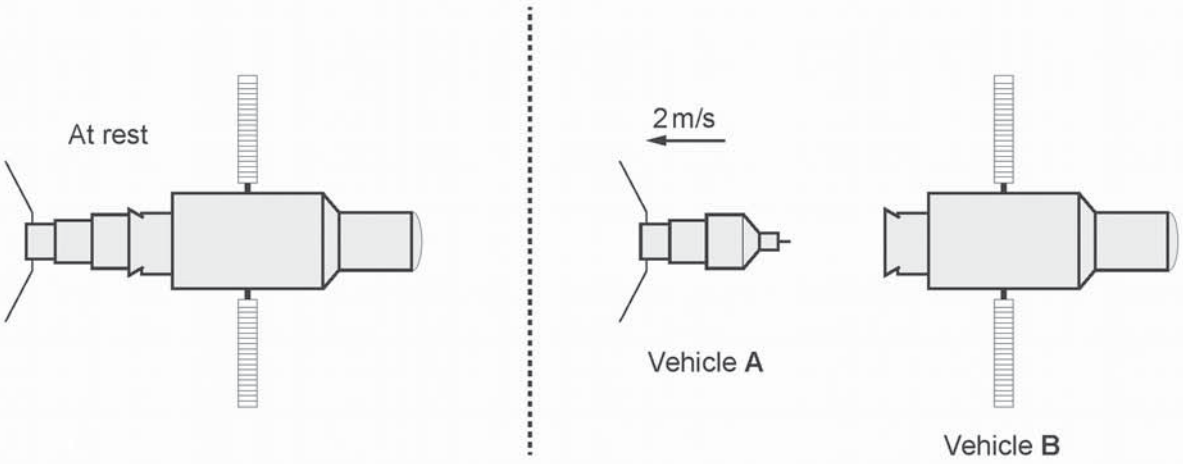
WJEC Physics GCSE
Topic 2.4: Further motion concepts
Questions by topic

1.

The diagrams show two stationary space vehicles in the act of separating.



Vehicle **A** has a mass of 50 000 kg.

Vehicles **A** and **B** are at rest before the separation. **The total momentum is zero.**
After the separation, vehicle **A** moves with a velocity of **–2 m/s**.

(i) Use the equation:

$$\text{momentum} = \text{mass} \times \text{velocity}$$

to calculate the momentum of **A** after the separation. [2]

momentum = ... kg m/s

(ii) No momentum is lost when they separate.
Write down the momentum of **B** after they separate. [1]

momentum = ... kg m/s

(iii) Vehicle **B** has a mass of 80 000 kg. Use the equation:

$$\text{velocity} = \frac{\text{momentum}}{\text{mass}}$$

to find the velocity of vehicle **B** after the separation. [2]

velocity = ... m/s

2 (HIGHER).

(a) State the law of conservation of momentum. [1]

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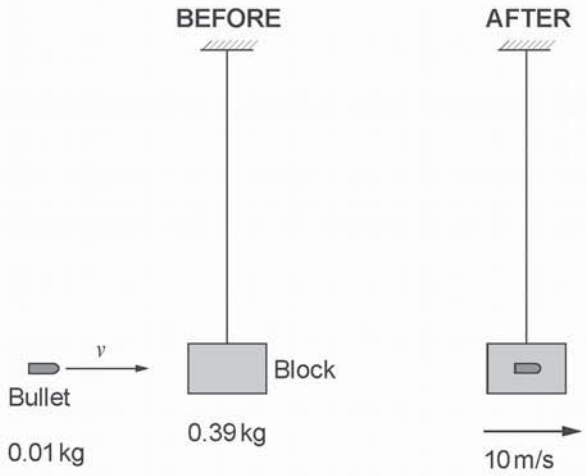
(b) A bullet of mass 0.01 kg is fired into a wooden block of mass 0.39 kg that is hanging at rest on a string. The bullet becomes embedded in the block which then starts to move with a velocity of 10 m/s.



(i) Use an equation from page 2 to calculate the velocity of the bullet, v before it enters the block. [3]

velocity of bullet, v = ... m/s

(ii) Use an equation from page 2 to calculate the kinetic energy lost in the collision. [3]

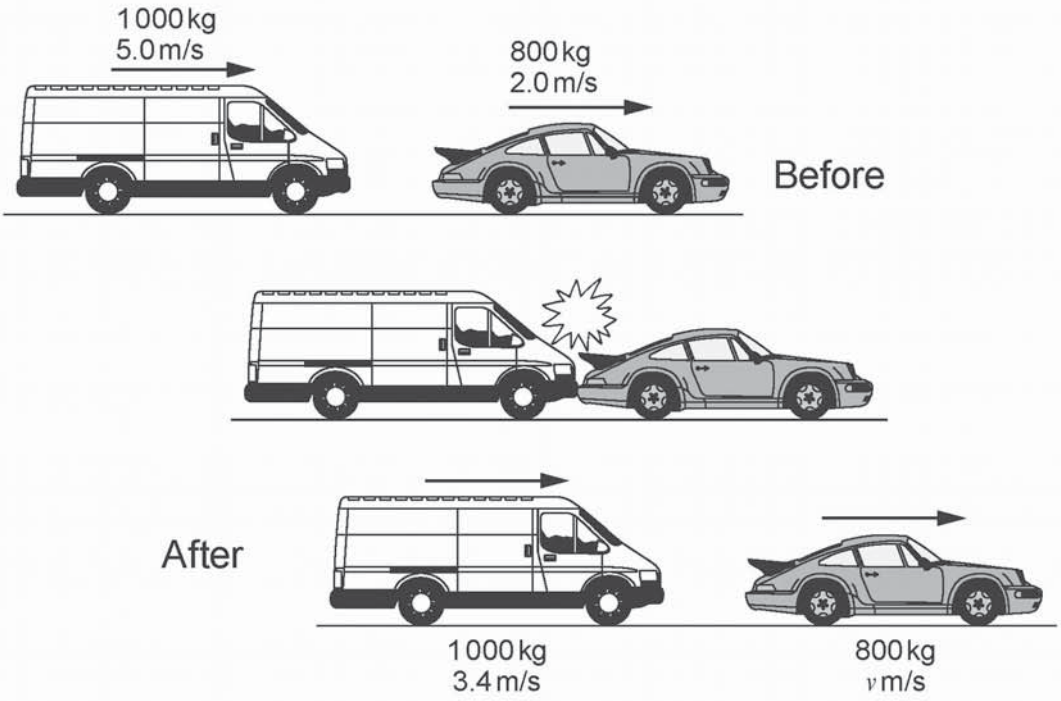
KE lost = ... J

3.

(a) Complete the following statement of the law of conservation of momentum. [2]

For a collision occurring between object 1 and object 2 the total momentum before the collision ..... the total momentum of the two objects after the collision providing there are no external ..... acting.

(b) The diagram below shows the stages in a collision between a van and a car.



(i) Use an equation from page 2 to calculate the total momentum before the collision. [3]

momentum = ... kg m/s

(ii) Calculate the momentum of the van after the collision. [1]

momentum of van = ... kg m/s

(iii) Calculate the momentum of the car after the collision. [1]

momentum of car = ... kg m/s

(iv) Use the equation:

$$\text{velocity} = \frac{\text{momentum}}{\text{mass}}$$

to calculate the velocity, v of the car after the collision. [1]

velocity, v = ... m/s

(c) During the collision, the van exerts a force of 16000 N on the car. State the size **and** direction of the force exerted by the car. [1]

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4.

A girl catches and stops a ball of mass 0.15 kg which is moving at a speed of 20 m/s.

(a) (i) Use the equation:

momentum = mass × velocity

to calculate the change in momentum of the ball. [2]

Momentum change = ... kg m/s

(ii) Use an equation from page 2 to calculate the force applied by the girl if the ball is stopped in 0.5 seconds. [2]

Force = ... N

(iii) The girl now doubles the time taken to stop the ball by moving her hands towards her as she catches it. What is the size of the force now? [1]

Force = ... N

(b) In some situations people have to be stopped suddenly and safely. The force on them is reduced by increasing the stopping time.

(i) Name a situation in which this happens. [1]

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(ii) Describe how the stopping time is increased. [1]

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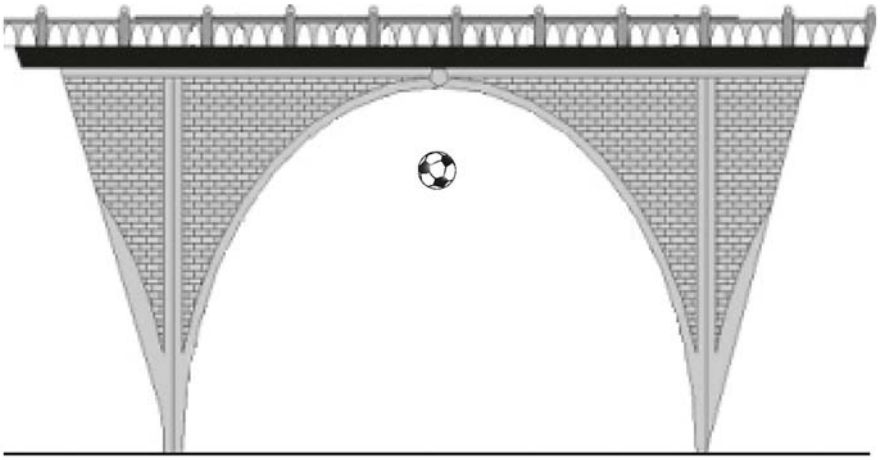
7

5 (HIGHER).

A football of mass 0.3 kg is dropped from rest off a bridge and takes 2.8 seconds to reach the ground below.



The diagram is not drawn to scale

Use equations from page 2 to answer the questions below.
Assume the acceleration due to gravity = 10 m/s^2 and that air resistance is negligible.

(a) Calculate the height of the bridge. [2]

height = ... m

(b) Calculate the momentum of the ball just before it hits the ground. [3]

momentum = ... kg m/s

(c) The ball rebounds from the ground with a speed of 14 m/s.

(i) Calculate the kinetic energy of the football as it leaves the ground. [2]

kinetic energy = ... J

(ii) Calculate the change in momentum of the ball due to the bounce. [2]

change in momentum = ... kg m/s

(iii) Explain how momentum is conserved when the ball rebounds from the Earth. [2]

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(d) Describe how Newton's third law of motion applies when the ball hits the ground. [2]

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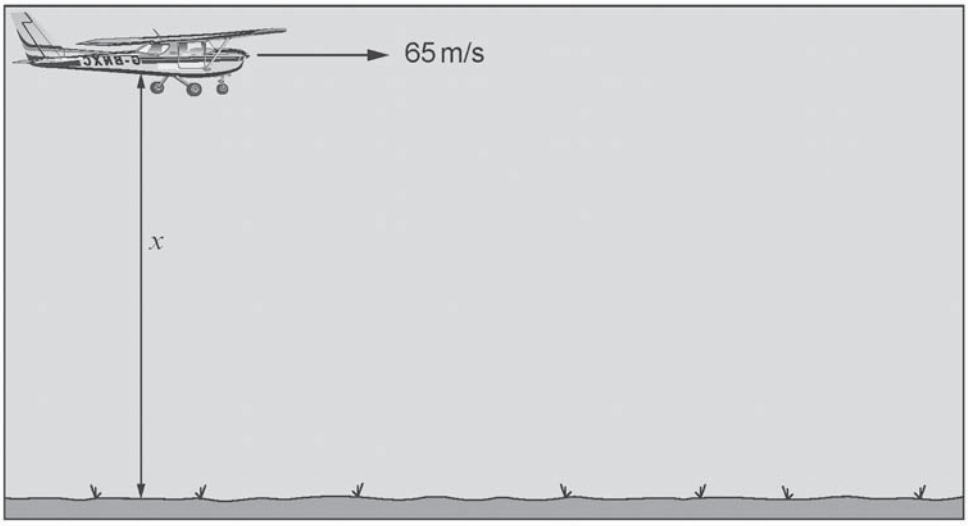
6.

An aeroplane flies horizontally at a constant speed of 65 m/s at a height, x when it drops a package. The package reaches the ground 12 s later.



Ignore air resistance throughout the question.

(a) Use an equation from page 2 to calculate the vertical speed, v of the package when it reaches the ground. (Acceleration due to gravity, g = 10 m/s^2) [3]

v = ... m/s

(b) Use an equation from page 2 to calculate the height, x of the plane above the ground. [3]

x = ... m

(c) Use the equation:

$$\text{distance} = \text{speed} \times \text{time}$$

to calculate how far the aeroplane moves horizontally in 12 s. [2]

distance = ... m

7.

(a) A car is travelling at 20 m/s before slowing down to a velocity of 5 m/s.

(i) Calculate the change in velocity of the car. [1]

change in velocity = ... m/s

(ii) The driver of the car has a mass of 60 kg. Use the equation:

$$\text{momentum} = \text{mass} \times \text{velocity}$$

to calculate the change in momentum of the driver. [1]

change in momentum = ... kg m/s

(iii) The car slowed down for 6 s. Use the equation:

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

to calculate the size of the force acting on the driver during braking. State the unit. [2]

force = ...

unit .....

(b) In another situation, the car slowed down from 20 m/s to 5 m/s in less time. Explain what effect this has on the force acting on the driver. [2]

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.....

.....

(c) Seat belts help to keep drivers and passengers safer when the car stops suddenly during an accident.
Name **two** *other* safety features that help to do this. [2]

1. .....

2. .....

8

8.

(a) Define the moment of a force.

.....

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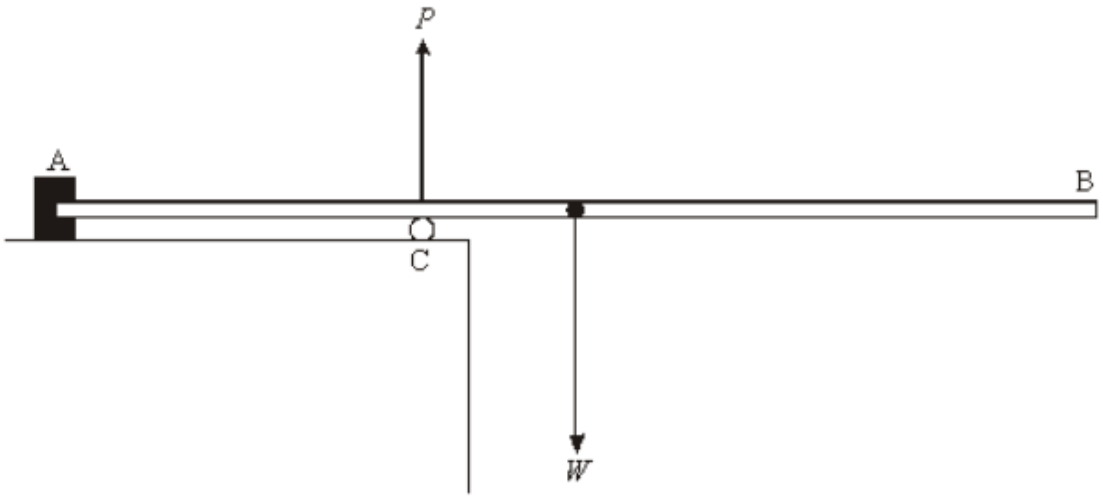
(2)

(b) The diagram shows a uniform diving board of weight, *W*, that is fixed at A. The diving board is supported by a cylinder at C, that exerts an upward force, *P*, on the board.



(i) By considering moments about A, explain why the force *P* must be greater than the weight of the board, *W*.

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(ii) State and explain what would be the effect on the force *P* of a girl walking along the board from A to B.

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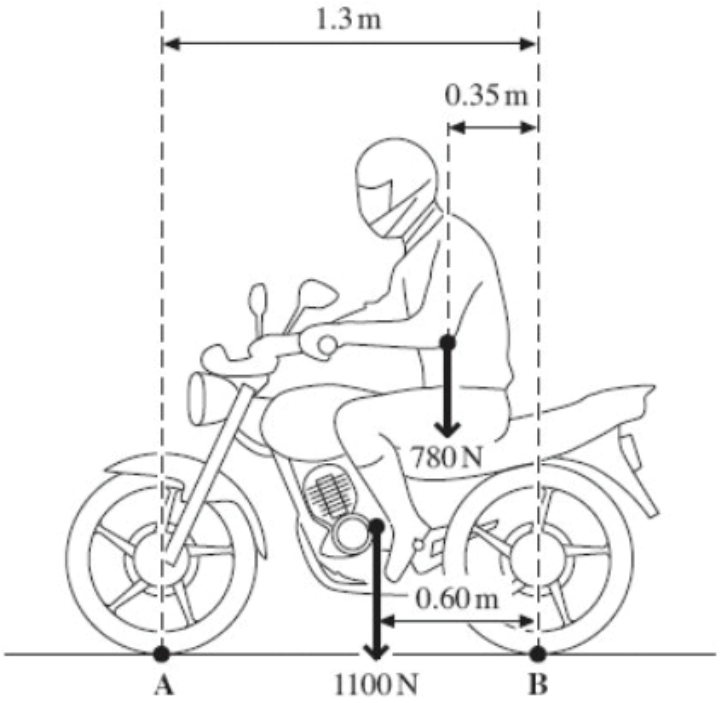
(4)
(Total 6 marks)

9.

The figure below shows a motorcycle and rider. The motorcycle is in contact with the road at **A** and **B**.



The motorcycle has a weight of 1100 N and the rider's weight is 780 N.

(a) State the Principle of Moments.

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(2)

(b) Calculate the moment of the rider's weight about **B**. Give an appropriate unit.

answer = ...

(2)

(c) By taking the moments about **B**, calculate the vertical force that the road exerts on the front tyre at **A**. State your answer to an appropriate number of significant figures.

answer = ... N

(4)

(d) Calculate the vertical force that the road exerts on the rear tyre at **B**.

answer = ... N

(1)