



Subject Title: Automobile Systems and Body Engineering

Subject Code:

17409

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 judgement 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.

Q. No	Sub Q. N.	Answer	Marking Scheme								
1	a)	Attempt any SIX of the following	12								
	i)	How dead axle is different from live axle?	02								
		<div>Answer: (Any suitable difference can get full marks)</div> <table><thead><tr><th>Dead Axle</th><th>Live axle</th></tr></thead><tbody><tr><td>1) It has no connection with engine means it is dead and will not carry the engine power.</td><td>1) It is axle which contains differential mechanism through which the engine power flows towards the front wheels.</td></tr><tr><td>2) It has sufficient rigidity and strength to transmit the weight of vehicle from the springs to the front wheels.</td><td>2) In addition to transmit weight live has to supply engine power to wheels.</td></tr><tr><td>3) Generally front axle is dead in front engine real wheel drive or rear engine rear wheel drive.</td><td>3) Generally rear axle is live axle in front engine real wheel drive or rear engine rear wheel drive.</td></tr></tbody></table>	Dead Axle	Live axle	1) It has no connection with engine means it is dead and will not carry the engine power.	1) It is axle which contains differential mechanism through which the engine power flows towards the front wheels.	2) It has sufficient rigidity and strength to transmit the weight of vehicle from the springs to the front wheels.	2) In addition to transmit weight live has to supply engine power to wheels.	3) Generally front axle is dead in front engine real wheel drive or rear engine rear wheel drive.	3) Generally rear axle is live axle in front engine real wheel drive or rear engine rear wheel drive.	(Any 2, 1 mark each)
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	ii)	Define king pin inclination	02								
		Answer: It is the angle between vertical line and centre line of king pin or steering axis when viewed from the front of the vehicle. It is normally about 70 to 80	02								
	iii)	Define co-efficient of friction	02								
		Answer: Coefficient of friction : A ratio of limiting friction to the normal reaction of the surfaces in contact is constant, which is called Coefficient of friction (μ)	02								
	iv)	State chemical name and chemical formula for refrigerant R-12	02								



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		Answer: Chemical Name of R-12 Dichloro- difluoro-methane or Freon -12 (R-12) Chemical formula or R-12: CCl ₂ F ₂	02
	v)	Define the terms rolling and pitching.	02
		Answer: Rolling: While cornering, the centrifugal force produces a movement of the vehicle about a longitudinal axis through center of gravity and is known as rolling. Pitching: It is rocking chair action or rotating action about a transverse axis through the vehicle parallel to ground is known as pitching.	1 mark for each
	vi)	State four properties of brake fluid	02
		Answer: Properties of brake fluid: (any 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.	½ marks for each
	vii)	List components of hydraulic power assisted steering system used in car.	02
		Answer: Components of power steering system: (Any 04) 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	½ mark each
	viii)	State two advantages of independent suspension system.	02
		Answer: 1) Lighter springs can be used in case of independent suspension. 2) Unsprung weight is reduced. 3) Tyre scrub reduced and tyre life increases. 4) Softer spring can be used without increasing rolling effect and soft spring improves ride comfort. 5) Steering geometry is not altered with spring deflection as in case of	01 mark for each (Any two)

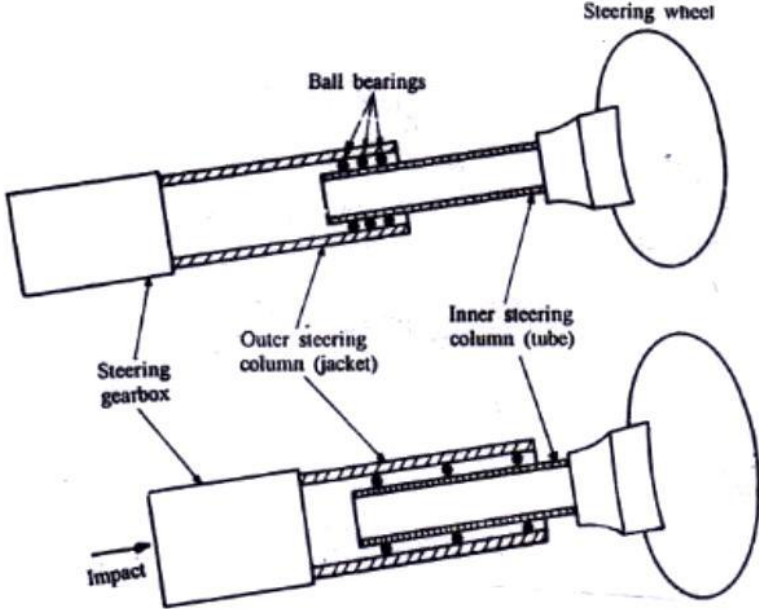
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		conventional rigid axle suspension. 6) It is possible to locate springs apart enough to obtain understeering conditions, which is always preferred than oversteering.	
1	b)	Attempt any TWO of the following	08
	(i)	Describe working of collapsible steering with sketch	04
		<p>Answer: 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. 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.</p>  <p style="text-align: center;">Figure: Collapsible steering.</p>	02
	(ii)	Define – Tractive effort, draw bar pull, Air resistance and Gradient resistance.	04
		<p>Answer: Tractive effort: Tractive effort is the force available at the points of contact between the rear wheel tyres and the road. Therefore, the useful tractive effort is always less than the traction.</p> <p>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.</p> <p>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.</p> <p>Gradient Resistance: It is force that opposing forward motion of vehicle on the</p>	1 mark for each definition



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gradient.

It is expressed as

$$R_g = \frac{W \cdot G}{mg} \quad G = W \sin \theta$$

Where, R_g = Gradient resistance in N

$W = mg$ = Weight of the vehicle in N.

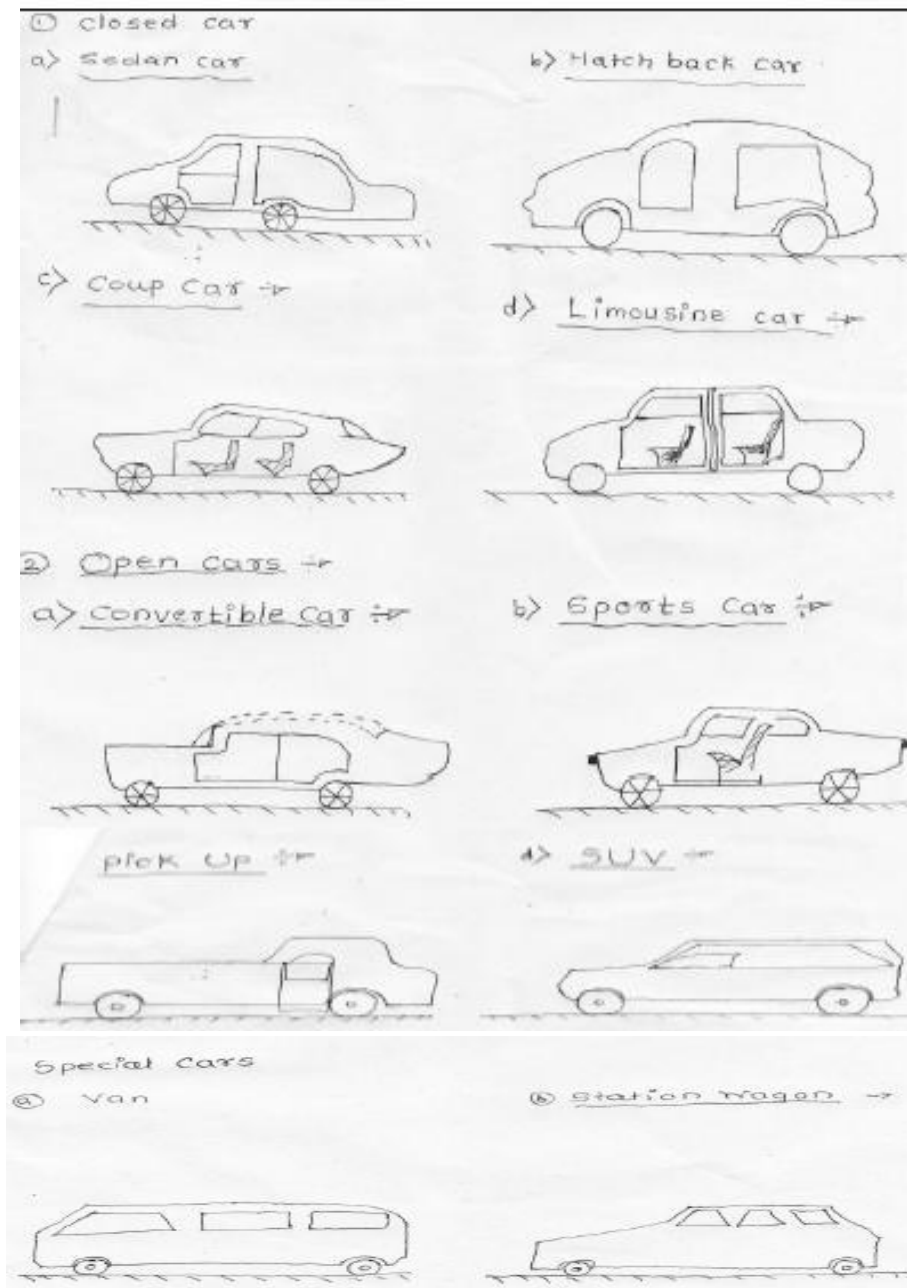
G = Gradient

θ = Angle of gradient

(iii) Draw neat sketch of any four body styles used for cars.

04

Answer: **Body styles:** (Any 04-1mark each)





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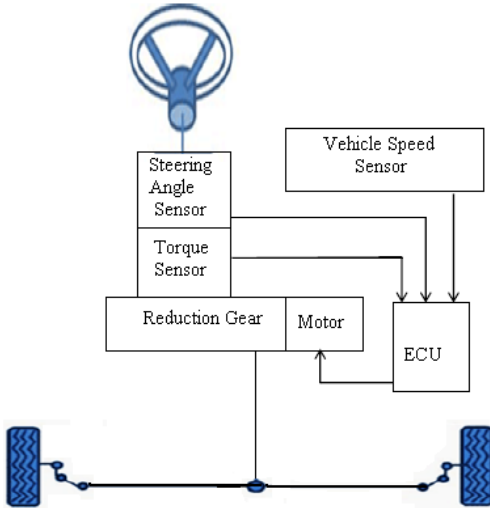


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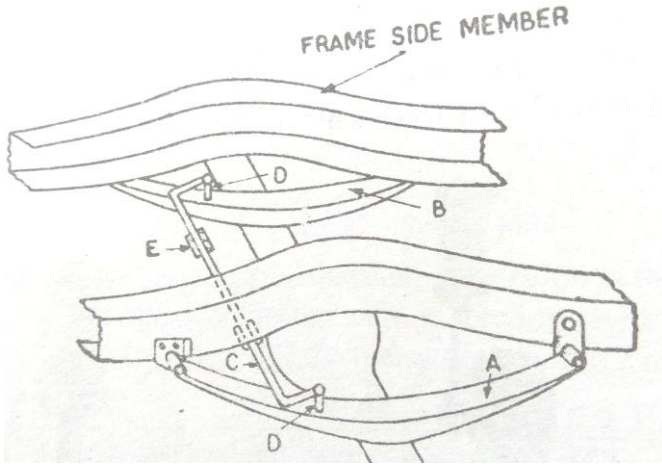
c)	Describe with neat sketch electrical power steering	04
	<p>Electrical power steering: The system consists of following components: 1. Steering column that connects the steering pinion with steering wheel inside the vehicle. 2. Steering pinion that converts the rotating steering movement into linear movement of the rack. 3. Rack connected to the wheels via tie rods and links. 4. Sensors to record the information required to calculate the necessary supporting steering torque. 5. Servo unit consisting of an ECU and servo motor (electric motor) that generates the supporting steering torque. When the driver moves the steering wheel a sensor registers the steering torque exerted and sends this information as an electric signal to ECU. This calculates the supporting torque and activates the servo motor on the basis of the calculated result. Generally the steering torque generated by these motors is 3-6 Nm. The direction of rotation of motors depends on the direction of motion of steering wheel. The control electronics takes into account the different signals and parameters e.g. Driving speed, steering angle, steering torque and steering speed with the help of other sensors in the vehicle and due to networking of steering ECU with other ECUs in the vehicle framework. This steering system can be used to implement assistance function to enhance comfort and safety.</p>  <p style="text-align: center;">Figure: Electronic Power Steering</p>	<p>4</p> <p>02</p> <p>02</p>
d)	State use of caliper in disc brake and state any two advantages of disc brake.	04
	<p>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.</p> <p>Advantages of disc brake system: (Any 02 , 1mark each)</p> <ol style="list-style-type: none"> 1) It has comparatively better anti-fade characteristic. 2) Better heat dissipation as braking surface is directly exposed to air. 3) The linings of disc brakes brush lightly against the rotating disc, even when the brakes are not applied therefore no brake adjustment is required. 4) It is possible to check condition of pad wear without dismantling the brake system. 	<p>02</p> <p>02</p>



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e)	Describe with sketch stabilizer bar for rigid axle suspension.	02
	<p>Answer: when one wheel is deflected more than the other, e.g. , when it comes over a bump on the road, there is a tendency for the vehicle to roll. To obviate this tendency, a stabilizer (also called as anti-roll device) is used in the form of a torsion bar. Fig. describes such a device used in a vehicle. The torsion bar C is fixed to springs A & B by means of two short rods D. The torsion bar is supported in two bearings E which are fixed to the frame (fixing not shown).</p> <p>To understand the working of stabilizer bar, consider a situation when the car rolls out such that the nearer side in fig. moves up that decreases load on spring A which causes the nearer rod D to move down. On other hand the load on spring B is increased, thereby letting the farther rod D to move up. Thus the bar C which is supported in bearings undergoes twisting. It is the tendency of the bar to twisting that counters the tendency of car to roll out, thereby providing stability against lateral forces.</p> 	02
f)	Describe working of antilock braking system.	04
	<p>Answer: 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. 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.</p>	02



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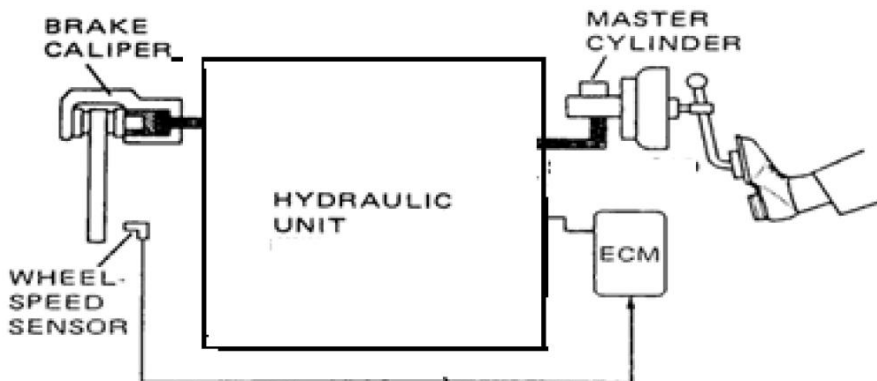


Figure: Antilock brake system.

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

02

3

Attempt any FOUR of the following

16

a)

Differentiate between drum brake and disc brake.

04

Difference between disc-brake and drum-brake: (Any 04)

04

(01 each)

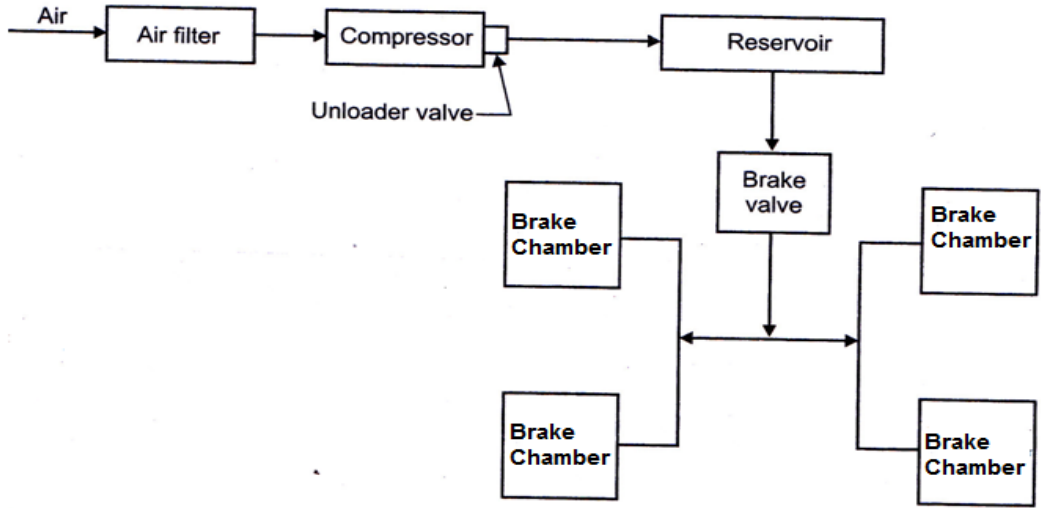
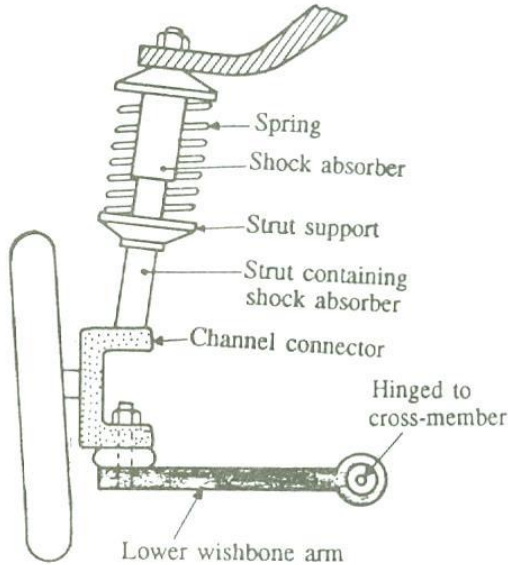
Sr. No.	Disc Brake	Drum brake
01	Friction surfaces are directly exposed to the cooling air.	Friction occurs on the internal surfaces, therefore heat dissipated only by conduction through the drum.
02	Flat friction pads are used.	Curved friction linings are used.
03	There is uniform wear of friction pads.	Non uniform wear of friction linings.
04	There is no loss of efficiency due to expansion.	There is loss of efficiency due to expansion.
05	Weight is less so saving upto 20 % is possible.	Comparatively higher weight.
06	Disc brakes have comparatively better anti-fade characteristics.	Comparatively poor anti-fade characteristics.
07	Simple in design.	Complicated design.
08	Comparatively easy to remove and replace friction pads.	Removal and replacement of brake linings is difficult and consumes more time.
09	Less frictional area	More frictional area
10	Pressure intensity is more	Pressure intensity is less



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b)	Draw a layout of air brake system and label it	04
		04
c)	State suspension used on front wheel of Maruti 800/santro and describe its working with neat sketch	04
	<p>Answer: Mc-pherson strut type independent suspension system used in MARUTI 800: In this type, only lower wishbones are used as shown in fig. A strut containing shock absorber and the spring carries also the stub axle on which the wheel is mounted. The wishbone is hinged to the cross member and positions the wheel as well as resists accelerating, braking and side forces. This system is simple, lighter and keeping the unsprung weight lower. Further the camber also does not change when the wheels move up and down. This type of suspension provides the maximum area in the engine compartment and is, therefore, commonly used on front wheel drive cars.</p> 	02 02



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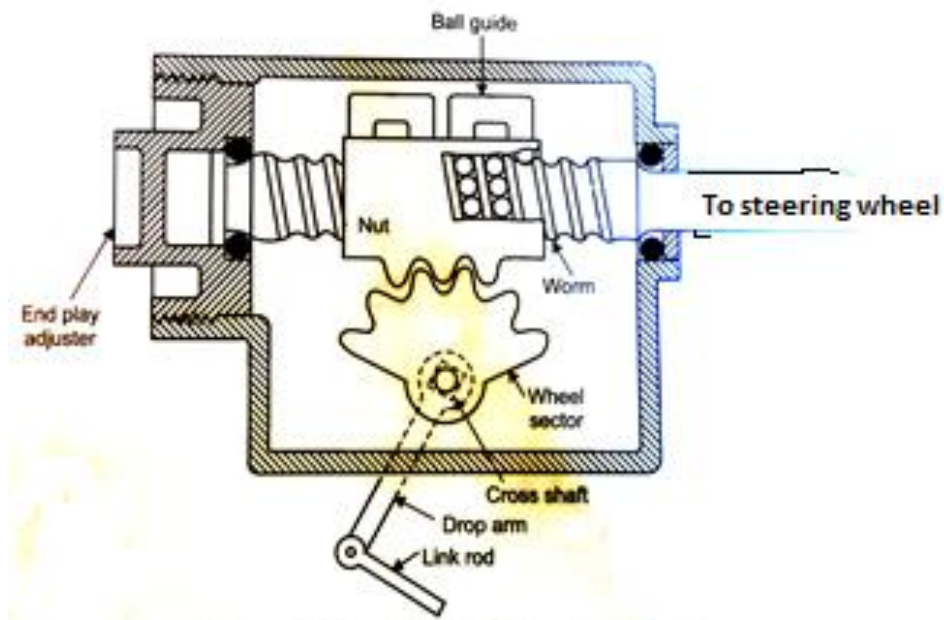
d)	Describe four properties of refrigerants used in automobiles.	04
	<p>Properties of refrigerant: (Any 04)</p> <ol style="list-style-type: none">1) The refrigerant should have low freezing point.2) It must have high critical pressure and temperature to avoid large power requirement.3) It must have low 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)	Describe materials used for body construction	04
	<p>Materials used for body construction: (Explain any 04 material, 01 mark each)</p> <ol style="list-style-type: none">1. Steel sheets and high-strength, low-alloy steels: The main factors of selecting material especially for body is wide variety of characteristics such as thermal, chemical or mechanical resistance, ease of manufacture and durability. Steel sheets are used for paneling over a timber frame work and also for press work such as roof, scuttle, door and wings.2. Aluminum: Aluminum 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 aluminum sections and sheets.3. 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 than steel.4. Glass - fiber composites: It is lighter than steel and aluminum, easy to be shaped and rust-proof. It is cheap to be produced in small quantity.5. Wood: Timber in common forms like Log, balk, billet, plank, board, batten, pillars etc are used for commercial body building. Plywood also largely used due to its property like uniformity in strength along and across the grain.6. Glass: The wind screens and window panels, doors are made up of glass sheet. Toughened glass sheet, if broken into pieces in case of accident cause injury, but now a days laminated glass sheets are used which do not break into pieces.7. Rubber: Natural and synthetic rubbers are used in upholstery work as well as internal trimming of door and window panels.8. Carbon-fibre epoxy composite: It is because the composite structures are the high strength/low weight ratio. The most common materials used for racing cars are carbon (graphite), Kevlar and glass fibres.9. Magnesium: Magnesium is another light metal that is becoming increasingly common in automotive engineering. It is 33% lighter than aluminium and 75% lighter than steel/cast iron components.	04



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f)	<p>Explain working of central locking system. Write one advantage and one disadvantage of it.</p>	04
	<p>Working of central locking system: Central locking system is electromechanical system. A two-position solenoid actuator is installed in each door to electrically operate the door locking mechanism. It locks the doors when the current passed in it by the electronic control module (ECM) in one direction and unlock when the direction of current is reversed. In replacement of solenoid valve DC motor can be used as an actuator. Each door can be locked or unlocked individually or alternatively all the doors can be locked or unlock with one switch. <i>Note: Credit shall be given to any other suitable answer (i.e. Manually or electrically operated central locking system).</i></p> <p>Advantages of central locking system: (Any 01)</p> <ol style="list-style-type: none"> 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. <p>Disadvantages of central locking system: (Any 01)</p> <ol style="list-style-type: none"> 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 	<p>02</p> <p>01</p> <p>01</p>
4	<p>Attempt any TWO of the following</p>	16
a)	<p>Describe with neat sketch working of recirculating ball type steering gear box and state its applications.</p>	08
	 <p style="text-align: center;">Fig. Recirculating Ball Type Steering Gear</p>	03

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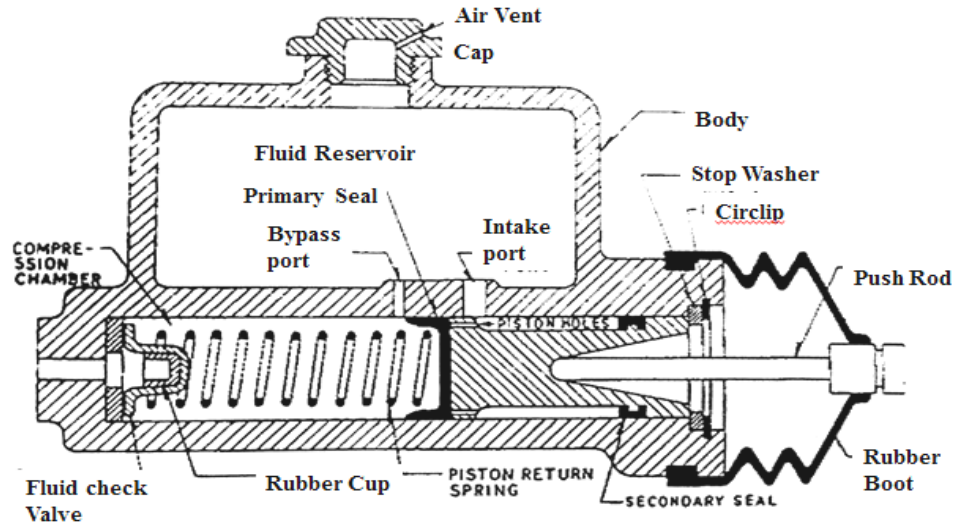
		<p>Working of Recirculating type steering gear box: It consists of worm at the end of steering rod. A nut is mounted on the worm with two sets of balls in the grooves of the worm, in between the nut and worm. The balls reduce the friction during the movement of nut on the worm. the nut has large number of teeth on the outside, which mesh with the teeth on a worm wheel sector, on which is further mounted the drop arm, which steers the road wheels through the link rod and steering arm. When the steering wheel is turned, the balls in the worm roll in the grooves and cause the nut to travel along the length of the worm. The balls , which are in Two sets are recirculated through the guides as shown in the fig. the movement of the nut causes the wheel sector to turn at an angle and actual the link rod through the drop arm, resulting in the desired steering of the wheels.</p> <p>Application: Trucks and SUV's (Any suitable applications should get full marks)</p>	03
			02
b)		Describe with neat sketch working of Tandem master cylinder	08
		<p>Working of Tandem Master cylinder: In tandem master cylinder the brake fluid will transmit the pressure both to front as well as to the rear brakes when the brake pedal is applied. However, when the front brake lines are damaged, the piston (2) will move till it comes up against stop (3). After this pressure will start building up in the space between piston (1) and (2) and the rear brakes will be applied. Similarly when the rear brake lines are damaged, no pressure will build up in space between piston (1) and (2) so piston (1) will move freely till it comes up against (2). Further push at the brake pedal will move both piston (1) and (2) together thereby applying the front brakes.</p>	04
		OR	04
			(OR)



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**Figure: Master Cylinder.***(Note: Equivalent credit shall be given to schematic diagram if drawn)*

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 of 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.

c) **Describe construction and working of gas filled shock absorber with neat sketch**

Construction:

- 1) The piston rod is attached to two way valve while another similar two way valve is attached at the lower end of the cylinder.
- 2) There is a mixture of oil and gas in the space below the valve assembly, below valve and also in the annular space between cylinder and tube, which is connected to the space below valve assembly.
- 3) The bottom eye is connected to the axle while the top eye is connected to the chassis frame.
- 4) The mixture of oil and gas is used for damping.

Working: Fig. shows the sectional view of the gas-filled shock absorber. In this type of shock absorbers, instead of only oil, the mixture of oil and gas is used for the damping effect. During compression, the working direction is controlled by the valves on the piston rod side of the damping piston. The additional volume of the piston rod compresses the gas cushion. During expansion, the oil between the piston and guide must be compressed via the spring washer package on the gas chamber side. Due to the ascending piston rod, the gas cushion expands

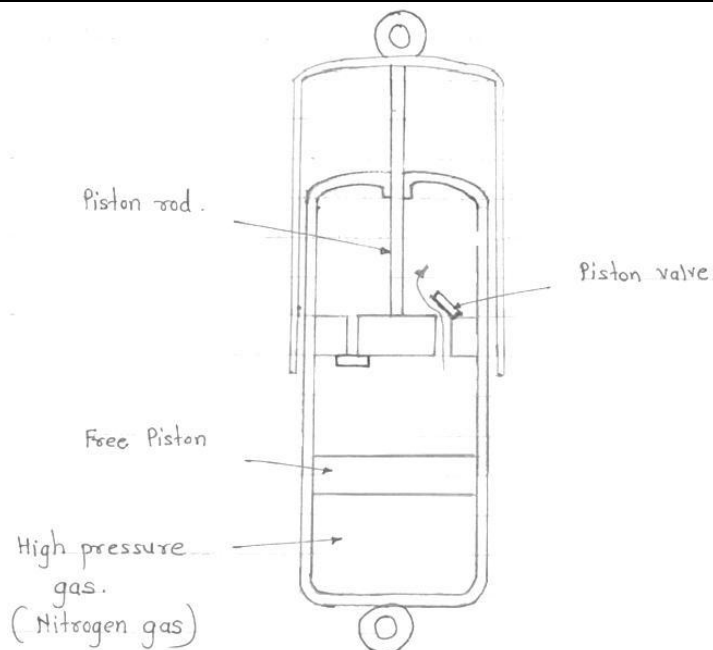


Figure: gas filled shock absorber

04

5

Attempt any FOUR of the following

16

a)

What do you understand by understeering and oversteering ? state its effect on vehicle stability.

04

Answer: (Any suitable answer get full marks)

During turns, centrifugal force acts on the wheels. Two cases can arise:

i) 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

ii) 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.

01

Effect on vehicle stability: (Any Suitable effects should get full marks)

In Fig. (a) the vehicle is understeering.

It is trying to continue straight ahead and the driver needs to apply more steering effect in order to get round the bend.

02

In Fig. (b) oversteer is occurring.

The vehicle turns sharply than it should be for a given rotation of steering wheel. Driver has to steer less than desired.



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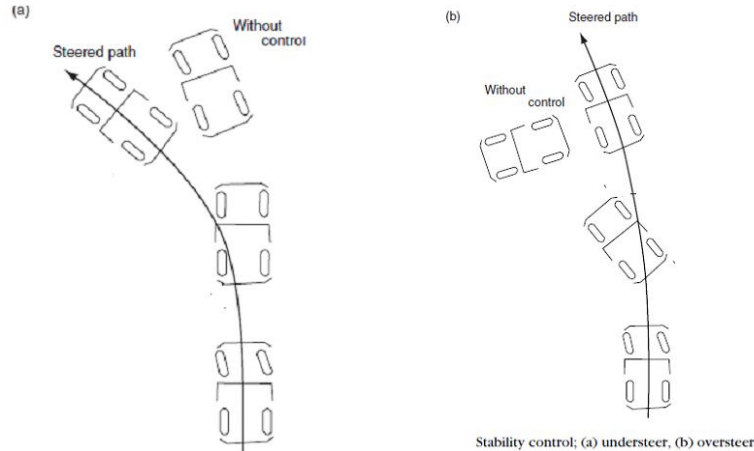


Figure: understeering

Figure: oversteering

Stability control; (a) understeer, (b) oversteer

b) Describe with sketch working of exhaust brake.

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.

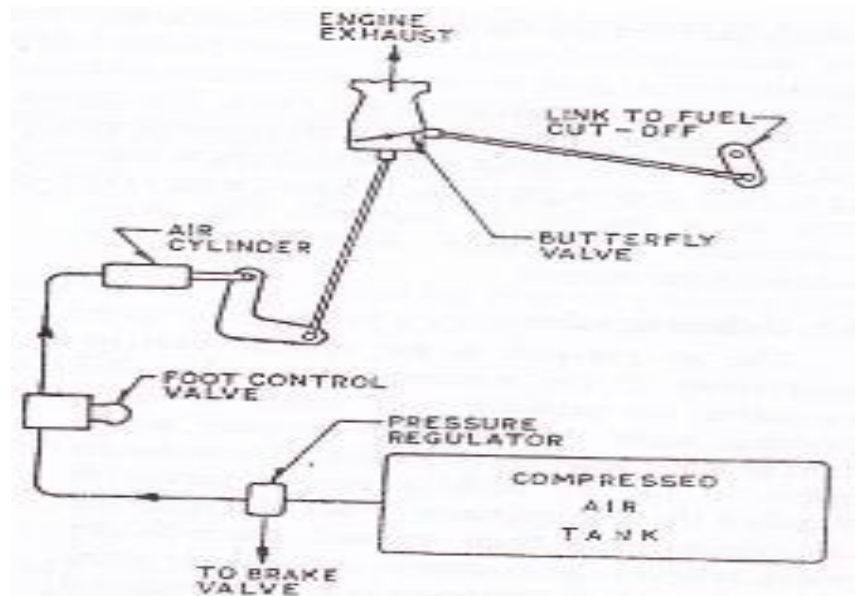


Figure: Exhaust brake

02

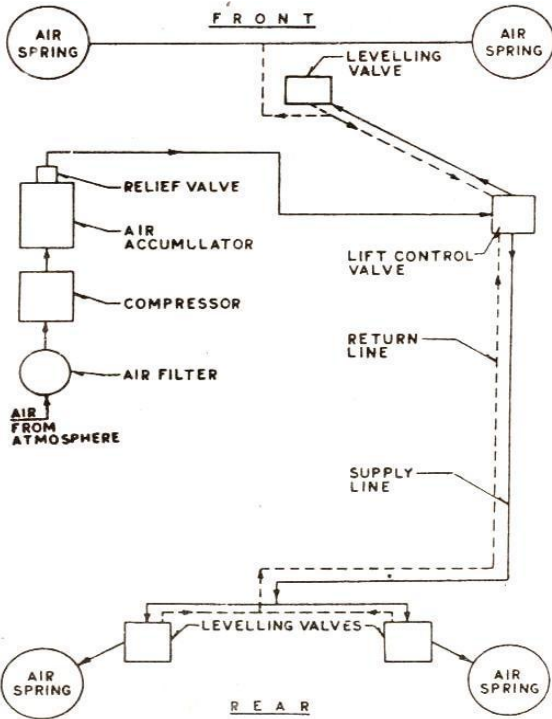
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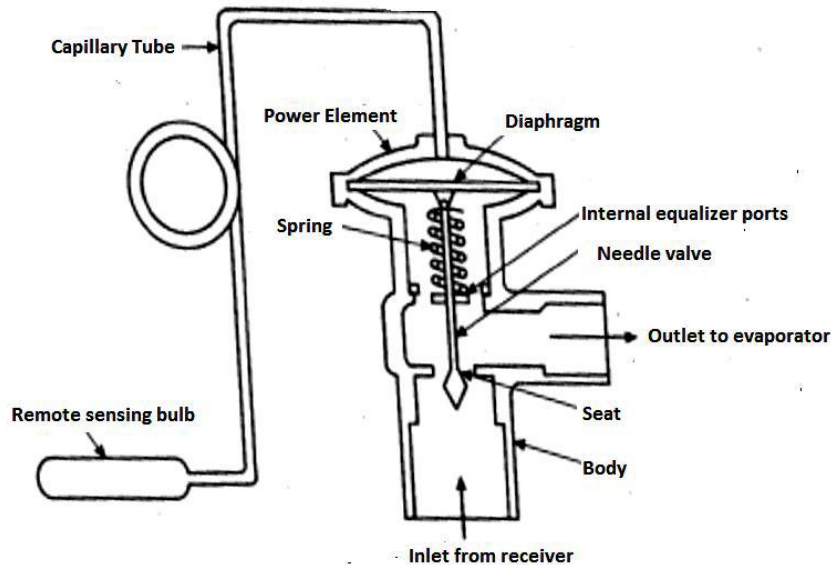


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c)	Draw the layout of air suspension and describe its working	04
	<p>Layout of Air suspension system: Working: An air compressor takes the atmospheric air through a filter and compresses it to a pressure of about 240 MPa, at which pressure the air in the accumulator tank is maintained, which is also provided with a safety relief valve. This high pressure air goes through the lift control valve and the leveling valves, to the air springs as shown. Each air spring is filled with compressed air which supports the weight of the vehicle. The air gets further compressed and absorbs the shock when the wheel encounters a bump on the road.</p>	02
	 <p>Figure: Schematic diagram showing the layout of an air suspension system.</p>	02
d)	Describe how temperature and humidity is controlled by HVAC system	04
	<p>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.</p>	01

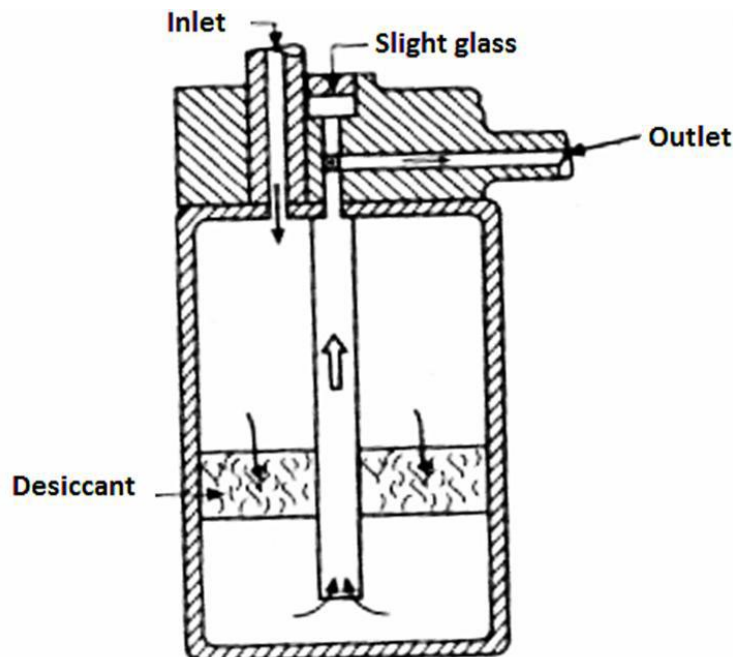


01

Figure : Control of temperature

Control of humidity: 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.

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Figure: Control of humidity:

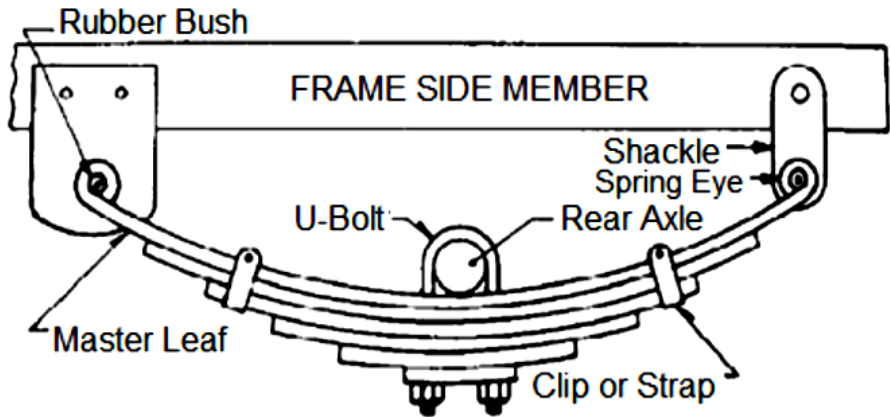


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e)	Describe construction of semi-elliptical leaf spring with neat sketch.	04
	<p>Answer: Construction: It consists of number of leaves called blades. The blades vary in length. The lengthiest blade has eyes on its ends called master leaf. All the leaves 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.</p>  <p>Figure: semi-elliptical leaf spring</p>	02 02
f)	State role of a dehydrator and evaporator in air conditioning system.	
	<p>Answer: Role of dehydrator : 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.</p> <p>Role of evaporator: 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.</p>	02 02

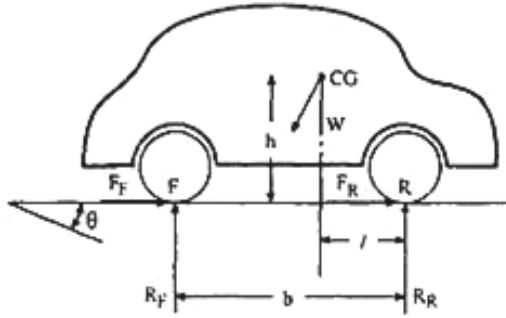
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6		Attempt any TWO of the following	16
	a)	Describe repainting procedure for a car met with accident.	08
		<p>Answer: Repainting procedure for car met with accident:</p> <p>1) Remove dent using denting tools and dent removing procedure.</p> <p>2) Preparing the Surface: Begin by sanding the car's surface with a dual action sander and 120 grit sand papers to remove old paint and primer.</p> <p>3) Carryout any necessary masking so that paint remover may not fall on the finished surface.</p> <p>4) Wipe the surface down with a proprietary sprit.</p> <p>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.</p> <p>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.</p> <p>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.</p>	08
	b)	Draw a layout of vapour compression cycle and describe its working.	08
		<p style="text-align: center;">Figure: Vapour compression cycle.</p> <p>Working: 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. 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</p>	04
			04



		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.	
c)		i) Describe stability of vehicle on slope.	04
		<p>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 components along the perpendicular to the inclined plane as shown in Fig.</p>  <p>Figure: Stability of vehicle on slope.</p> <p>If the angle θ_L is increased gradually, a situation arises when,</p> <ol style="list-style-type: none"> 1. The vehicle about to overturn, or 2. The vehicle is about to slide down the slope, <p>The limiting angle θ_L for overturning is given by,</p> $\tan \theta_L = \frac{b-l}{h}$ <p>If the second condition arises, the limiting angle θ_L is given by,</p> $\tan \theta_L = \mu.$	<p>02</p> <p>01</p> <p>01</p>
		ii) Describe the effect of streamlining on vehicle performance.	04
		<p>Answer: Effect 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:</p> <ol style="list-style-type: none"> 1. Aerodynamic Drag <ol style="list-style-type: none"> a. Induced drag b. Profile drag c. Friction drag 2. Aerodynamic Lift <p>Aerodynamic Drag: It is the resistance offered by air while moving the vehicle on road; it is called as aerodynamic drag. In fig. F_x is the aerodynamic drag.</p>	



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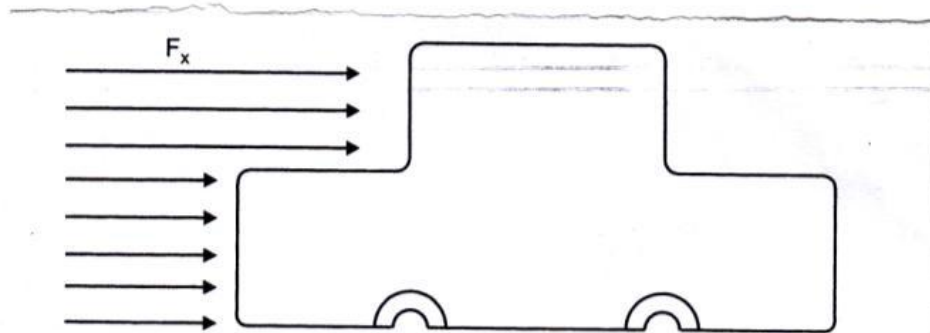


Figure: Aerodynamic Drag

Aerodynamic Lift: The vertical component of the resultant of air force is called as aerodynamic lift. Due to the lift force, one moment is created about centre of gravity is called pitching moment.

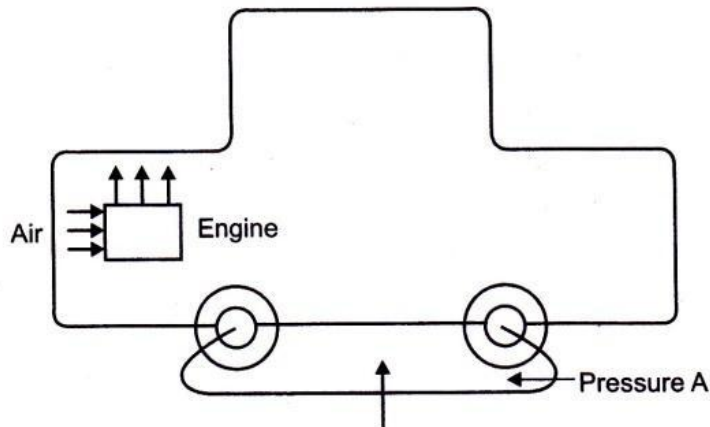


Figure: Aerodynamic Lift

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