Level 2 Physics, 2014

91173 Demonstrate understanding of electricity and electromagnetism

2.00 pm Tuesday 18 November 2014
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 2–10 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.

Not Achieved

TOTAL 08

ASSESSOR'S USE ONLY

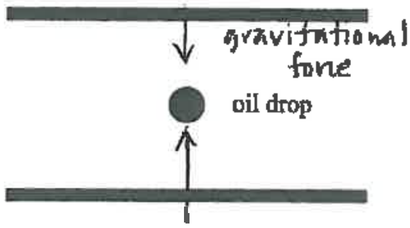
QUESTION ONE: MILLIKAN'S OIL DROP EXPERIMENT

Charge on electron: -1.6×10^{-19} C
Mass of electron: 9.11×10^{-31} kg
Charge on proton: $+1.6 \times 10^{-19}$ C
Mass of proton: 1.67×10^{-27} kg

In 1909 Robert Millikan performed an experiment to determine the size of the charge on an electron. He put a charge on a tiny drop of oil, and measured how strong an applied electric field had to be in order to stop the oil drop from falling.

Janet is doing a similar experiment. She has an electrically charged oil drop held stationary in an electric field, so that it floats.

The oil drop has a net negative charge of 24×10^{-10} C, and is placed in a uniform electric field of strength 610 N C^{-1} directed vertically. The oil drop " floats" (is held suspended) between the plates. (Assume any buoyancy effect of air to be negligible.)



(a) Name the forces (including directions) acting on the oil drop while it is suspended between the plates.

gravitational force - down
pacitive charge - up

Needed to identify the electric force up.

A

(b) Calculate the mass of the oil drop. (Use $g = 9.8$ N kg^{-1} and $F = mg$.)

$F = mg$ $\quad\quad$ $F = Eq$

$\therefore m = \frac{F}{g}$ $\quad\quad$ $= 610 \times 24 \times 10^{-10}$

$= 1464 \times 10^{-6}$

$= \frac{1464 \times 10^{-6}}{9.8}$

$= 1.493877551 \times 10^{-7}$

$= 1.5 \times 10^{-7}$ Kg

Correct Mass

M

ASSESSOR'S USE ONLY

(c) Explain what the same charged oil drop would do if the plates were brought closer together.

Assume the charge on the oil drop remains the same, and the voltage across the plates remains unchanged.

It would stay at the middle because ~~the~~ of the forces. the gravitational force will attract the charged oil down and the positive charge will attract the oil drop upwards.

Needed to state that the electric field strength increases and so does the electric force

N

(d) A free electron and a free proton are placed in identical electrical fields (same electric field strength).

Compare:

- the strength of the electric force on each particle
- the acceleration of each particle (you may neglect gravity and use $a = \frac{F}{m}$).

Give reasons to justify your comparisons.

Electric force: ~~E=Eq~~ the electric force will be ~~electron~~ different because ~~the~~ the electron and proton have different charges, ~~Electron~~ Electron force is ~~calculated~~ Force over charge. Because they have different charges, ~~their~~ their electric force will be different.

Acceleration: ~~they~~ the electron and proton will have different masses because ~~mass is actual~~ acceleration is calculated by force over mass so a change in mass will change acceleration.

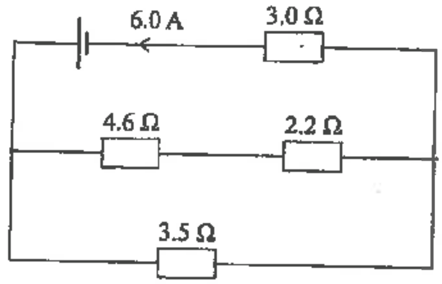
N

Didn't realise that electrons and protons have the same charge and thus the same force would apply.

N2

QUESTION TWO: RESISTORS IN A DC CIRCUIT

Sandra is investigating electrical circuits in the lab. She connects various resistors in combination. The current drawn from the supply is 6.0 A.



(a) Calculate the effective resistance of the circuit.

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

$\frac{1}{R_T} = \frac{1}{3} + \frac{1}{6.8} + \frac{1}{3.5}$

$\frac{1}{R_T} = 0.7661$

$\frac{0.7661 R_T}{0.7661} = \frac{1}{0.7661}$

$R_T = \frac{1}{0.77}\ \Omega$

Failed to see the 3 ohm was in series with the rest

(b) Calculate the size of the voltage across the 3.5 Ω resistor.

$V = IR$

$V = 2 \times 3.5$

$V = 7$

7V

Assumed 2 A in 3.5 ohm

(c) Express your answer to Question Two (b) to the correct number of significant figures. Give a reason for your choice of significant figures.

7.0 V (2sf) because the given values are in 2 sf

Correctly rounded and stated 2sf with reason

(d) Explain which resistor, the 4.6 Ω or the 2.2 Ω resistor, would convert the greater amount of energy per second into heat.

ASSESSOR'S USE ONLY

2.2 Ω because it has less resistance

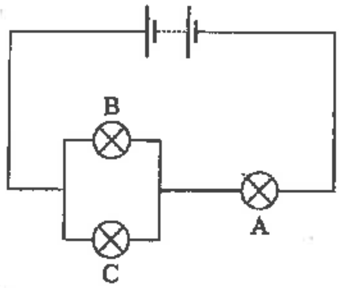
n

N

QUESTION THREE: LAMPS AND RESISTORS IN A DC CIRCUIT

ASSESSOR'S USE ONLY

Stephen connects identical lamps, as shown in the diagram below.



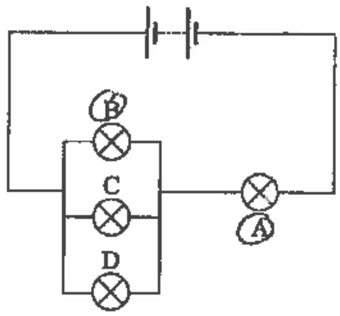
(a) Lamp B blows.

State what happens to the brightness of lamp A.

It will stay the same

(b) Stephen replaces lamp B with a new one.

Explain what would happen to the voltage across lamp B and the voltage across lamp A if another identical lamp, D, was added in parallel, as shown in the diagram below.

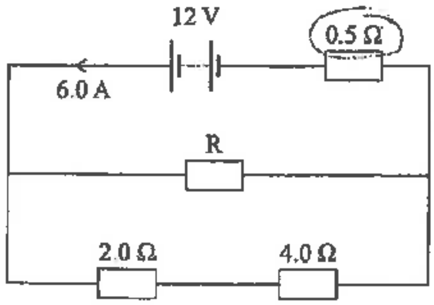


The voltage across lamp A will stay the same because Lamp A is in a ~~sa~~ series circuit so its voltage will remain the same. The voltage across lamp B will reduce because ~~se~~ it is in a ~~parol~~ parallel series and the voltage from the source will split up. Lamp B will only have ~~get~~ 1/3 of the voltage of the source.

Stated the voltage across B reduces

Stephen then takes a selection of resistors and connects them as shown in the diagram below.

ASSESSOR'S USE ONLY



(c) Calculate the voltage across the 0.5 Ω resistor.

$V = IR$

$= 6 \times 0.5$

$= 3\ V$

(d) Calculate the resistance of resistor R.

Begin your answer by calculating the voltage across each branch.

$V = IR$

S

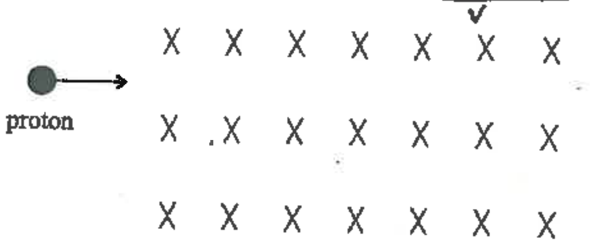
N

A3

QUESTION FOUR: ELECTROMAGNETISM

ASSESSOR'S USE ONLY

A proton of charge $+1.6 \times 10^{-19}$ C moves at right angles across a magnetic field of strength 0.65 T. The constant speed of the proton (in the magnetic field) is 4.8×10^{3} m s^{-1}. ✓



(a) Calculate the size of the magnetic force on the proton while it is in the field.

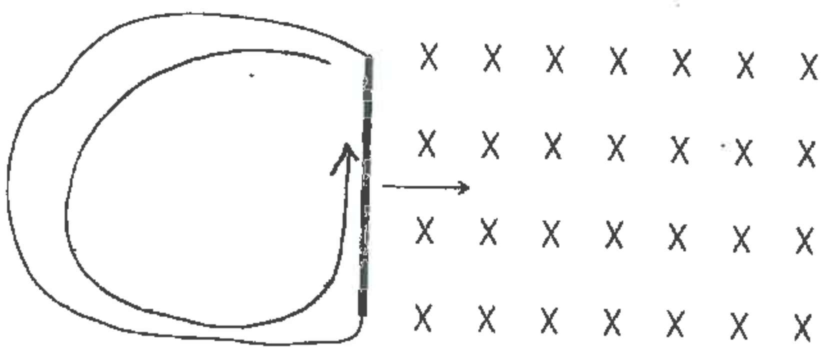
$F = Bqv$

$= 0.65 \times 1.6 \times 10^{-19} \times 4.8 \times 10^{3}$

$= 4.992 \times 10^{-16}$ N

A

A piece of conducting rod whose ends are connected by a wire as shown, is moved through a magnetic field that is directed into the page. The direction in which the rod is moved is indicated by an arrow.



A

(b) On the diagram draw an arrow to show the direction of the induced current (conventional current) around the loop formed by the rod and wire.

(c) Explain why there will be an induced current in the rod and wire due to movement of the rod across the magnetic field.

there will be an induced current in the rod and wire ~~due to movement of the rod across the magnetic field~~ because of poles, N and S. The current will be induced by the N pole.

N

No mention of the force on the electrons in the wire d B

(d) In the situation above, the length of the rod is 0.40 m and the magnetic field strength is 0.85 T. The rod is moved with a speed of 4.6 m s^{-1} through the field. The combined resistance of the rod and wire is 0.68 Ω.

v r

ASSESSOR'S USE ONLY

By calculating the voltage induced, calculate the size of the force that must be applied to the rod to keep it moving at a steady speed through the magnetic field.

$V = IR$

$=$

N

N