1 9 An alpha particle is moving towards a stationary gold nucleus. The alpha particle has a kinetic energy of 9.0×10^{-13} J when it is a large distance from the gold nucleus.
The gold nucleus contains 79 protons.

What is the closest possible distance of approach of the alpha particle to the gold nucleus?

[1 mark]

A 2.5×10^{-16} m ⬭

B 2.0×10^{-14} m ⬭

C 4.0×10^{-14} m ⬭

D 2.0×10^{-7} m ⬭

2 0 A wire is at right angles to a uniform magnetic field and carries an electric current.
The wire is 150 mm in length.

When the current in the wire is increased by 4.0 A, the force acting on the wire increases by 3.6×10^{-3} N.

What is the magnetic flux density of the field?

[1 mark]

A 6.0×10^{-6} T ⬭

B 6.0×10^{-3} T ⬭

C 1.7×10^{2} T ⬭

D 1.7×10^{5} T ⬭

Turn over for the next question

2 1 A beam consists of ionised atoms of two isotopes of an element.
When the beam enters a uniform magnetic field, the ions move in circular paths.
The ions have the same charge and travel at the same speed when they enter the magnetic field.

Which statement is true?

[1 mark]

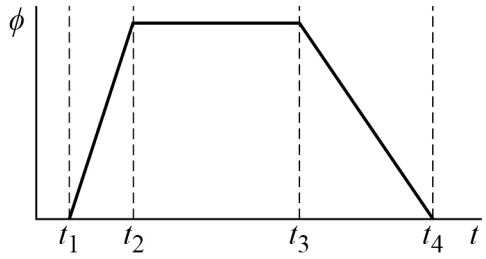
A The force acting on an ion is different for each isotope. ⬭

B The radius of the path followed by an ion is different for each isotope. ⬭

C The kinetic energy of an ion increases for both isotopes. ⬭

D The acceleration of an ion is the same for both isotopes. ⬭

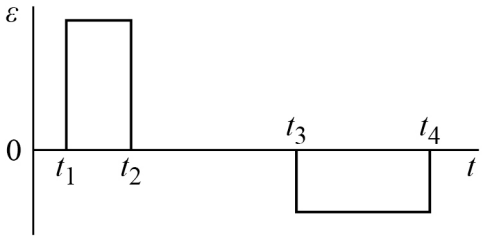
2 2 The magnetic flux ϕ in a coil varies with time t as shown.



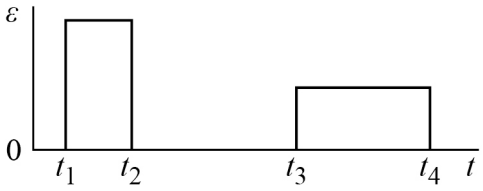
Which graph shows how the emf ε induced in the coil varies with t?

[1 mark]

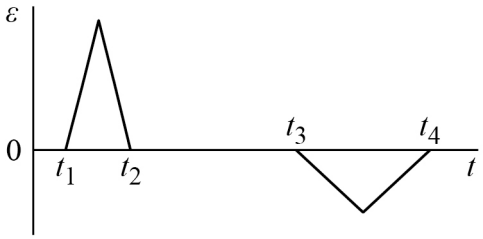
A



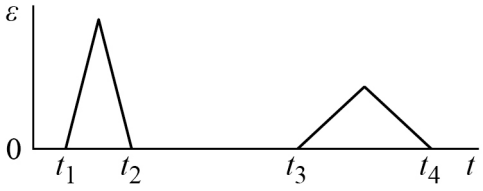
B



C



D



2 3 The distance between the wing tips of a metal aircraft is $30\ \text{m}$.
The aircraft flies horizontally at a steady speed of $100\ \text{m s}^{-1}$.
The aircraft passes through a vertical magnetic field of flux density $2.0 \times 10^{-7}\ \text{T}$.

What is the emf induced between its wing tips?

[1 mark]

A $0.2\ \mu\text{V}$ ⬭

B $20\ \mu\text{V}$ ⬭

C $300\ \mu\text{V}$ ⬭

D $600\ \mu\text{V}$ ⬭

2 4 A circular coil with a radius of $0.10\ \text{m}$ has 200 turns.
The coil rotates at 50 revolutions per second about an axis which is perpendicular to a uniform magnetic field and in the plane of the coil.
The magnetic flux density of the field is $0.20\ \text{T}$.

What is the maximum emf induced in the coil?

[1 mark]

A $63\ \text{V}$ ⬭

B $126\ \text{V}$ ⬭

C $195\ \text{V}$ ⬭

D $395\ \text{V}$ ⬭

2 5 After radioactive waste is removed from a cooling pond, it is often stored in underground caves.
This is to protect workers from the effects of

A alpha particles from nuclides with a large decay constant. ⬭

B alpha particles from nuclides with a small decay constant. ⬭

C gamma radiation from nuclides with a large decay constant. ⬭

D gamma radiation from nuclides with a small decay constant. ⬭

2 6 Alpha particle scattering can be demonstrated using a thin gold foil.

Which statement about this demonstration is **not** true?

[1 mark]

A The foil is thin enough to assume that alpha particles are deflected only once. ⬭

B Nuclei are more massive than alpha particles which allows the alpha particles to be deflected by more than $90°$. ⬭

C The number of alpha particles deflected backwards is greater than the number that pass straight through the foil. ⬭

D Deflections of alpha particles by electrons in the foil are much smaller than deflections due to nuclei. ⬭

2 7 A transformer for use in a $230\ \text{V}$ ac supply is 90% efficient.
The transformer provides a current of $3.00\ \text{A}$ at $12.0\ \text{V}$.

What is the current in the primary coil?

[1 mark]

A $0.141\ \text{A}$ ⬭

B $0.156\ \text{A}$ ⬭

C $0.174\ \text{A}$ ⬭

D $5.75\ \text{A}$ ⬭

2 8 The random nature of radioactive decay means that it is never possible to predict

[1 mark]

A when a particular nucleus will decay. ⬭

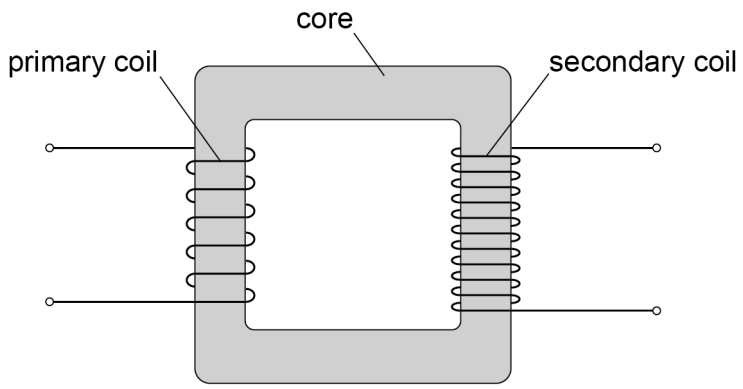
B whether a β^- particle or a β^+ particle is emitted. ⬭

C the approximate time taken for the activity to decrease to a specified value. ⬭

D the approximate thickness of an absorber needed to reduce the count rate to a specified value. ⬭

0 5 **Figure 7** shows a transformer.

Figure 7



0 5 . 1 Explain the functions of the core and the secondary coil.

[3 marks]

core _____

_____

_____

_____

secondary coil _____

_____

_____

_____

_____

_____

0 5 . 2 **Figure 8** shows a cross-section through the transformer core. Thin iron sheets are separated by material **M**.

Explain how the efficiency of the transformer is increased by constructing the core in this way.

[3 marks]

Figure 8

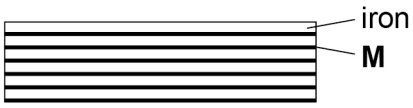
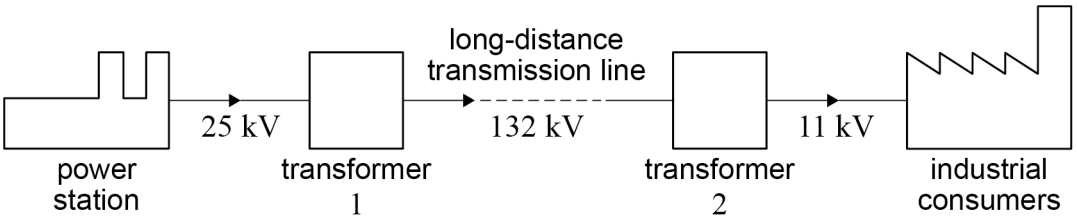


Figure 9 shows a schematic diagram of a power transmission system.

Figure 9



0 5 . 3 Voltages between 33 kV and 400 kV are used for long-distance transmission.

Suggest why engineers have chosen 132 kV for this system.

[2 marks]

Question 5 continues on the next page

0 5 . 4 The industrial consumers use $72\ \text{MW}$ of power.
Transformers 1 and 2 each have an efficiency of 98% and the transmission line has an efficiency of 94%.

Calculate the current in the $25\ \text{kV}$ line from the power station.

[3 marks]

current = _____ A

11

1 4 When an electron moves at a speed v perpendicular to a uniform magnetic field of flux density B, the radius of its path is R.

A second electron moves at a speed $\frac{v}{2}$ perpendicular to a uniform magnetic field of flux density $4B$.

What is the radius of the path of the second electron?

[1 mark]

A $\frac{R}{8}$ ⬭

B $\frac{R}{4}$ ⬭

C $2R$ ⬭

D $8R$ ⬭

1 5 A particle of mass m and charge Q is accelerated from rest through a potential difference V. The final velocity of the particle is u.

A second particle of mass $\frac{m}{2}$ and charge $2Q$ is accelerated from rest through a potential difference $2V$.

What is the final velocity of the second particle?

[1 mark]

A $\sqrt{2}u$ ⬭

B $2\sqrt{2}u$ ⬭

C $4u$ ⬭

D $8u$ ⬭

2 0 A parallel plate capacitor is connected across a battery and the energy stored in the capacitor is E.
Without disconnecting the battery, the separation of the plates is halved.

What is the energy now stored in the capacitor?

[1 mark]

A $0.5E$ ⬭

B E ⬭

C $2E$ ⬭

D $4E$ ⬭

2 1 A fully charged capacitor of capacitance $2.0\ \text{mF}$ discharges through a $15\ \text{k}\Omega$ resistor.

What fraction of the stored energy remains after 1.0 minute?

[1 mark]

A $\frac{1}{4}$ ⬭

B $\frac{1}{e^2}$ ⬭

C $\frac{1}{16}$ ⬭

D $\frac{1}{e^4}$ ⬭

2 2 A horizontal wire of length $0.25\ \text{m}$ carrying a current of $3.0\ \text{A}$ is perpendicular to a magnetic field. The mass of the wire is $3.0 \times 10^{-3}\ \text{kg}$ and the weight of the wire is supported in equilibrium by the magnetic field.

What is the flux density of the magnetic field?

[1 mark]

A $2.6\ \text{T}$ ⬭

B $3.9 \times 10^{-2}\ \text{T}$ ⬭

C $2.2 \times 10^{-2}\ \text{T}$ ⬭

D $4.0 \times 10^{-3}\ \text{T}$ ⬭

2 3 A coil is rotated at frequency f in a uniform magnetic field.
The magnetic flux linking the coil is a maximum at time t_1 and the emf induced in the coil is a maximum at time t_2.

What is the smallest value of $t_1 - t_2$?

[1 mark]

A 0 ⬭

B $\frac{1}{4f}$ ⬭

C $\frac{1}{2f}$ ⬭

D $\frac{3}{4f}$ ⬭

2 4 Power P is dissipated in a resistor of resistance R carrying a direct current I.

A second resistor of resistance $2R$ carries an alternating current with peak value I.

What is the power dissipated in the second resistor?

[1 mark]

A $\sqrt{2}P$ ⬭

B P ⬭

C $2P$ ⬭

D $4P$ ⬭

2 5 What was deduced or observed in the Rutherford scattering experiment?

[1 mark]

A All gold atoms are not alike. ⬭

B Alpha particles are helium nuclei. ⬭

C Some particles were deflected through angles greater than $90°$. ⬭

D The motion of most alpha particles was reversed. ⬭