Q1. An uncharged 4.7 nF capacitor is connected to a 1.5 V supply and becomes fully charged.

How many electrons are transferred to the negative plate of the capacitor during this charging process?

A 2.2×10^{10}

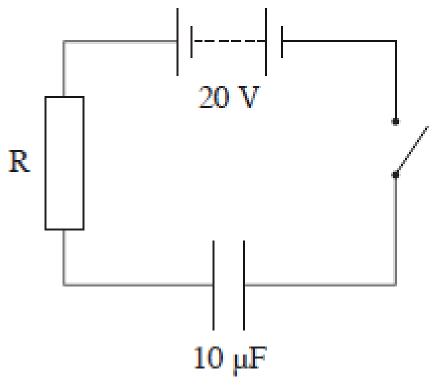
B 3.3×10^{10}

C 4.4×10^{10}

D 8.8×10^{10}

(Total 1 mark)

Q2.A capacitor of capacitance 10 μF is charged through a resistor R to a potential difference (pd) of 20 V using the circuit shown.



When the capacitor is fully charged which one of the following statements is **incorrect**?

A The energy stored by the capacitor is 2 mJ.

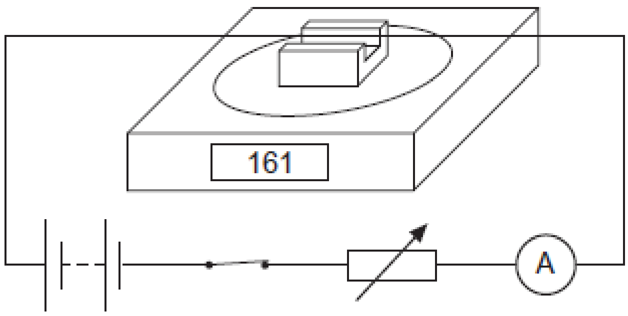
B The total energy taken from the battery during the charging process is 2 mJ.

C The pd across the capacitor is 20 V.

D The pd across the resistor is 0 V.

(Total 1 mark)

Q3. The diagram shows a rigidly-clamped straight horizontal current-carrying wire held mid-way between the poles of a magnet on a top-pan balance. The wire is perpendicular to the magnetic field direction.



The balance, which was zeroed before the switch was closed, read 161 g after the switch was closed. When the current is reversed and doubled, what would be the new reading on the balance?

A −322 g

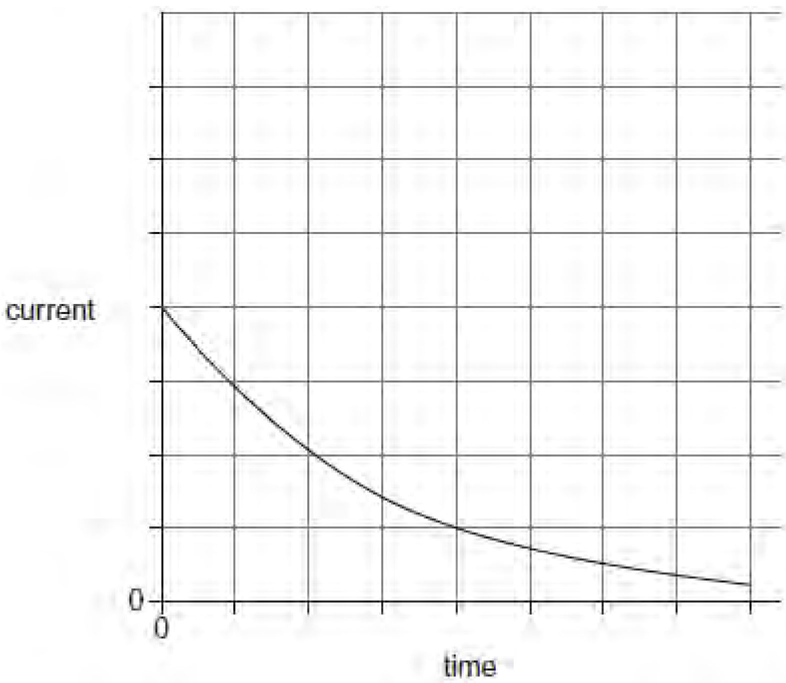
B −161 g

C zero

D 322 g

(Total 1 mark)

Q4.(a) The graph shows how the current varies with time as a capacitor is discharged through a 150 Ω resistor.



(i) Explain how the initial charge on the capacitor could be determined from a graph of current against time.

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(1)

(ii) The same capacitor is charged to the same initial potential difference (pd) and then discharged through a 300 kΩ resistor. Sketch a second graph on the same axes above to show how the current varies with time in this case.

(3)

(b) In an experiment to show that a capacitor stores energy, a student charges a capacitor from a battery and then discharges it through a small electric motor. The motor is used to lift a mass vertically.

(i) The capacitance of the capacitor is 0.12 F and it is charged to a pd of 9.0 V. The weight of the mass raised is 3.5 N.
Calculate the maximum height to which the mass could be raised.
Give your answer to an appropriate number of significant figures.

maximum height .... m

(4)

(ii) Give **two** reasons why the value you have calculated in part (i) would not be achieved in practice.

1 ....

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2 ....

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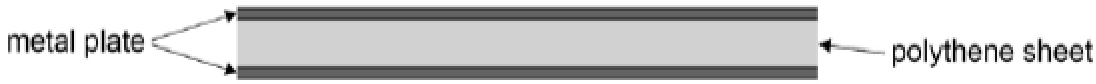
(2)
(Total 10 marks)

Q5. The figure below shows a capacitor of capacitance 370 pF. It consists of two parallel metal plates of area 250 cm^2. A sheet of polythene that has a relative permittivity 2.3 completely fills the gap between the plates.



not to scale

(a) Calculate the thickness of the polythene sheet.

thickness = ______________m

(2)

(b) The capacitor is charged so that there is a potential difference of 35 V between the plates. The charge on the capacitor is then 13 nC and the energy stored is 0.23 μJ.

The supply is now disconnected and the polythene sheet is pulled out from between the plates without discharging or altering the separation of the plates.

Show that the potential difference between the plates increases to about 80 V.

(2)

(c) Calculate the energy that is now stored by the capacitor.

energy stored = ______________μJ

(2)

(d) Explain why there is an increase in the energy stored by the capacitor when the polythene sheet is pulled out from between the plates.

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(2)
(Total 8 marks)

Q6. Which of the following statements about a parallel plate capacitor is **incorrect**?

A The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1 V. ☐

B A uniform electric field exists between the plates of the capacitor. ☐

C The charge stored on the capacitor is inversely proportional to the pd across the plates. ☐

D The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates. ☐

(Total 1 mark)

Q7.(a) When an uncharged capacitor is charged by a **constant** current of 4.5 μA for 60 s the pd across it becomes 4.4 V.

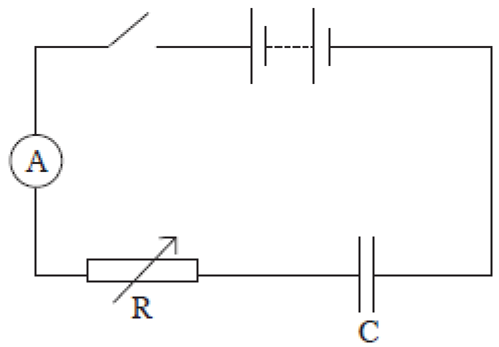
(i) Calculate the capacitance of the capacitor.

capacitance .... F

(3)

(ii) The capacitor is charged using the circuit shown in **Figure 1**. The battery emf is 6.0 V and its internal resistance is negligible. In order to keep the current constant at 4.5 μA, the resistance of the variable resistor R is decreased steadily as the charge on the capacitor increases.

Figure 1



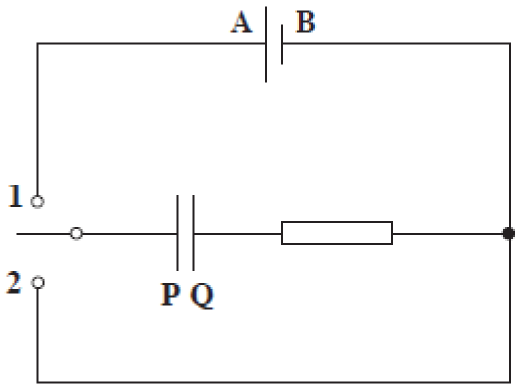
Calculate the resistance of R when the uncharged capacitor has been charging for 30 s.

resistance .... Ω

(3)

(b) The circuit in **Figure 2** contains a cell, an uncharged capacitor, a fixed resistor and a two-way switch.

Figure 2



The switch is moved to position **1** until the capacitor is fully charged. The switch is then moved to position **2**.

Describe what happens in this circuit after the switch is moved to position **1**, and after it has been moved to position **2**. In your answer you should refer to:

- the direction in which electrons flow in the circuit, and how the flow of electrons changes with time,
- how the potential differences across the resistor and the capacitor change with time,
- the energy changes which take place in the circuit.

The terminals of the cell are labelled **A** and **B** and the capacitor plates are labelled **P** and **Q** so that you can refer to them in your answer.

The quality of your written communication will be assessed in your answer.

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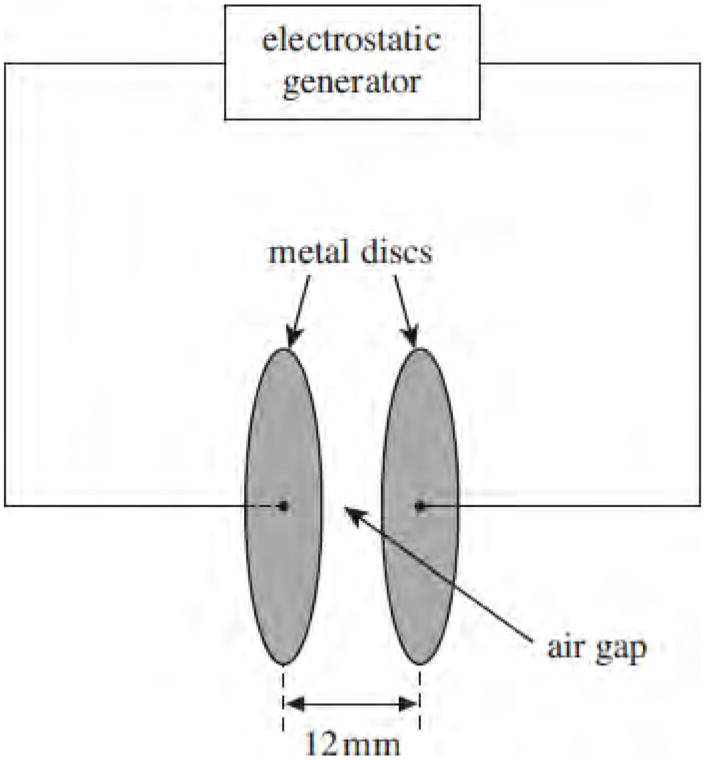
(6)
(Total 12 marks)

Q8. The diagram below shows an arrangement to demonstrate sparks passing across an air gap between two parallel metal discs. Sparks occur when the electric field in the gap becomes large enough to equal the breakdown field strength of the air. The discs form a capacitor, which is charged at a constant rate by an electrostatic generator until the potential difference (pd) across the discs is large enough for a spark to pass. Sparks are then produced at regular time intervals whilst the generator is switched on.



(a) The electrostatic generator charges the discs at a constant rate of 3.2×10^{-8} A on a day when the minimum breakdown field strength of the air is 2.5×10^{6} V m^{-1}. The discs have a capacitance of 3.7×10^{-12} F.

(i) The air gap is 12 mm wide. Calculate the minimum pd required across the discs for a spark to occur. Assume that the electric field in the air gap is uniform.

pd V

(1)

(ii) Calculate the time taken, from when the electrostatic generator is first switched on, for the pd across the discs to reach the value calculated in part (a)(i).

time .... s

(2)

(b) The discs are replaced by ones of larger area placed at the same separation, to give a larger capacitance.

State and explain what effect this increased capacitance will have on:

(i) the time between consecutive discharges,

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(2)

(ii) the brightness of each spark.

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(2)
(Total 7 marks)

Q9. An initially uncharged capacitor of capacitance 20 μF is charged by a constant current of 80 μA. Which line, **A** to **D**, in the table gives the potential difference across, and the energy stored in, the capacitor after 50 s?

	potential difference / V	energy stored / J

A	4.0×10^{-3}	2.0×10^{-3}
B	4.0×10^{-3}	4.0×10^{-1}
C	2.0×10^{2}	2.0×10^{-3}
D	2.0×10^{2}	4.0×10^{-1}

(Total 1 mark)

Q10. Which one of the following statements about a parallel plate capacitor is **incorrect**?

A The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1V.

B A uniform electric field exists between the plates of the capacitor.

C The charge stored on the capacitor is inversely proportional to the pd across the plates.

D The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates.

(Total 1 mark)

Q11. A 1000 μF capacitor and a 10 μF capacitor are charged so that they store the same energy. The pd across the 1000 μF capacitor is V_1 and the pd across the other capacitor is V_2.

What is the value of the ratio $\left(\frac{V_1}{V_2}\right)^2$?

A $\frac{1}{1000}$

B $\frac{1}{100}$

C $\frac{1}{10}$

D 10

(Total 1 mark)

Q12. A capacitor stores a charge of 600 μC when charged to a potential difference (pd) of 6.0 V. What will be the pd across the plates if the charge stored increases by 50%?

A 3.0 V

B 4.5 V

C 9.0 V

D 12.0 V

(Total 1 mark)