Year 12 Physics NAME_____

Test: Electricity and Magnetism

Total marks: 63

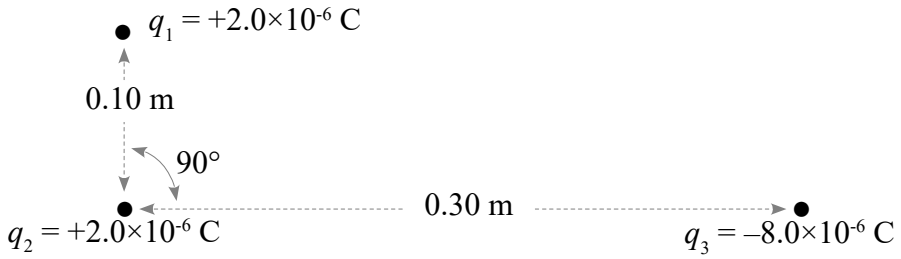
Electric Fields, Motion of Charged Particles in Electric Fields, Magnetic Fields, Motion of Charged Particles in Magnetic Fields, Electromagnetic Induction

1. Two point charges, q_1 and q_2, of equal magnitude and opposite sign, are placed a small distance apart in a vacuum, as shown in the diagram below.

   (a) Sketch the electric field produced by this arrangement of q_1 and q_2.

(3)

   (b) Consider the arrangement of three charges below (diagram not to scale).



Calculate the magnitude of the electric force on q_2 due to q_1 and q_3.

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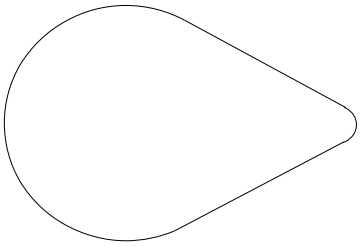
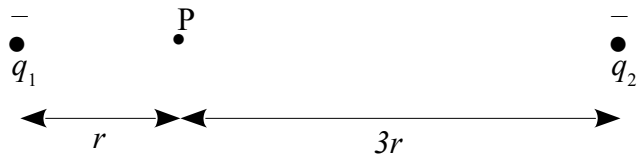
_____ (5)

2. The shaped conductor below is positively charged. Sketch the resulting electric field.



(2)

3. Consider point P between two equally charged negative point charges. Point P is three times the distance from q_2 compared to q_1. The diagram is not to scale.



Using proportionality, calculate the ratio $E_1 : E_2$ of the magnitude of the electric field strengths at point P due to q_1 and q_2.

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_____ (3)

4. Neon ions (Ne^+) are accelerated by a potential difference of 895 V between two oppositely charged plates.

(a) Show that the increase in kinetic energy of one of the neon ions is 1.43×10^{-16} J.

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_____ (2)

(b) Convert 1.43×10^{-16} J into electronvolts.

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_____ (1)

(c) Calculate the magnitude of the electric field between the plates, if they are 15.0 cm apart.

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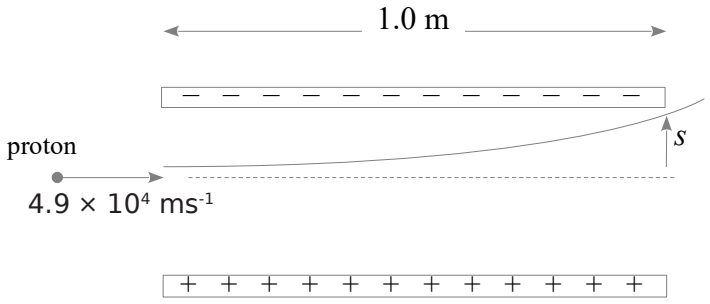
_____ (2)

5. A proton is fired horizontally into a vacuum halfway between two oppositely charged parallel conducting plates at a speed of 4.9×10^4 ms^{-1}, as shown in the diagram below.

The plates are 1.0 m long and between them is a uniform electric field of 1.2 Vm^{-1}.
Ignore end effects and the effect of gravity.



(a) Show that the time of flight of the proton through the uniform electric field is 2.0×10^{-5} s.

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_____ (1)

(b) Calculate the magnitude of the acceleration of the proton between the charged plates.

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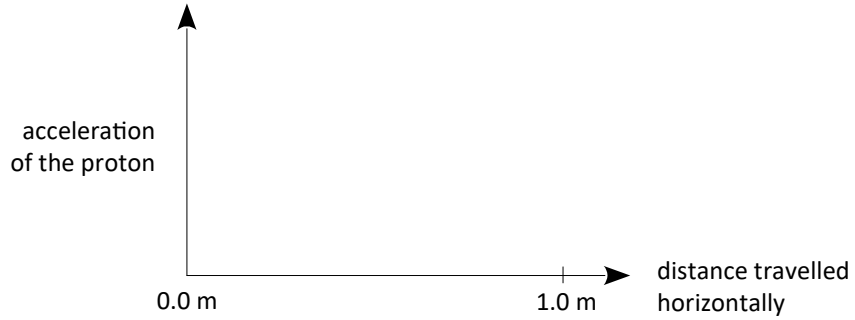
_____ (2)

(c) On the axes below, sketch a graph of the magnitude of the proton's acceleration.



(1)

(d) Calculate the vertical deflection *s* of the proton while it is in the electric field.

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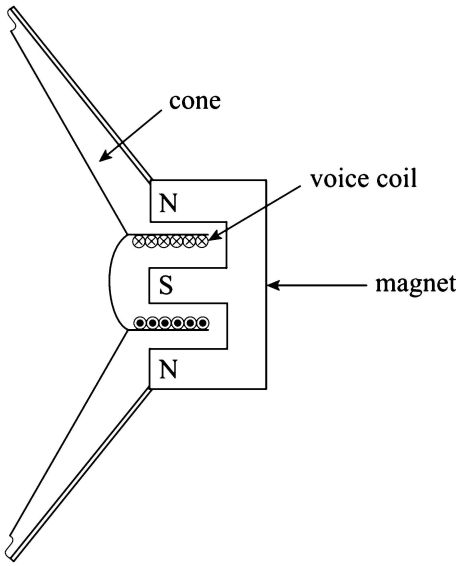
_____ (2)

6. A moving-coil loudspeaker produces sound by providing an oscillating current to a coil running through a magnetic field as shown below:



[This diagram is not drawn to scale.]

(a) In the diagram above, the current in the voice coil is into the page at the top and out of the page at the bottom.
State the direction of the force applied to the voice coil by the magnetic field.

_____ (1)

(b) The length of the wire in the voice coil is 58 m. The wire carries a current of 0.125 A. The wire is within, and perpendicular to, a uniform magnetic field of magnitude 2.4×10^{-4} T. Calculate the magnitude of the force acting on the wire.

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_____ (2)

7.

(a) The diagram below shows a straight conductor, with current directed perpendicularly into the page.
Sketch at least three magnetic field lines produced by the current.

(2)

(b) Calculate the magnitude of the magnetic field strength at a distance of 3.2 cm from the straight conductor, given it is carrying a current of 25 A.

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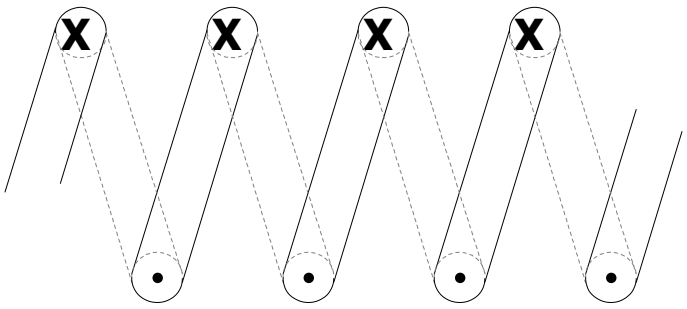
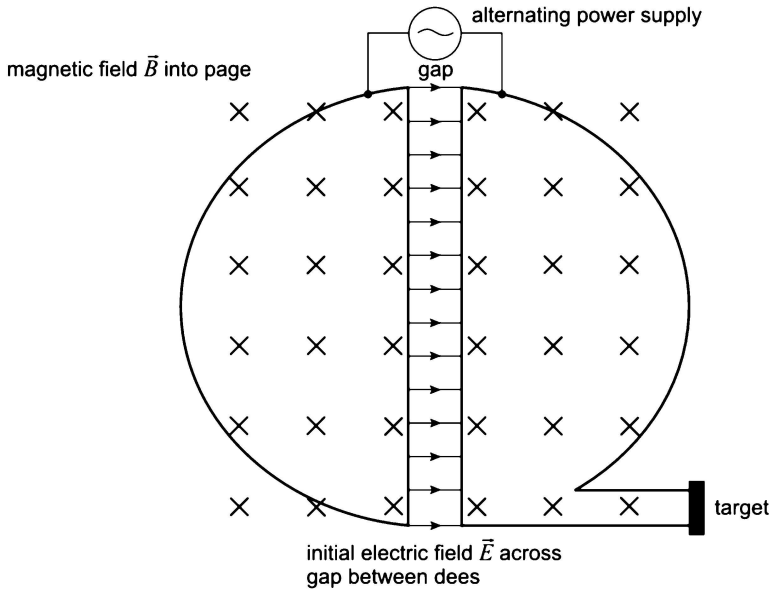
_____ (2)

(c) The diagram below shows a solenoid, with current flowing into the page at the top and out of the page at the bottom.
Sketch at least three magnetic field lines produced by the current.
You are not required to indicate whether the field is behind the current-carrying wire.



(2)

8. A cyclotron can accelerate protons, using a magnetic field to cause the proton to travel in circular motion.



(a) Describe how the dees of a cyclotron increase the speed of a proton.

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_____ (2)

(b) Explain the importance of the relationship between the period of motion and the speed of the protons.

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_____ (3)

(c) State one thing that could be changed for this cyclotron to be used to accelerate electrons instead of protons. Give a reason for your answer.

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_____ (2)

(d) Derive the formula $r = \frac{mv}{qB}$ for the radius of the circular path followed by protons in the cyclotron.

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_____ (3)

(e) The cyclotron has a radius of 1.00 m and accelerates protons to an energy of 10.0 MeV. Calculate the magnetic field strength needed to achieve this energy.

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_____ (3)

(f) A proton accelerated in the cyclotron completes 50 revolutions before emerging from the cyclotron. Calculate the potential difference between its dees.

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_____ (2)

(g) State one use for isotopes produced in cyclotrons.

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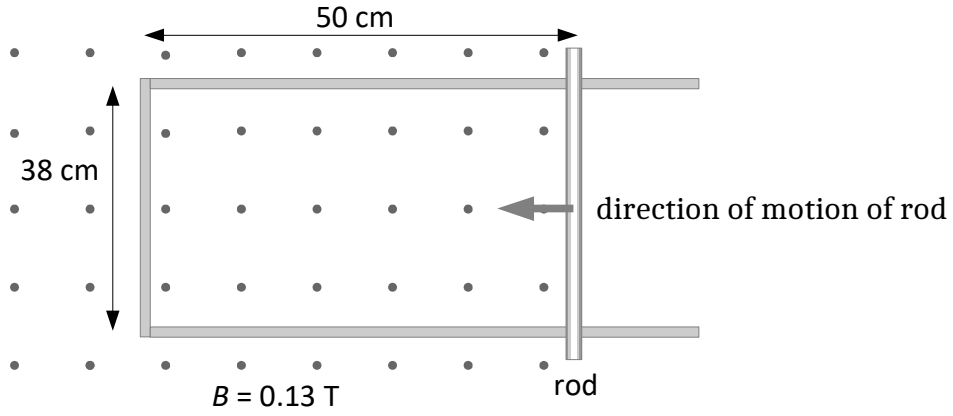
_____ (1)

9. Consider a conducting rod which is able to be freely moved along a pair of conducting rails, creating an enclosed conducting loop. This is placed in a magnetic field, as shown below:



(a) Calculate the magnetic flux passing through the enclosed loop.

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_____ (2)

(b) Calculate the emf induced if the rod is moved 20 cm to the left over 4.5 seconds.

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_____ (3)

10. Electric generators are used in power plants to supply power to consumers such as homes and industries.

(a) Explain how generators can be used to produce electric current.

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_____ (3)

(b) The 20 kV output of a power plant generator is converted by a transformer for transmission over long distances.
Calculate the transmission current if the transformer has 22 turns on the primary coil and 360 turns on the secondary coil, and the transmission power is 582 MW.

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_____ (3)

(c) State whether the transformer in part (b) is a step-up or a step-down transformer.

_____ (1)