A-Level Edexcel

PHYSICS

UNIT 4(IAL)

2015 — 2019

1 - (PHY-W 2017-Unit 4(IAL)-Q12) - *Behaviour of Waves*

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 $E_k = p^2/2m$

(2)

....

....

....

....

....

....

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

(4)

....

....

....

....

....

....

....

....

de Broglie wavelength = ...

2 - (PHY-S 2016-Unit 4(IAL)-Q8) - *Further Momentum*

A proton accelerates in an electric field and gains kinetic energy, giving it a change in momentum Δp. An alpha particle accelerates in the same electric field and gains the same kinetic energy.

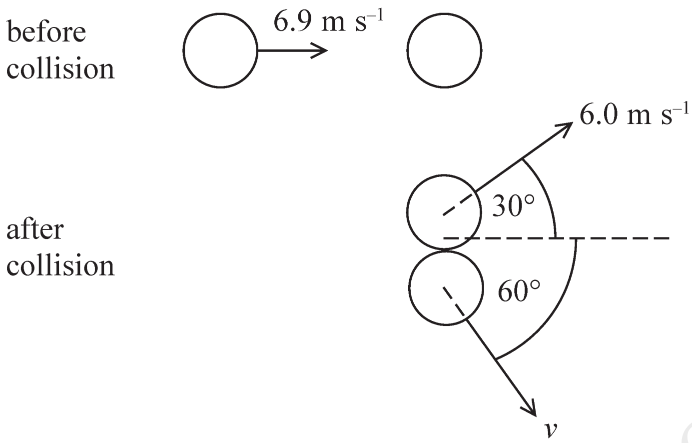
The magnitude of the change in momentum of the alpha particle is given by

- ☒ **A** $\sqrt{2}\,\Delta p$
- ☒ **B** $2\Delta p$
- ☒ **C** $\sqrt{8}\,\Delta p$
- ☒ **D** $4\Delta p$

3 - (PHY-S 2016-Unit 4(IAL)-Q13) - *Further Momentum*

In the game of air hockey, small identical discs move across a frictionless surface.

One disc moving with a velocity of 6.9 m s^{-1} collides with a stationary disc. After the collision the discs move apart as shown in the diagram.



(a) Calculate the velocity *v*.

(3)

....

....

....

....

....

....

....

v = ...

(b) Explain whether the collision is elastic or inelastic.

(2)

....

....

....

....

4 - (PHY-S 2016-Unit 4(IAL)-Q18) **-** *Further Momentum, Electric Fields*

In a large-angle alpha particle scattering experiment, alpha particles were directed at thin gold foil and their paths observed. Most of the alpha particles passed straight through the foil or were deflected through a small angle. A very small number were deflected through an angle greater than 90°.

(a) State what can be deduced about the atom given that most alpha particles passed straight through the foil.

(1)

....

....

(b) The point below represents a gold nucleus.

Add lines to show the electric field due to the gold nucleus.

(2)

(c) An alpha particle that is moving directly towards a gold nucleus is deflected back along its original path. The minimum separation between the alpha particle and the gold nucleus is 3.8×10^{-14} m.

atomic number of gold = 79

(i) Calculate the electrostatic force on the alpha particle when it is at the minimum separation from the gold nucleus.

(2)

....

....

....

....

Force on alpha particle = ...

(ii) The initial kinetic energy of the alpha particle is 6.0 MeV.

Calculate the change in momentum of the alpha particle, in N s, as it travels to its minimum separation from the gold nucleus.

(3)

Change in momentum = ... N s

5 - (PHY-S 2017-Unit 4(IAL)-Q3) - *Further Momentum*

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?

☒ **A** acceleration

☒ **B** kinetic energy

☒ **C** resultant force

☒ **D** speed

6 - (PHY-S 2017-Unit 4(IAL)-Q10) - *Further Momentum*

A non-relativistic particle of mass m has momentum p and kinetic energy E_k.

Another non-relativistic particle of mass $2m$ has momentum $\frac{p}{2}$.

What is the kinetic energy of the second particle?

☒ **A** $\frac{E_k}{8}$

☒ **B** $\frac{E_k}{2}$

☒ **C** E_k

☒ **D** $2\,E_k$

7 - (PHY-S 2017-Unit 4(IAL)-Q12) - *Further Momentum*

It is thought that an asteroid on a collision course with Earth could be deflected by making a fast moving spacecraft collide with it when it is still very far away.

To test this idea, there are plans to send a spacecraft, DART, to collide with a small asteroid. After the collision, DART and the asteroid will stick together.

DART will have a relative speed of 6250 m s^{-1} when it collides with the asteroid. This is expected to cause a change in the asteroid's velocity of 0.40 mm s^{-1}.

(a) Show that the mass of the asteroid is about 5×10^9 kg.

mass of DART = 300 kg

(3)

....

....

....

....

....

....

....

(b) Suppose that DART will collide at 90° to the direction of the asteroid's velocity. The asteroid is orbiting at a speed of 0.16 m s^{-1} about a larger partner.

Calculate the angle through which the velocity of the asteroid is deflected.

(2)

....

....

....

....

Angle = ...

8 - (PHY-S 2017-Unit 4(IAL)-Q16) - *Further Momentum*

According to Einstein's theory of relativity, the total energy E of a particle with rest mass m and momentum p is given by the equation

$$E^2 = m^2c^4 + p^2c^2$$

where c is the speed of light in a vacuum.

(a) Show that the base units on both sides of the equation are the same.

(3)

(b) Simplify the equation for particles with zero velocity.

(2)

(c) For particles with relativistic velocities, m^2c^4 is negligible compared to E^2 so the equation simplifies to

$$E = pc$$

Show that this is correct and that the simplification is justified for an electron of energy 45 GeV.

(4)

9 - (PHY-W 2017-Unit 4(IAL)-Q9) - *Further Momentum*

A ball of mass m with velocity v strikes a wall perpendicularly and bounces off with the same speed in the opposite direction. The collision takes time t.

Which of the following is the mean force acting on the ball during the collision?

- **A** mv/t
- **B** $2mv/t$
- **C** $-mv/t$
- **D** $-2mv/t$