Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

(a) A particular heart pacemaker uses a capacitor which has a capacitance of 4.2 *μ*F. Explain what is meant by *a capacitance of 4.2 μF*.

_____

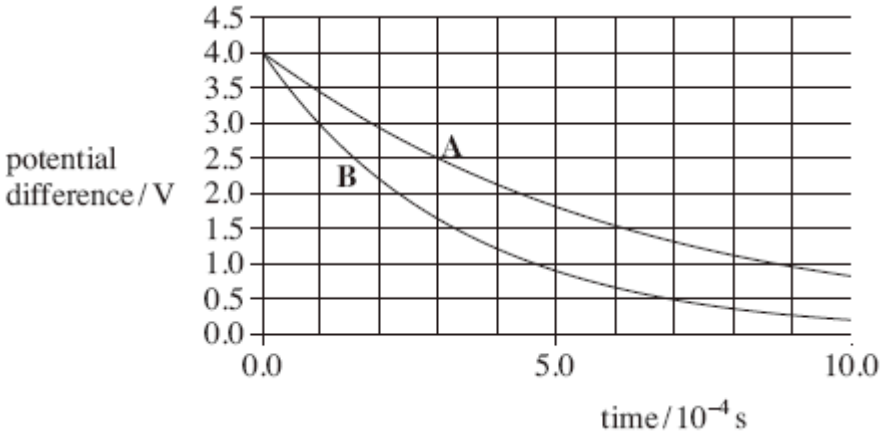
_____

_____

_____

(2)

(b) Capacitor **A**, of capacitance 4.2 *μ*F, is charged to 4.0 V and then discharged through a sample of heart tissue. This capacitor is replaced by capacitor **B** and the charge and discharge process repeated through the same sample of tissue.
The discharge curves are shown in the figure below.



(i) By considering the discharge curve for capacitor **A**, show that the resistance of the sample of heart tissue through which the discharge occurs is approximately 150 Ω.

_____

_____

_____

_____

_____

(4)

(ii) State and explain whether capacitor **B** has a larger or smaller capacitance than that of

capacitor **A**.

_____

_____

_____

_____

(2)

(c) Capacitor **A** was charged to a potential difference of 4.0V before discharging through the sample of heart tissue.
Determine how much energy it passed to the sample of heart tissue in the first 0.90 m s of the discharge.

_____

_____

_____

_____

_____

_____

_____

_____

energy _____ J

(3)

(Total 11 marks)

Q2.

Figure 1 shows a circuit that is used in a defibrillator in which a short pulse of charge is used to revive a patient who suffers a cardiac arrest in which their heart stops beating.

Figure 2 shows how the charge on the capacitor varies with time when the capacitor is charging.

Figure 1

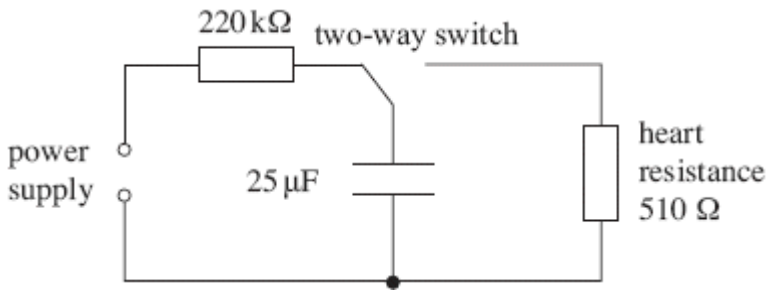
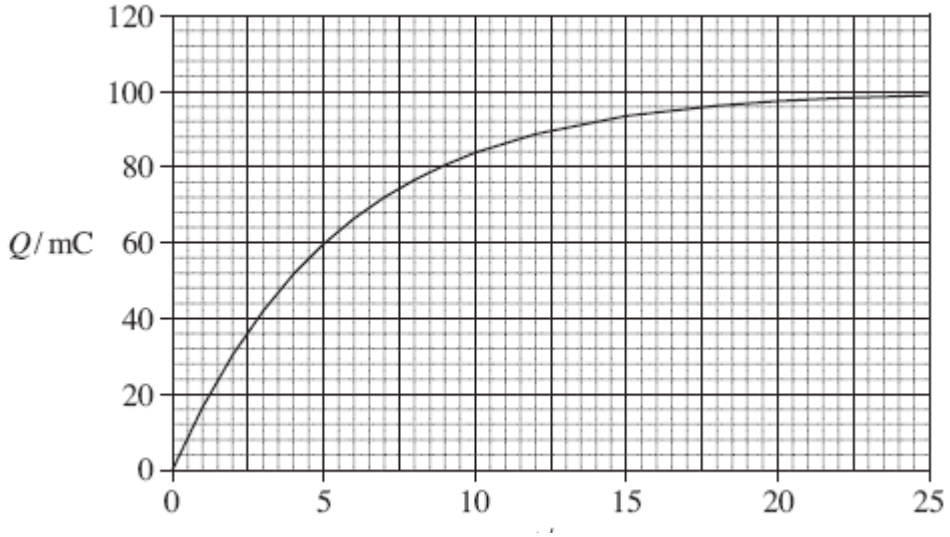


Figure 2



(a) (i) Use **Figure 2** to determine the initial charging current.

initial charging current _____ A

(2)

(ii) Calculate the emf of the supply used to charge the capacitor.
Assume that the supply has negligible internal resistance.

emf of the supply _____ V

(2)

(iii) Explain why the current that charges the capacitor falls as the capacitor charges.

_____

_____

(3)

(b) For the system to work successfully, the capacitor has to deliver 140 J of energy to the heart in a pulse that lasts for 10 ms.

(i) Show that the charge on the capacitor when it is storing this much energy is about 85 mC.

_____

_____

_____

_____

_____

(2)

(ii) Calculate the average power supplied during the pulse.

_____

_____

_____

average power _____ W

(1)

(c) The circuit designer suggests that the capacitor can be used successfully after a charging time equal to 1.5 time constants of the charging circuit shown in **Figure 1**.

Explain with a calculation whether or not the designer's suggestion is valid.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)