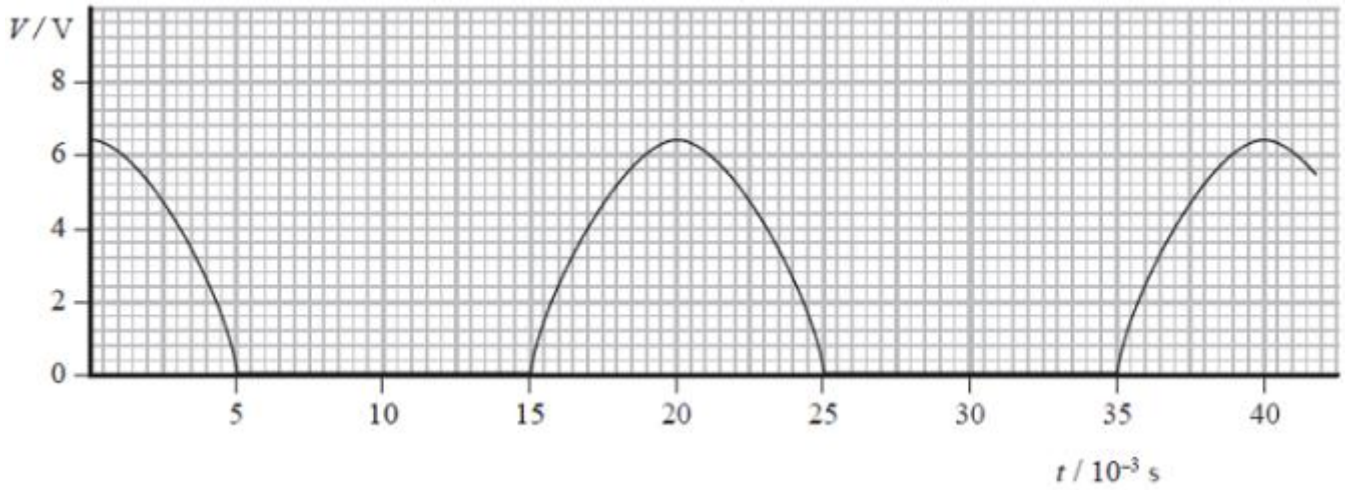
**Student**:_____
**Max. Marks : 20 Marks** **Time : 20 Minutes**

**Q1.**

The graph shows how the output *V* from the terminals of a power supply labelled d.c. (direct current) varies with time *t*. This type of supply will not allow current to flow backwards through it.




(a) A student connects a capacitor across the terminals of this power supply in order to try to produce a constant voltage.

Suggest how this produces a constant voltage.

**(2)**

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(b) The student then connects a resistor across the capacitor as shown.

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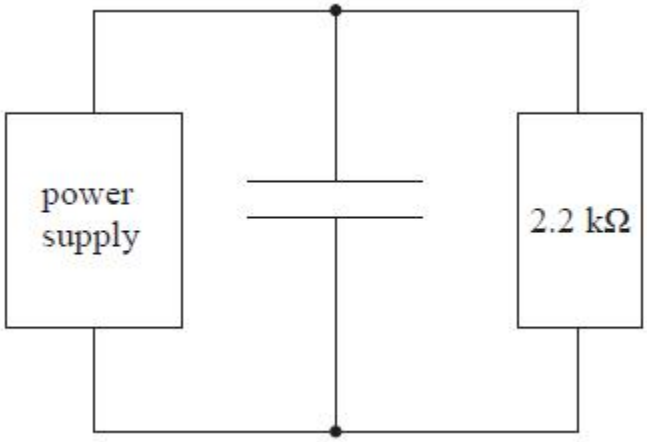
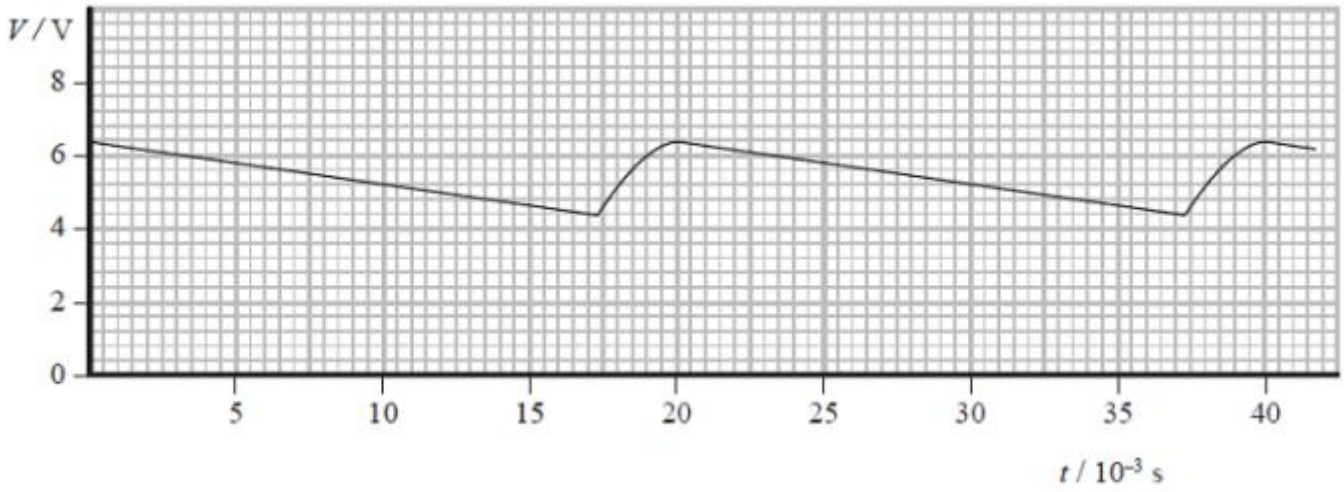



The graph shows the variation of the potential difference *V* across the resistor with time *t*.




(i) Estimate the average potential difference across the resistor.

**(1)**

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Average potential difference = .....

(ii) Calculate the average current in the resistor.

**(2)**

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Average current = .....

(iii) Determine the time in each cycle for which the capacitor discharges through the resistor.

**(1)**

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Discharge time = .....

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(iv) Calculate the charge passing through the resistor during one discharge of the capacitor and hence determine the capacitance of the capacitor.

**(4)**

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Charge = .....

Capacitance = .....

(c) The student wants to produce a potential difference across the same resistor that has less variation in magnitude.
State, with a reason, what the student could do to achieve this.

**(2)**

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**(Total for question = 12 marks)**

**Q2.**

A 'Gauss gun' can be made from five ball bearings of equal mass and two magnets, as shown.

Pairs of ball bearings are placed to the right of two strong magnets. A single ball bearing is released from the left, as shown. The ball bearing is attracted to, and collides with, the first magnet. This and all subsequent collisions can be assumed to be elastic.

A student set up the apparatus shown to measure the speed of the last ball bearing. The 'Gauss gun' was placed at the end of a bench, so that the ball bearing left the gun and broke two strips of metal foil which formed part of an electric circuit.

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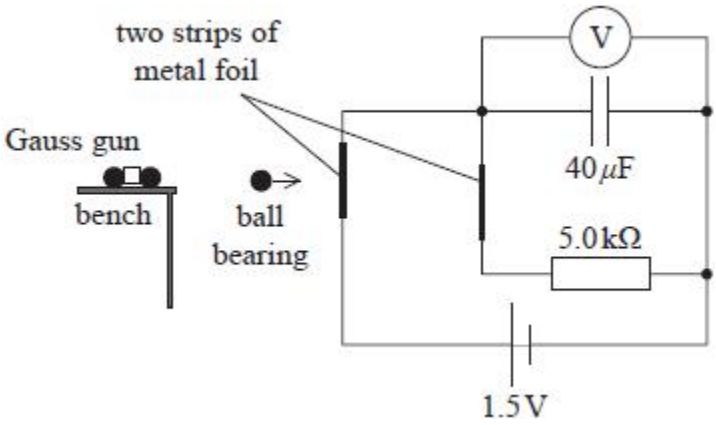


As the ball bearing left the gun, it broke the first foil strip at its centre so that the capacitor started to discharge. When the ball bearing broke the second foil strip the capacitor discharge stopped.

(i) Calculate the energy stored in the capacitor when it was fully charged.

**(2)**

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Energy stored = .....

(ii) The voltmeter reading halved in the time taken for the ball bearing to travel between the two foil strips.

Show that the time taken for the ball bearing to travel between the two foil strips was about 0.1 s.

**(2)**

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(iii) The two foil strips were 0.50 m apart.

Calculate the horizontal velocity of the ball bearing.

**(2)**

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Horizontal velocity = .....

(iv) The student positioned the second foil strip with its centre 8.0 cm lower than the centre of the first foil strip.

Deduce whether the ball bearing broke the second foil strip at its centre.
Assume the ball bearing was travelling horizontally as it broke the first foil strip.

**(2)**

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**(Total for question = 8 marks)**

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