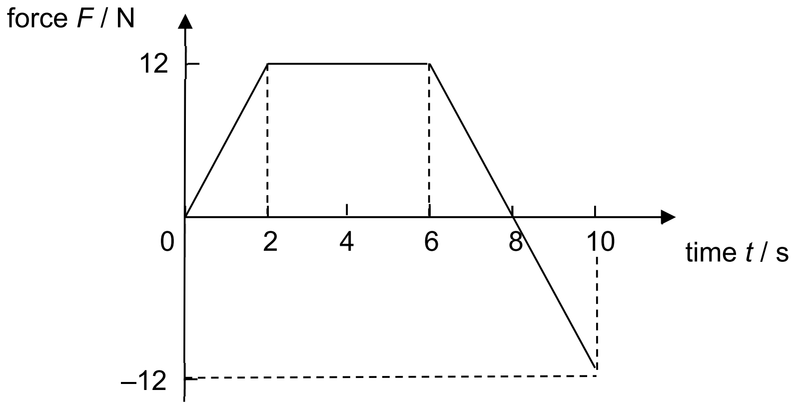
Chapter 3: Dynamics (Momentum and Collisions)

Worked Example 1 (Impulse)

A body of mass 300 g, initially at rest, is acted on by a force F which varies with time t as shown below.

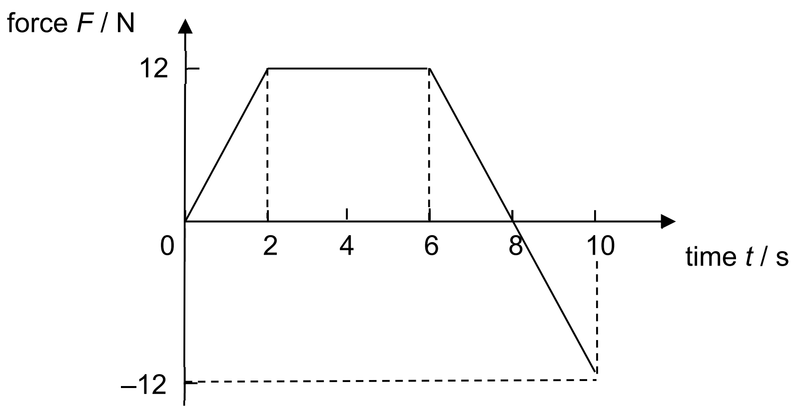


The speed of the body after 10 s is

A 180 m s^{-1} **B** 200 m s^{-1} **C** 220 m s^{-1} **D** 240 m s^{-1}

TJC/09/I/8

1 A body of mass 200 g, initially moving at a speed of 50 m s^{-1}, is acted on by a force F in the direction of motion which varies with time t as shown below.



The speed of the body after 10 s is

A 250 m s^{-1} **B** 300 m s^{-1} **C** 350 m s^{-1} **D** 470 m s^{-1}

2 A ball of mass 80 g collides with a vertical wall. The ball has a velocity of 23 m s^{-1} in a horizontal direction. After hitting the wall the ball moves with a velocity of 18 m s^{-1} in the opposite direction.

What is the impulse provided by the wall?

A 0.40 N s in a direction away from the wall

B 3.3 N s in a direction away from the wall

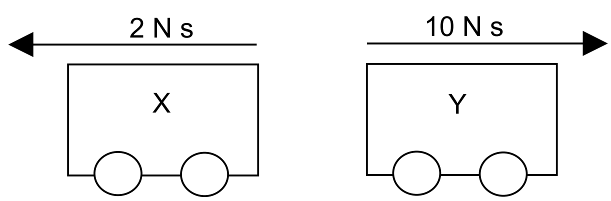
C 0.40 N s in a direction towards the wall

D 3.3 N s in a direction towards the wall

Alvl/2011/1/7 (modified)

Worked Example 2 (Principle of Conservation of Momentum)

The diagram shows the momentum of two trolleys X and Y after they have collided with each other. During the collision, the directions of motion of both trolleys are reversed. The magnitude of momentum of X is 22 N s before the collision.



What is the magnitude of the momentum of Y before collision?

A 8 N s **B** 12 N s **C** 14 N s **D** 22 N s

IJC/09/I/12

3 A particle Q moving with kinetic energy E and momentum p makes a head-on collision with an identical particle R which is initially at rest but free to move. The particles coalesce after the collision.

Which of the following correctly represents the kinetic energy and magnitude of the momentum of particle Q and the system as a whole **after** the collision?

	Kinetic energy of		Momentum of	
	Q	system	Q	system
A	0	E	0	p
B	E / 4	E / 2	p / 4	p / 2
C	E / 4	E / 2	p / 2	p
D	E	E	p / 2	p

NJC/09/I/6

4 A truck of mass 22 000 kg and moving at a speed of 3 m s^{-1} catches up and collides with a truck of mass 66 000 kg moving in the same direction at 1 m s^{-1} as shown in Fig.1.1.

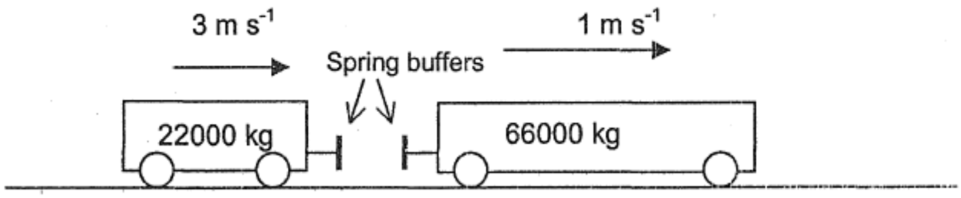


Fig.1.1

Fig.1.2 shows the speeds of the trucks before, during and after the collision.

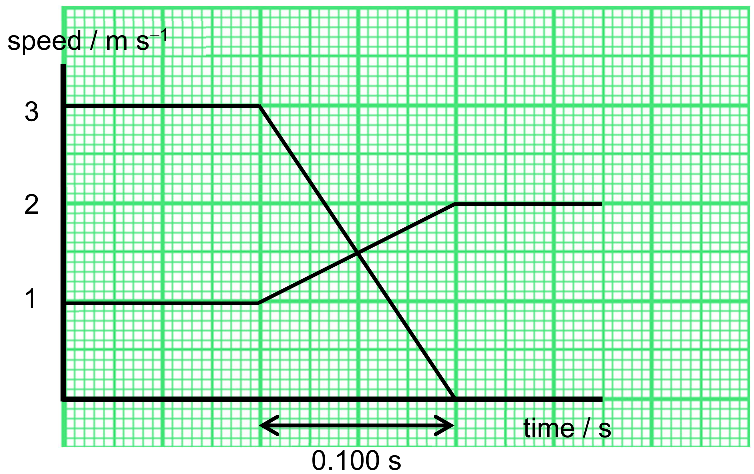


Fig 1.2

Question

(a) Determine the magnitude and direction of the impulse exerted by the lighter truck on the heavier truck during the collision.

magnitude of impulse = ………………………… kg m s^{-1}

direction of impulse = ………………………… kg m s^{-1} [2]

(b) Use the information from Fig.1.2 to determine whether the collision is elastic.

[2]

(c) The total kinetic energy at the instant halfway through the collision is **lower** than the total kinetic energy of the trucks after the collision. Suggest a reason for this difference.

[1]

5 A hydrogen nucleus moves towards a tritium nucleus as illustrate in Fig. 2.1.

Fig. 2.1

The nuclei initially have the same speed u. The tritium nucleus consists of two neutrons and a proton. The proton and the neutron have the same mass m.

Fig. 2.2 is a sketch of the velocity-time graph for one of the two nuclei. The interaction between the nuclei is elastic.

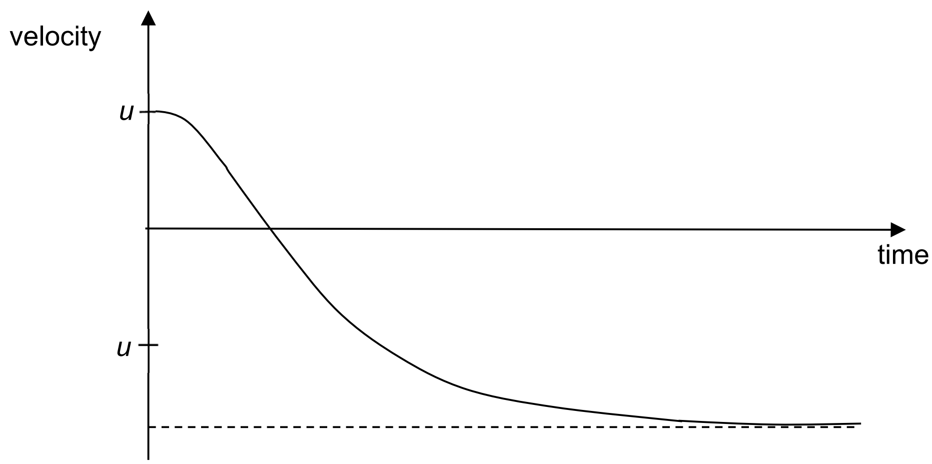


Fig. 2.2

(a) At one instant during the interaction between the nuclei, they are both travelling **in the same direction** with the same speed. Calculate this speed v_c in terms of u.

v_c = ... [2]

(b) Determine the final speed of each nucleus in terms of u.

final speed of hydrogen nucleus = ...

final speed of tritium nucleus = ... [4]

(c) On Fig. 2.2, sketch the velocity-time curve for the other nucleus. Label on the graph

1. speed v_c,
2. time T at which they are at their distance of closest approach. Label it T.

[3]