Name:

Date:

MAGNETIC FIELDS
TEST 3

A2-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

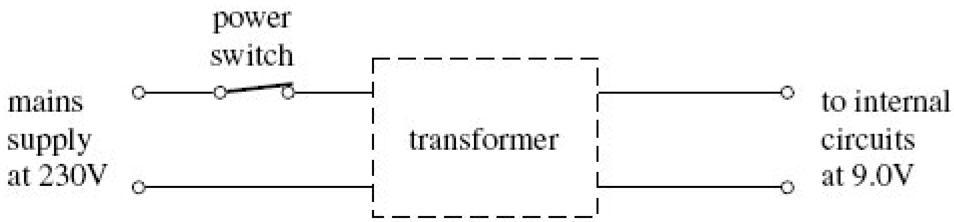
1 (a) (i) Outline the essential features of a step-down transformer when in operation.

(2)

(ii) Describe **two** causes of the energy losses in a transformer and discuss how these energy losses may be reduced by suitable design and choice of materials.
The quality of your written communication will be assessed in this question.

(6)

(b) Electronic equipment, such as a TV set, may usually be left in 'standby' mode so that it is available for instant use when needed. Equipment left in standby mode continues to consume a small amount of power. The internal circuits operate at low voltage, supplied from a transformer. The transformer is disconnected from the mains supply only when the power switch on the equipment is turned off. This arrangement is outlined in the diagram below.



When in standby mode, the transformer supplies an output current of 300 mA at 9.0V to the internal circuits of the TV set.

(i) Calculate the power wasted in the internal circuits when the TV set is left in standby mode.

answer = ____________________ W

(1)

(ii) If the efficiency of the transformer is 0.90, show that the current supplied by the 230 V mains supply under these conditions is 13 mA.

(2)

(iii) The TV set is left in standby mode for 80% of the time. Calculate the amount of energy, in J, that is wasted in one year through the use of the standby mode.

1 year = 3.15×10^7 s

answer = ____________________ J

(1)

(iv) Show that the cost of this wasted energy will be about £4, if electrical energy is charged at 20 p per kWh.

(2)

(c) The power consumption of an inactive desktop computer is typically double that of a TV set in standby mode. This waste of energy may be avoided by switching off the computer every time it is not in use. Discuss **one** advantage and **one** disadvantage of doing this.

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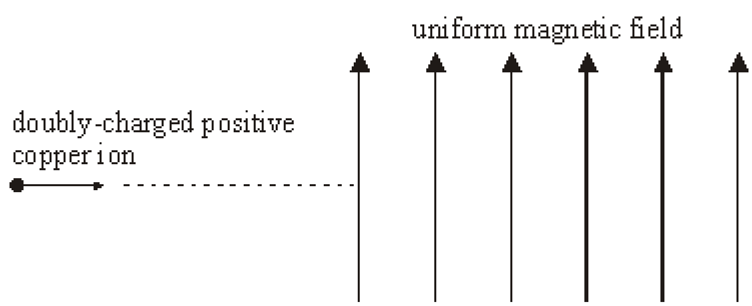
(2)

(Total 16 marks)

2 (a)



The diagram above shows a doubly-charged positive ion of the copper isotope $^{63}_{29}\text{Cu}$ that is projected into a vertical magnetic field of flux density 0.28 T, with the field directed upwards. The ion enters the field at a speed of 7.8×10^5 m s^{-1}.

(i) State the initial direction of the magnetic force that acts on the ion.

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(ii) Describe the subsequent path of the ion as fully as you can.
Your answer should include both a qualitative description and a calculation.

mass of $^{63}_{29}Cu$ ion = 1.05×10^{-25} kg

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(5)

(b) State the effect on the path in part (a) if the following changes are made separately.

(i) The strength of the magnetic field is doubled.

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(ii) A singly-charged positive $^{63}_{29}Cu$ ion replaces the original one.

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(3)

(Total 8 marks)

3 (a) Complete the table of quantities related to fields. In the second column, write an SI unit for each quantity. In the third column indicate whether the quantity is a scalar or a vector.

quantity	SI unit	scalar or vector
gravitational potential		
electric field strength		
magnetic flux density		

(3)

(b) (i) A charged particle is held in equilibrium by the force resulting from a vertical electric field. The mass of the particle is 4.3×10^{-9} kg and it carries a charge of magnitude 3.2×10^{-12} C. Calculate the strength of the electric field.

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(ii) If the electric field acts upwards, state the sign of the charge carried by the particle

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(3)

(Total 6 marks)

4 (a) The equation $F = BIl$, where the symbols have their usual meanings, gives the magnetic force that acts on a conductor in a magnetic field.

Given the unit of each of the quantities in the equation.

F ____________________ B ____________________

I ____________________ l ____________________

State the condition under which the equation applies.

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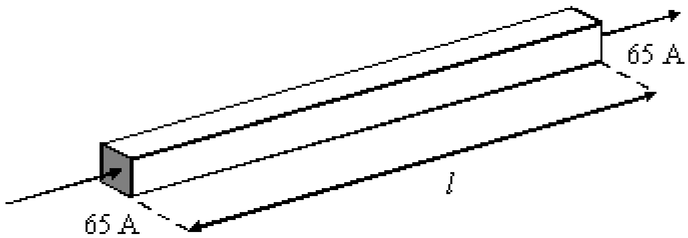
(2)

(b) The diagram shows a horizontal copper bar of 25 mm × 25 mm square cross-section and length l carrying a current of 65 A.



(i) Calculate the minimum value of the flux density of the magnetic field in which it should be placed if its weight is to be supported by the magnetic force that acts upon it.

density of copper = 8.9×10^3 kg m^{-3}

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(ii) Draw an arrow on the diagram above to show the direction in which the magnetic field should be applied if your calculation in part (i) is to be valid. Label this arrow M.

(5)

(Total 7 marks)

5 Protons and pions are produced in a beam from a target in an accelerator. The two types of particles can be separated using a magnetic field.

(a) State the quark composition of

(i) a proton,

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(ii) a positive pion, π^+

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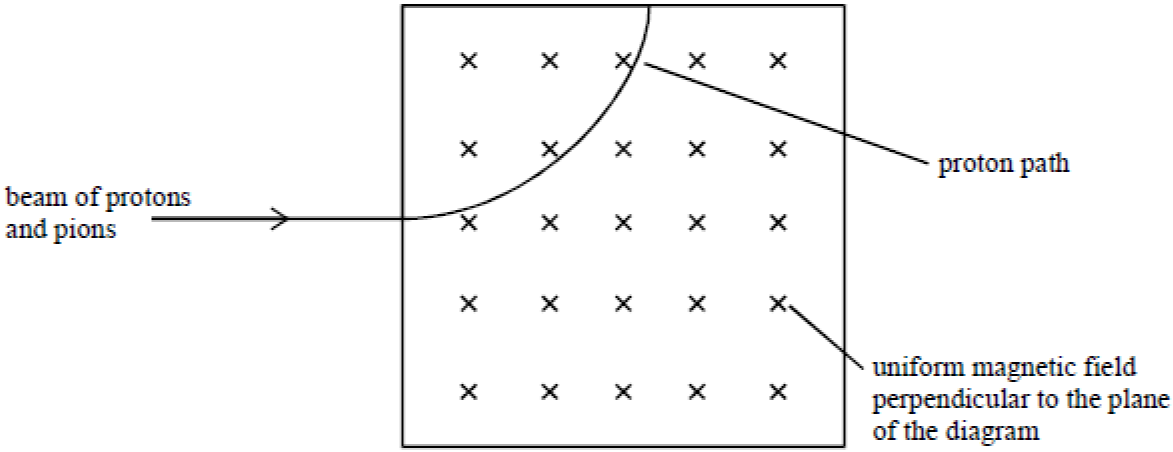
(2)

(b) A narrow beam consisting of protons and positive pions, all travelling at a speed of 1.5×10^7 m s^{-1}, is directed into a uniform magnetic field of flux density 0.16 T, as shown in the diagram.



(i) Calculate the radius of curvature of the path of the protons in the field.

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(ii) Sketch, on the diagram above, the path of the pions from the point of entry into the field to the point of exit from the field.

(iii) If the magnetic field were increased, how would this affect the paths of the particles?

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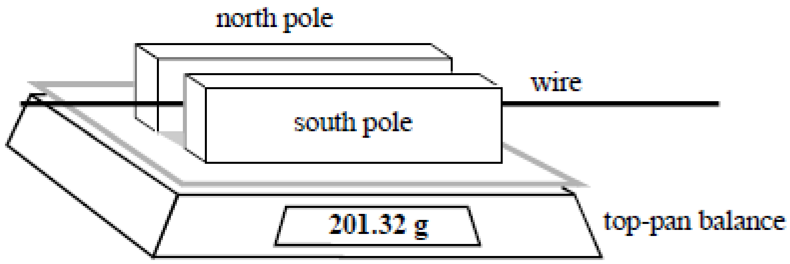
(7)

(Total 9 marks)

6 The diagram shows a magnet placed on a top-pan balance. A fixed horizontal wire, through which a current can flow, passes centrally through the magnetic field parallel to the pole-pieces. With no current flowing, the balance records a mass of 201.32 g. When a current of 5.0 A flows, the reading on the balance is 202.86 g.



(a) (i) Explain why the reading on the balance increased when the current was switched on.

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(ii) State the direction of current flow and explain your answer.

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(iii) If the length of the wire in the magnetic field is 60 mm, estimate the flux density of the magnetic field.

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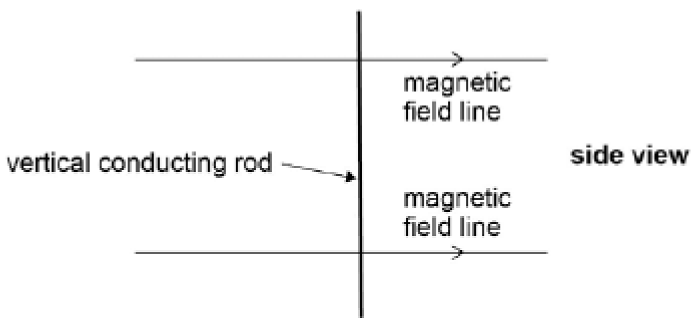
(6)

(b) Sketch a graph to show how you would expect the balance reading to change if the current through the wire was changed.

(2)

(Total 8 marks)

7 A vertical conducting rod of length l is moved at a constant velocity v through a uniform horizontal magnetic field of flux density B.

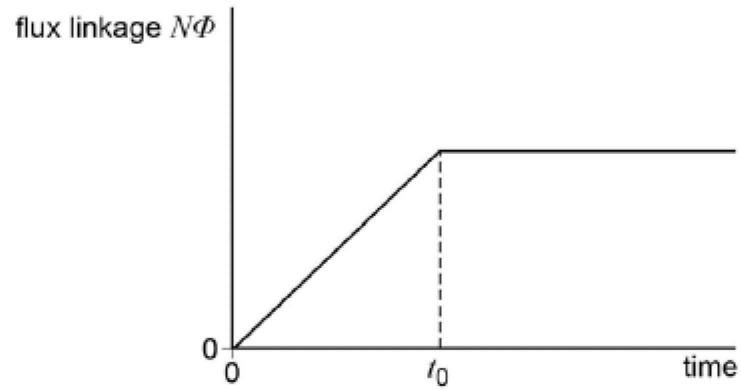


Which of the rows gives a correct expression for the induced emf between the ends of the rod for the stated direction of the motion of the rod?

	Direction of motion	Induced emf	
A	Vertical	$\frac{B}{lv}$	◯
B	Horizontal at right angles to the field	Blv	◯
C	Vertical	Blv	◯
D	Horizontal at right angles to the field	$\frac{B}{lv}$	◯

(Total 1 mark)

8 The graph shows how the flux linkage, $N\Phi$, through a coil changes when the coil is moved into a magnetic field.

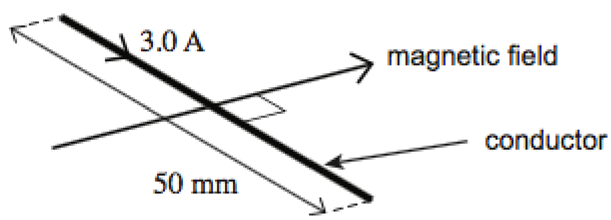


The emf induced in the coil

A	decreases then becomes zero after time t_0.	⬭
B	increases then becomes constant after time t_0.	⬭
C	is constant then becomes zero after time t_0.	⬭
D	is zero then increases after time t_0.	⬭

(Total 1 mark)

9 The diagram shows a horizontal conductor of length 50 mm carrying a current of 3.0 A at right angles to a uniform horizontal magnetic field of flux density 0.50 T.

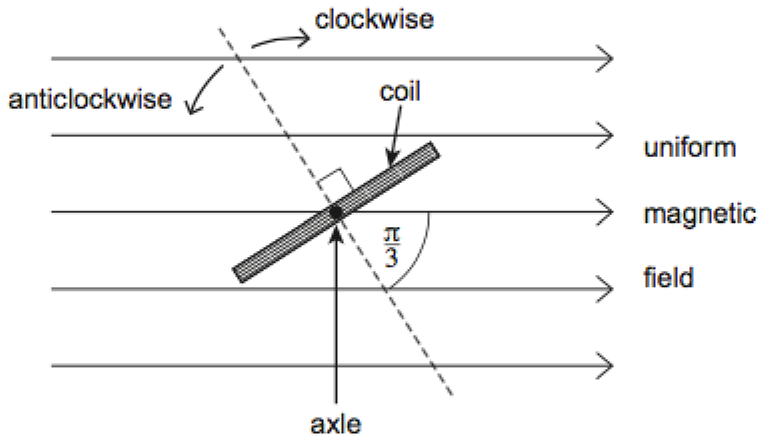


What is the magnitude and direction of the magnetic force on the conductor ?

A 0.075 N vertically upwards
B 0.075 N vertically downwards
C 75 N vertically upwards
D 75 N vertically downwards

(Total 1 mark)

10 The diagram shows a coil placed in a uniform magnetic field. In the position shown, the angle between the normal to the plane of the coil and the magnetic field is $\frac{\pi}{3}$ is rad.



Which line, **A** to **D**, in the table shows the angles through which the coil should be rotated, and the direction of rotation, so that the flux linkage becomes (i) a maximum, and (ii) a minimum?

Angle of rotation / rad		
	(i) for maximum flux linkage	**(ii) for minimum flux linkage**
A	$\frac{\pi}{6}$ clockwise	$\frac{\pi}{3}$ anticlockwise
B	$\frac{\pi}{6}$ anticlockwise	$\frac{\pi}{3}$ clockwise
C	$\frac{\pi}{3}$ clockwise	$\frac{\pi}{6}$ anticlockwise
D	$\frac{\pi}{3}$ anticlockwise	$\frac{\pi}{6}$ clockwise

(Total 1 mark)