4.1 Momentum & Impudence

MCQ

Easy

1 mark

Which row of the table identifies what happens to momentum and kinetic energy in an elastic collision?

	Momentum	Kinetic energy
☐ A	conserved	conserved
☐ B	conserved	not conserved
☐ C	not conserved	conserved
☐ D	not conserved	not conserved

Medium

1

1 mark

A particle of mass m has kinetic energy E_k and momentum p. A second particle of mass $2m$ has kinetic energy $2E_k$. Both particles are non-relativistic.

Which of the following is equal to the momentum of the second particle?

A. $\sqrt{2}p$

B. p

C. $2p$

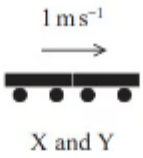
D. $4p$

2

1 mark

The diagram shows the momentum of two trolleys, X and Y, before a collision. The mass of each trolley is 0.25 kg.

The two trolleys join together after the collision and move on with a velocity of 1 m s^{-1}.



Which row of the table is correct for this collision?

	Momentum	Elastic or inelastic collision
A	conserved	elastic
B	conserved	inelastic
C	not conserved	elastic
D	not conserved	inelastic

3

1 mark

A sphere travelling at speed v collides elastically with an identical sphere which is at rest.

After the collision, both spheres move off at an angle θ to the direction of travel of the first sphere, as shown. The spheres have the same speed as each other.

What is the speed of the spheres after the collision?

A. v

B. $\frac{v}{\sqrt{2}}$

C. $\frac{v}{2}$

D. $\frac{v}{4}$

Structured Questions

1a

2 marks

Some asteroids pass very close to the Earth. Scientists are planning methods to deflect asteroids, to prevent them from hitting the Earth.

One method would involve colliding a spacecraft into the surface of the asteroid, to change the path and speed of the asteroid. The spacecraft would remain joined to the asteroid after the collision.

This collision method is modelled for a spacecraft travelling in a direction at 90° to the path of the asteroid.

Sketch a labelled vector diagram to show the momenta of the bodies before and after the collision.

1b

2 marks

Show that the momentum of the spacecraft is about 10^7 N s.

mass of spacecraft = 920 kg
speed of spacecraft = 12 000 m s^{-1}

1c

2 marks

Show that this collision method causes the asteroid to change its direction through an angle of about 10^{-7} radian.

momentum of asteroid = 7.6×10^{13} N s

1d

2 marks

After the collision, the asteroid and spacecraft remain joined and move together.

Calculate the component of their velocity at 90° to the original path of the asteroid after the collision.

mass of asteroid = 2.8×10^9 kg

Component of velocity = ...

1e

2 marks

Another method would involve attaching a rocket motor to the asteroid and using the motor to apply a force to the asteroid. In this method the force is applied at 90° to the path of the asteroid.

Deduce whether this would produce a change in momentum as great as the change produced by the collision method.

force exerted by rocket motor = 5.1×10^6 N

time for which rocket motor applies force = 6 minutes