



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: Camber	2
Answer : Camber: It is the angle between centre line of tyre and vertical line when viewed from front of the vehicle. Camber is the tilt of the car wheels from the vertical, when viewed from the front of the vehicle. Camber is positive if the tilt is outward at the top. Camber should not generally exceed 2°.	02
ii) Name the components of power steering system used in case of car (any four)	2
Answer: Components of power steering system: (Any 04- 1/2 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	02
iii) State two advantages of air braking system.	2
Answer: Advantages of air braking system: (Any 02- 01mark each) 1. The compressed air can be used for tyre inflation, windscreen wipers, horns etc. 2. Required less effort to operate the brake as compared to hydraulic system. 3. The air brake parts can be located anywhere making the chassis design simpler. 4. These are more powerful than hydraulic or mechanical brakes and therefore used for heavy vehicles.	02



iv) State the function of suspension system .(any two)	2
Answer: Function of suspension system: (Any 02- 01mark each) 1. To prevent road shocks from being transmitted to the vehicle component and the passengers. 2. To safeguard the occupants form road shocks. 3. To preserve stability of vehicle while in motion. 4. To maintain the road wheels in contact with road surface.	02
v) Mention name of refrigerant used in car air conditioning(any two)	2
Answer: Refrigerant used in car air conditioning: 1. Dichloro- difluoro-methane or Freon -12 (R-12) 2. Tetra fluoro- ethane or R-134a or HFC-134a	02
vi) State the function of the evaporator in car HVAC system.	2
Answer: Function of the evaporator: The evaporator unit where the cooling effect is obtained, 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.	02
vii) Define tractive effort.	2
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.	02
viii) Define pitching.	2
Answer: Pitching: It is rotating action about a transverse axis through center of gravity parallel to ground is known as pitching. <p style="text-align: center;">OR</p> It is rocking chair action or rotating action about a transverse axis through the vehicle parallel to ground is known as pitching.	02
b) Attempt any TWO of the following:	08
i) Briefly explain procedure of painting of a new car.	4
Answer: Procedure of painting of a new car: (Note: Credit shall be given to any other suitable Procedure) 1. Thoroughly wash the vehicle. 2. Carryout protective and anticorrosive treatment. 3. Spray a thin coat of primer. Allow to dry for 15 min. 4. Apply three full coats of surfacer allowing 10 – 15 minutes between the coats. 5. Allow it to dry for 1 hour. Then wet flat with P 600 grade paper. 6. Apply stopper (putty) wherever necessary allowing 15 to 20 minutes between the layers. 7. Allow to dry for 1 to 1½ hours. 8. Spray surfacer to stop-up areas and flat with P 600 grade paper.	04

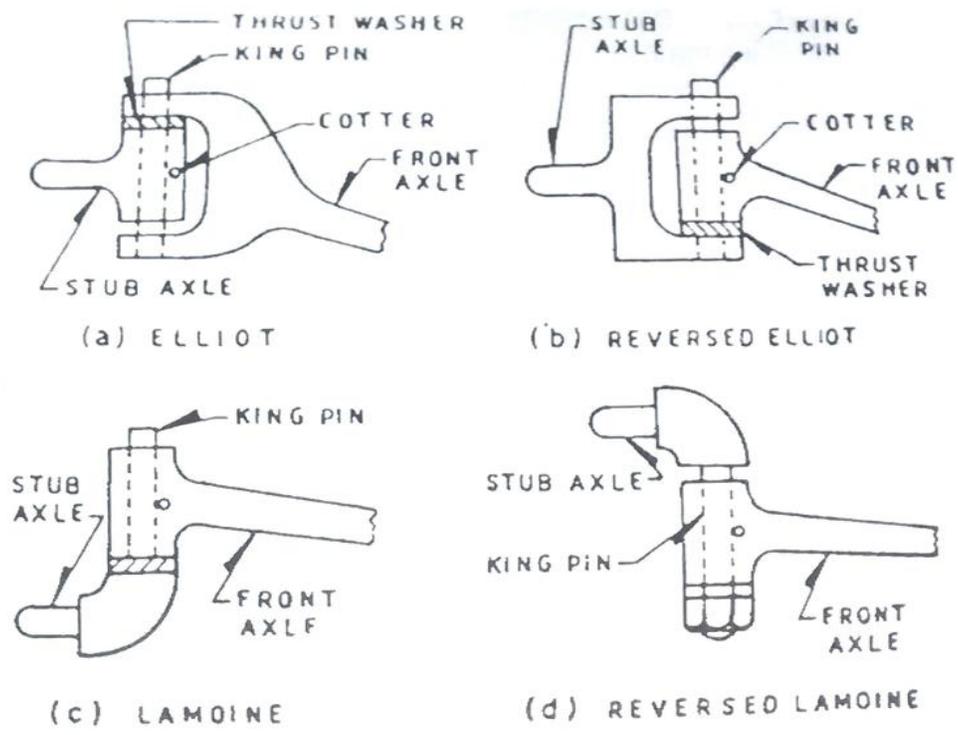


9. Blow off vehicle with air gun and tack off. 10. Spray finishing material, apply one coat and allow it to dry for 15 to 30 minutes. Then apply second coat. 11. Allow overnight drying. Wet flat with P 800 grade paper and dry with air gun. 12. Spray double header coat.	
ii) Define the terms Rolling, Yawing.	4
Answer: Rolling: While cornering, the centrifugal force produces a movement of the vehicle about a longitudinal axis through centre of gravity and is known as rolling.	02
Yawing: It is the turning movement of the body around the center point of the vehicle. Yaw occurs as the vehicle corners. If the cornering speed is too high, the transfer of weight can cause the vehicle to spin.	02
iii) What is the function of the compressor and expansion valve in car HVAC system?	4
Answer: Function of Compressor: The compressor is the heart of HVAC system. The refrigerant in the form of vapor comes to compressor, where it is compressed to high pressure and then sent to the condenser. The compressor is driven by means of a belt drive from the engine pulley, through an electromagnetic clutch	02
Function of Expansion Valve: The refrigerant goes from the receiver-drier to the expansion valve where a sudden expansion to a much lower pressure occurs. The refrigerant changes back to vapor state and this cause a big chilling effect.	02
2. Attempt any <u>FOUR</u> of the following	16
a) State the types of stub axle and draw any one type of stub axle arrangement.	4
Answer : Types of stub axle arrangement: ($\frac{1}{2}$ mark each) 1. Elliot 2. Reversed elliot 3. Lamoine 4. Reversed lamoine (Any one Diagram of stub axle arrangement)	02

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 <p>(a) ELLIOT</p> <p>(b) REVERSED ELLIOT</p> <p>(c) LAMOINE</p> <p>(d) REVERSED LAMOINE</p>	02
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b) What is effect of king pin inclination on vehicle stability?

4

Answer : Effect of king pin inclination on vehicle stability:

King pin inclination helps the straight ahead recovery of steering wheel, thus providing directional stability. When the vehicle takes a turn, the inclination of king pin causes the vehicle body to move up, in relation to the wheels. So, as soon as the steering wheel is left after the turn is completed, the weight of the vehicle tends to return the wheels to the straight ahead position. If it is greater on one side than other, the vehicle will tend to pull to the side having greater angle. Also, if the angle is too large, the steering will become exceedingly difficult.

03

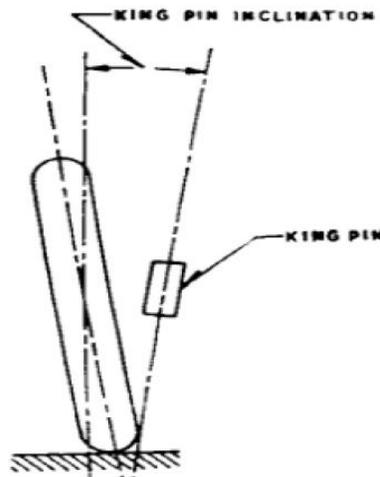
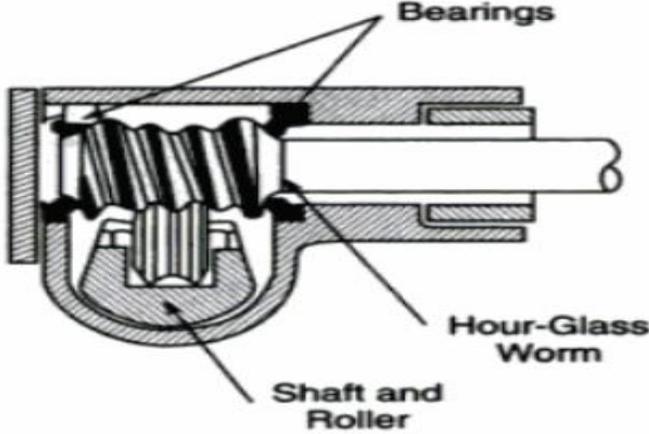


Figure: King pin inclination.

01



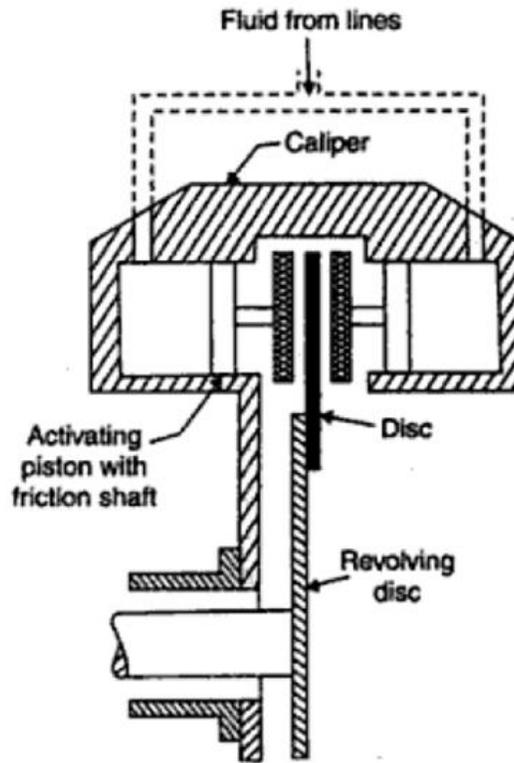
c) Draw a neat sketch of worm and roller type steering gear box.		4																								
<p>Answer: Worm and roller type steering gear box:</p>  <p>Figure: Worm and roller type steering gear box.</p>		04																								
d) State the function of the brakes. Classify the brakes on the basis of method of actuation.		4																								
<p>Answer: Function of Brakes: (Any 02- 01mark each)</p> <ol style="list-style-type: none"> 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. <p>Classification of brakes on the basis of method of actuation: (Any 04- 1/2 mark each)</p> <ol style="list-style-type: none"> 1. Mechanical brakes 2. Hydraulic brakes 3. Air brakes 4. Vacuum brakes 5. Electric brakes 		02																								
e) Differentiate between telescopic shock absorber and gas filled shock absorber (any four parameters)		4																								
<p>Answer: Difference between telescopic shock absorber and gas filled shock absorber. (Any 04 – 01 mark each)</p> <table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Telescopic shock absorber</th> <th>Gas filled shock absorber</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>In this only hydraulic oil is used.</td> <td>In this both oil and gas is used.</td> </tr> <tr> <td>02</td> <td>The tolerance to heat is less.</td> <td>The tolerance to heat in gas filled shock absorber is greater.</td> </tr> <tr> <td>03</td> <td>In this foaming of oil may occur.</td> <td>A gas filled shock absorber is designed to reduce foaming of the oil.</td> </tr> <tr> <td>04</td> <td>Atmospheric conditions do not affect the system.</td> <td>Atmospheric condition affect on the system.</td> </tr> <tr> <td>05</td> <td>Operating cost is lower.</td> <td>Cost of nitrogen gas is more as compare to hydraulic oil.</td> </tr> <tr> <td>06</td> <td>Maintenance is comparatively easy.</td> <td>Maintenance is difficult as compare to hydraulic shock absorber.</td> </tr> <tr> <td>07</td> <td>Damping effect is relatively less.</td> <td>Better damping is obtained.</td> </tr> </tbody> </table>		Sr. No.	Telescopic shock absorber	Gas filled shock absorber	01	In this only hydraulic oil is used.	In this both oil and gas is used.	02	The tolerance to heat is less.	The tolerance to heat in gas filled shock absorber is greater.	03	In this foaming of oil may occur.	A gas filled shock absorber is designed to reduce foaming of the oil.	04	Atmospheric conditions do not affect the system.	Atmospheric condition affect on the system.	05	Operating cost is lower.	Cost of nitrogen gas is more as compare to hydraulic oil.	06	Maintenance is comparatively easy.	Maintenance is difficult as compare to hydraulic shock absorber.	07	Damping effect is relatively less.	Better damping is obtained.	04
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f) Draw a neat labeled sketch of disc brake with fixed caliper.

4

Answer:



04

Figure: Disc Brake.

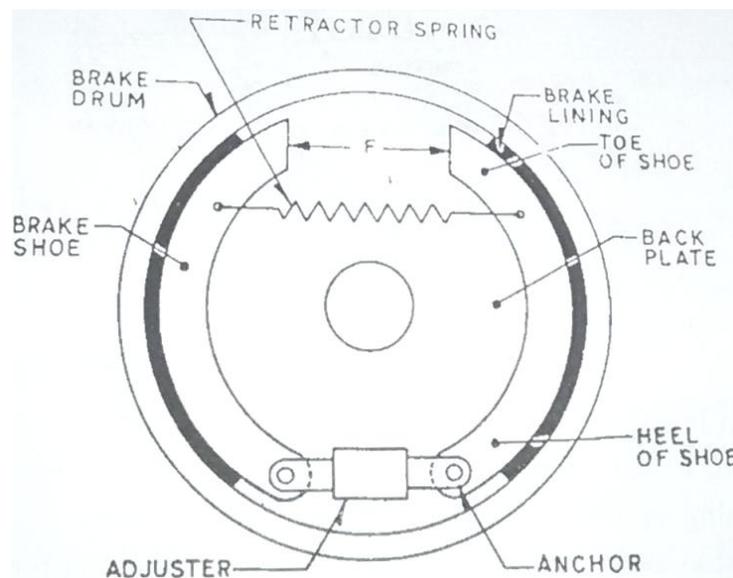
3. Attempt any FOUR of the following:

16

a) With the help of labeled sketch explain the working of drum brake.

4

Answer:



02

Figure: Drum Brake.

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Working of drum brake:

When the drum is rotating, the upper tips of the shoes are pushed apart by the expander force and rub against the inside surface of the drum. The force F is applied by means of some brake actuating mechanism, which forces brake shoe against the revolving drum thereby applying the brakes. An adjuster is also to compensate for wear of friction linings with use. One or two retractor springs are used which serve to keep the brake shoe away from drum when the brakes are not applied.

02

b) Draw the layout of HVAC used in cars and explain its operations.

4

Answer:

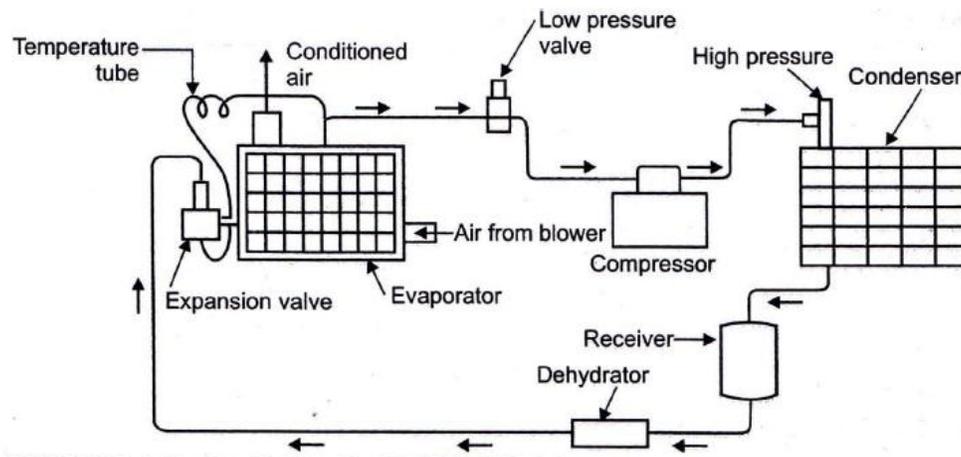


Figure: Layout of HVAC.

02

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 warm 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.

02

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.

c) Differentiate between independent suspension system and rigid axle suspension system.

4

Answer: Difference between independent suspension system and rigid axle suspension system:
(Any 04 – 01 mark each)

Sr. No.	Independent suspension system	Rigid axle suspension system
01	Lighter springs can be used.	Comparatively heavier springs are used.
02	It reduces un-sprung weight.	Un-sprung weight is more.
03	It increases tyre life.	It reduces tyre life as compared to independent suspension system.
04	Initial cost is high.	Initial cost is low.

04



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05	Greater maintenance is required because of large number of bearings.	Lesser maintenance is required.
06	There is no possibility of tilting of axle.	In this the axle tilts and the wheels no longer remain vertical.
07	In this steering geometry is not altered with spring deflection as in case of rigid axle suspension.	In this steering geometry is altered with spring deflection.
08	More space is available for engine compartment and for passenger.	Less space is available for engine compartment and for passenger.
09	It provides softer suspension, because the low spring rate enables large wheel movement.	It provides harder suspension as compared to independent suspension.

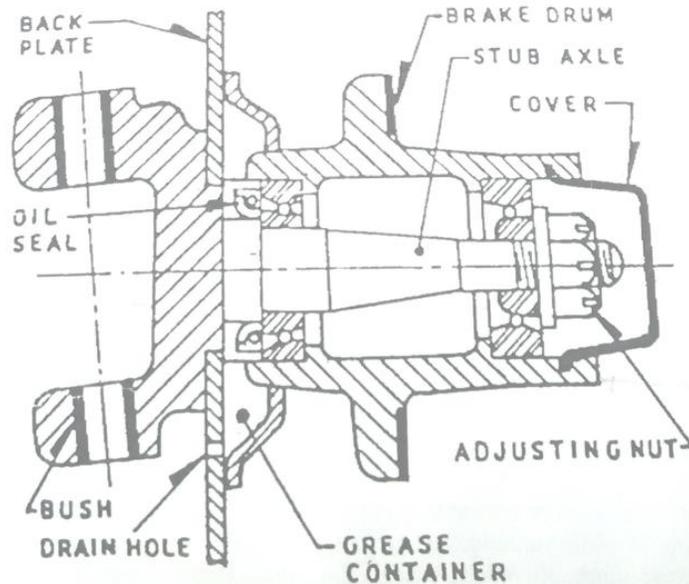
d) Explain with neat sketch, 'Front wheel assembly'.

4

Answer:

In front wheel assembly, the wheel revolves over two ball bearings, which can be adjusted by means of an adjusting nut. Oil seals are provided to prevent the leakage of lubricant from bearing.

01



03

Figure: Front wheel assembly.

e) List any four types of vehicle bodies and writes the material used for it.

4

Answer: Types of vehicle body: (Any 04- 1/2 mark each)

1. Car
2. Jeep
3. Pick up
4. Straight truck
5. Half body truck
6. Platform truck

02



<p>7. Delivery van 8. Tanker 9. Dumper truck 10. Station wagon 11. Bus 12. Trailer</p> <p>Materials used for vehicle body: (Any 04- 1/2 mark each)</p> <p>1) Steel 2) Alloy steel 3) Aluminum 4) Plastic a) Thermoplastic b) Thermosetting plastic c) Glass reinforced plastic 5) Fiber glass 6) Wood etc.</p>	02
<p>f) Explain the working of central locking system. Also write one advantage and one disadvantage of it.</p>	4
<p>Answer: Working of central locking system:</p> <p>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.</p> <p><i>Note: Credit shall be given to any other suitable answer (i.e. Manually or electrically operated central locking system).</i></p>	02
<p>Advantages of central locking system: (Any 01- 01 mark)</p> <p>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>	01
<p>Disadvantages of central locking system: (Any 01- 01 mark)</p> <p>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>	01

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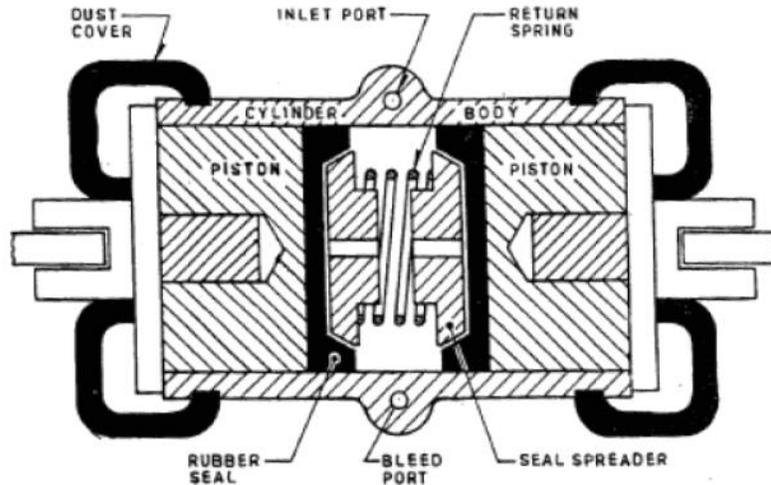


Figure: Wheel Cylinder.

04

c) Explain gas filled shock absorber with neat sketch.

8

Answer: Gas filled shock absorber:

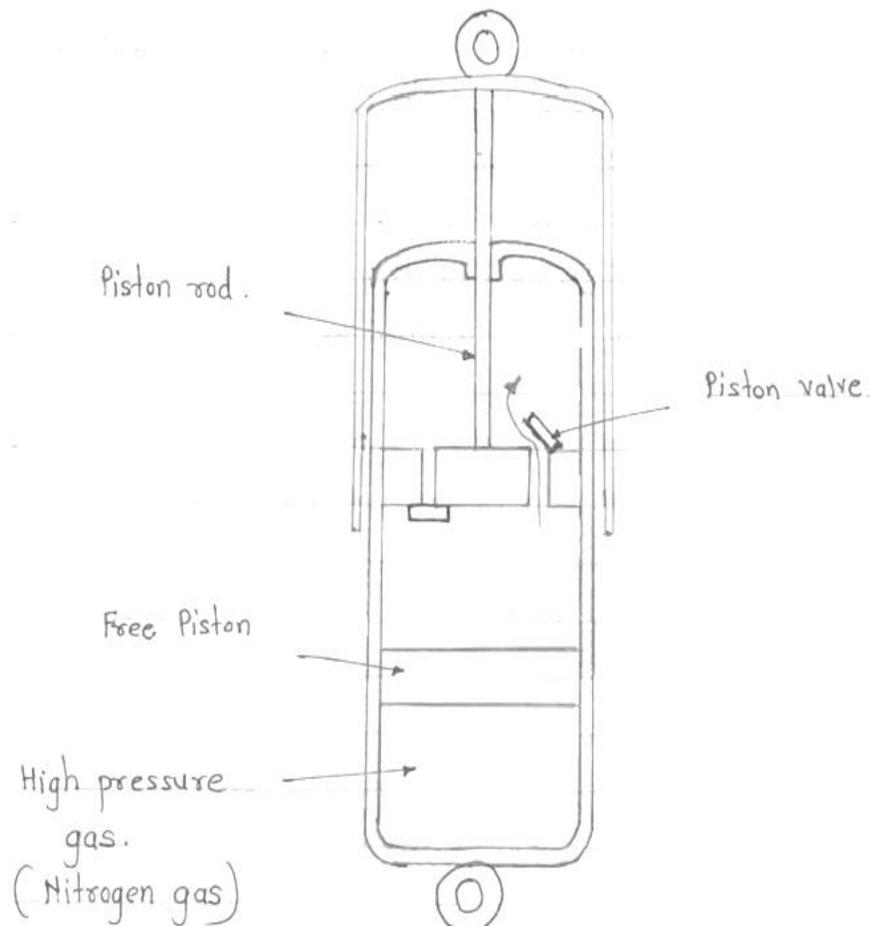


Figure: Gas filled shock absorber.

04



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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.

04

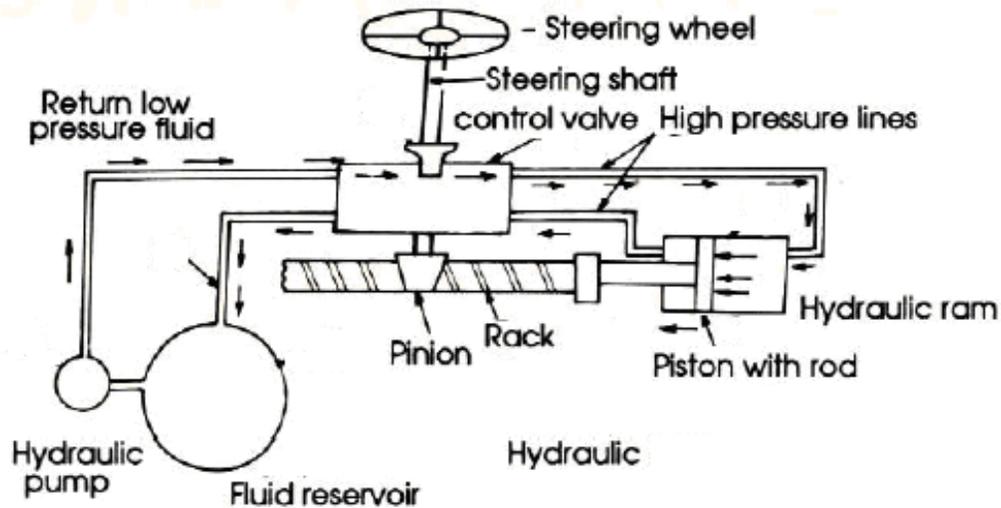
5. Attempt any FOUR of the following:

16

a) Draw a layout of Hydraulic power steering and state its advantages.

4

Answer: (Any suitable diagram should be given credit)



02

Figure: Hydraulic power steering.

Advantages of power steering: (Any 02- 01 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.

02

b) Explain inflation of air bag during collision. Name the gas used in air bags.

4

Answer: Inflation of Air bag:

As vehicle comes across the impact, the sensor detects it and triggers the inflator. Once the electrical circuit has been turned on by the sensor, a pellet of sodium azide (NaN_3) is ignited. A rapid reaction occurs, generating nitrogen gas (N_2). This gas fills a nylon or polyamide bag at a velocity of 150 to 250 miles per hour. This process, from the initial impact of the crash to full inflation of the airbags, takes only about 40 milliseconds. Thus minimizing the injury to the passenger or driver. When N_2 generation stops, gas molecules escape the bag through vents. The pressure inside the bag decreases and the bag deflates slightly to create a soft cushion. By 2 seconds after the initial impact, the pressure inside the bag has reached atmospheric pressure.

03

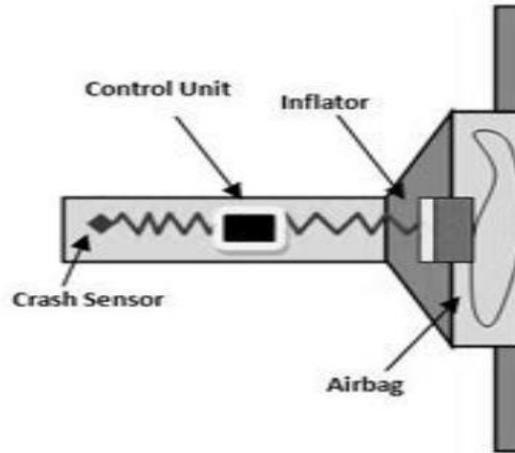


Figure: Air bag system.

Gas used in air bags: Nitrogen (N_2)

01

c) Draw the layout of air suspension system.

4

Answer:

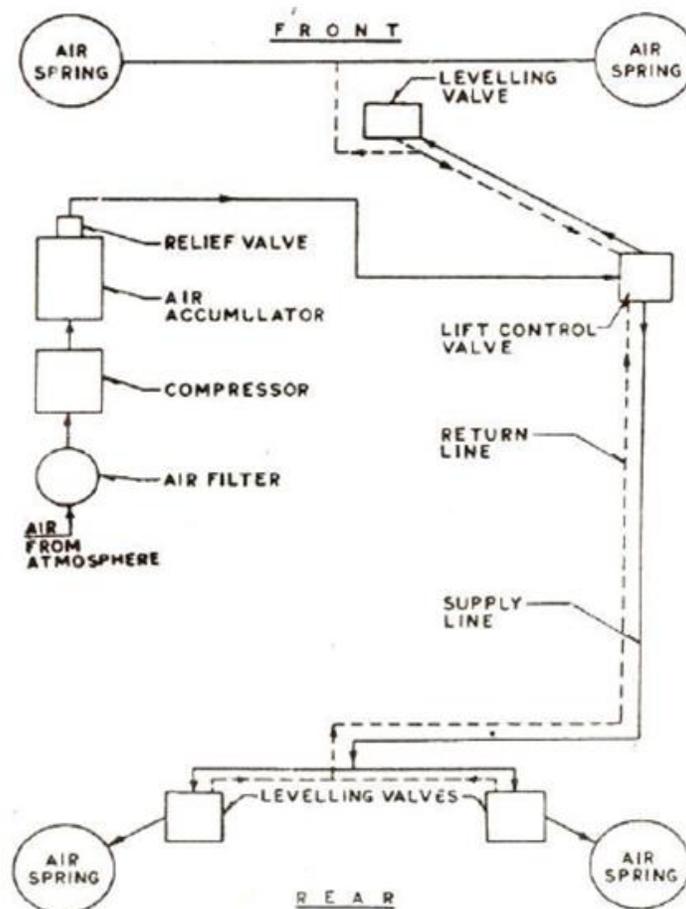


Figure: layout of air suspension system.

04



d) Write four properties of ideal refrigerant.

4

Answer: Properties of ideal refrigerant: (Any 04 – 01 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 unflammable, 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) Explain semi- elliptic leaf spring with neat sketch.

4

Answer:

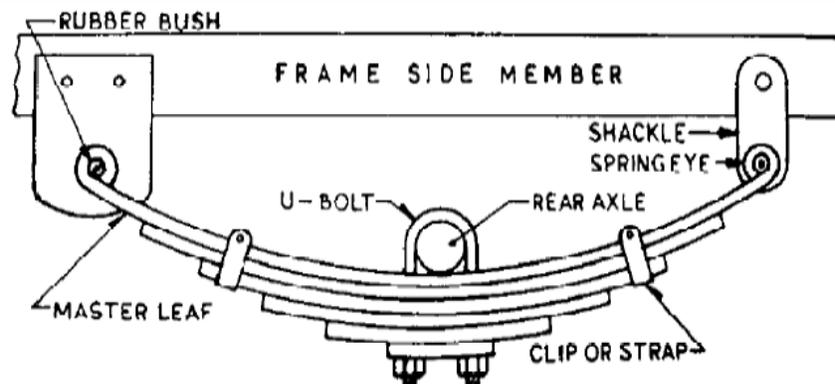


Figure: Semi- elliptic leaf spring.

02

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

f) Explain the effect of stream lining on vehicle performance.

4

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:

1. Aerodynamic Drag
 - a. Induced drag
 - b. Profile drag
 - c. Friction drag
2. Aerodynamic Lift

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.

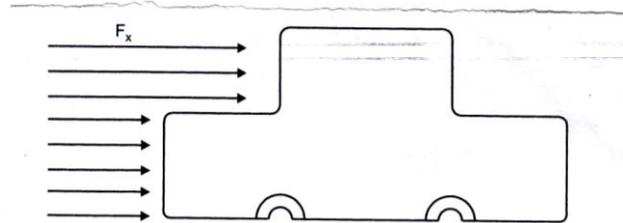


Figure: Aerodynamic Drag

02

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.

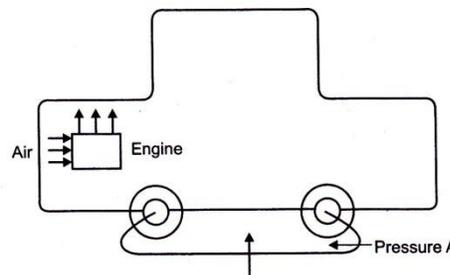


Figure: Aerodynamic Lift

02

6 Attempt any TWO of the following

16

a) Why tandem master cylinder is used? Explain the working of tandem cylinder with neat sketch.

8

Answer: Tandem master cylinder operates two different sections of the vehicle brakes, known as split system. In this, the front and the rear brakes are operated by different chambers of tandem master cylinder. To different chambers can be designed different in size according to the braking effect required on the two axles. It gives larger braking effort as compare to conventional master cylinder.

02

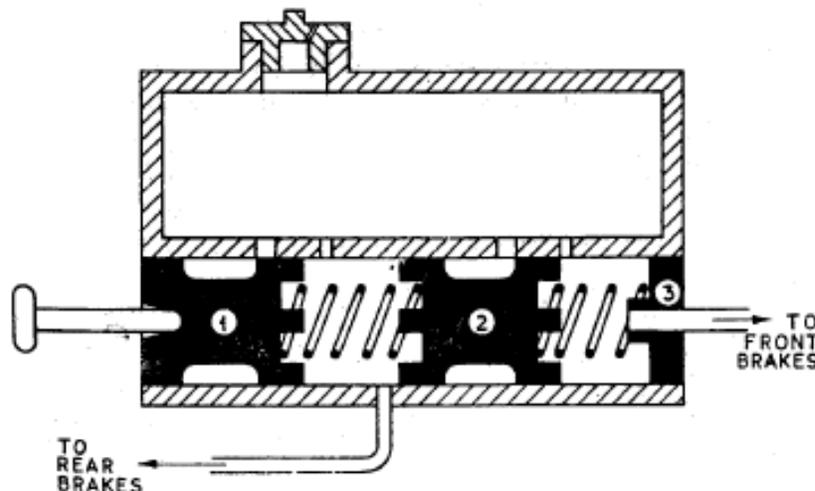


Figure: Tandem Master cylinder.

03

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.

03

b) Draw a layout of vapour compression cycle and explain its working.

8

Answer: Layout of Vapour compression cycle:

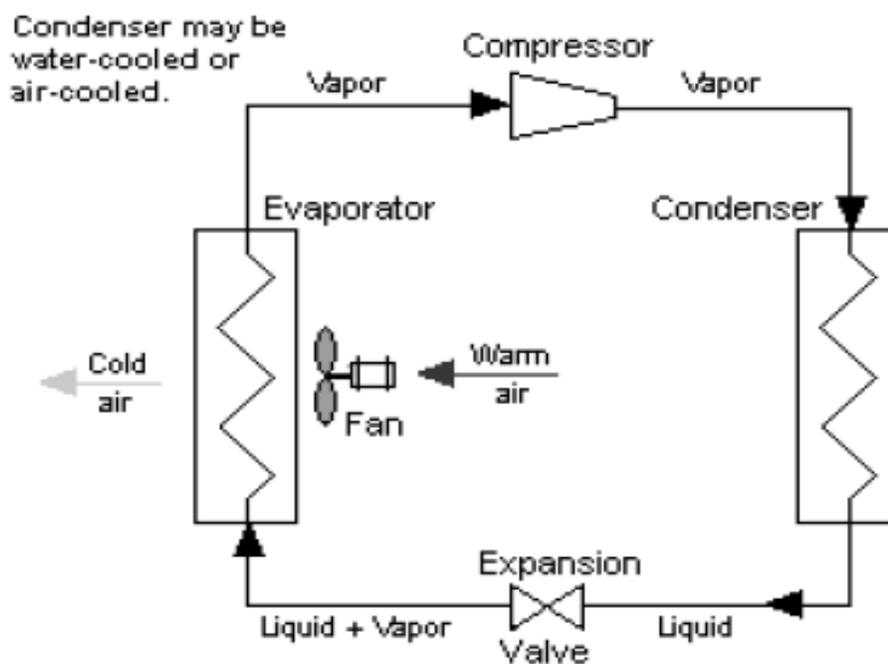


Figure: Layout of Vapour compression cycle.

04

Working of 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.

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.

04

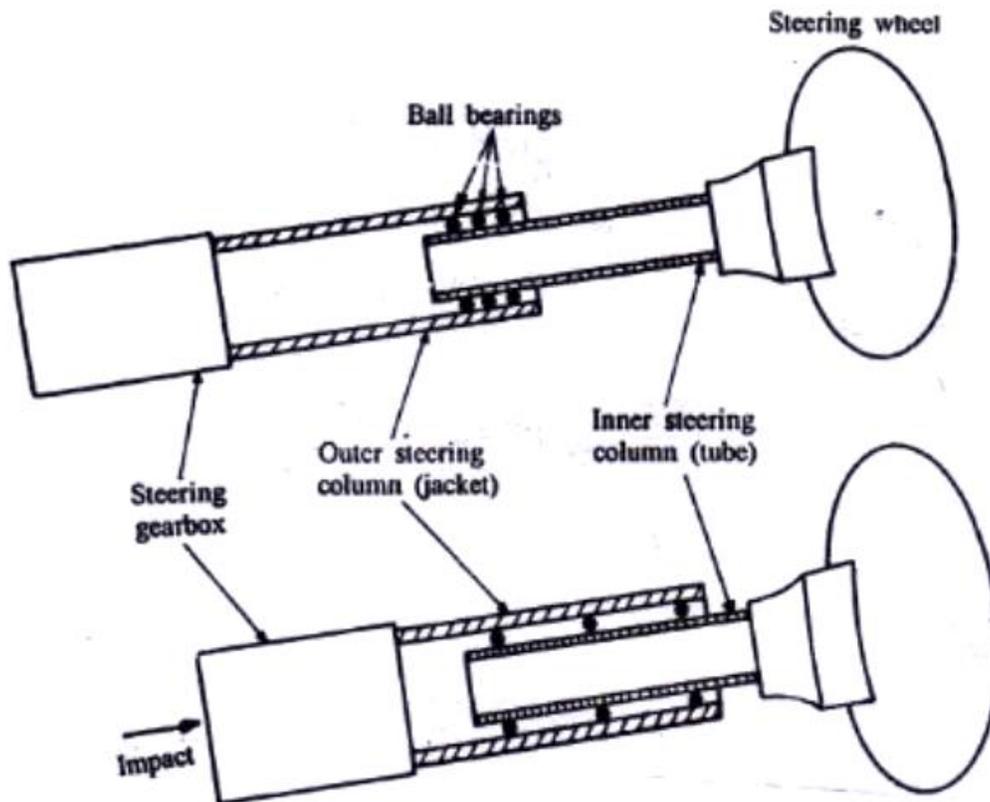
c) With a neat sketch explain a collapsible steering.

8

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.

04



04

Figure: Collapsible steering.