

Question 1 [7 marks]

- A. Define momentum. [1]
 B. Fig below shows two toy trains, A and B, on a track.

The mass of train A is 0.45 kg and the mass of train B is 0.21 kg. The trains do not have motors. Train A travels towards train B and they collide.

Immediately before the collision:

- the velocity of train A is 0.34 m / s to the right
- the velocity of train B is 0.12 m / s to the left.

The trains stick together when they collide.

Calculate the magnitude and direction of velocity of the trains immediately after the collision. [4]



C. A different train is travelling with a momentum of 0.26 kg m / s. The train slows down and stops after 2.1 s. Calculate the average force acting on the train during this time. [2]

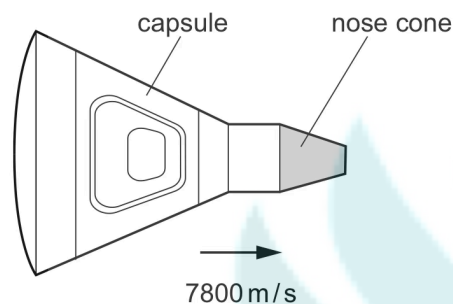
Question 2 [6 marks]

The figure below depicts a space vehicle comprising a capsule and a nose cone.

The space vehicle is moving at a velocity of 7800 m / s. The mass of the space vehicle is 840 kg.

- A. Show that the momentum of the space vehicle is approximately 6.55×10^6 kg m / s. [1]
 B. The capsule ejects the nose cone, as shown in Fig. below.

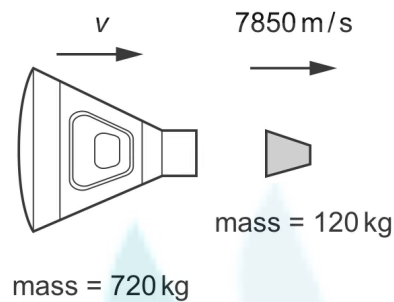
Determine the velocity v of the capsule after the nose cone is ejected. Give your answer to 3 significant figures. [3]



C. A different space capsule returns to Earth.

Fig. below shows this capsule just before it lands in the sea.

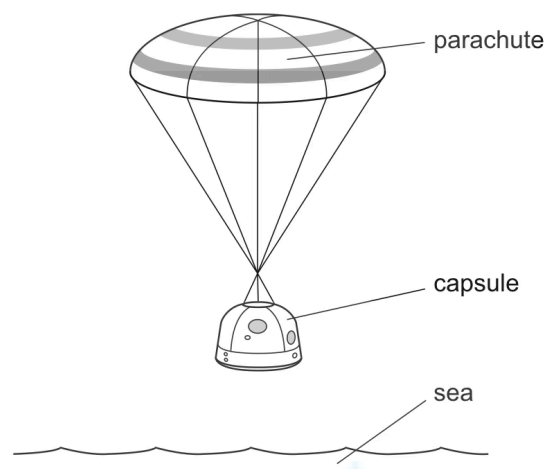
The capsule travels at terminal velocity. The upward vertical force acting on the capsule is 120 kN.



Calculate the mass of the capsule. [2]

Question 3 [5 marks]

A tennis player throws a tennis ball into the air. The mass of the tennis ball is 5.8×10^{-2} kg. The tennis ball leaves the tennis player's hand and reaches a maximum height of 5.0 m above



Theo point of release

A. Show that the initial velocity of the tennis ball is 9.9 m / s upwards. [3]

B. Calculate the momentum of the tennis ball as it leaves the tennis player's hand. [2]

Question 4 [5 marks]

A cricket ball is travelling at a speed of 25 m / s horizontally through the air. The mass of the ball is 0.14 kg.

A. A player catches the ball and the ball comes to rest. Calculate the change in momentum of the ball during the catch. [2]

B. The player's hands are in contact with the moving ball for 9.7 ms.

Calculate the horizontal force exerted by her hands to bring the ball to rest. [3]

Question 5 [6 marks]

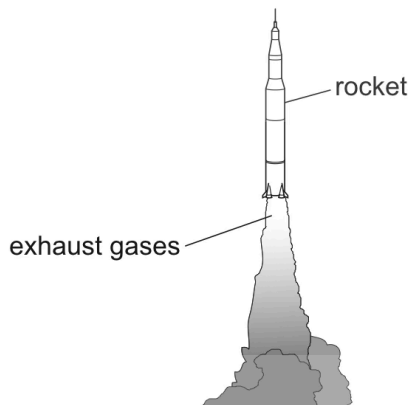
A. Define impulse. [1]

B. Fig. below shows a rocket and its exhaust gases. The exhaust gases are emitted from the rocket with a velocity of 1400 m/s and at a rate of 2800 kg/s . Show that the force exerted on the rocket by the exhaust gases is 3900 kN . [2]

C. Calculate the maximum mass that this force can lift from the ground. Ignore air resistance. [3]

Question 6 [3 marks]

The concrete floor under the seesaw is replaced with a rubber floor. A child falls from the seesaw and experiences an impulse when they hit the floor. Explain how the rubber floor reduces injury to the child.



Use ideas about impulse, force, momentum and time in your answer. [3]

Reference - IGCSE physics past papers