2

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91173

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Level 2 Physics, 2016

91173 Demonstrate understanding of electricity and electromagnetism

9.30 a.m. Tuesday 15 November 2016
Credits: Six

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

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 L2–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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 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.

Achievement

TOTAL 10

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QUESTION ONE: DC

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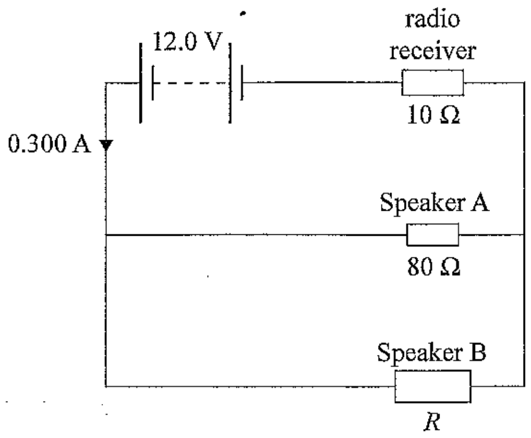
A car radio can be modelled by the use of resistors. One resistor can be used to model the radio receiver. Two different-sized resistors can be used to model two different-sized speakers. The circuit is shown below. The resistance of the radio receiver is 10 Ω, and the resistance of the small speaker is 80 Ω. The current from the car battery is 0.300 A.



(a) Calculate the voltage across the radio receiver.

$V = IR$

$= 0.3 \times 10 = 3$

a

(b) Calculate the current passing through Speaker A.

$I = 12 \div 80 = 0.15$

incorrect voltage used

a

(c) Speaker B uses more power than Speaker A.

Compare the resistance of Speaker B with the resistance of Speaker A.

No calculations are required.

Speaker B uses more power so has bigger resistance

n

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(d) The 12 V car battery can be connected to a car's headlight. One of the bulbs in the car's headlight is rated 12 V, 60 W. A normal household bulb is rated 240 V, 60 W, and is connected to the 240 V household supply.

(i) Carry out calculations to explain which bulb (the car's headlight bulb or a normal household bulb) has more current passing through it.

$I = \frac{60}{12} = 5$ car

house $\frac{60}{240} = 0.25$

(ii) Discuss how the brightness of the car's headlight bulb compares with that of the normal household bulb.

Assume both bulbs are the same type.

The car lights shine brighter than the house lights

needs to link brightness to power

A3

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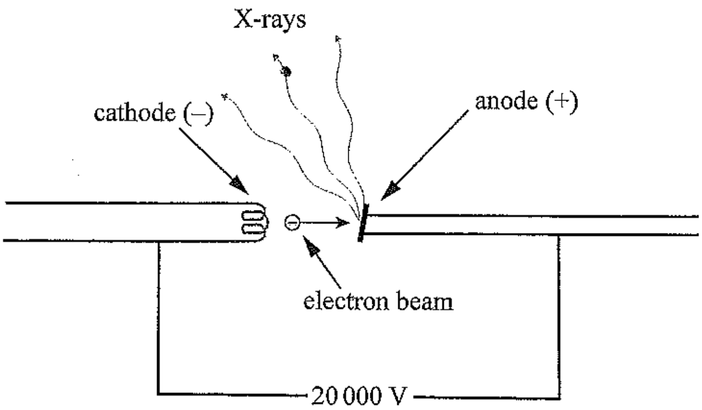
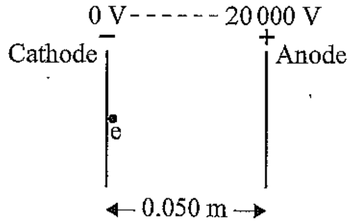
QUESTION TWO: STATIC ELECTRICITY

In an X-ray machine, a heating element releases electrons from a negatively charged plate called the cathode. The electrons are then accelerated by an electric field that exists between the cathode and a positively charged tungsten plate called the anode.

The cathode and the anode are connected to a high voltage source of 20 000 V. The distance between the cathode and anode plates is 0.050 m. The beam of electrons causes X-rays to be released from the anode.

Charge on an electron $= 1.60 \times 10^{-19}$ C
Mass of an electron $= 9.11 \times 10^{-31}$ kg





The diagram on the right shows the arrangement to accelerate the electrons as they leave the cathode.

(a) Calculate the electric field strength between the plates, and state its direction.

$E = \frac{20\,000}{0.05} = 400000$ anode to cathode

(b) State what type of energy an electron would have at the cathode (negative plate), and what would happen to that energy as the electron moved towards the anode (positive plate).

The electron would have ~~negative energy~~ at the cathode this would change to kinetic energy at the anode.

only one energy stated

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(c) Calculate the speed of the electron as it reaches the anode (positive plate).

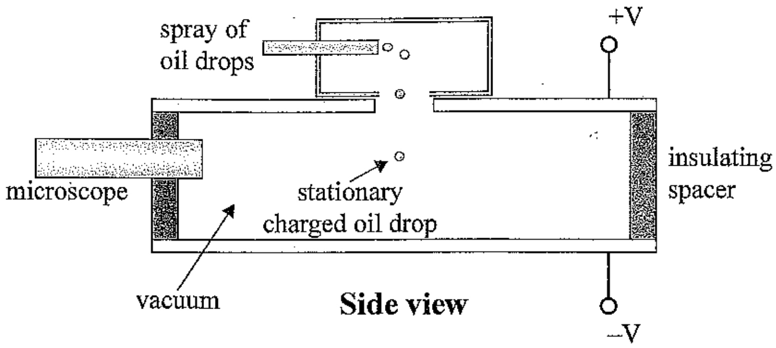
Ep = Ek
1/2mv²

links Ep to Ek

9

(d) In 1909 Millikan used two oppositely charged metal plates to keep a charged oil drop falling at terminal velocity when he was experimenting to find the charge of an electron. A modified form of his experiment keeps an oil drop stationary.

The diagram below shows part of the equipment.



Discuss how it was possible to make the oil drop stationary between the plates.

In your comprehensive answer you should

- identify the forces acting on the oil drop
- describe how the forces can combine to cause the oil drop to be stationary
- explain what **type** of charge the oil drop must have in order to remain stationary.

There is no forces acting that is in a vaccum

n

A3

QUESTION THREE: ELECTROMAGNETISM

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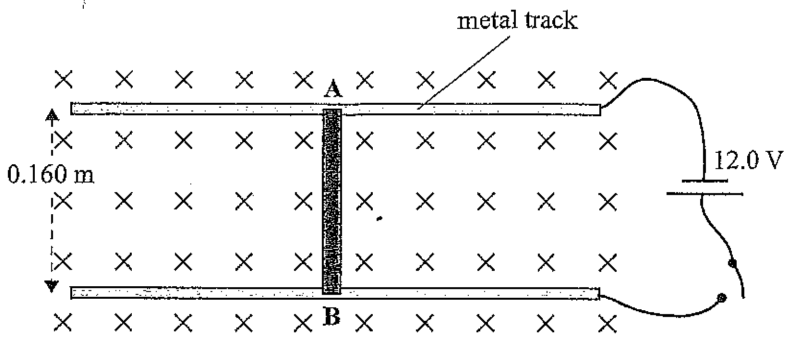

A metal rod AB of length 0.160 m is free to slide, without friction, on two parallel metal tracks. The two tracks are connected to a 12.0 V battery so that the rod and the tracks form a closed circuit when the switch is closed. The rod AB has a resistance of 20.0 Ω, and the tracks have negligible resistance. A uniform magnetic field, of strength 1.50×10^{-3} T, is applied perpendicular to the plane of this circuit.

When the switch is closed, the rod AB moves.

(a) In what direction does the rod AB move when the switch is closed?

Left

A

(b) Calculate the size of the force experienced by the rod AB.

I = 12/20 = 0.6

F = Bvq

= 1.5 × 10^-3 × 12 × 20

= 0.288

A

Correct current Found

Needed to use F=BIL For M.

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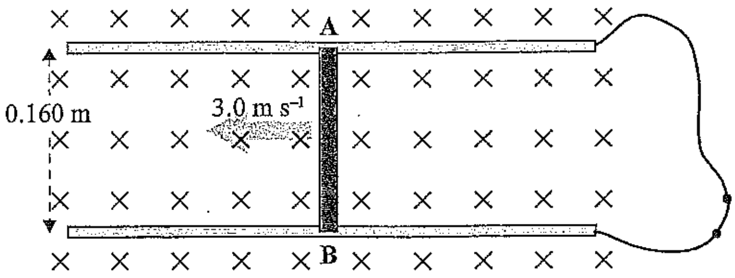
The battery is removed and replaced by a conducting wire, as shown below. The rod AB is pushed to the left at a constant speed of 3.0 m s^{-1}.



(c) Explain why a voltage is induced.

As the rod moves cutting through the feild a voltage is induced because the electrons get pushed towards A

M

(d) Calculate the size and direction of the induced current (conventional current) flowing through the ~~metal rod~~ when it is moved to the left with a constant speed of 3.0 m s^{-1}.

B to A

NO size and incorrect direction

N

A4