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## PRACTICE PAPER - ANSWER BANK

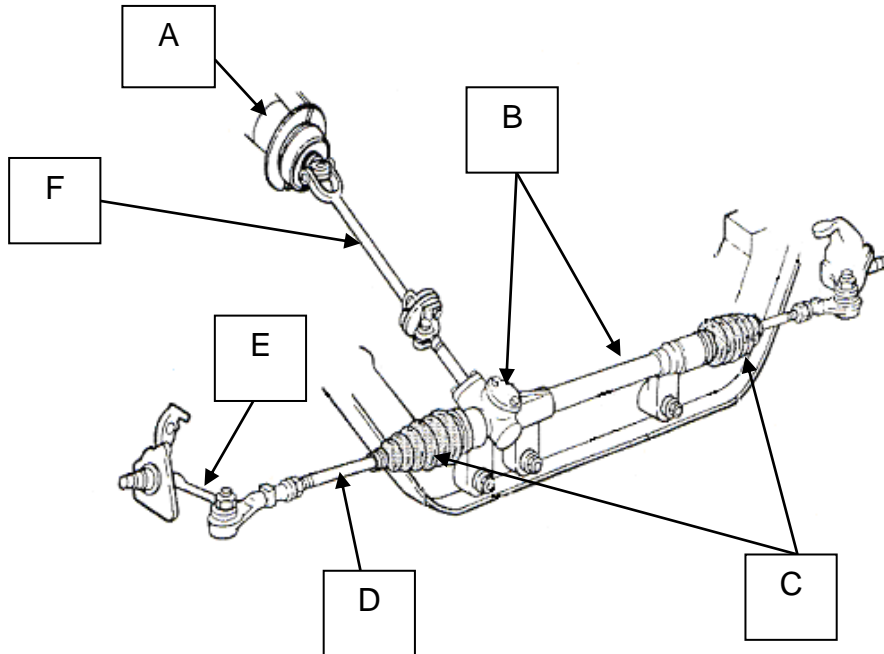
**Assessors Note:**

**This answer bank should be used as the primary resource when marking students work. However, responses to some questions may be subjective and tutors are advised to exercise their professional judgement when making assessment decisions.**

## ELEMENT ONE

Demonstrate knowledge of vehicle steering systems.

1a. Identify the components labelled A-F.



A	Steering column	D	Tie rod arm
B	Rack and pinion	E	Spindle
C	Rubber boots	F	Intermediate shaft

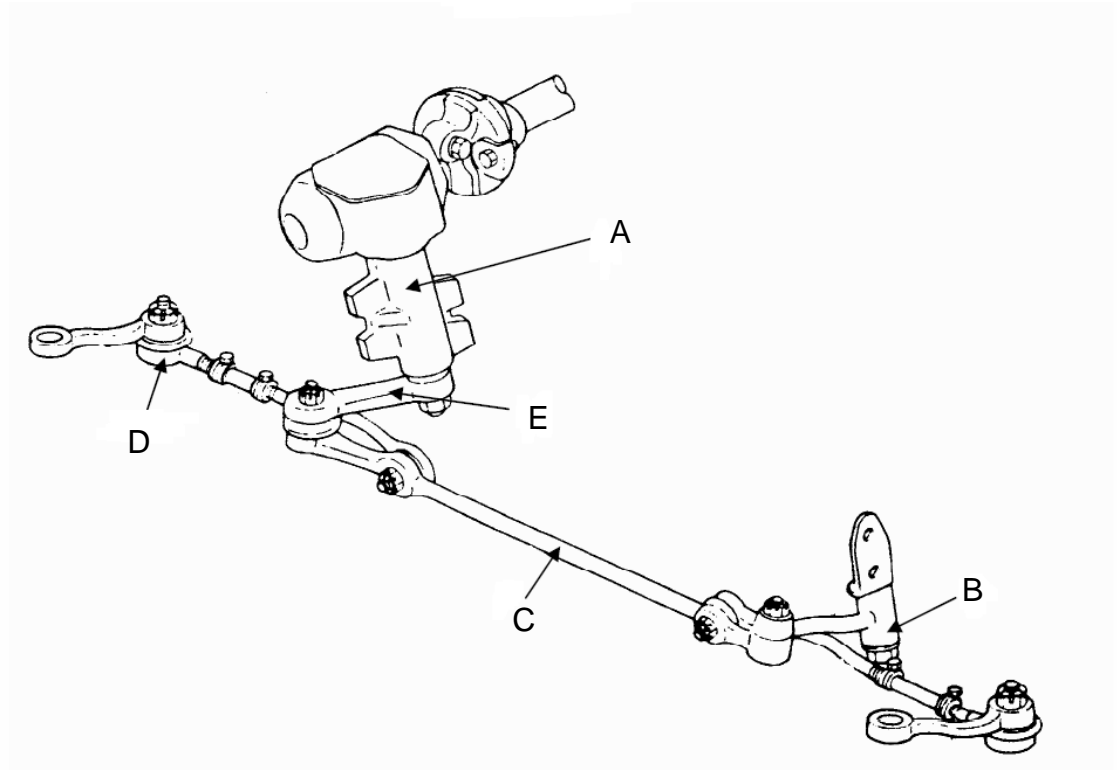
1b. Please circle the correct steering system as shown in the diagram above:

Rack and pinion steering

1c. Briefly explain the function of the component labelled A above.

Transfers the turning force of the steering wheel to the intermediate shaft and rack and pinion steering assembly.

**2. Identify the components labelled A-E.**

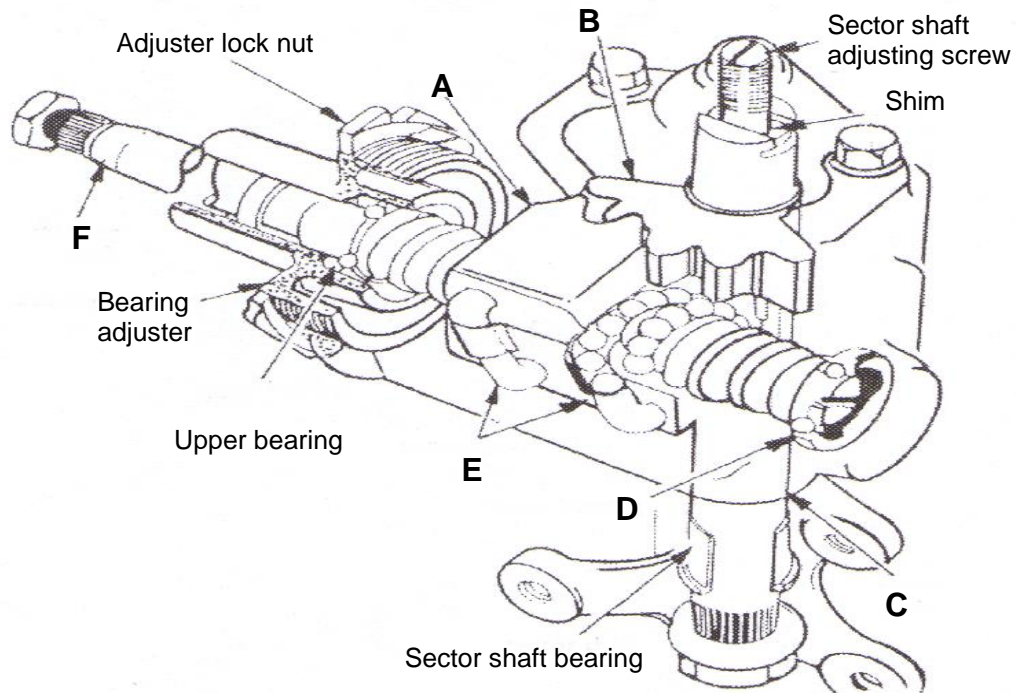


<b>A</b>	Steering box	<b>B</b>	Steering idler
<b>C</b>	Drag link	<b>D</b>	Tie rod end
<b>E</b>	Pitman arm		

**2B. Briefly explain the function of the component labelled C above.**

Connects the tie rods, tie rod arms, stub axle and wheels in parallel.

3. Identify the components labelled A-E.

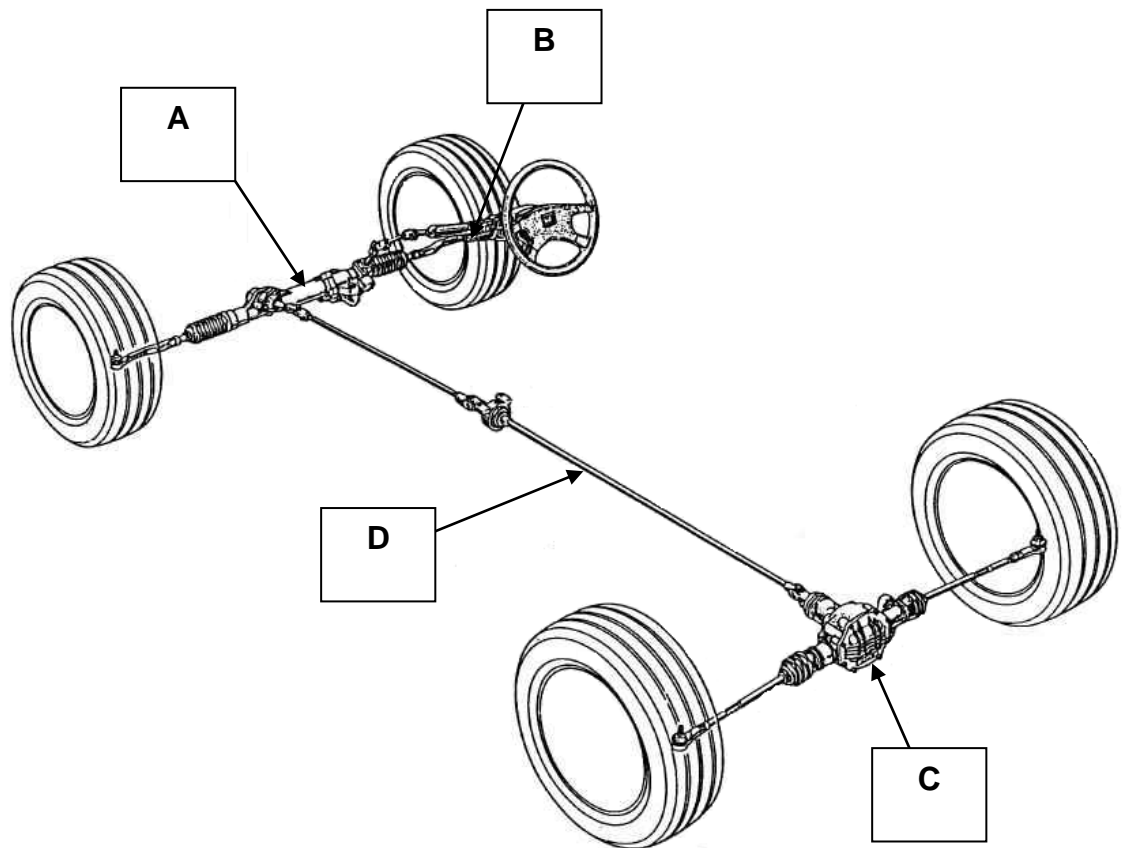


A	Ball nut	B	Sector gear
C	Sector shaft	D	Lower bearing
E	Ball return guides	F	Input shaft

3B. Briefly explain the function of the component labelled E above.

Ball return guides are used to keep the ball bearings within the limits of the thread and to allow the ball bearings to recirculate from one end of the ball nut rack to the other.

4. Identify the components labelled A-D.



A	Front steering rack	B	Steering column
C	Rear steering box	D	Centre steering shaft

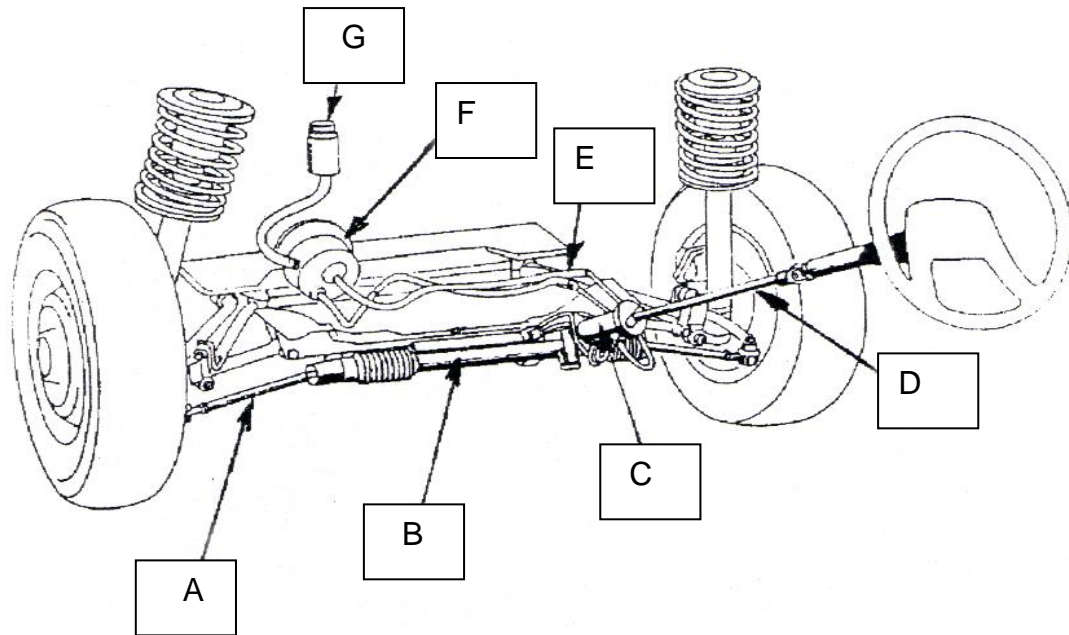
5. Briefly outline the main functions of vehicle steering systems.

Allow the driver to turn the front wheels of the vehicle to the desired direction.

Provide the vehicle with directional stability. This ensures that the vehicle will track evenly along the road and will not pull to one side.

Prevent the vehicle tyres from scrubbing under normal driving conditions.

6. Identify the components labelled A-G.



A	Tie rod arm	B	Rack housing
C	Pinion housing	D	Steering column shaft
E	High pressure hose	F	Power steering pump
G	Power steering fluid reservoir		

7. What is the main advantage of power steering systems?

Power steering reduces the effort required by the driver for steering.

**8. Match up the steering component with its function: For example**

**A – Drag link = 8 – Connects the tie rods. Tie rod arms, stub axle and wheels in parallel.**

<b>A</b>	Drag link	<b>A8</b>	1	A ball joint that swivels to move the spindle
<b>B</b>	Idler arm	<b>B4</b>	2	Transfers the turning force of the steering wheel to the intermediate shaft and rack and pinion steering assembly
<b>C</b>	Pitman arm	<b>C5</b>	3	Mounts the wheel bearings, hub, disc and road wheels and transfers steering action to the hubs and wheels
<b>D</b>	Power steering pump	<b>D7</b>	4	Connects the drag link to a fixed idler arm support
<b>E</b>	Spindle	<b>E6</b>	5	Transfers the rotational motion of the steering box to the lateral movement of the drag link
<b>F</b>	Steering column	<b>F2</b>	6	Turns the stub axle
<b>G</b>	Stub axle (RWD)	<b>G3</b>	7	Supplies oil under pressure to boost the turning effort exerted by the driver.
<b>H</b>	Tie rod arm	<b>H9</b>	<b>8</b>	Connects the tie rods. Tie rod arms, stub axle and wheels in parallel.
<b>I</b>	Tie rod end	<b>I1</b>	9	Connects the steering rack to the tie rod end

9. Match up the safety and technological steering system enhancement with its description.

A	Automatic steering	<b>A3</b>	1	An inflatable pillow that acts as a safety device on the steering wheel. Can be removed easily.
B	Brake steering	<b>B5</b>	2	Designed to collapse on impact, reducing the risk of driver injury in the event of an accident.
C	Collapsible column	<b>C2</b>	3	Uses a GPS to automatically steer a tractor or other agricultural type vehicle along consistently straight or curved rows.
D	Cushion steering wheel	<b>D1</b>	4	A system used as a back up to the steer by wire system.
E	Electronic stability and feel control	<b>E7</b>	5	Used to steer heavy earthmoving equipment such as bulldozers and diggers.
F	Failsafe	<b>F4</b>	6	A system that removes the need for mechanical steering components.
G	Rear wheel steering	<b>G8</b>	7	A system that is designed to improve a vehicles handling and feel, especially where the driver may lose control.
H	Steer-by-wire systems	<b>H6</b>	8	Used commonly on forklifts that have a weight bearing front rigid type axle.

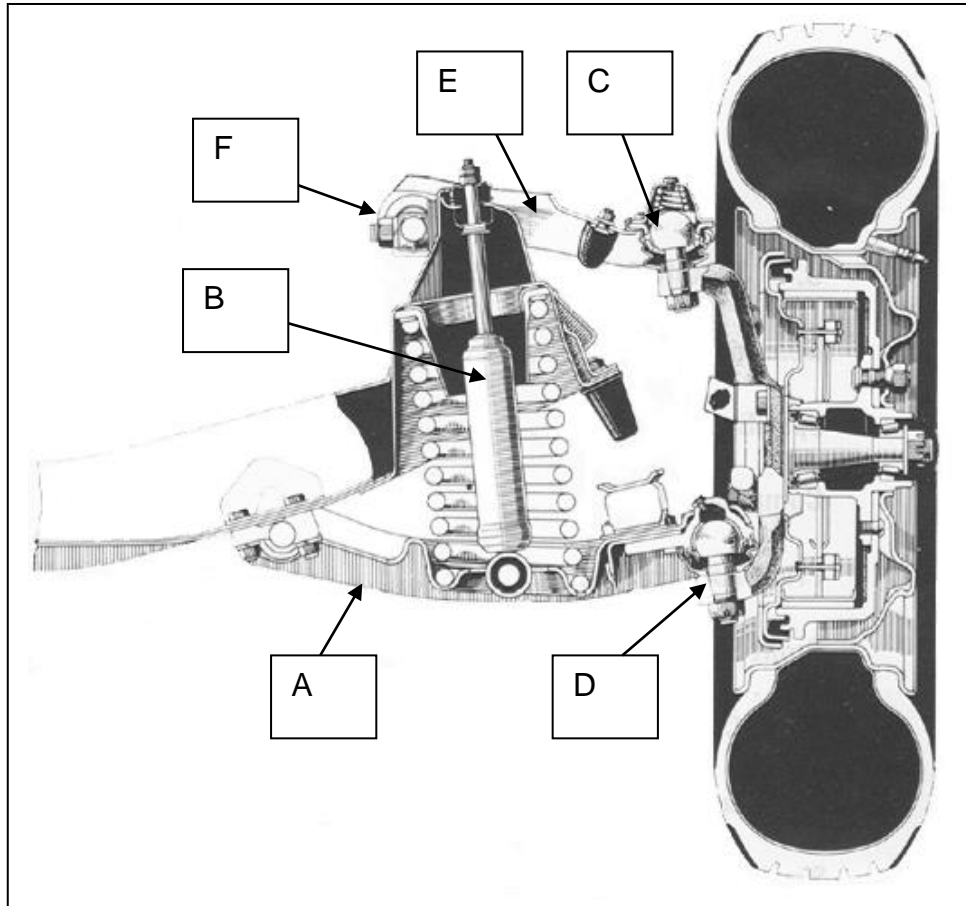


## ELEMENT TWO

Demonstrate knowledge of vehicle suspension systems.

1. Refer to the list provided to match each suspension component with its correct location in the diagram below. Write the appropriate letter in the box next to its arrow.

- |    |                      |    |                            |
|----|----------------------|----|----------------------------|
| A. | Lower suspension arm | B. | Shock absorber             |
| C. | Upper ball joint     | D. | Lower ball joint           |
| E. | Upper suspension arm | F. | Upper suspension arm pivot |



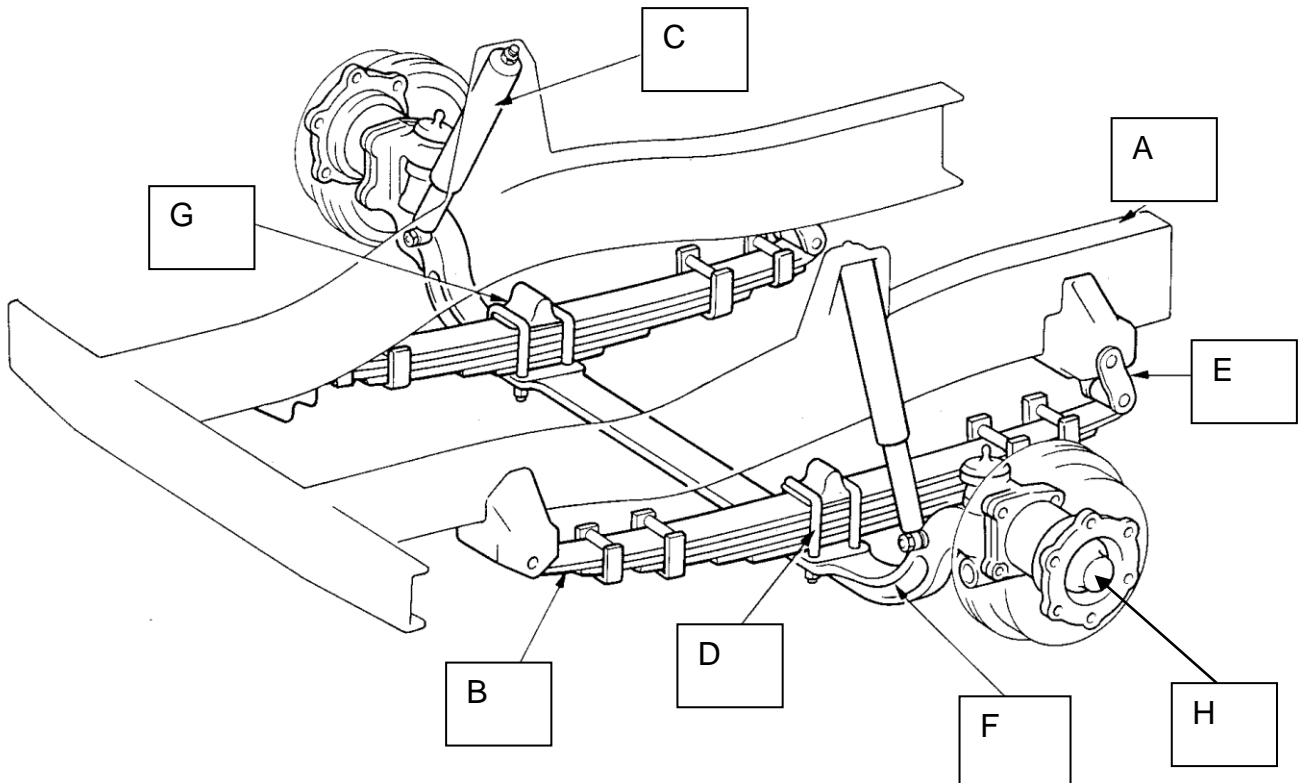
Name the suspension system shown above and briefly describe how it works.

Name: Double Wishbone

Description: The double wishbone independent suspension utilises both upper and lower suspension arms, a shock absorber and a coil spring in its assembly. It allows the wheels to move up and down, left and right, while the keeping the wheel in the correct position with respect to the road and the car.

2. Refer to the list provided to match each suspension component with its correct location in the diagram below. Write the appropriate letter in the box next to its arrow.

- |    |                |    |               |
|----|----------------|----|---------------|
| A. | Chassis rail   | B. | Leaf spring   |
| C. | Shock absorber | D. | Spring U bolt |
| E. | Spring shackle | F. | Axle beam     |
| G. | Bump stop      | H. | Wheel hub     |



Name the suspension system shown above and briefly describe how it works.

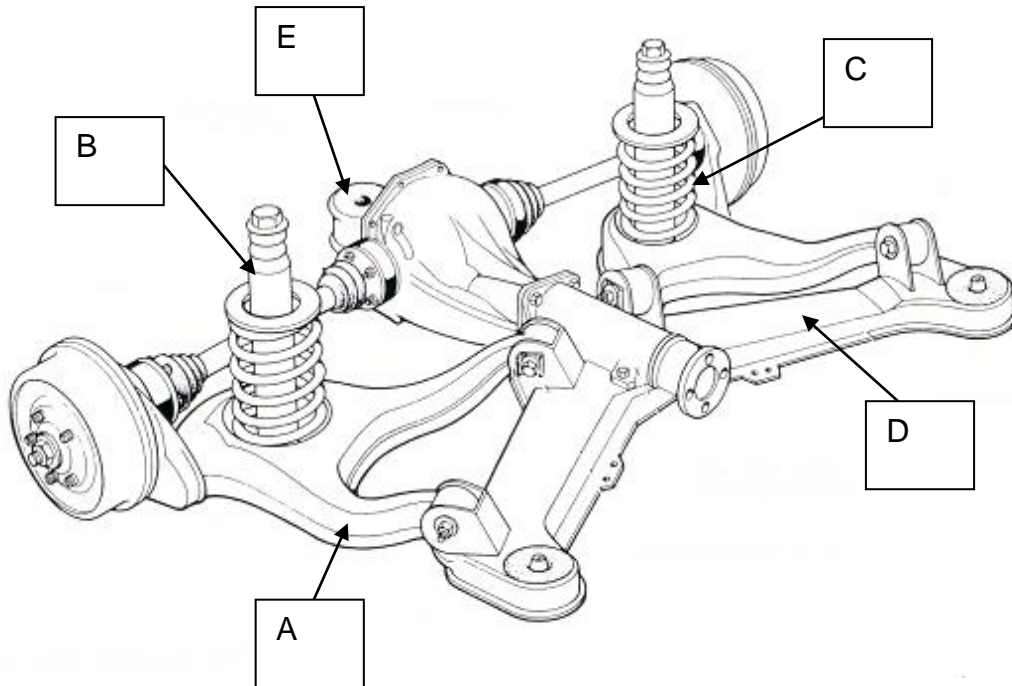
Name: **Leaf Spring Suspension**

Description: Leaf springs are designed to absorb shocks by bending. They can be made of metal or plastic strips stacked in a layer.

They are leaf-shaped under normal conditions, however, during compression the leaves straighten out to resist the force. A leaf spring may consist of one leaf that is thicker in the middle than at the ends. Most leaf suspensions consist of one main leaf spring along with several progressively shorter leaves that are bolted together by a centre bolt and are aligned using spring clips. The number of springs can vary depending on the design of the vehicle and its load bearing requirements.

3. Refer to the list provided to match each suspension component with its correct location in the diagram below. Write the appropriate letter in the box next to its arrow.

- |    |                 |    |                |
|----|-----------------|----|----------------|
| A. | Trailing arm    | B. | Shock absorber |
| C. | Coil spring     | D. | Sub frame      |
| E. | Rubber mounting |    |                |



Is this a front or rear suspension set up? Please circle appropriate answer below.

**REAR**

Name the suspension system shown above and briefly describe how it works.

Name: **Trailing Arm Suspension**

Description: The front end of the trailing arm is mounted to a solid beam. The rear end is connected to the chassis via a shock absorber. This allows for upward and downward movement of the trailing arm.

The coil spring is fitted between a spring mount in the trailing arm and the chassis. The coil spring assists the shock absorber in returning the vehicle to standard suspension height after compression.

4. **Provide a brief explanation of the purpose of each of the following suspension components:**

**Sway Bars**

Sway bars are used in most suspension systems to help reduce body roll when cornering. The sway bar runs across the vehicle from one suspension arm to the other. The centre of the sway bar is attached to the chassis or sub frame. As the suspension arm is compressed on one side, a twisting force is exerted on to the sway bar, which compresses the suspension arm on the other side and as a result keeps the vehicle level.

**Torsion Bars**

A torsion bar is a heavy spring steel rod that can vary in diameter and length. They are designed to absorb shock by twisting. Two rods of spring steel are used in this type of suspension. The bar twists and absorbs more of the road shocks before they can reach the body of the car. The bar untwists when the pressure is released, just like a spring rebounding after being compressed.

**Coil springs**

Coil springs are the most common type of springs used in suspension systems. They are designed to absorb shocks by compressing and extending. Coil springs are constructed from metal wire wound into a coil.

Coil springs are used in conjunction with struts and suspension arms.

**Bump stops**

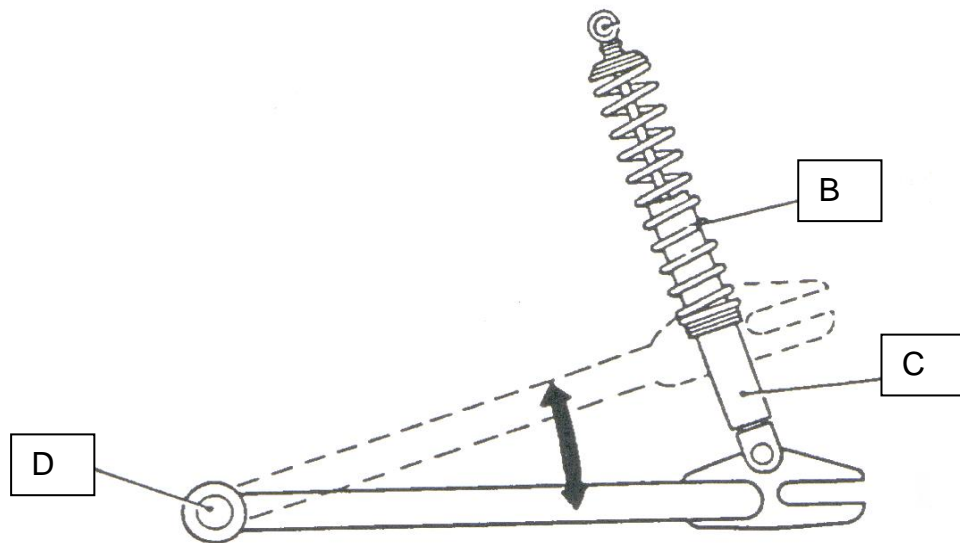
Rubber bump stops are located at each suspension system mounting point. They are designed to prevent the suspension parts from colliding with the chassis during compression. This not only prevents metal to metal contact damage, but it also reduces the transmission of road noise and vibration to the vehicle body and interior.

**Ball Joints**

Ball joints allow the suspension arms to react to road irregularities. As a wheel travels over a bump in the road, the suspension arm moves up and down, utilising the flexibility of the ball joint.

A ball joint consists of a ball stud that fits tightly into sockets. The ball can rotate freely in the socket but cannot slip out of it.

5. Identify the components labelled A-D



A	Front fork	B	Spring
C	Shock absorber	D	Pivot

6. How do motorcycle manufacturers deal with brake dive?

Manufacturers reduce this by increasing the spring rate of the fork springs, increasing spring pre-load or increasing the compression damping of the forks. Another method to reduce or eliminate brake dive in telescopic forks is to use a reactive link or torque arm to connect the braking components to the motorcycle frame via a triple link clamp.

**7. Trucks usually have a non-independent suspension set up, provide an advantage and a disadvantage of this set up?**

Advantage

The strength horizontal axle beam which run across the underbody of the truck provides the vehicle with a high load capacity.

Disadvantage

Due to the interconnection of the wheels, both wheels react when one wheel encounters a bump. This reduces vehicle contact with the road and provides an uncomfortable ride for passengers.

**8. From the clues provided identify the suspension system to its description.**

This system uses air pressure through an inflated bag to provide spring action when the wheels travel over a bump.

**System:** Pneumatic

This system adjusts the height of both the rear and front of the vehicle trim to suit varying vehicle loads.

**System:** Levelling

This system is fitted to some heavy vehicles as its highly elastic material provides excellent springing qualities.

**System:** Rubber

### ELEMENT THREE

Demonstrate knowledge of steering and suspension geometry.

1. Match up the wheel alignment term with its description (enter the appropriate number next to its letter)

A	Caster	<b>A2</b>	1	Measures the distance between the centre of the front wheel and the centre of the rear wheel.
B	Toe out on turns	<b>B6</b>	2	Measures forward or rearward tilt of the steering axis when viewed from the side. Usually more positive angles for vehicles with power steering.
C	Scrub radius	<b>C4</b>	3	Describes the moment that the suspension springs back.
D	Rebound	<b>D3</b>	4	Measures the distance between the centre of the tyre and the point at which the SAI intersects the ground. If not the same from side to side the vehicle will pull strongly.
E	Steering angle inclination	<b>E7</b>	5	Describes the moment that the suspension compresses.
F	Jounce	<b>F3</b>	6	Measures the angles that the inside front wheel and inside rear wheels travel when turning. As the outside front wheel has further to travel than the inside wheel, the inside wheel will have a sharper angle.
G	Wheelbase	<b>G1</b>	7	Angle that measures the steering pivot line when viewed from the front of the vehicle. Angle is known as KPI on heavy vehicles.

2. Match up the wheel alignment term with its description (enter the appropriate number next to its letter)

A	Bump steer	<b>A6</b>	1	Refers to the relative positions of the front wheels and rear wheels. Ideally the rear wheels should follow the front wheels when travelling in a straight line.
B	Camber	<b>B3</b>	2	Angle in which the rear wheels are pointing in relation to the centre line of the vehicle.
C	Included angle	<b>C5</b>	3	Is the tilt of the wheel when viewed from the front of the vehicle. If the tyre appears to tilt inwards at the top the angle is negative.
D	Thrust line and angle	<b>D2</b>	4	Refers to the direction the wheels are pointing when viewed from above.
E	Toe	<b>E4</b>	5	Angle that is created when the SAI is added to the camber. If the angle is not the same from side to side a suspension component is likely to be bent.
F	Tracking	<b>F1</b>	6	Change in toe that causes the vehicle to veer when the tyres lose contact with the road surface.