



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 <u>SIX</u> of the following	12
	i)	Define live axle & Dead Axle	02
		<p>Answer:</p> <p>1. Live front axle: It is axle which contains differential mechanism through which the engine power flows towards the front wheels.</p> <p>2. Dead front axle: It has no connection with engine means it is dead and will not carry the engine power.</p>	<p>01</p> <p>01</p>
	ii)	Draw a neat labelled sketch of Elliot type of stub axle	02
		<p style="text-align: center;">(i) Elliot</p>	02



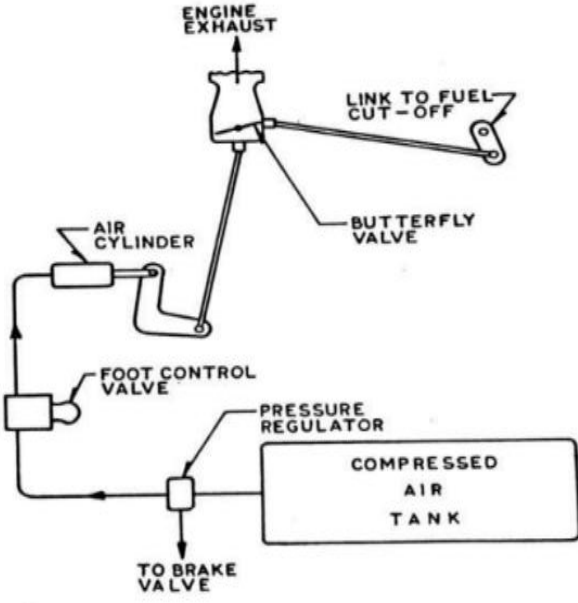
MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)
WINTER- 16 EXAMINATION

Model Answer

Subject Code: **17409**

iii)	List any two functions of braking system	02
	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.	02
iv)	Name any four components of air conditioning system used in car	02
	Answer: (½ mark each) i)Compressor ii)condenser iii)Receiver & Drier iv) expansion valve v)Evaporator	02
v)	Define -Air Resistance & rolling resistance	02
	Answer: Air or wind 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. 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.	01 01
vi)	State the two functions of parking brake	02
	Answer: i) 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 slowdown continuously over a large distance. This type of brake effects fuel economy of vehicle. ii) 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.	01 01
vii)	List the four type of steering gearbox	02
	Answer: i)Rack & Pinion type ii)Recirculating Ball Type iii) Worm & Gear type iv) Worm & Roller type	(½ mark each)



Q. No.	Sub Q. N.	Answer	Marking Scheme
	ii)	Define –i) Drawbar pull ii) Gradeability	04
		Answer: 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.	02
		Gradeability: It is the maximum percentage grade negotiated by a vehicle under full rated condition.	02
	iii)	Explain the working of exhaust brake with neat sketch	04
		 <p style="text-align: center;">Schematic diagram showing engine exhaust brake.</p> <p>Working:-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.</p>	02

2		<p>Attempt any <u>FOUR</u> of the following</p>	16
	a)	<p>What is effect of castor & camber on stability of vehicle</p>	04
		<p>Answer: i) Castor provides directional stability that is kept vehicle on straight path. 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 30 for good directional stability.</p> <div style="text-align: center;"> </div>	01
		<p>ii) 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°. Positive camber helps steering wheel to retain its original position after completion of turn</p> <div style="text-align: center;"> </div>	01

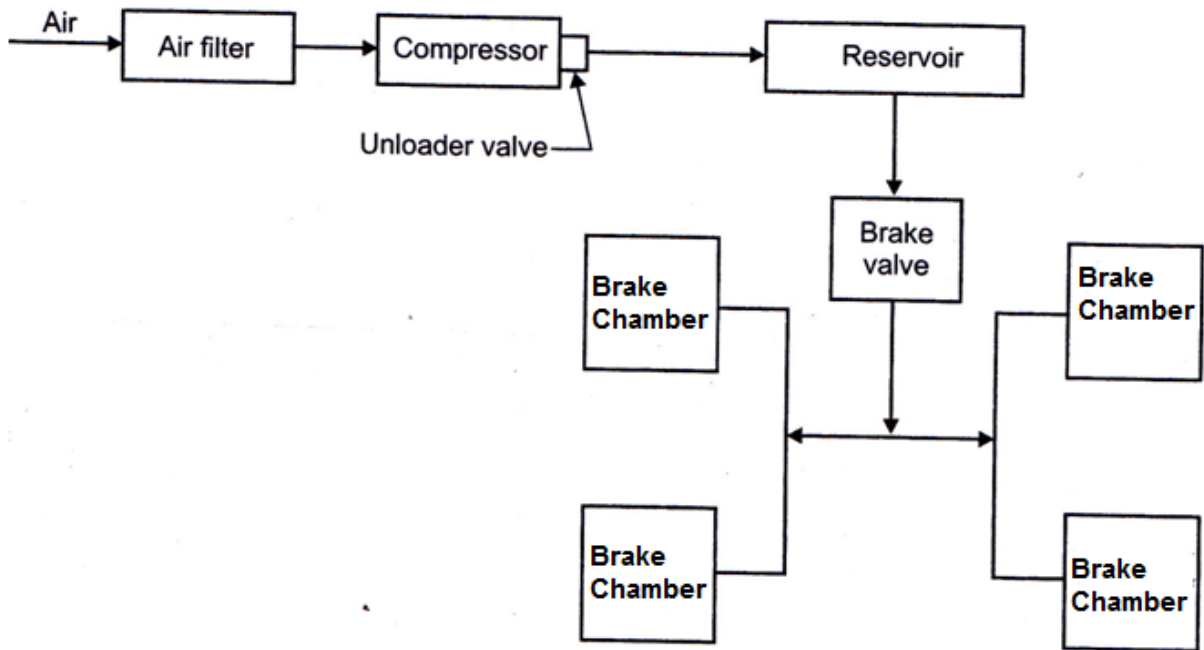
b)	<p>Draw a labelled sketch of rack & pinion type steering gearbox</p>	04
	<p style="text-align: center;">Fig:- Rack & Pinion Type Steering Gear Box</p>	04
c)	<p>Explain the Ackerman's steering mechanism with neat labelled sketch</p>	04
	<p>Answer:-Ackermann steering mechanism:</p> <p>The Ackermann steering gear consists of turning pairs rather than sliding pairs. The whole of the mechanism is placed on the back of the front wheels. In Ackermann steering gear, the mechanism ABCD is a four bar crank chain. The shorter links BC and AD are equally inclined to the longitudinal axis of the vehicle.</p> <p>For the correct steering the following three positions are obtained:</p> <ol style="list-style-type: none"> 1. When the vehicle moves along the straight path, the longer links AB and CD are parallel at 	02

Shorter links BC and AD are equally inclined to the longitudinal axis of the vehicle.

2. When the vehicle is moving to the right or left, the lines of the front wheel axle intersect on the back wheel axle at I for correct steering.

d) Describe the working of air braking system with neat labelled sketch.

04



03

Fig: Air Braking System Layout

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.

01

e) Explain the protective treatment of vehicle

04

Answer:-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, and 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

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manganese deposited on steel surfaces. They provide a good anchorage to the paint film and prevent rust creep underneath the paint film.

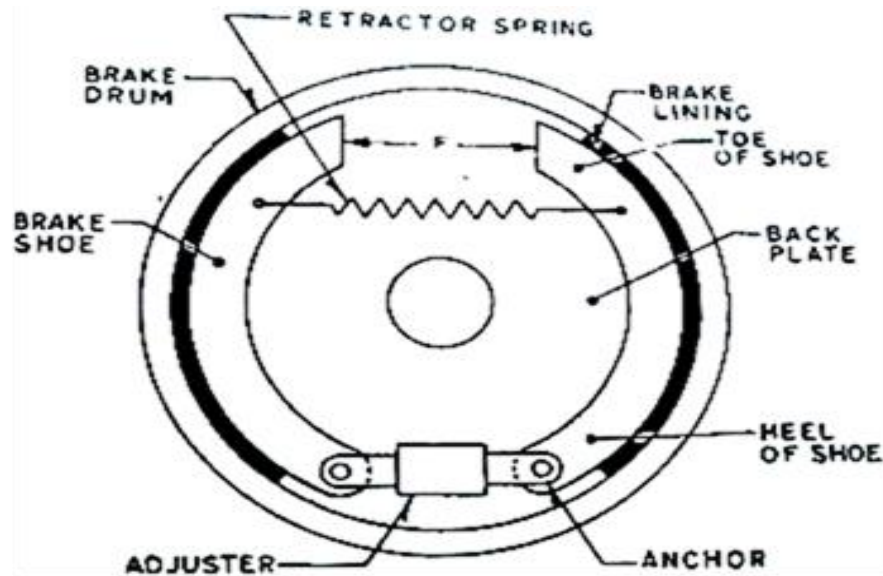
4. **Passivation:** After Phosphate coating and rinsing, surfaces are given a final passivation rinse with solution of chromic acid to improve their corrosion resistance.

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.

f) **Draw a neat labelled sketch of drum brake**

04

Answer:-(Diagram 3 marks & Labeling 1 mark)



04

03	a)	Attempt any <u>FOUR</u> of the following	16										
	a)	Explain working of disc brake with neat labeled sketch	04										
		<p>Answer: Working of Disc Brake:</p> <p>In a disc brake, the fluid from the master cylinder is forced into a caliper where it presses against a piston. The piston in turn crushes two brake pads against the disc that is being attached to wheel, making it to stop or slow down. Main advantage of disc brakes is their resistance to wear as the discs remain cool even after repeated brake applications.</p> <div style="text-align: center;"> </div> <p style="text-align: center;">Figure: Disc Brake</p>	02 02										
	b)	Define coefficient of friction and list the material used for brake liner.	04										
		<p>Answer: Material used for brake shoe and its coefficient of friction</p> <p>Definition: 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)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Brake shoe material</th> <th>Coefficient of friction</th> </tr> </thead> <tbody> <tr> <td>Asbestos</td> <td>0.35 to 0.4</td> </tr> <tr> <td>Ferodo</td> <td>0.4 to 0.5</td> </tr> <tr> <td>Cork</td> <td>0.37</td> </tr> <tr> <td>Leather</td> <td>0.25</td> </tr> </tbody> </table>	Brake shoe material	Coefficient of friction	Asbestos	0.35 to 0.4	Ferodo	0.4 to 0.5	Cork	0.37	Leather	0.25	02 02
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	c)	Compare Air Suspension System over Rigid Suspension System	04										
		<p>Answer:- (any 4 points</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Air Suspension System</th> <th style="text-align: center;">Rigid Suspension System</th> </tr> </thead> <tbody> <tr> <td>1. In this system air springs or air bellows are used</td> <td>1. In this system leaf spring or coil spring or both are used.</td> </tr> <tr> <td>2. In air suspension system wheel deflection is controlled by automatic control devices.</td> <td>2. In this system there is no automatic control device.</td> </tr> </tbody> </table>	Air Suspension System	Rigid Suspension System	1. In this system air springs or air bellows are used	1. In this system leaf spring or coil spring or both are used.	2. In air suspension system wheel deflection is controlled by automatic control devices.	2. In this system there is no automatic control device.					
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	3. Increased riding comfort and decreased noise level.	3 Riding comfort is less as compared to air suspension system.	04
	4. The springing rate varies much less between the laden and unladen conditions, as compared with that of conventional springs.	4. The springing rate is more as compared to air suspension system.	
	5. Stiffness of the system increases with increase in deflection.	5. Stiffness of the system decreases with increase in deflection.	
	6. Application: Volvo bus, Luxury cars	6. Application: Heavy and medium duty vehicles, passenger cars etc.	
	7. Reduced fatigue to the driver and passenger.	7. More fatigue to the driver and passenger as compared to air suspension system.	
	8. It consists of Compressor, reservoir, leveling valve, air springs or air bellows etc.	8. It consists of leaf spring, coil spring, shock absorber, shackle joint, bracket etc.	

d)	How temperature and humidity is controlled in car air conditioning.	04
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Answer:
Control of temperature :

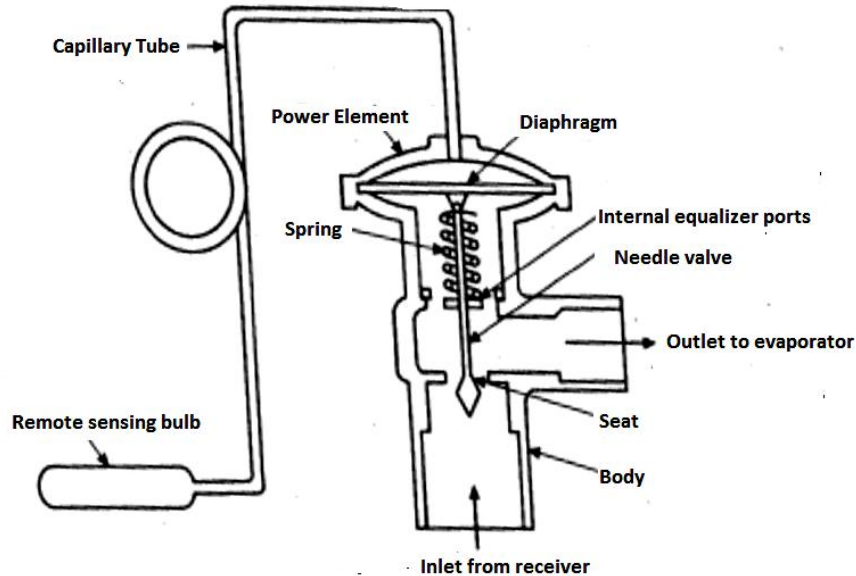


Figure -Control of temperature

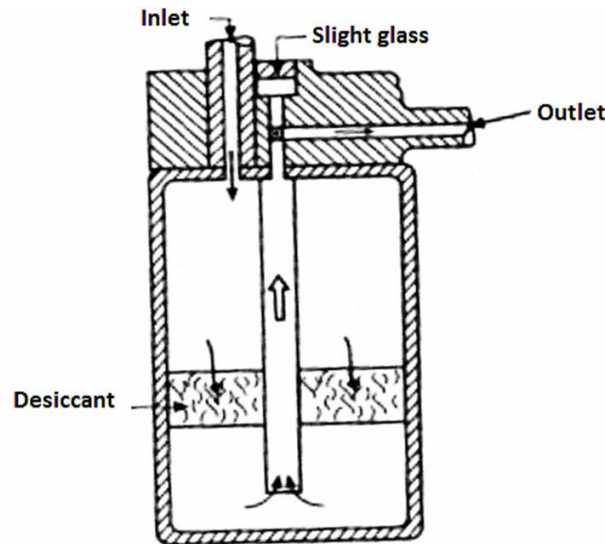
The expansion valve is placed at the evaporator inlet tube. It is used to control refrigerant flow into the evaporator. The expansion valve contains a variable orifice that is controlled by a sensing bulb placed inside the evaporator cooling fins. The sensing bulb is a sealed tube containing a small 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.

01

01



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.

01

01

e) **List the types of materials used in body construction.**

04

Answer:

Materials used for body construction: (Explain any 04 material, 01 mark each)

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., whereas 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

04



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 aluminum and 75% lighter than steel/cast iron components.

F) **Write two advantages and two disadvantages 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.

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.

4 **Attempt any TWO of the following** 16

a) **Draw a neat labeled sketch of worm and roller type steering gear box and explain it's working** 08

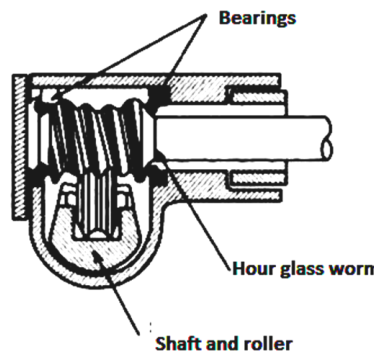


Fig :-Worm and roller type steering gear box:

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.

04

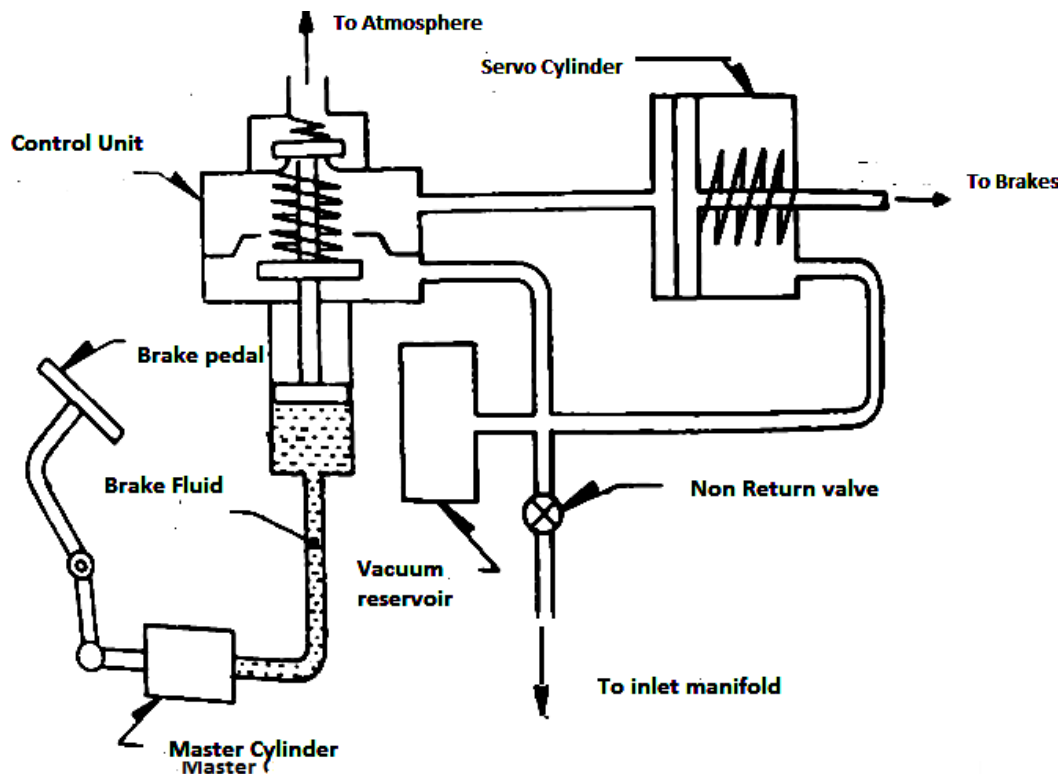
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The worm is supported and located by two ball or taper roller bearings mounted in the case and its end float may be adjusted by shims placed between the outer bearing track and the end plate of the case. The roller shaft is eccentric and may be turned 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.

b)

Describe the hydraulic operated air braking system with neat labeled sketch

08



04

Figure: Vacuum assisted braking system

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 there by applying brake. When pedal is released both side of servo piston is once again exposed to vacuum.

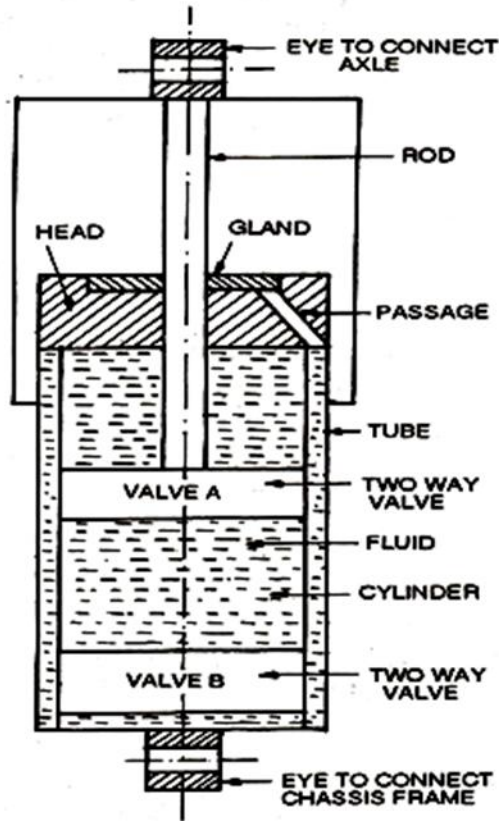
04

C)

Explain the working of telescopic shock absorber with neat labeled sketch.

08

Answer:



04

Figure: Telescopic shock absorber

Working: 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.

04



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Model Answer

Subject Code: **17409**

5		Attempt any <u>FOUR</u> of the following	16
	a)	State 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
	b)	Explain the painting procedure for new vehicles.	04
		Answer: Procedure of painting: 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. Wet flat stopper with 320 wet paper. 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) Spay double header coat.	04
	c)	Draw a neat labelled sketch of wishbone type Independent suspension system	04
		Ans: Independent suspension system: (Diagram: 03 Marks & Correct Labeling : 01 Marks)	

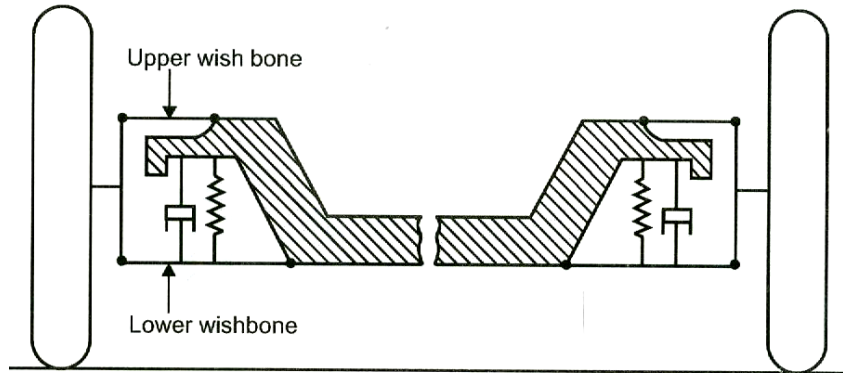


Fig. Wishbone type independent suspension

d) **State any four properties of refrigerant.**

04

Answer: Properties of refrigerant: (Any 04- 1 mark each)

- 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.

04

e) **Name the types of suspension springs and draw any one.**

04

Answer: Types of suspension springs: (Any 04, ½ mark each, Figure 02)

- 1) Leaf spring
 - a. Semi elliptical leaf spring
 - b. Quarter elliptical leaf spring
 - c. Three Quarter elliptical leaf spring
 - d. Transverse spring
 - e. Full elliptical leaf spring
 - f. Platform type spring
- 2) Coil spring
- 3) Torsion spring
- 4) Air spring
- 5) Rubber spring

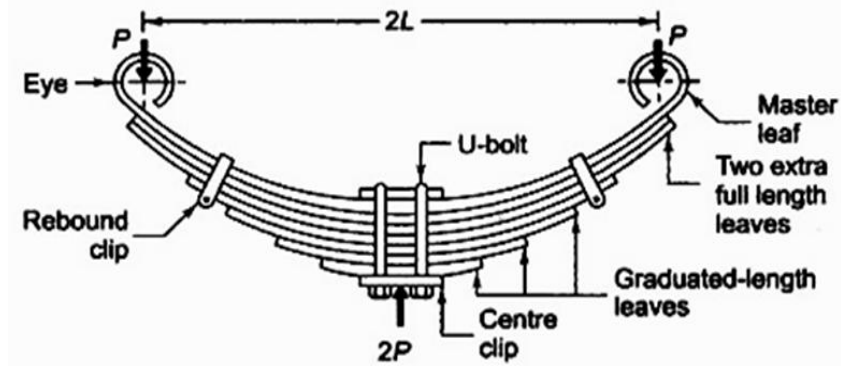


Figure: Multi leaf Semi-Elliptical Leaf Spring

f) **Draw a labeled layout of HVAC**

04

Answer: (Diagram: 02 Marks & Correct Labeling : 02 Marks)

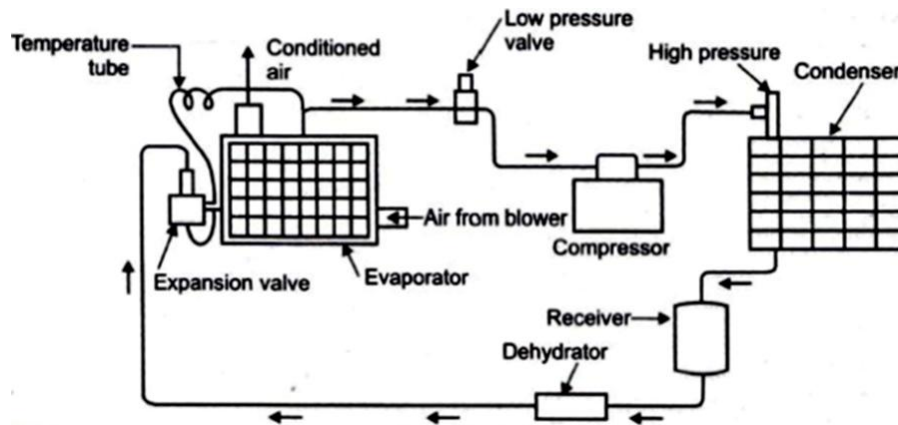


Figure. Car Air-Conditioning System

Q6 **Attempt any TWO of the following**

16

a) **Explain the working of Air- bag used in automobile. State the material and locations of air bags in an automobile.**

08

Answer: Working of Air- bag

As vehicle comes across, the sensor detects it and triggers the impact 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 deflates slightly to create a soft cushion. By 2 seconds after the initial impact, the pressure inside the bag has reached atmospheric pressure.

02

- **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 helps reduce the risk of serious injury by distributing crash forces more evenly across the occupant's body.
- **Material:** Nylon or polyamide bag
- **Location:**
 1. Front air bag- In steering wheel & in dashboard
 2. Side Air bag: In doors.

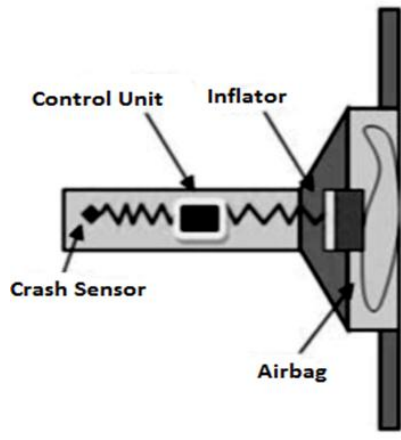


Figure: Air bag.

b) **Draw a layout of Vapour Compression Cycle with sketch.**

Answer: Vapour Compression Cycle:

In Vapor compression cycle working medium is liquid refrigerant, (i.e. R12 or R 134a) 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 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.

		<p style="text-align: center;">Figure: Vapour Compression Cycle.</p>	04
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	c)	Describe stability of vehicle on slope	08
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		<p>Answer:</p> <p>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> <div style="text-align: center;"> </div> <p style="text-align: center;">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> <p>If the second condition arises, the limiting angle θ_L 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> $\tan \theta_L = \mu$	02
			02
			04