1. A stationary helicopter hovers above the ground.

A 38 kg object is released from the helicopter and falls vertically.

(a) (i) The object falls 12.6 m.

Calculate the change in gravitational potential energy (GPE) of the object during the fall.

(2)

GPE change=.....J

(ii) Assuming no air resistance, state the amount of kinetic energy (KE) gained by the object after falling 12.6 m.

(1)

KE gained=.....J

(b) Closer to the ground, the object encounters air resistance. When the object reaches a constant speed, the air resistance equals the object's weight.

Calculate the magnitude of the air resistance acting on the object at constant speed.

(2)

Air resistance=.....N

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(c) After falling, the object hits the ground and comes to rest without bouncing.

Draw a Sankey diagram in the following space to represent above energy transfers.

(3)

2. A car moving at a velocity of 20 m/s uniformly decelerates to a velocity of 5 m/s. During this time, it makes a displacement of 2 km. Find the car's deceleration.

(3)

3. A car travels along a straight, horizontal road at a constant speed. Which of the following statements is **correct** about the forces acting on the car?

(1)

A) The frictional force of the road on the tires can be ignored.

B) The frictional force of the road on the tires is equal to the resultant force on the car.

C) The frictional force of the road on the tires is in the direction of motion of the car.

D) The frictional force of the road on the tires is in the opposite direction to the motion of the car.

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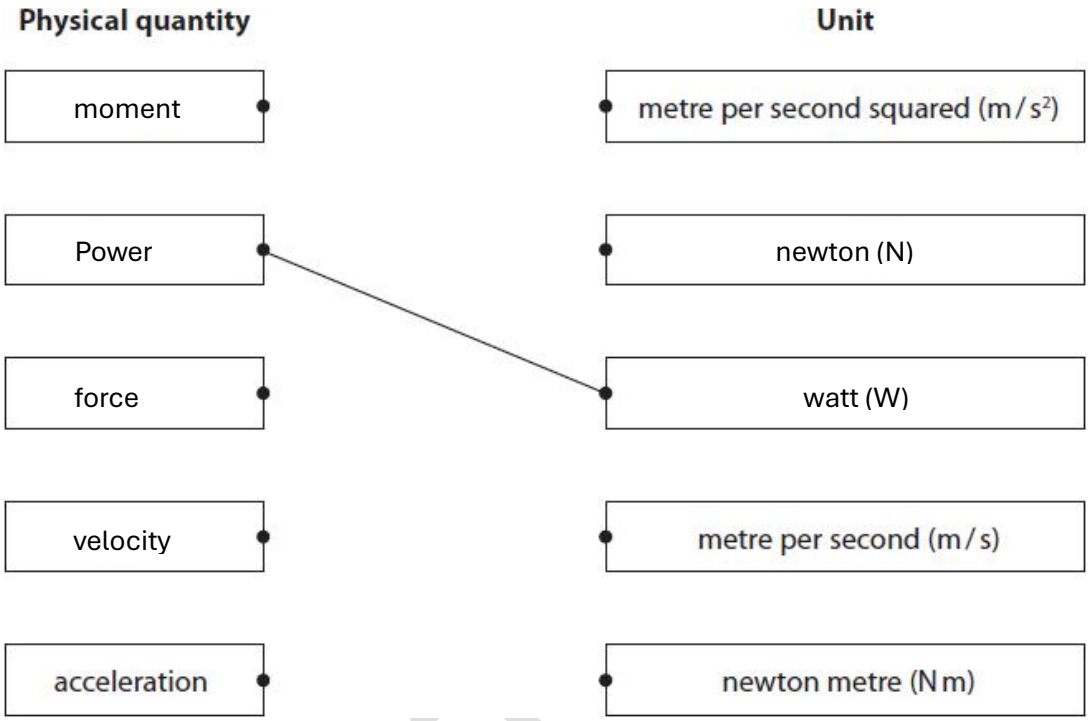
4. (a) The boxes show some physical quantities and their units.
Draw a straight line from each physical quantity to its correct unit.
One has been done for you.

(3)



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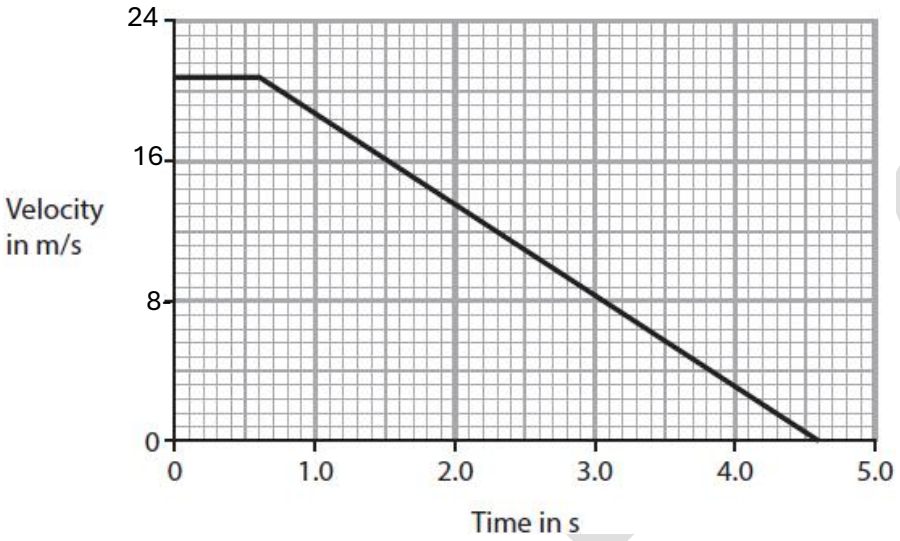
5. A driver notices an obstruction on the road and must slow down the vehicle to a complete stop.

The velocity-time graph illustrates the change in the vehicle's velocity from the moment the driver perceives the obstruction until the vehicle halts.



(i) State what is meant by thinking distance.

(2)

(ii) Determine the reaction time of the driver.

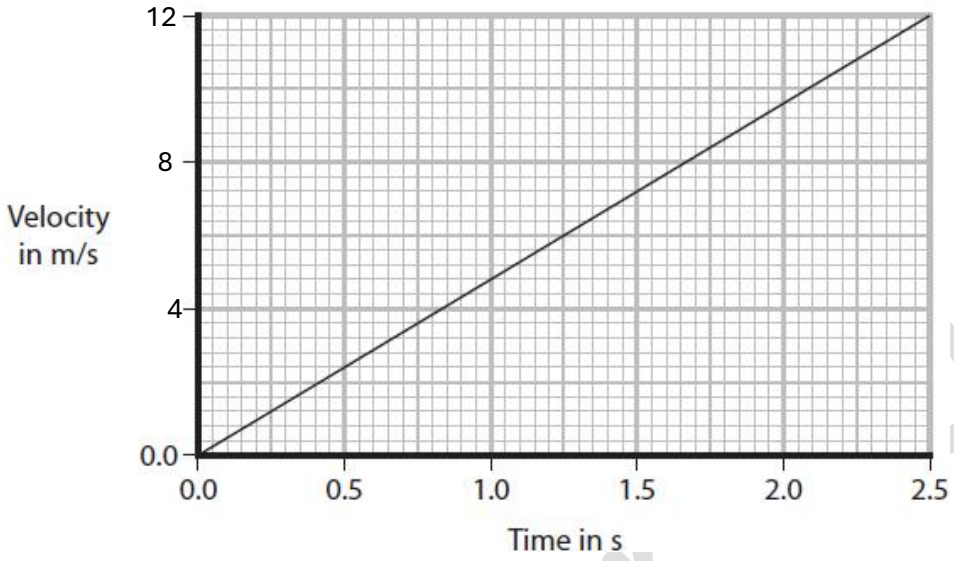
(1)

reaction time = ... s

(iii) Calculate the total stopping distance of the car.

(4)

6. The graph depicts how the speed of a ball moving down a slope varies over time.



(i) Using the graph, calculate the acceleration of the ball.

(3)

acceleration = ... m/s^2

(ii) State the feature of the graph that gives the distance travelled by the ball.

(1)

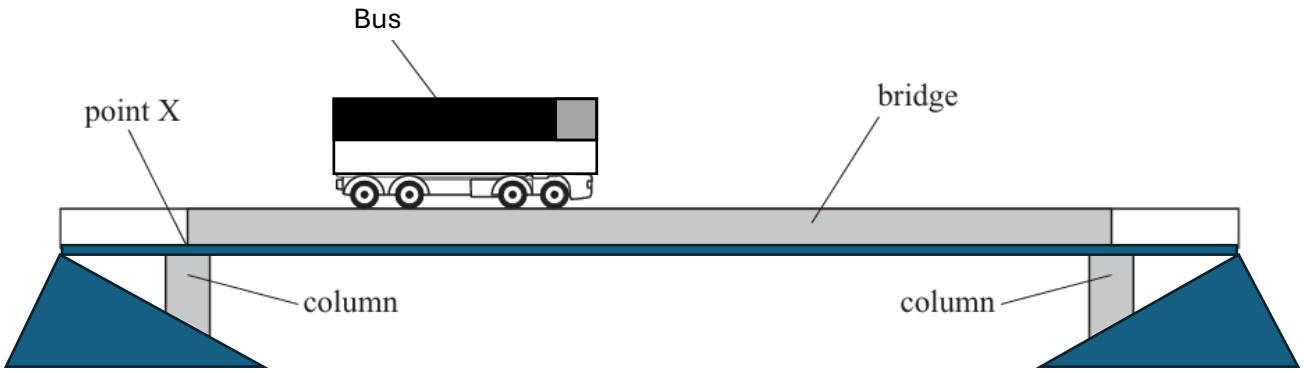
.....

(iii) Calculate the distance travelled by the ball in 2.5 seconds.

(3)

distance = ... m

7. A bus is crossing a bridge. The bridge is supported by two columns, as shown.

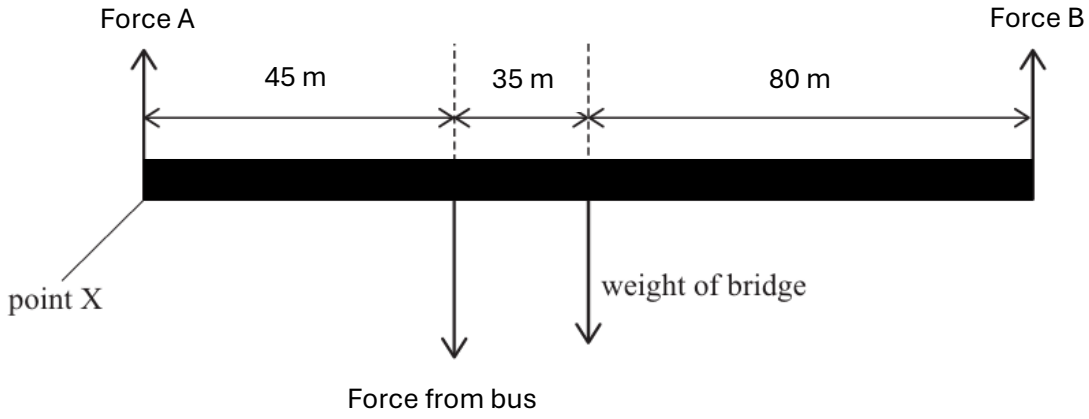


Forces A and B act on the bridge from the columns.

The centre of gravity of the bridge is at its centre.

At a particular time, the bus is 45 m from point X.

A simplified diagram showing the positions of the forces on the bridge is shown below.



(a) State the relationship between moment, force and perpendicular distance from the pivot.

(1)

(b) (i) Calculate total clockwise moment around point X.

force from bus = 4.3×10^5 N

weight of bridge = 9.7×10^5 N

(3)

(ii) State the **principle of moments**. **(1)**

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(iii) Find force **B** by taking moment around point X.

(3)

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(c) (i) State **Newton's first law** of motion. **(3)**

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(ii) Find force **A**.

(3)

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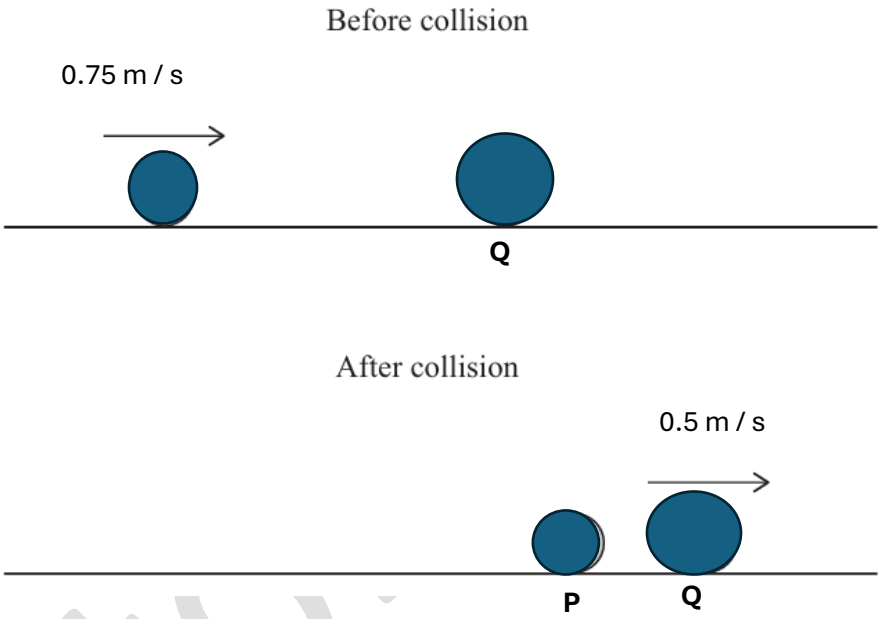
8. Balls **P** and **Q**, collide. Ball **Q** is initially at rest.

The mass of each ball **P** is 0.4 kg, and the mass of the ball **Q** is 0.8 kg.

The initial velocity of ball **P** is 0.75 m s^{-1}.

After the collision, the velocity of ball **Q** is 0.5 m s^{-1}, as shown.



(a) Find the velocity of the ball **P** after the collision.

(3)

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9. The following bicycle is moving with constant acceleration.

Label the friction force acting on the two wheels of the bicycle.

(2)

10. A race car driver needs to stop in the pit lane during a race to replace the car's tires.

The pit lane is a designated area where maintenance is performed during the race.

(a) (i) The race car has a mass of 930 kg. The brakes can apply a maximum force of 42,000 N.
Using these values, calculate the car's maximum possible deceleration.

(3)

(b) The car slows down using its brakes, which rely on friction to reduce speed.

The brakes become very hot during this process.

Using principles of energy transfer, explain why the brakes heat up when the car slows down.

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(c) During a race, the tires of the car heat up significantly.

During the pit stop, a mechanic handles the tires while wearing gloves made from several layers of insulating materials.

Explain how these insulating layers help protect the mechanic's hands from being burned.

(2)

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Diagram 1 shows a wooden plank resting horizontally on two supports, labeled A and B.

A block is hanging from the plank, suspended by a cable with negligible weight.

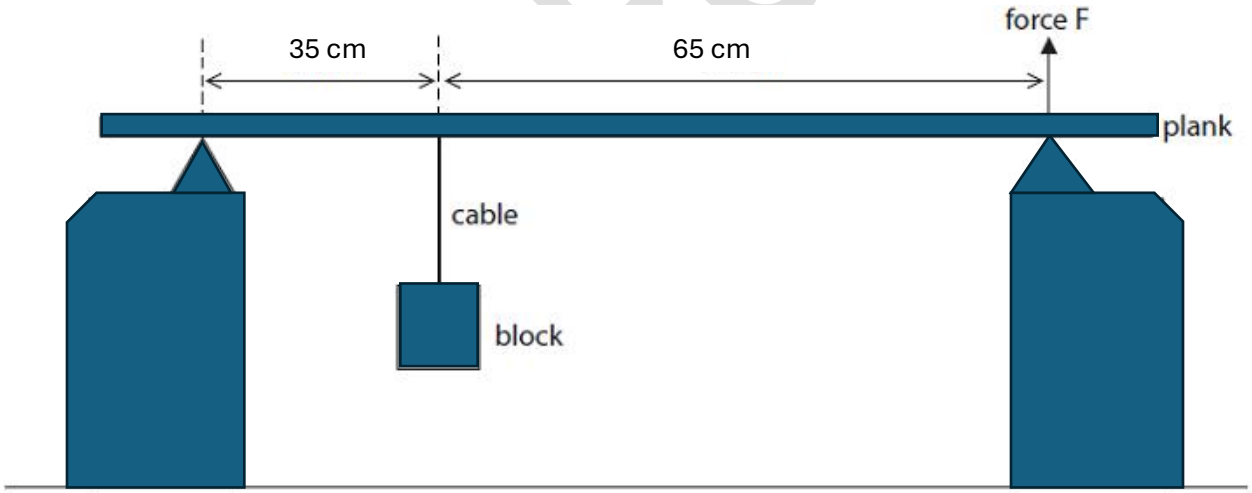

Diagram 1

(a) (i) Write the formula that relates the moment of a force, the force itself, and the perpendicular distance from the pivot point.

(1)

(iii) Take moments about support A to calculate the force F exerted by support B.

Assume the plank's weight is negligible, and the block's weight is 260 N.

(3)

11. A metal spring obeys Hooke's law.

Sketch a graph to show that the spring obeys Hooke's law as it is stretched.

You should label both axes with appropriate physical quantities.

(3)