8 The potential difference across a capacitor is V. The energy stored on the capacitor is X joules. The potential difference across this capacitor is increased to 3 V. The energy stored, in joules, is increased to

- ☒ **A** $3X$
- ☒ **B** $6X$
- ☒ **C** $9X$
- ☒ **D** $27X$

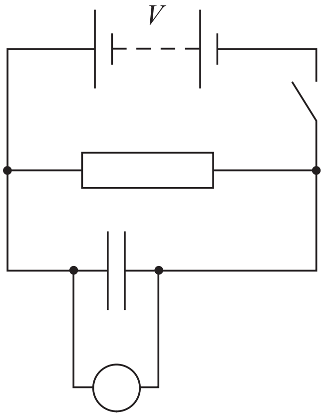
(Total for Question = 1 mark)

9 A capacitor of capacitance C has a potential difference V across it. The energy stored on the capacitor is Z joules. A second capacitor of capacitance $C/2$ has a potential difference $2V$ across it.
The energy stored on the second capacitor is

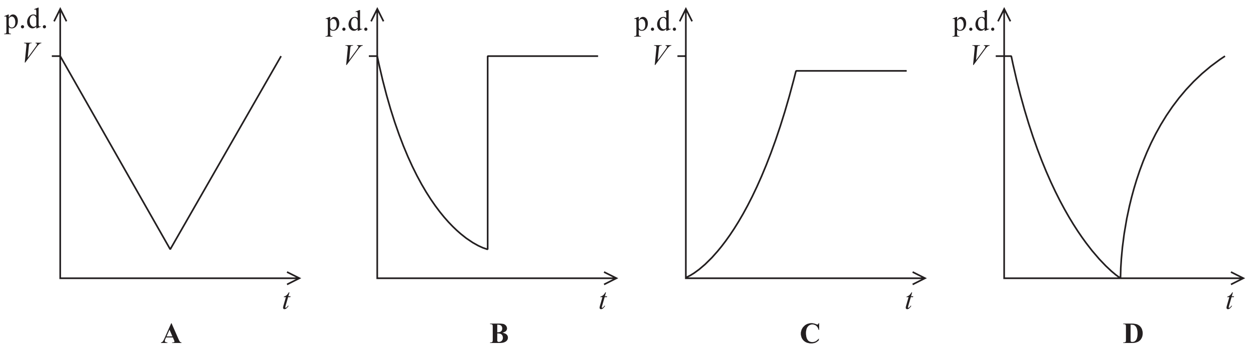
- ☒ **A** Z
- ☒ **B** 2Z
- ☒ **C** 4Z
- ☒ **D** 8Z

(Total for Question = 1 mark)

10 The capacitor shown in the circuit below is initially charged to a potential difference (p.d.) V by closing the switch.
The power supply has negligible internal resistance.



The switch is opened and the p.d. across the capacitor allowed to fall. A short time later the switch is closed again. Select the graph that shows how the p.d. across the capacitor varies with time, after the switch is opened.



☒ **A**

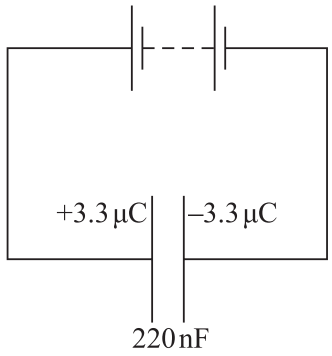
☒ **B**

☒ **C**

☒ **D**

(Total for Question = 1 mark)

2 A capacitor is charged by a battery as shown in the circuit diagram2



(a) Calculate the e.m.f. of the battery and the energy stored in the charged capacitor.

(4)

E.m.f. =

Energy =

(b) The capacitor is disconnected from the battery and discharged through a 20 MΩ resistor.

Calculate the time taken for 80% of the charge on the capacitor to discharge through the resistor.

(3)

Time taken =

(c) Use an equation to explain whether the time taken for the capacitor to lose half its energy is greater or less than the time taken to lose half its charge.

(3)

(d) A student carries out an experiment to record data so that she can plot a graph of potential difference against time as the capacitor discharges.

State **two** advantages of using a datalogger rather than a voltmeter and stopwatch to record this data.

(2)

(Total for Question = 12 marks)

3 In recent years there has been a development of ultracapacitors which have much higher capacitance than traditional capacitors. Capacitors store energy due to charge in an electric field whereas batteries store energy due to a chemical reaction. There are several applications where ultracapacitors have an advantage over batteries; for example storing energy from rapidly fluctuating supplies or delivering charge very quickly.

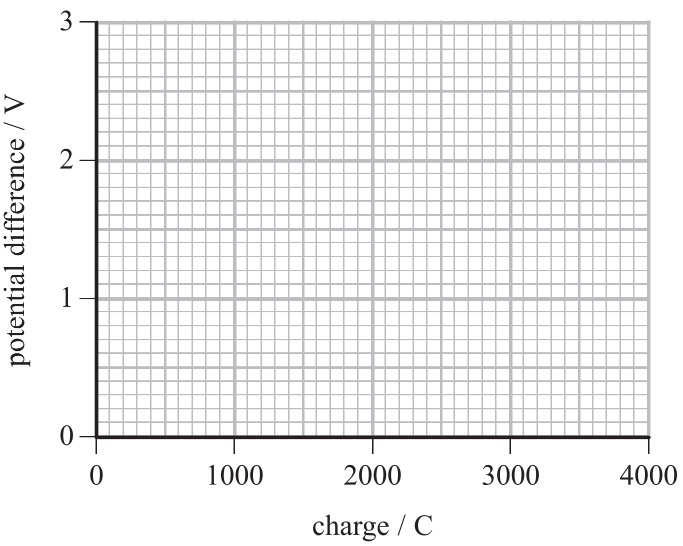
(a) A typical ultracapacitor has a capacitance of 1500 F and a maximum operating potential difference of 2.6 V.

(i) Show that the charge on this capacitor when fully charged is about 4000 C.

(2)

(ii) Complete the graph on the axes below to show how the potential difference varies with charge for this capacitor.

(2)

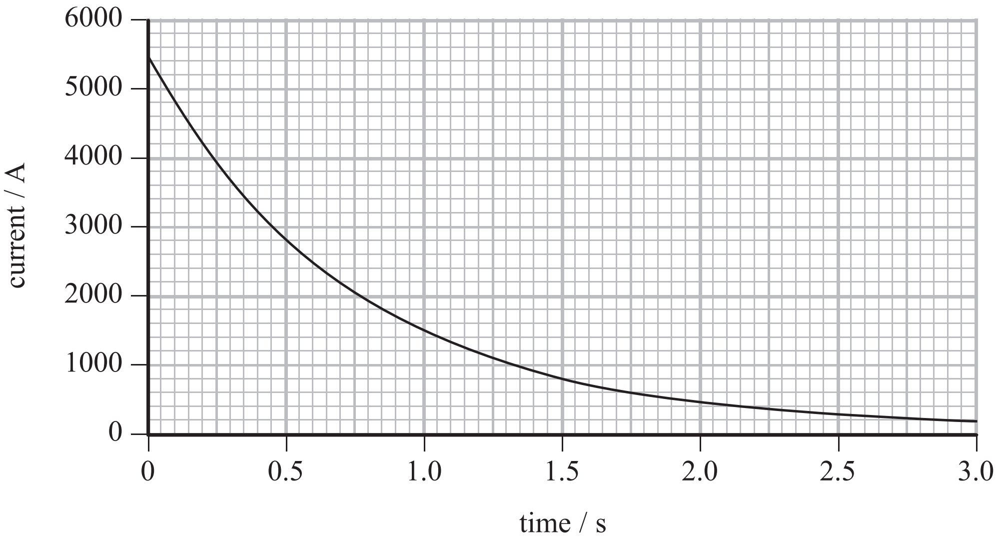


(iii) Calculate the energy stored in this capacitor when fully charged.

(2)

Energy =

(b) The graph below shows how the current varies with time as the capacitor is discharged through a circuit.



(i) Describe and explain the shape of the graph.

(2)

(ii) Calculate the resistance of the circuit.

(4)

Resistance =

(c) There is a limit to the amount of charge an ultracapacitor can hold but it can deliver the charge very quickly. A battery can deliver much more charge but only at a slower rate. For electric powered vehicles it is suggested that using a combination of batteries and ultracapacitors would give the best performance.

Suggest, with reasons, which stages of a journey would be more suited to ultracapacitors and which would be more suited to batteries.

(3)

(Total for Question = 15 marks)