importance of emergency brake:** It is the secondary braking system used to hold the car in stationary position when parked on a slope. By using emergency brake, vehicle can be brought to a complete stop if there's a failure of the brake system.	02 02
4. Attempt any **TWO** of the following:	16
a) Explain construction and working of a worm and roller type steering gear box with its application.	08
Answer: Worm and roller type steering gear box: **Construction and Working:** In the worm and roller type steering gear, a single or double roller is mounted between two arms integral with the inner end of the cross shaft, and this roller is meshed with the worm. The roller is free to turn on its shaft and moves in an arc, the correct mesh being obtained throughout its movement by the hour-glass shape of the worm. The worm is supported and located by two ball or taper roller bearings mounted in the case and its end float may be adjusted by shims placed between the outer bearing track and the end plate of the case. The roller shaft is eccentric and may be turned to compensate for wear between the roller and the worm. The upper end of the column is supported in the tube by a felt bush. As the steering wheel turns the worm, the roller turns with it, forcing the sector and pitman arm shaft to rotate.	04

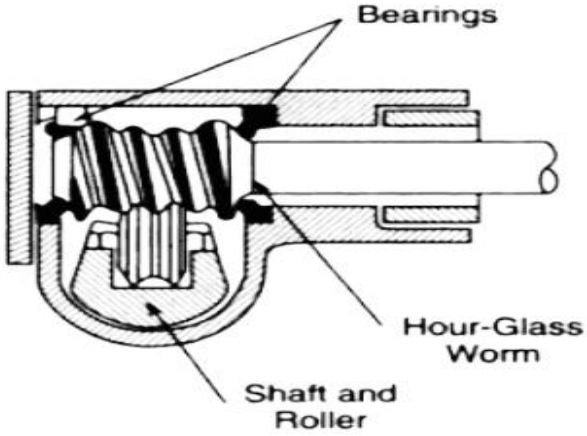


Figure: Worm and roller type steering gear box. — 02

Application: *(Any two)* — 02

1. Mahindra jeep
2. American passenger cars
3. Ford cars

b) Describe working of a hydraulic brake system with the help of diagram. — 08

Answer: Working of a hydraulic brake system:

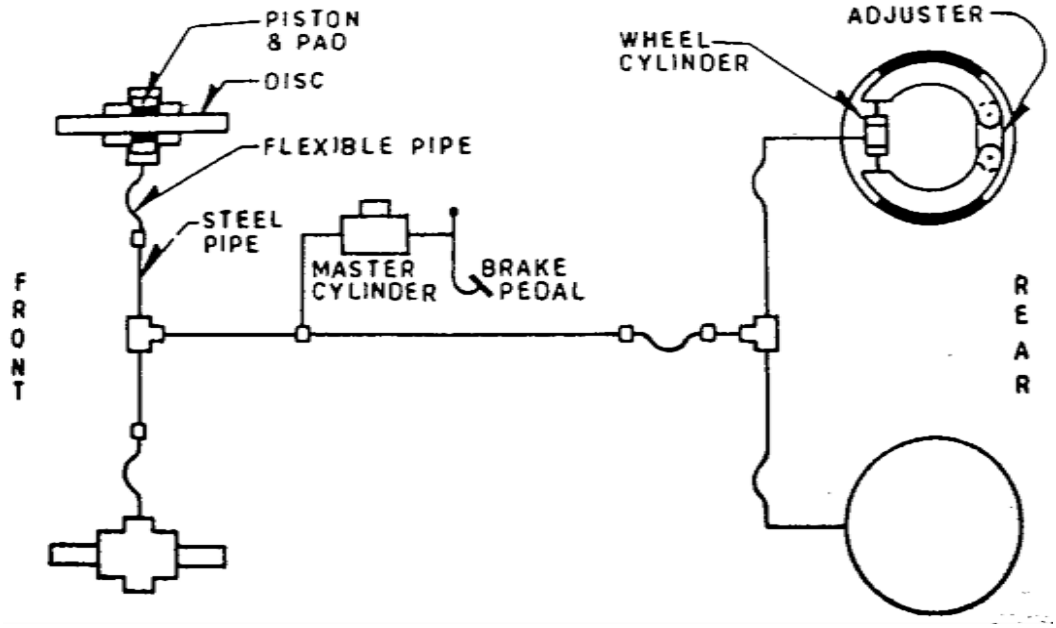


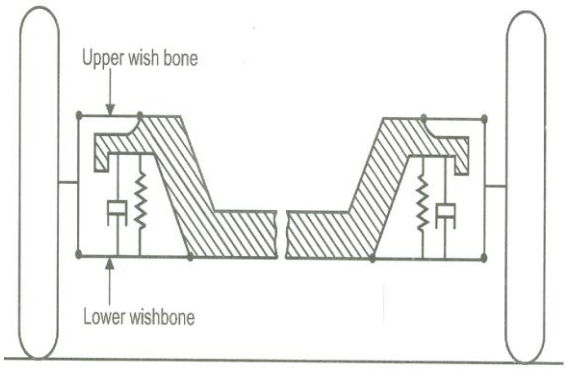
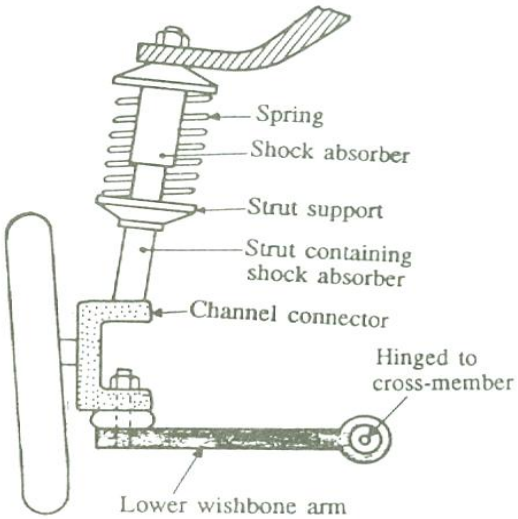
Figure: Hydraulic braking system. — 04

Working: When the brakes are not in operation, the system is filled with brake fluid under light pressure. When driver presses the brake pedal for applying the brake, the piston in the master cylinder moves forward and compresses the fluid in cylinder. It increases the pressure of the fluid in master cylinder and in entire hydraulic system. This pressure is instantly transferred to all four wheel cylinders (in case of disc brake this pressure is transferred to calipers). Thus the piston in wheel cylinders moves outward which moves brake shoes against brake drum to apply brakes. — 04

When driver releases the brake pedal, the master cylinder piston returns to its original position due to return spring and the pressure is dropped. It releases brake shoes from brake drum to their: original position and brakes are released.

c) Distinguish between wishbone type and Mcpherson strut independent suspension systems. — 08

Answer: Comparison between Wishbone and Macpherson strut type suspension: *(Diagrams-04 marks, Any 04 points- 01 mark each)* — 08

Wishbone type suspension	**Macpherson strut type suspension**
1. 	1. 
2. In this, upper & lower wishbones are used.	2. In this type only lower wishbones are used
3. It has less space for engine compartment.	3. It has more space for engine compartment
4. It is complicated is construction	4. It is simpler in construction
5. Applications: Honda Accord, Mercedez Benz etc.	5. Applications: Maruti 800, Volkswagen Jatta, Passat cars etc.
6. Ideal camber control.	6. Variation in camber when cornering due to body roll.
7. Costly due to more components involved	7. Cheap as compare to wishbone type.

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

a) Explain with neat sketches: — 4
i) camber and
ii) caster

Answer:

i) Camber:

It is the angle between centre line of tyre and vertical line when viewed from front of the vehicle **or** it is the tilt of the car wheels from the vertical, when viewed from the front of the vehicle. — 01

Camber is positive if the tilt is outward at the top. Unequal camber results in excessive wear by pulling the wheel to one side. Camber increases the straight ahead recovery. Camber should not generally exceed 2°.

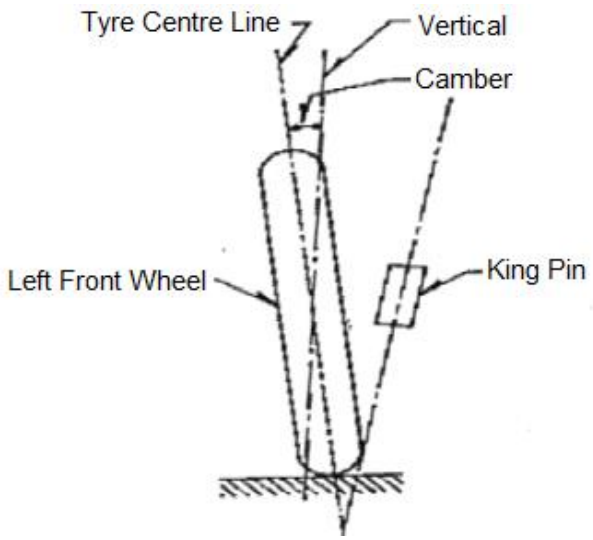


Figure: Camber. 01

ii) Caster:

It is the angle between the king pin center line & the vertical, in the plane of the wheel, when viewed from the side is called the caster angle. Directional stability i.e. straight line tracking is improved by caster. However, positive caster increases the effort required to turn the vehicle and high negative caster causes abnormal wobble. It is generally taken as 3^0 for good directional stability. 01

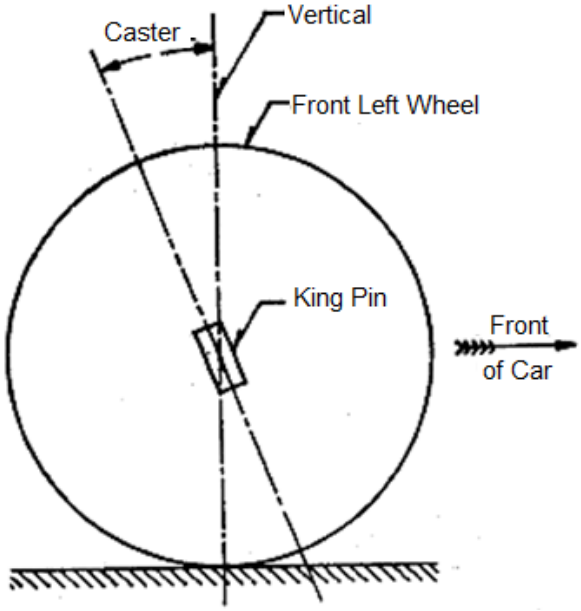
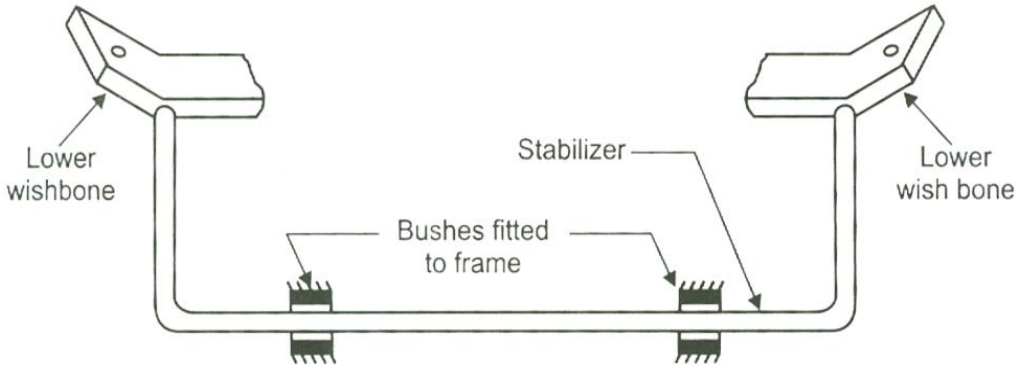
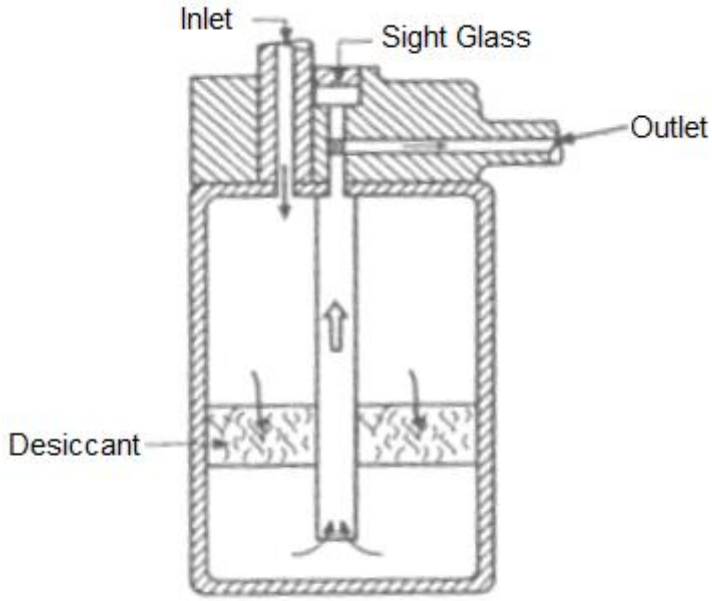
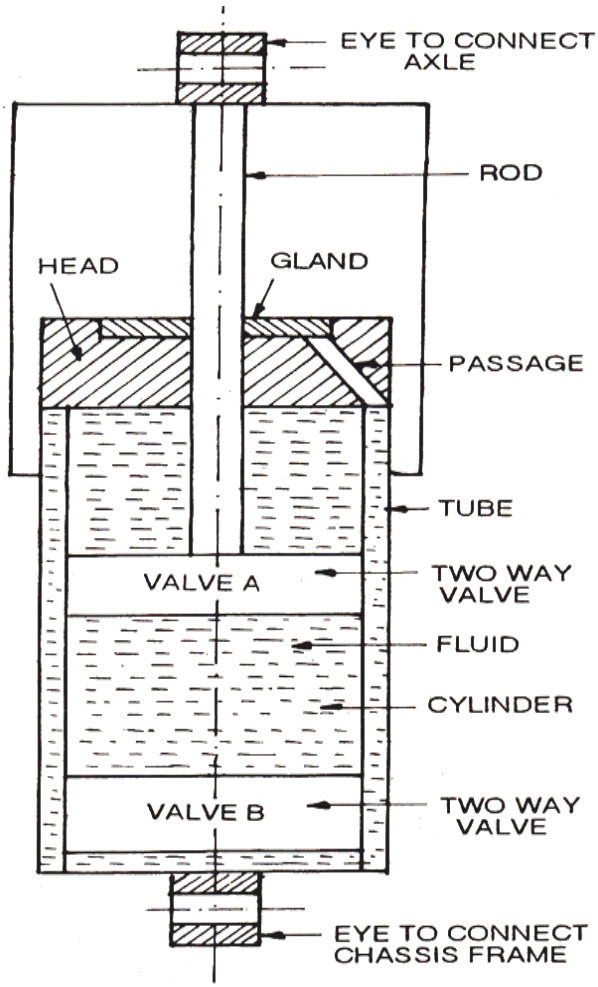


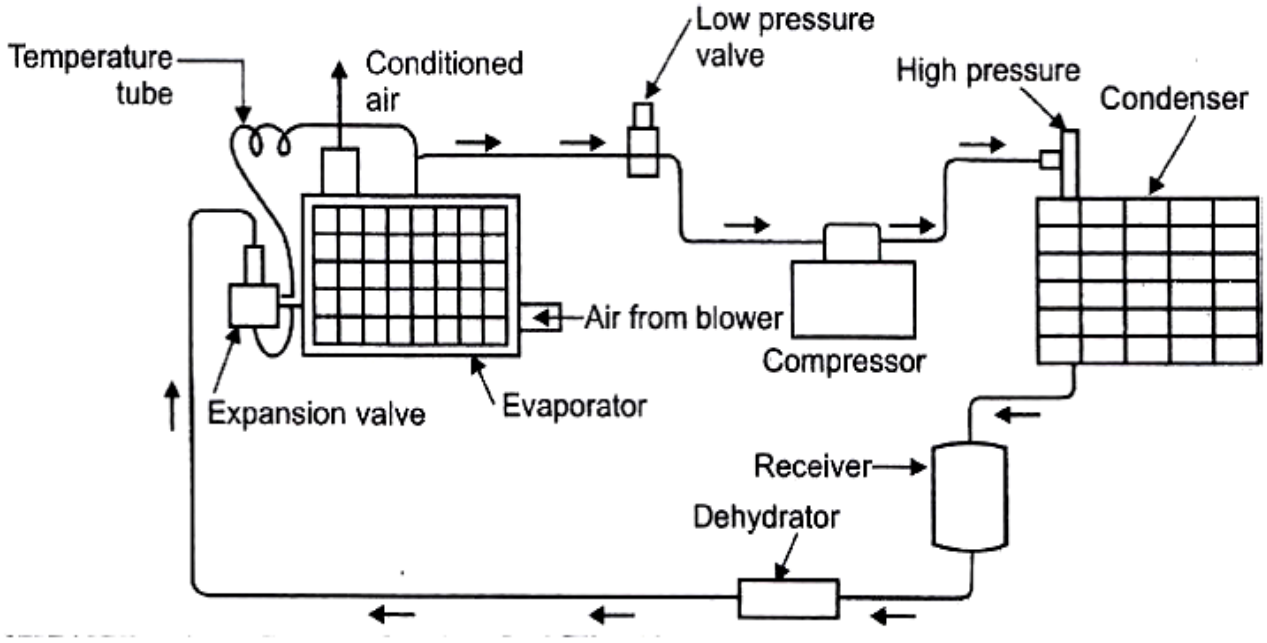
Figure: Caster. 01

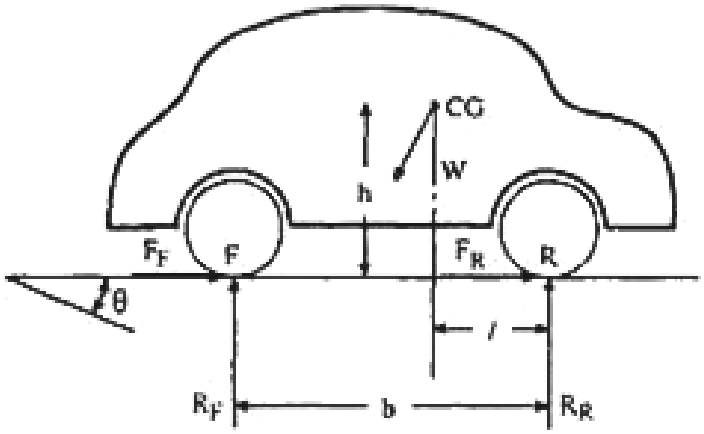
b) Explain function of air bags with examples.	04
Answer: Function of air bags: *(Any 02-01 mark each)* 1. To provide an additional level of protection in the event of a car accident. 2. Air bags supplement the safety belt by reducing the chance that the occupant's head and upper body will strike some 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	02

Examples of air bags: *(Any 02- ½ mark each)* 1. Driver's airbag 2. Passenger airbag 3. Side airbag 4. Head airbag 5. Knee airbag 6. Seat cushion airbag 7. Rear airbag 8. Motorbike airbag	02
c) State uses of antiroll bar and draw its neat sketch.	04
Answer: Uses of antiroll bar: 1. Antiroll bar is used to reduce the tendency of the vehicle to roll on either side when taking a turn. 2. It acts as a spring between the two sides of the independent suspension.  Figure: Anti roll bar for front axle independent suspension.	02 02
d) Explain humidity control system in HVAC.	04
Answer: Humidity control system in HVAC:  Figure: Desiccant used in receiver driver for moisture control	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
e) Explain working of telescopic shock absorber.	04
Answer: Working of Telescopic shock absorber:  Figure: Telescopic shock absorber. When the vehicle comes across a bump the lower eye moves up. Therefore the fluid passes from the lower side of the valve A to its upper side but since the volume of the space above valve A is less than the volume of the rod the fluid exerts pressure on the valve B. This pressure of the fluid through the valve opening provides the damping force. Similarly when the lower eye moves down the fluid passes from the upper side of the valve A to the lower side and also from the lower side of the valve B to its upper side.	02 02

f) State human comfort conditions used in car air conditioning system.	04
Answer: Human comfort conditions: 1) **Temperature:** Temperature is the most important factor which affects human comfort to a great extent. Most of the human being feels comfortable at a temperature 21^0C to 25^0C. Generally human being feels comfortable at relatively higher temperature in winter season and feels comfortable at relatively lower temperature in summer season. The comfort temperature of individual person depends on his body structure, eating habits, the area in which he is to make familiar to live. 2) **Humidity:** The control of humidity is not only necessary for human comfort but it is also important from point of view of efficiency of driver. For human comfort, relative humidity is kept within a range of 35% to 60%. 3) **Purity of air:** A person does not feel comfortable when breathing in contaminated air even if temperature and humidity is within comfortable range. Therefore, proper filtration, cleaning and purification of air is necessary to keep it free from dust, dirt and other impurities. The proper percentage of oxygen in air is necessary to be maintained for human comfort. Therefore, proper filtration system is provided in HVAC system in automobiles. 4) **Air motion and circulation:** Even if temperature, humidity and purity of air is satisfactory, certain amount of air motion is necessary for human comfort. We do not feel comfortable in dead or still air. It is therefore, necessary that there should be equi-distribution of air throughout the space to be air conditioned.	01 01 01 01
6. Attempt any **TWO** of the following.	16
a) Explain protective and anti corrosive treatment of vehicle body.	08
Answer: Protective and anticorrosive treatment of vehicle body: A relatively thin pressed–steel used in automotive body work undergo corrosion/rusting due to water, moisture etc. Therefore it is necessary to adopt rust preventive anti-corrosive treatments and given to metal body structures before application of primer. This also improves bonding strength and forms a good base for primer application. **A) Pre-treatment for Ferrous Metals (e.g. Steel):** **1. Surface preparation:** **a.** Degreasing: It is a process by which organic deposits such as oil, grease, metallic soaps and inorganic matters like soil, dirt, shop dust are removed from metal surface. **b.** Descaling: The process of removing scales on the ferrous surface. **c.** Derusting: If the metal is exposed to atmosphere or water, the oxides of iron are formed on the metal surface; these oxides are called as rust. This process of removing the rusting on the surface. **2. Rinsing:** To remove all acids and acid salts, the work is passed through 2 or 3 successive rinse baths. **3. Phosphate coating:** Phosphate coating is secondary metallic phosphate of iron, zinc or manganese deposited on steel surfaces. They provide a good anchorage to the paint film and prevent rust creep underneath the paint film. **4. Passivation:** After Phosphate coating and rinsing, surfaces are given a final passivation rinse with solution of chromic acid to improve their corrosion resistance. **5. Sealing:** After passivation and drying, the sealant is to be applied within 2 hours during monsoon and 6 hours during winter and summer months.	01 04

B) Pre-treatment for non- ferrous Metals (e.g. Aluminium): 1) **Surface preparation:** It includes descaling, degreasing as referred to ferrous metals. 2) **Anodising:** In this, the heavy oxide film obtained on aluminium surface by treating the metal anodically in certain electrolytes is uniform, inert, very hard and durable and offer very excellent protection against corrosion. 3) **Sealing:** It is done by heating the anodized work in water, steel, certain salt solution or treatment with waxes and lacquers. Efficient sealing ensures long life. 4) **Chromate conversion coating:** In this protective non metallic formed on a metal surface by treating with a solution containing a mixture of chromic and phosphoric acid.	03
b) Draw layout of HVAC and explain its operation.	08
Answer : HVAC:  Figure: Layout of HVAC. **Operation of HVAC:** HVAC works on Vapor compression cycle. It consists of compressor, condenser, evaporator, receiver, expansion valve, thermostat, blower fan and heating core. In compressor during suction stroke low pressure vapor in dry state is sucked from evaporator. It is then compressed to high pressure and temperature. These vapors are then passed into condenser where heat is removed by cooling medium which converts vapor into liquid. The liquid is stored into receiver. The liquid from receiver is then passed to evaporator through expansion valve. Expansion valve reduces pressure. The low pressure liquid refrigerant enters evaporator, where it absorbs the heat from the warm air which is passed over the evaporator. The worm air gets cooled thereby cooling the passenger compartment. Due to heat absorption, liquid refrigerant gets converted into vapor and these vapors are passing to compressor. For heating the passenger compartment, hot engine coolant is passed through heater core. The air from blower motor fan is passed over the core thus passenger compartment gets warm.	04 04

c) Describe stability of vehicle on slope and turn.	8
Answer: **Stability of vehicle on Slope:** Let the vehicle rest on a slope of inclination Q to the horizontal. This alters the distribution of the weight between the front and back axle and gives rise to reaction which can have com-ponents along the perpendicular to the inclined plane as shown in Fig**.**  Figure: Stability of vehicle on slope. If the angle θ_L is increased gradually, a situation arises when, 1. The vehicle about to overturn, or 2. The vehicle is about to slide down the slope, The limiting angle θ_L for overturning is given by, $$\tan \theta_L = \frac{b - l}{h}$$ If the second condition arises, the limiting angle θ_L is given by, $$\tan \theta_L = \mu.$$	04
Stability of vehicle on turn: When vehicle is taking a turn along a curved path three conditions arises - 1) Centrifugal force acts at centre of gravity in radially outward direction and normal reaction due to centrifugal force acts at wheel contact. The reactions (P_{IF}, P_{IR}) will be in inward direction at inner wheels and the reactions (P_{OF}, P_{OR}) outward directions at outer wheels. The centrifugal force and reactions forms overturning couple. 2) At the wheels reaction due to weight (R_{IF}, R_{IR}, R_{OF}, R_{OR}) acts at a wheel in radially outward direction. 3) Reaction at a wheel due to gyroscopic couple. These three conditions causes the over turning couple leads to sliding (skidding) and overturning of the vehicle. To avoid this height of center of gravity of the vehicle should be lower; speed during turning should be lower.	04

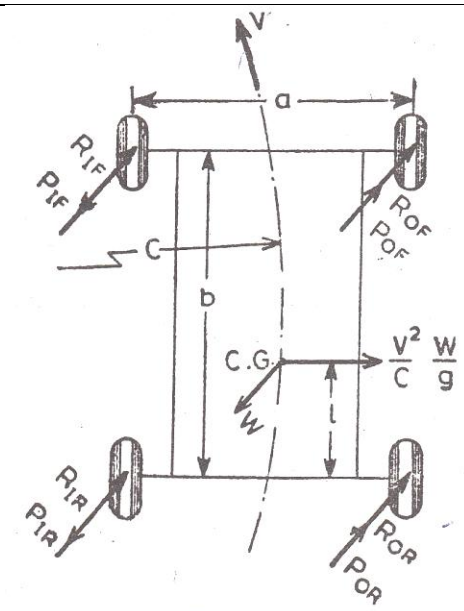


Figure: Stability of vehicle on turn.