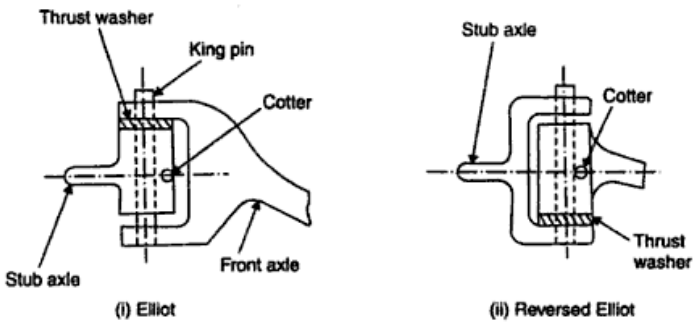
Important Instructions to examiners:

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 following:	**12**
i) State types of stub axles.	02
Answer: **Types of stub axles:** 1) Elliot 2) Reversed elliot 3) Lamoine 4) Reversed lamoine	½ each
ii) Define - Caster.	02
Answer: **Caster:** It is the angle between the king pin centre line & the vertical, in the plane of the wheel, when viewed from the side is called the caster angle.	02
iii) State the functions of brake.	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.	01 each
iv) State the necessity of suspension system.	02
Answer: **Necessity of suspension system**: *(Any 02)* 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.	01each

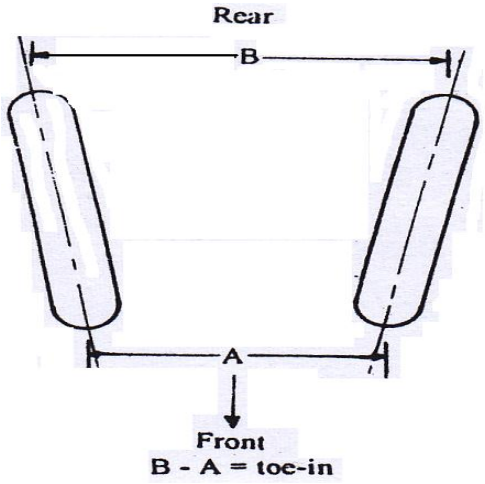
v) State any four materials used for body construction.	02
Answer: **Materials used for body construction**: *(Any 04)* 1) Steel 2) Alloy steel 3) Aluminum 4) Plastic • Thermoplastic • Thermosetting plastic • Glass reinforced plastic 5) Fiber glass 6) Wood 7) Glass 8) Rubber	½ each
vi) List any four safety devices used in automobile.	02
Answer: **Safety devices used in automobile:** *(Any 04)* 1) Exhaust brake 2) Central locking 3) Collapsible steering 4) Air bag 5) Seat belt	½ each
vii) State any two refrigerant used in car air conditioning.	02
Answer: **Refrigerant used in car air conditioning**: 1) Dichloro difluro-methane or Freon -12 (R-12) 2) Tetra fluro- ethane or R-134a or HFC-134a	01 each
viii) Define - Rolling.	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.	02
1 b. Attempt **any two** of following:	08
i. Sketch Elliot and reverse Elliot stub axles.	04
Answer:  Figure: Elliot and reverse Elliot stub axles.	02 each

ii. State types of front axles and explain any one.	04
Answer: **Types of front axle:** 1) Live front axle. 2) Dead front axle. **Live front axle:** It is axle which contains differential mechanism through which the engine power flows towards the front wheels. In case of front engine front wheel drive, for steering the front wheels, in this case constant velocity universal joints are contained in the axle half shafts. Without affecting the power flow through the half shafts, these joints help in turning the stub axle around the kingpin. OR **Dead front axle:** It has no connection with engine means it is dead and will not carry the engine power. It has sufficient rigidity and strength to transmit the weight of vehicle from the springs to the front wheels. Generally front axle is dead in front engine real wheel drive or rear engine rear wheel drive.	01 03
iii. Classify the brakes.	04
Answer: The brakes are classified according to following consideration: *(Any 04)* 1) With respect to purpose: a) Primary brake or Service brake b) Parking brake or Secondary brake 2) With respect to application: a) Foot brake b) Hand brake 3) With respect to number of wheels: a) Two- wheeler brakes b) Four-wheeler brakes 4) With respect to the method of braking contact: a) Internal expanding brakes b) External contracting brakes 5) With respect to the method of applying the braking force: a) Single acting brakes b) Double acting brakes 6) With respect to construction: a) Drum brake b) Disc brake 7) With respect to method of actuation: a) Mechanical brakes b) Hydraulic brakes c) Air brakes d) Vacuum brakes e) Electric brakes 8) With respect to speciality: a) Engine exhaust gas operated brake b) Pneumatic-hydro brake c) Hill-holding brake	01 each

Q2. Attempt **any four** of following:	16
a) Explain Toe-in and Toe-out and state its effect.	04

Answer:

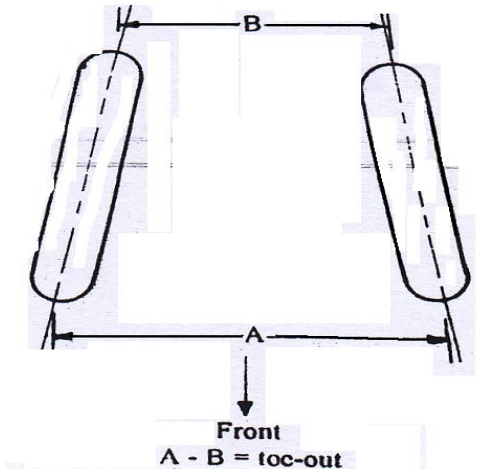
Toe-in: It is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary. The amount of toe-in is usually 3 to 5mm.



1 ½

Figure: Toe-in when viewed from the top.

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

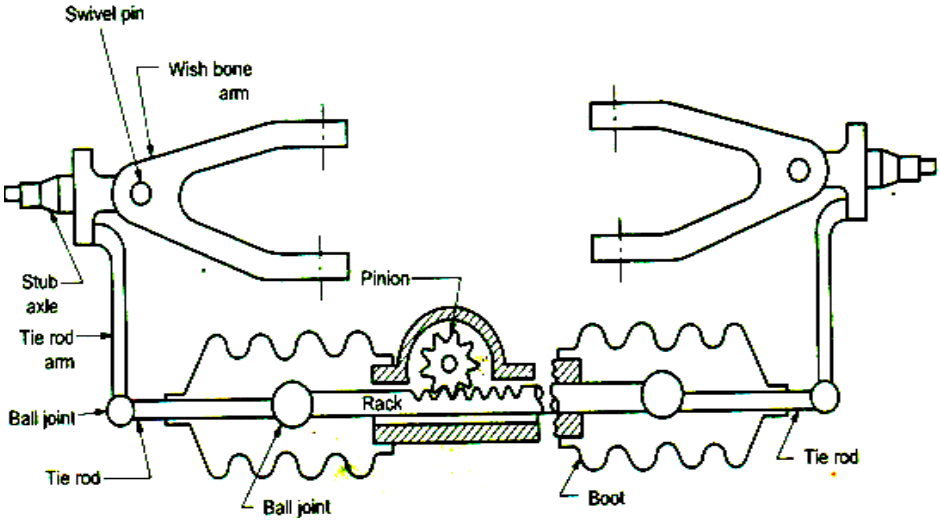


1 ½

Figure: Toe-out when viewed from the top.

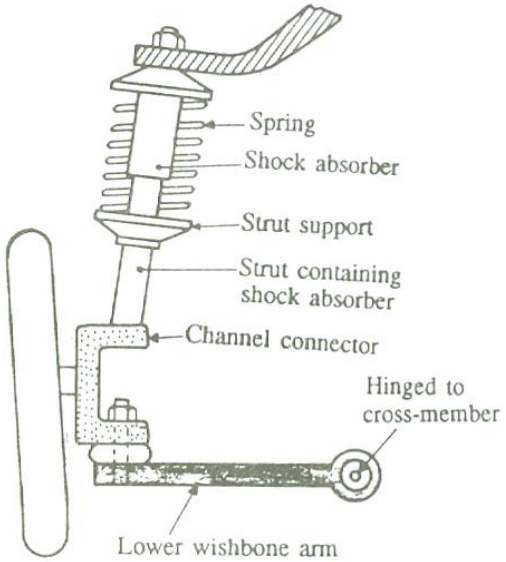
Effects of Toe-in & Toe-out: *(Any 02)* ½ each

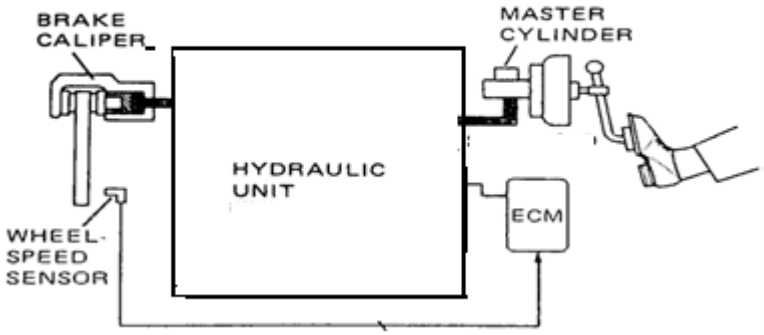
a) Tyre slips
b) Tyre wear on the outside or inside of the tread
c) Tyre scrub
d) Poor steering stability.

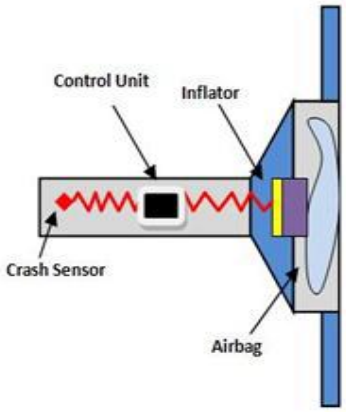
b) Draw neat sketch of rack and pinion type steering gear box.	04
Answer: *(03 marks for sketch, 01 mark for labels)*  Figure: Rack and Pinion type of steering gear box.	04
c) State any two friction materials used for brake shoes and give its coefficient of friction.	04
Answer: Material used for brake shoe and its coefficient of friction: *(Any 02, 02 marks each for material and its coefficient of friction)* Brake shoe material: Asbestos — Coefficient of friction: 0.35 to 0.4 Ferodo — 0.4 to 0.5 Cork — 0.37 Leather — 0.25	04
d) Differentiate between disc-brake and drum-brake.	04

Answer: **Difference between disc-brake and drum-brake:** *(Any 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

e) Sketch and explain Mc-pherson strut type independent suspension.	04
Answer: **Mc-pherson strut type independent suspension:** 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.  Figure: Mc-pherson strut type independent suspension.	02 02
f) State the function of anti roll bar and give application.	04
Answer: **Function of anti roll bar:** 1) It reduces the tendency of the vehicle to roll on either side when taking a turn. **Application:** *(Any 02)* • Bajaj Tempo Excel-4, Tata LPT 2416, Tata Sumo, Mitsubishi lancer car, Tatamobile 207, Premier Diesel Deluxe car, Premier Padmini. ***(Note: Any other application may be considered.)***	02 01 each
3. Attempt **any four** of following:	16
a) State the properties of brake fluid.	04
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	01 each

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.	
b) Explain working of anti lock brake system.	04
Answer: Anti lock brake system:  Figure: Antilock brake system. Fig. shows block diagram of the ABS system. Typically ABS 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. ***(Note: Any other figure may be considered.)***	02 02
c) Define – oversteering and understeering.	04
Answer: 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. 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.	02 02

d) Explain working of air bags and give its application.	04
Answer: **Working of air bag:**  Figure: Air bag. **Working:** As vehicle comes across the accident, 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. **Applications:** Maruti Swift, Honda City, Hyundai Verna, Audi, BMW. ***(Note: Any other application may be considered.)***	1 ½ 1 ½ 01
e) Explain repainting procedure for used car.	04
Answer: **Repainting procedure for used car:** 1) Remove dent using denting tools and dent removing procedure. 2) Preparing the Surface: Begin by sanding the car's surface with a dual action sander and 120 grit sandpaper to remove old paint and primer. 3) Carryout any necessary masking so that paint remover may not fall on the finished surface. 4) Wipe the surface down with a proprietary sprit. 5) Primer coat: Spray a coat of primer on the entire car and allow it to dry for 30 minutes. Use a long block sander and 120 grit sandpaper to slowly sand the entire car, keeping the sanding block flat and level. Repeat the primer and block sanding steps until the body is smooth. 6) Painting: Wipe the car with wax and grease remover. Spray the car with automotive spray paint, starting at the roof and work your way to the hood, trunk and then the sides of the car. Spray a total of four thin coats of paint on the car, allowing 30 minutes of dry time between each coat. 7) Polishing: Inspect the painted finish for runs and other imperfections. Use 800 grit sandpaper and water to sand the entire car. Once the car is sanded and looks dull, use a mildly abrasive liquid rubbing compound and a dual action orbital polisher to polish the car. Use circular and back and forth motions until the entire car has been polished.	04

f) State any four types of bodies and give its manufacturers name. 04

Answer: *(Any 04, 01mark each for type of vehicle body and its manufacturer.)* 04

Sr. No.	Types of vehicle body	Name of manufacturer
01	Car (Saloon or Sedan, hatchback, Coupe)	Maruti, Hundai, Volkswagen, Tata, Nissan, Renault, Ford.
02	Jeep	Mahindra, Tata, Ford.
03	Pick up	Mahindra, Tata.
04	Straight truck	Tata, Ashok Leyland, Force motors, Mahindra, local body manufacturers,
05	Half body truck	Tata, Ashok Leyland, Mahindra,
06	Platform truck	Tata, Ashok Leyland Mahindra
07	Delivery van	Maruti.
09	Dumper truck	L&T, Tata, Mahindra, ANG industries, Ashok Leyland, TRATEC
10	Bus and coaches	Tata, Ashok Leyland, Volvo, Mercedes, Mahindra, Auto body, Sutlej coach, MSRTC, Ruby Coach, ACGL,
11	Trailer	Tata, TRATEC, ANG industries
12	Tanker	Tata, Hi-Tech Services, Seamless Auto tech Pvt. Ltd., Bharat tank and Vessels.

4. Attempt **any two** of following: 16

a) Explain construction and working of air suspension system with neat sketch. 08

Answer: **Air suspension system:** 04

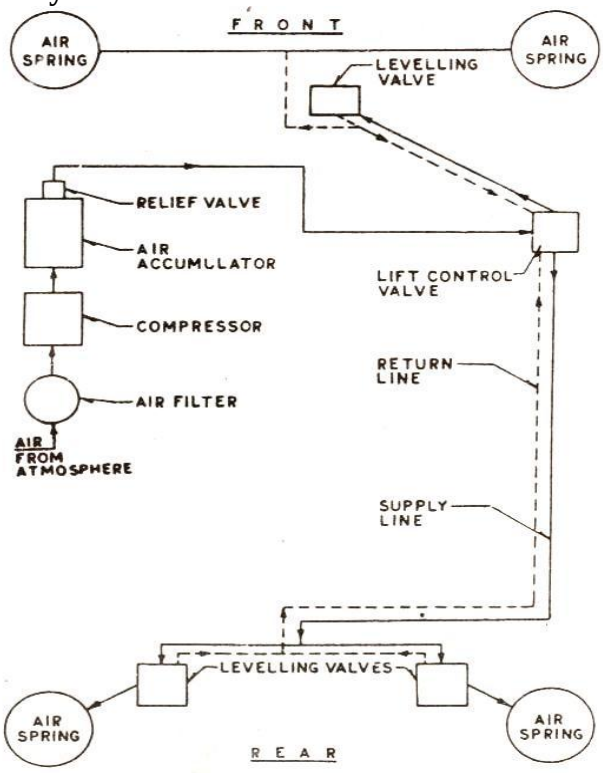
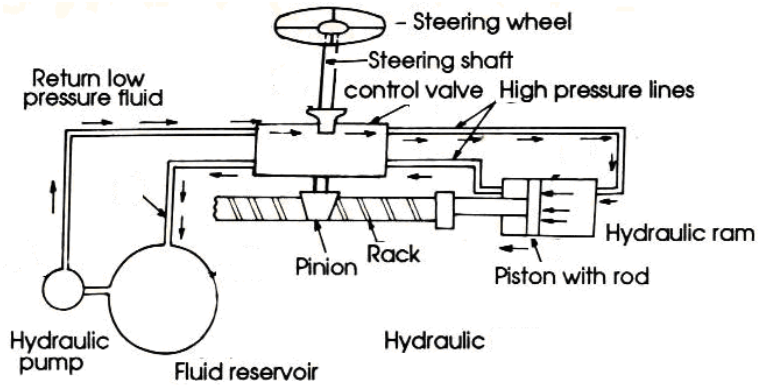
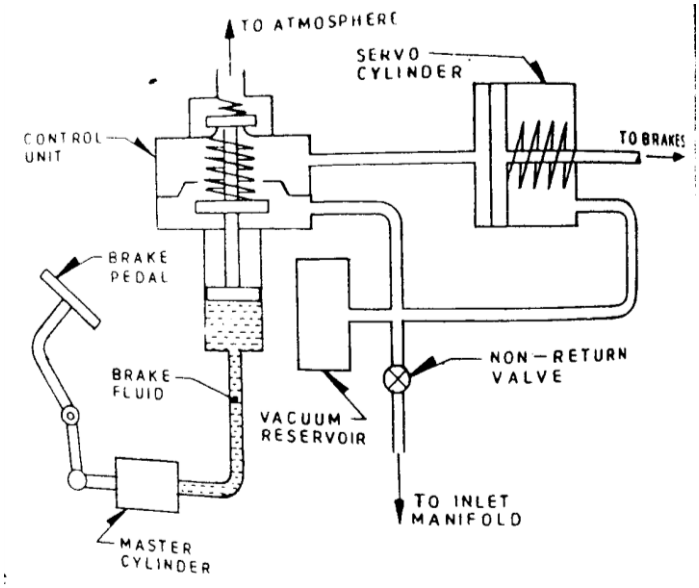
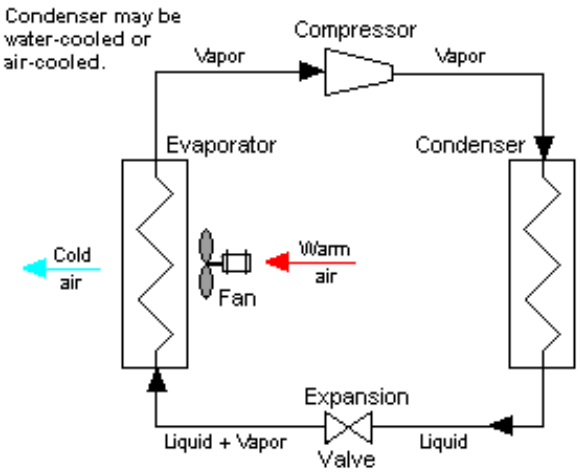
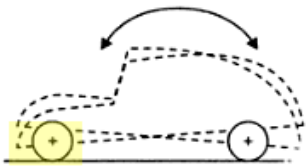
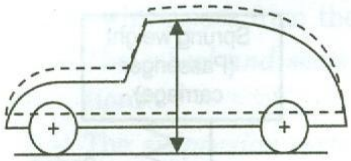


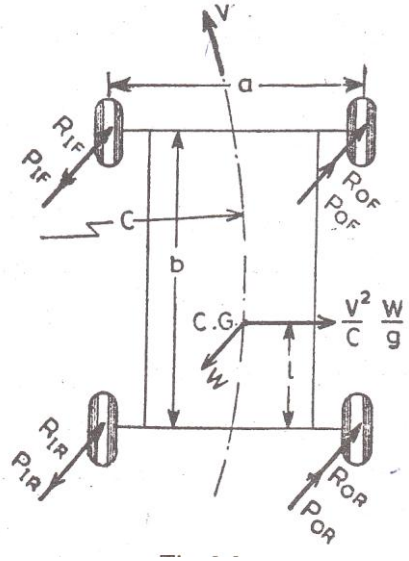
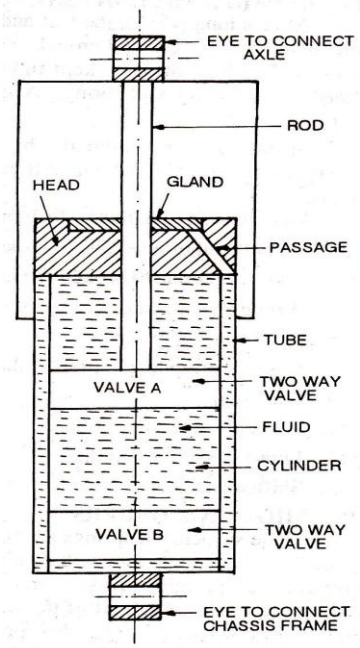
Figure: Schematic diagram showing the layout of an air suspension system.

Construction: The layout of an air suspension system has been shown in Fig. The four air springs, which may be either the bellows type or the piston type, are mounted on the same position where generally the coil springs are mounted. It also consists of air compressor, air accumulator, relief valve, lift control valve, leveling valve and pipeline. **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.	02 02
b) Explain linkage power steering with neat sketch and give its application.	08
Answer: **Hydraulic type linkage power steering:** Construction: The hydraulic power assisted steering system is shown in fig. It consists of hydraulic pump, hydraulic ram, hydraulic control valve, fluid reservoir, rack & pinion gear box, steering shaft, & steering wheel. The hydraulic fluid is stored into a reservoir to which a pump is connected. This pump lifts the fluid from reservoir & sends it to hydraulic control valve through the feed line. The steering wheel is connected to hydraulic control valve through the steering shaft. Working: When the steering wheel is at rest & the vehicle is going in straight ahead, at that time the both high pressure lines are open in position. So fluid exerts the same pressure on both sides of piston. So the rack does not operate the front wheels to turn in either side. As soon as the driver turn the steering wheel, the contact control valve operates hydraulic control valve which closes one of the port or pressure line, while the other remains open. So high pressure fluid from the pump goes to one side of the piston & operates the rack which in turn to operate the front wheels to turn in desired direction.  Figure: Linkage power steering system. Application: *(Any 02)* 1) Maruti 800 2) Alto 3) Santro-Hyundai 4) Tata indica ***(Note:Any suitable power steering linkage and its application should be given credit)***	02 02 03 01 each

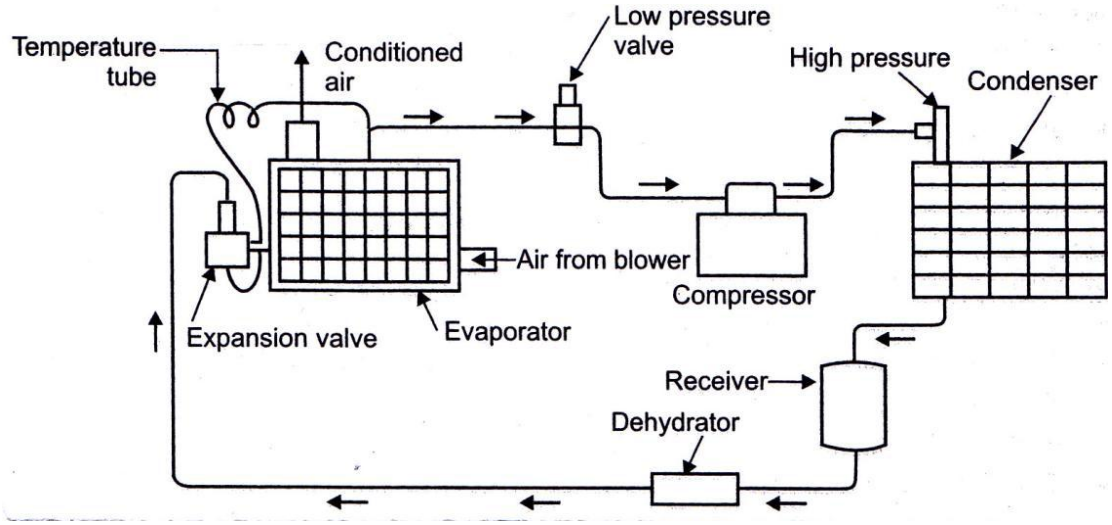
c) Explain working of vacuum assisted braking system with neat sketch and give its application.	08
Answer: **Vacuum assisted braking system:**  Figure: Vacuum assisted braking system. **Working:** When brake pedal is free, upper valve in the control unit is closed and lower is opened. Thus both side 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 thereby applying brake. When pedal is released both side of servo piston is once again exposed to vacuum. Application: *(Any 04)* 1) Alto 800 2) Maruti 800 3) i10- Hundai 4) Swift desire 5) Hundai Xcent 6) Maruti SX4 7) Tata Indica 8) Tata manza ***(Note: Any suitable application may be considered.)***	03 03 02
5. Attempt **any four** of the following:	16
a) Describe vapour compression cycle with proper sketch.	04
Answer: **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	02

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.  : Figure: Vapour compression cycle.	02
b) State and explain human comfort condition.	04
Answer: **Human comfort condition:** 1) **Temperature:** Temperature is the most important factor which affects human comfort to a great extent. Most of the human being feels comfortable at a temperature 21^0C to 25^0C. Generally human being feels comfortable at relatively higher temperature in winter season and feels comfortable at relatively lower temperature in summer season. The comfort temperature of individual person depends on his body structure, eating habits, the area in which he is to make familiar to live. 2) **Humidity:** The control of humidity is not only necessary for human comfort but it is also important from point of view of efficiency of driver. For human comfort, relative humidity is kept within a range of 35% to 60%. 3) **Purity of air:** A person does not feel comfortable when breathing in contaminated air even if temperature and humidity is within comfortable range. Therefore, proper filtration, cleaning and purification of air is necessary to keep it free from dust, dirt and other impurities. The proper percentage of oxygen in air is necessary to be maintained for human comfort. Therefore, proper filtration system is provided in HVAC system in automobiles. 4) **Air motion and circulation:** Even if temperature, humidity and purity of air is satisfactory, certain amount of air motion is necessary for human comfort. We do not feel comfortable in dead or still air. It is therefore, necessary that there should be equi-distribution of air throughout the space to be air conditioned.	01 each
c) Explain the necessity of humidity control.	04
Answer: **Necessity of humidity control:** Human feels comfortable at 60% humidity if the humidity is higher he feels sweating and if lower he feels dryness in various organs. Some people experience difficulty breathing in high humidity environments. Some cases may possibly be related to respiratory conditions such as asthma, while others may be the product of anxiety. Humans are sensitive to humid air because the human body uses evaporative cooling as the primary mechanism to regulate temperature.	04

Under humid conditions, the rate at which perspiration evaporates on the skin is lower than it would be under arid conditions. Because humans perceive the rate of heat transfer from the body rather than temperature itself, we feel warmer when the relative humidity is high than when it is low. Hence there is necessity to control humidity in car air conditioning.	
d) Define – Traction and Tractive effort.	04
Answer: Traction: The traction is the ability of the rear wheels to transmit the tractive effort without slipping. 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 02
e) Define – Pitching and Bouncing.	04
Answer: **Pitching:** Rotating action produced in the vehicle about transverse axis through C.G. parallel to ground is known as Pitching.  Figure: Pitching. **Bouncing:** It is the vertical movement of the complete body. When the body of the vehicle rises up and down, it is known as bounce or bouncing. It occurs when each corner of the body moves up and down vertically at the same time.  Figure: Bouncing.	02 02
f) Explain stability of vehicle on turn.	04
Answer: When vehicle is taking a turn along a curved path three conditions arises 1) Centrifugal force acts at centre of gravity in radially outward direction and normal reaction due to centrifugal force acts at wheel contact. The reactions (P_{IF}, P_{IR}) will be in inward direction at inner wheels and the reactions (P_{OF}, P_{OR}) outward directions at outer wheels. The centrifugal force and reactions forms overturning couple. 2) At the wheels reaction due to weight (R_{IF}, R_{IR}, R_{OF}, R_{OR}) acts at a wheel in radially outward direction. 3) Reaction at a wheel due to gyroscopic couple. These three conditions causes the over turning couple leads to sliding (skidding) and overturning of the vehicle. To avoid this height of centre of gravity of the vehicle should be lower; speed during turning should be lower.	02

 Figure: Stability of vehicle on turn. ***(Note: If derivation is written, due credit should be given.)***	02
6. Attempt **any two** of the following:	16
a) Explain construction and working of telescopic shock absorber with neat sketch.	08
Answer:  Figure: Telescopic shock absorber **Construction:** The telescopic shock absorber is shown in fig its upper eye is connected to the axle and the lower eye to the chassis frame. A two way valve A is attached to a rod another two way valve B is attached to the lower end of cylinder the fluid is in the space above and below the valve A and also in the annular space between the cylinder and tube which is connected to the space below the valve B the heat has a gland. Any fluid scraped off by the rod is brought down into the annular space through the inclined passage.	04 02

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.	02
b) Explain the procedure for protective, anticorrosive treatment and painting.	08
Answer: **Procedure for protective, anticorrosive treatment:** **1) Surface preparation:** • Degreasing: It is a process by which organic deposits such as oil, grease, metallic soaps and inorganic matters like soil, dirt, shop dust are removed from metal surface. • Descaling: The process of removing scales on the ferrous surface. • Derusting: If the metal is exposed to atmosphere or water, the oxides of iron are formed on the metal surface, these oxides are called as rust. This process of removing the rusting on the surface. 2) **Rinsing:** To remove all acids and acid salts, the work is passed through 2 or 3 successive rinse baths. 3) **Phosphate coating:** Phosphate coating is secondary metallic phosphate of iron, zinc or manganese deposited on steel surfaces. They provide a good anchorage to the paint film and prevent rust creep underneath the paint film. 4) **Passivation:** After Phosphate coating and rinsing, surfaces are given a final passivation rinse with solution of chromic acid to improve their corrosion resistance. 5) **Sealing:** After passivation and drying, the sealant is to be applied within 2 hours during monsoon and 6 hours during winter and summer months. **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 stopped 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 04

c) Draw the layout of HVAC and explain its operation.	08
Answer:  Figure: Layout of HVAC. **Operation of HVAC:** HVAC works on Vapor compression cycle. It consists of compressor, condenser, evaporator, receiver, expansion valve, thermostat, blower fan and heating core. In compressor during suction stroke low pressure vapor in dry state is sucked from evaporator. It is then compressed to high pressure and temperature. These vapors are then passed into condenser where heat is removed by cooling medium which converts vapor into liquid. The liquid is stored into receiver. The liquid from receiver is then passed to evaporator through expansion valve. Expansion valve reduces pressure. The low pressure liquid refrigerant enters evaporator, where it absorbs the heat from the warm air which is passed over the evaporator. The worm air gets cooled thereby cooling the passenger compartment. Due to heat absorption, liquid refrigerant gets converted into vapor and these vapors are passing to compressor. For heating the passenger compartment, hot engine coolant is passed through heater core. The air from blower motor fan is passed over the core thus passenger compartment gets warm.	04 04