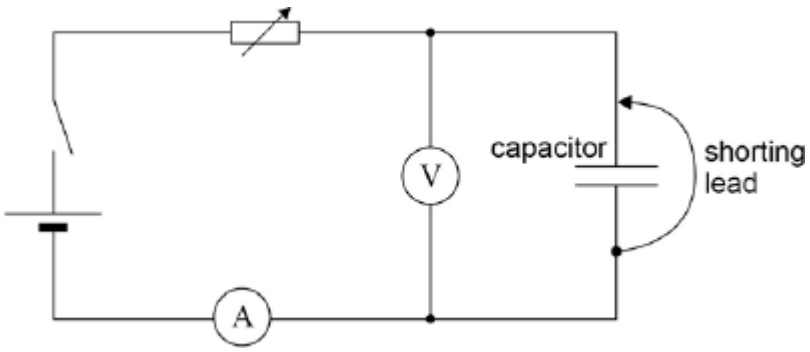
Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

This question is about capacitor charging and discharging.

A student designs an experiment to charge a capacitor using a constant current. The figure below shows the circuit the student designed to allow charge to flow onto a capacitor that has been initially discharged.



The student begins the experiment with the shorting lead connected across the capacitor as in the figure above. The variable resistor is then adjusted to give a suitable ammeter reading. The shorting lead is removed so that the capacitor begins to charge. At the same instant, the stop clock is started.

The student intends to measure the potential difference (pd) across the capacitor at 10 s intervals while adjusting the variable resistor to keep the charging current constant.

The power supply has an emf of 6.0 V and negligible internal resistance. The capacitor has a capacitance of 680 μF. The variable resistor has a maximum resistance of 100 kΩ.

(a) The student chooses a digital voltmeter for the experiment. A digital voltmeter has a very high resistance.

Explain why it is important to use a voltmeter with very high resistance.

_____

_____

_____

(1)

(b) Suggest **one** advantage of using an analogue ammeter rather than a digital ammeter for this experiment.

_____

_____

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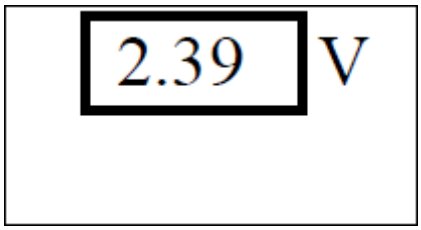
(1)

(c) Suggest a suitable full scale deflection for an analogue ammeter to be used in the experiment.

full scale deflection = _____

(2)

(d) The diagram shows the reading on the voltmeter at one instant during the experiment. The manufacturer gives the uncertainty in the meter reading as 2%.



Calculate the absolute uncertainty in this reading.

uncertainty = _____V

(1)

(e) Determine the number of different readings the student will be able to take before the capacitor becomes fully charged.

number = _____

(3)

(f) The experiment is performed with a capacitor of nominal value 680 μF and a manufacturing tolerance of ± 5 %. In this experiment the charging current is maintained at 65 μA. The data from the experiment produces a straight-line graph for the variation of pd with time. This shows that the pd across the capacitor increases at a rate of 98 mV s^{-1}.

Calculate the capacitance of the capacitor.

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capacitance = _____μF

(2)

(g) Deduce whether the capacitor is within the manufacturer's tolerance.

_____

_____

_____

(1)

(h) The student decides to confirm the value of the capacitance by first determining the time constant of the circuit when the capacitor **discharges** through a **fixed** resistor.

Describe an experiment to do this. Include in your answer:

- a circuit diagram
- an outline of a procedure
- an explanation of how you would use the data to determine the time constant.

_____

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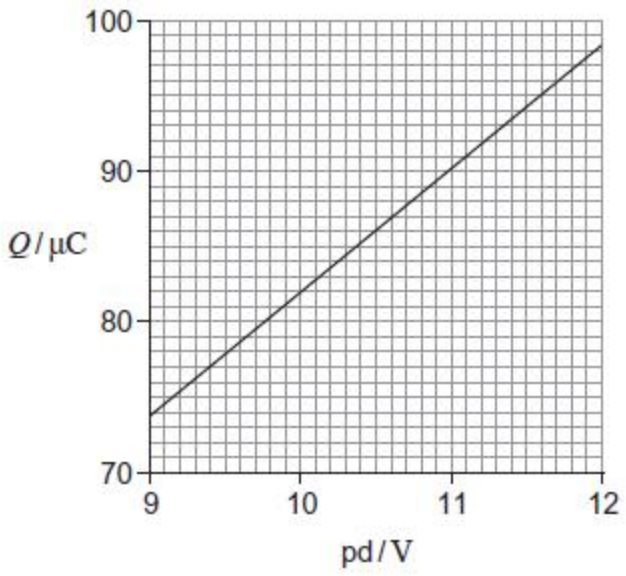
(4)

(Total 15 marks)

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Q2.

The graph shows how the charge Q stored by a capacitor varies with the potential difference (pd) V across it as V is increased from 9.0 V to 12.0 V.



(a) (i) Use the graph to determine an accurate value for the capacitance of the capacitor.

capacitance = _____ μF

(2)

(ii) Calculate the additional energy stored by the capacitor when V is increased from 9.0 V to 12.0 V.

additional energy = _____ J

(3)

(b) When a 470 μF capacitor is discharged through a fixed resistor R, the pd across it decreases by 80% in 45 s.

(i) Calculate the time constant of the capacitor–resistor circuit.

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time constant = _____ s

(3)

(ii) Determine the resistance of R.

resistance = _____ Ω

(2)

(iii) At which point during the discharging process is the capacitor losing charge at the smallest rate? Tick (✔) the correct answer.

	✔ if correct
when the charge on the capacitor is greatest	
when energy is dissipated at the greatest rate	
when the current in the resistor is greatest	
when the pd across R is least	

(1)

(Total 11 marks)

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