Impulse and Momentum 2 - Questions by Topic

Q1.

A particle *Z* has kinetic energy *E* and momentum *p*. A second particle *X* has twice the mass and half the momentum of particle *Z*.

The kinetic energy of X is

☐ **A** $2E$

☐ **B** $\frac{E}{4}$

☐ **C** $\frac{E}{8}$

☐ **D** $\frac{E}{16}$

(Total for question = 1 mark)

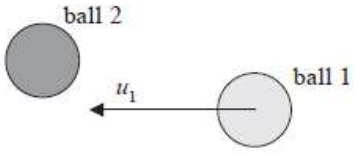
Q2.

A student read the following extract from a textbook.

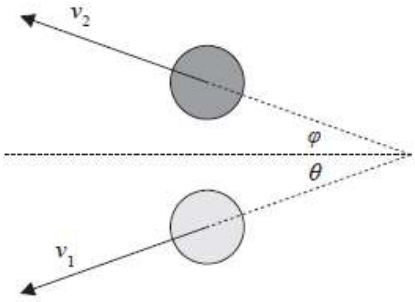
'In an elastic collision between objects of equal mass, where one is initially stationary, the objects move off at 90° to each other after the collision.'

The student investigated this using a collision between two identical steel balls, each of mass 66 g.

(a) The diagrams illustrate the collision between the balls.



Before collision



After collision

In one experiment u_1 was 0.72 m s^{-1} and θ was 29°. For such a collision it can be shown that, if the balls are to separate at 90°, then

v^1 = 0.63 m s^{-1}
φ = 61°
v_2 = 0.35 m s^{-1}

(i) Show that these values satisfy the conditions for conservation of momentum in the initial direction of ball 1.

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(ii) Show that these values satisfy the condition for elastic collisions.

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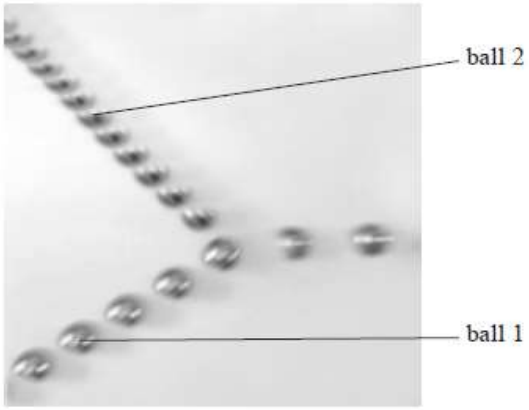
(b) The photograph shows the student's actual results for this experiment. The positions of the colliding balls at successive time intervals have been overlaid on a single image.



(i) State the additional information that the student needs in order to determine the speeds of the balls.

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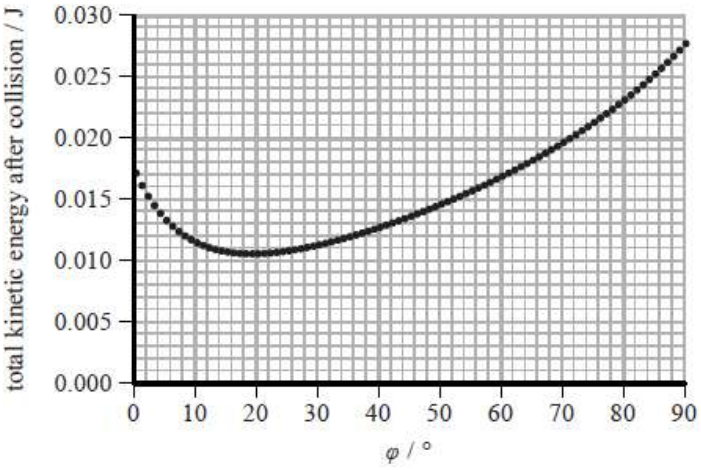
(ii) The student looked at the photograph and noticed that the angle between the paths of the two balls after the collision was not 90°. He modelled the collision on a computer.
He used the same initial conditions for ball 1 and the same value of θ. The computer calculated the total kinetic energy after the collision for a range of angles φ. The following graph was produced.



Measure φ from the photograph and use the graph to suggest why the angle between the paths is not 90°.

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(Total for question = 12 marks)

Q3.

An electron has a momentum of 1.9×10^{-24} kg m s^{-1}.
The kinetic energy of the electron is

- ☒ **A** 1.1×10^{-21} J
- ☒ **B** 2.0×10^{-18} J
- ☒ **C** 4.0×10^{-18} J
- ☒ **D** 1.0×10^{6} J

(Total for question = 1 mark)

Q4.

(a) State the principle of conservation of momentum.

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(b) State the relationship between the resultant force acting on an object and the momentum of the object.

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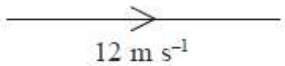
(c) A car is travelling due east with a velocity of 12 m s^{-1}. The driver of the car changes direction to travel due north with a velocity of 15 m s^{-1}.

(i) The initial velocity is shown in the diagram.
Complete the vector diagram to represent the change in velocity. You do not need to draw it exactly to scale.

(2)



(ii) Determine the change in velocity of the car.

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Magnitude of change of velocity = ...

Direction of change of velocity = ...

(iii) The mass of the car is 1500 kg and the change in velocity took 4.0 s.

Calculate the average force that was needed.

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Force = ...

(Total for question = 10 marks)

Q5.

A toy car rolls down a slope. A graph is plotted of momentum against time. Which of the following is represented by the gradient of the graph?

(1)

☐ **A** acceleration

☐ **B** kinetic energy

☐ **C** resultant force

☐ **D** speed

(Total for question = 1 mark)

Q6.

The wavelength associated with a moving particle, known as the de Broglie wavelength, depends on the momentum of the particle.

(a) Show that momentum and kinetic energy are related by the equation $E_k = p^2/2m$

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(b) Hence determine the de Broglie wavelength for a proton with kinetic energy 18.8 keV.

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de Broglie wavelength =.....

(Total for question = 6 marks)