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90937

909370

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NZQA

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Level 1 Physics, 2016

90937 Demonstrate understanding of aspects of electricity and magnetism

2.00 p.m. Tuesday 15 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of electricity and magnetism.	Demonstrate in-depth understanding of aspects of electricity and magnetism.	Demonstrate comprehensive understanding of aspects of electricity and magnetism.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L1–PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 23

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QUESTION ONE: STATIC ELECTRICITY WITH THE FUN-FLY-STICK

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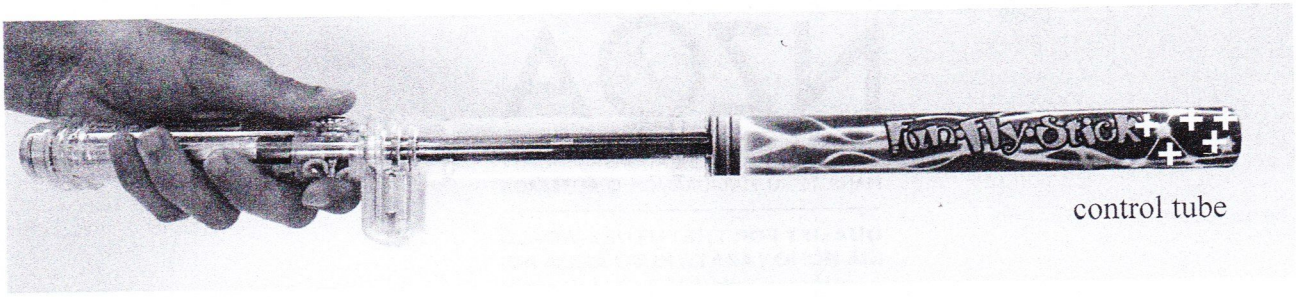
The Fun-Fly-Stick is a hand-held battery-operated toy that is similar to a Van de Graaff generator. It has a rubber belt inside, which when in motion, redistributes charge, which leads to the control tube becoming **positively charged**.

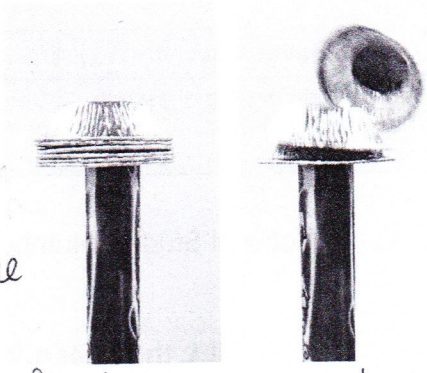


(a) Describe, in terms of movement of charge, the difference between a conductor and an insulator.

Conductors allow the movement of charge through them but insulators do not.

a

(b) Small aluminium cupcake pans are placed on top of the control tube. The control tube is then turned on, and the pans quickly move upward, away from the control tube.



Explain why the aluminium cupcake pans move away once the control tube is turned on.

Aluminium is a conductor so when the cupcake pan touches the positively charged control tube, electrons move off the pan and are redistributed. This causes the pan to become positively charged. This means that the pan and the control tube are both positively charged so the pan repels from the control tube because like charges repel.

m

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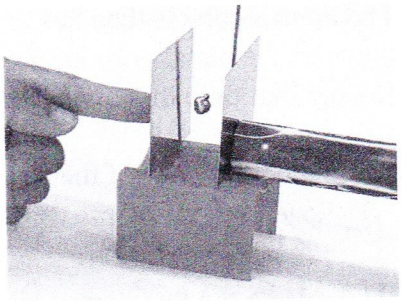
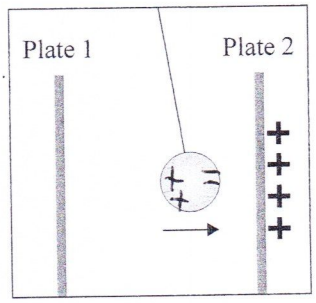
(c) A neutral metal bead is then suspended by a nylon string between two metal plates in a plastic holder. The Fun-Fly-Stick is held to touch the outside of one plate while a student's finger touches the other plate.



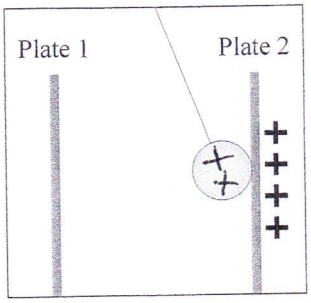
The control tube is turned on, and the metal bead is given an initial push towards the right plate. The metal bead then bounces repeatedly back and forth between both plates.

(i) Complete the following diagrams showing the charge distribution on the metal bead in the following three positions.

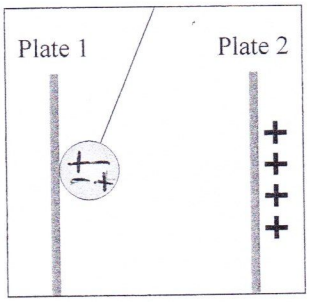
If you need to redraw this, use the diagrams on page 10.



Position One:
Moving towards Plate 2



Position Two:
Touching Plate 2



Position Three:
Touching Plate 1

(ii) Explain why the metal bead bounces back and forth between both plates.

At the start, plate 2 induces a non-uniform charge distribution on the metal bead. This means the electrons are attracted to the plate and move towards it. Because the electrons are nearer, there is a greater force of attraction between the bead and the plate, resulting in the ball moving to touch plate 2. When it touches plate 2, the electrons are stripped from the bead because it is connected to the Fun-Fly stick by a conductor. This means the bead becomes positively charged and repels plate 2 because like charges repel. The bead touches the neutral Plate 1 which earths the bead by electrons in the plate being attracted to the positive bead. The bead is neutral again so the electrons in it are attracted to Plate 2 again and the cycle continues.

e

(d) The control tube is then held close to a metal door handle. A small electrical spark was seen between the metal door handle and the Fun-Fly-Stick. The spark lasted for a time of 0.002 s. During that time the total energy transferred by the spark was 1.5×10^{-5} J.

Calculate the power of the spark, and write your answer in milliwatts.

$P = E/t$ $E = 1.5 \times 10^{-5}$ J $t = 0.002$ s

$P = 1.5 \times 10^{-5} \div 0.002$ $P = 0.0075$ W

$P = 7.5$ mW

Power: 7.5 mW

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m

E8

QUESTION TWO: CIRCUITS WITH A CHILDREN'S TOY

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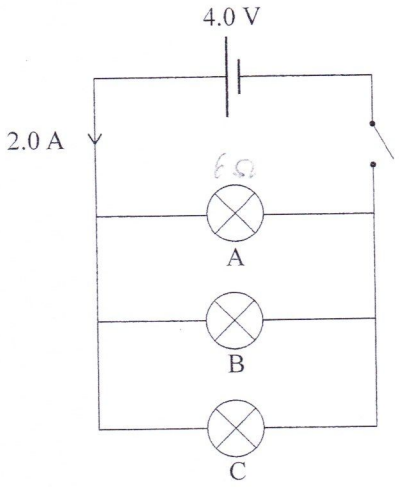
A children's toy contains three bulbs which each have an identical **resistance of 6.0 Ω**. The bulbs are connected to a 4.0 V cell, as shown in the diagram below.



(a) (i) State the name given to this arrangement of bulbs in a circuit.

Parallel

(ii) Give ONE advantage of connecting the bulbs together in this way.

If one bulb blows, the brightness of each other bulb is not affected

a

(b) A **total** current of 2.0 A is drawn from the cell.

(i) Show, by **calculation or reasoning**, that the voltage across bulb B is 4.0 V.

$V = IR$ $I_B = 2 \div 3 = 0.67\,A$ (2dp) $R = 6\Omega$

$V_B = 0.67 \times 6$ $V_B = 4V$

(ii) Calculate the power used by bulb B.

$P = IV$ $V = 4V$ $I = 0.67\,A$ (2dp)

$P = 0.67 \times 4$ $P = 2.67\,W$ (2dp)

m

Power: 2.67 (2dp) W

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(c) The same three bulbs are then re-wired so that the **total resistance of the circuit is 18 Ω.**

(i) Calculate the current in this new circuit.

$V = I R_T$ $I_T = V_T / R_T$ $I_T = 4 \div 18$ $I_T = 0.22\ A$ (2dp)

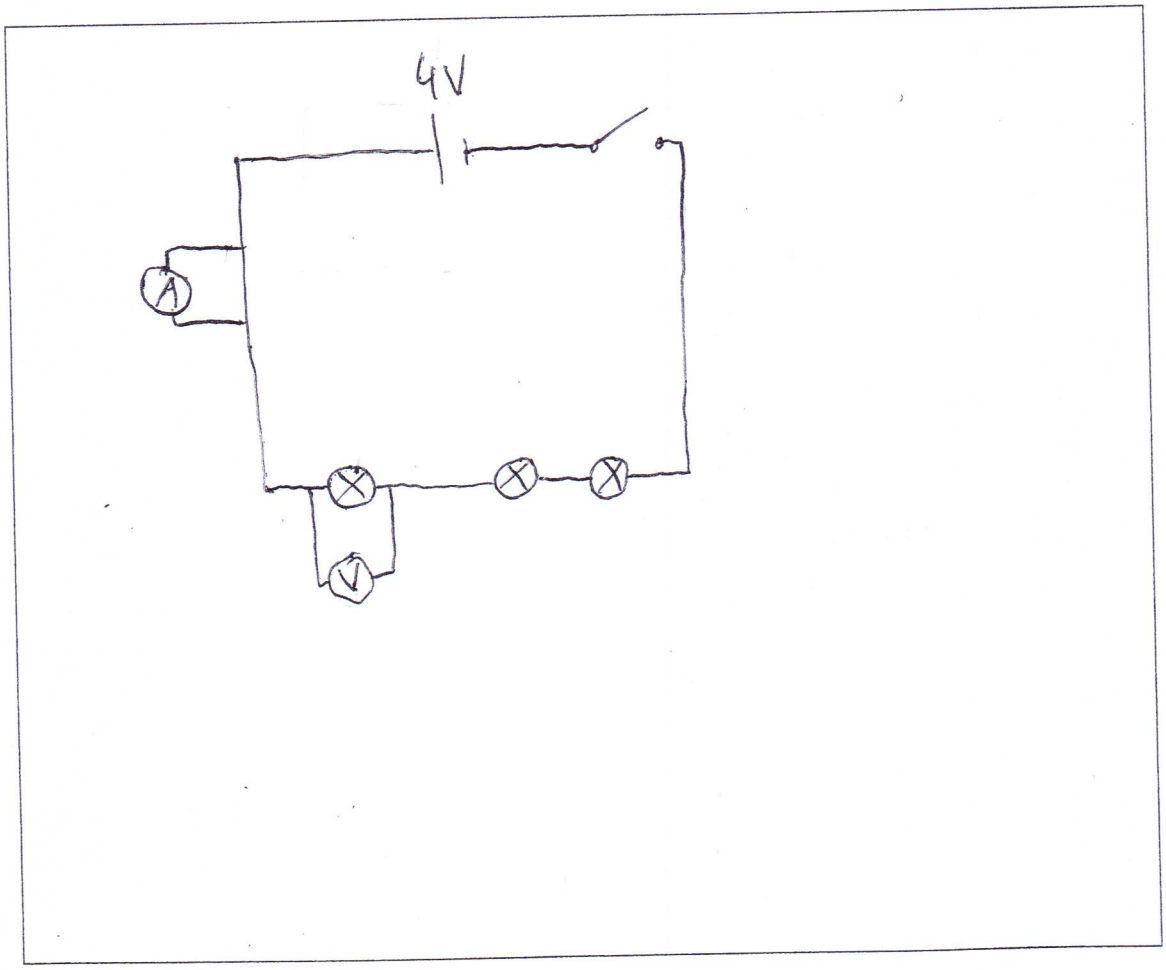
Current: 0.22 A (2dp)

(ii) The new circuit includes:

- three bulbs
- one 4.0 V cell
- a switch
- an Ammeter for measuring the total current
- a Voltmeter for measuring the voltage across ONE bulb.

If you need to redraw this diagram, use the space on page 10.

Draw a diagram of the new circuit in the space below.



a

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(d) Compare the power used by bulb B in this new circuit to the power used by bulb B in the previous circuit in part (b).

In your answer you should:

- calculate the new power used by bulb B
- state which circuit has the greater power used by bulb B
- explain the reasons why the power used has now changed.

$P_B = I_B V_B$ $V_B = 4 \div 3 = 1.3\dot{3}V$

$I_B = 0.2\dot{2}A$

$P_B = 1.3\dot{3} \times 0.2\dot{2}$ $P_B = 0.2962962963$

The new power used by BulbB is 0.30W (2dp)

The first circuit has greater power used by Bulb B which is 2.67W whereas in the new circuit, 0.30W was used by Bulb B.

The power has decreased because the current through Bulb B and the voltage across Bulb B has decreased. The current has decreased from 2.0A to 0.22A because the total resistance has increased from 2Ω to 18Ω. The voltage has decreased because 4V has to be shared etween 3 bulbs in series because it only has one pathway, so it has dropped to 1.33V for BulbB.

e

E7

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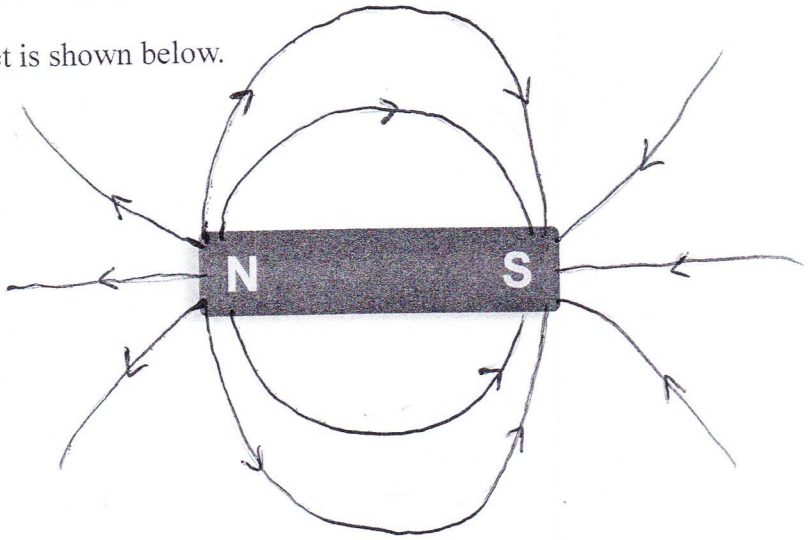
QUESTION THREE: MAGNETIC FIELDS

A simple bar magnet is shown below.



If you need to redraw this, use the diagram on page 11.

(a) On the diagram above, draw field lines to show the shape and direction of the magnetic field around the bar magnet.

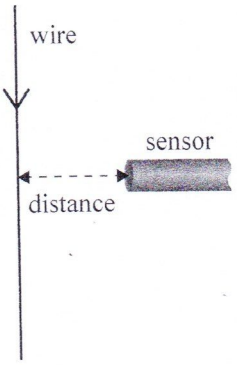
a

(b) Describe how the strength of the magnetic field changes around the bar magnet, and explain how the field lines in the diagram show this.

The strength of the magnetic field weakens the further away from the magnet. Field lines in the diagram show this because the closer together the lines are, the stronger the magnetic field and the further apart the lines are, the weaker the magnetic field

m

(c) A straight wire is connected to a circuit with a voltage supply of 30 V. The total resistance of the circuit is 2.0 Ω. A sensor measures a magnetic field strength of 3.2×10^{-5} T caused by the current through the wire.



Calculate the **distance** between the sensor and the wire.

Give your answer in cm.

$V = IR \quad I = V/R \quad I = 30 \div 2 \quad I = 15A$

$B = \frac{kI}{d} \quad d = \frac{kI}{B} \quad d = \frac{2.0 \times 10^{-7} \times 15}{3.2 \times 10^{-5}}$

$d = 0.09375$ m $\quad d = 9.375$ cm

Distance: 9.375 cm

m

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(d) A wire is wound around an iron nail and connected to a circuit to form an electromagnet. A student brings the electromagnet close to a permanent bar magnet and feels the two objects **repelling** away from each other.

If you need to redraw this, use the diagram on page 11.

(i) Draw the direction of the current through the coil of wire, and explain how you determined this direction.

I used the right hand grip rule. I pointed my thumb in the direction of the north pole of the electromagnet (which would be to the right because like poles repel) to see the direction of the coils current. I found the current was coming down the front side of the electromagnet.

(ii) A small compass is then placed halfway between the electromagnet and the bar magnet. The electromagnet and the bar magnet have the same magnetic field strength.

Explain which direction the compass will point. Give reasons for your answer.

e

The compass would follow the earths magnetic north (south magnetic pole) because the opposing magnetic fields would cancel out resulting in a null point of no magnetic field strength. If the electromagnet were to be stronger than the magnet, the compass would point to the right but if the magnet were stronger, the compass would point to the left.

E8

Annotated Exemplar

Excellence exemplar 2016

Subject:	Physics	Standard:	90937	Total score:	23

Q	Grade score	Annotation
1	E8	This answer was scored E8 because the explanations showed understanding of charging by contact and earthing in terms of electron transfer and the net charge on and object. The explanation could be improved by reference to the relative number of electrons and protons following each electron transfer.
2	E7	The correct use of data, and an understanding of the rules for voltage and current in circuits allowed the calculations to be completed accurately. The change in power is explained giving reasons for the decrease in current and voltage. To obtain a higher score the circuit diagram in part (c)(ii) needed to have the ammeter connected in series.
3	E8	The answer to part (d) showed a clear understanding that the magnetic fields were equal and opposite, and so cancelled out. The answer also recognised the presence of the earth's magnetic field which would still influence the compass.