

Student: _____

Max. Marks : 26 Marks

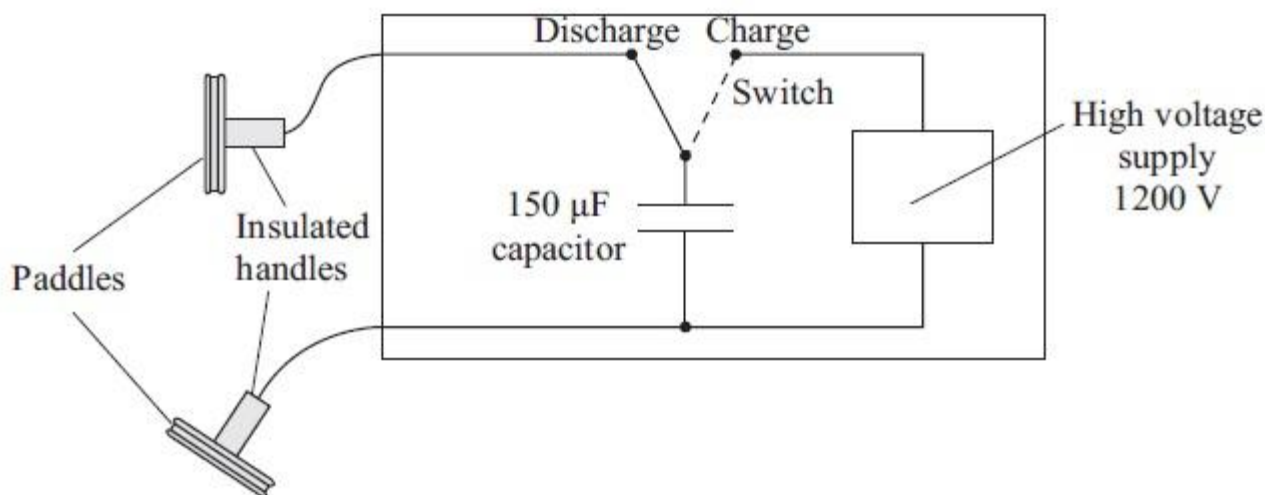
Time : 26 Minutes

Q1.

A defibrillator is a machine that is used to correct an irregular heartbeat or to start the heart of someone who is in cardiac arrest.



The defibrillator passes a large current through the heart for a short time. The machine includes a high voltage supply which is used to charge a capacitor. Two defibrillation 'paddles' are placed on the chest of the patient and the capacitor is discharged through the patient.



(a) The $150 \mu\text{F}$ capacitor is first connected across the 1200 V supply
Calculate the charge on the capacitor.

(2)

.....

.....
Charge =

(b) Calculate the energy stored in the capacitor.

(2)

.....
.....
.....
Energy stored =

(c) When the capacitor discharges there is an initial current of 14 A in the chest of the patient.

(i) Show that the electrical resistance of the body tissue between the paddles is about 90Ω

(1)

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(ii) Calculate the time it will take for three quarters of the charge on the capacitor to discharge through the patient.

(3)

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Time =

(iii) Body resistance varies from person to person. If the body resistance was lower, the initial current would be greater.

State how this lower body resistance affects the charge passed through the body from the defibrillator.

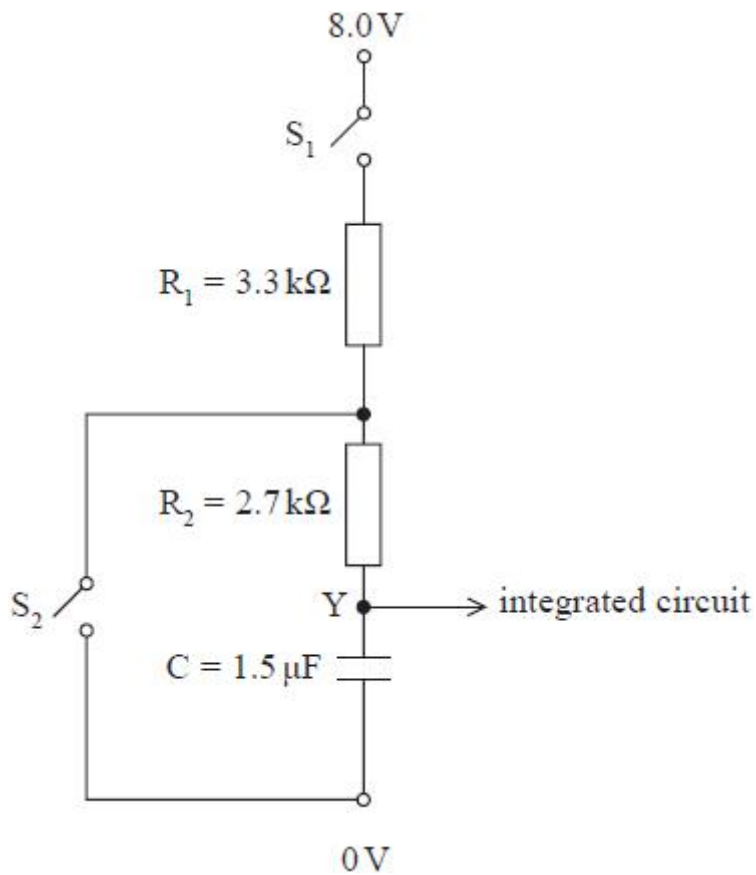
(1)

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(Total for question = 9 marks)

Q2.

The properties of capacitors make them useful in timing circuits.

The following circuit is used to provide an input Y to an integrated circuit.



When the potential at Y is 8.0 V, the switch S_2 is closed.

(i) Calculate the time taken for the potential at Y to decrease to 2.0 V.

(3)

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Time taken =

(ii) Calculate the energy stored on the capacitor when the potential at Y is 2.0 V.

(2)

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Energy stored =

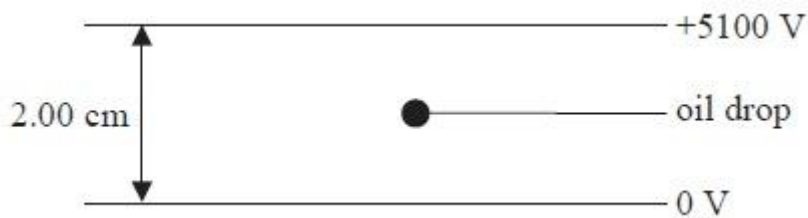
(Total for question = 5 marks)

Q3.

The charge on an electron was originally measured in an experiment called the Millikan Oil Drop experiment.

In a simplified version of this experiment, an oil drop with a small electric charge is placed between two horizontal, parallel plates with a large potential difference (p.d.) across them. The p.d. is adjusted until the oil drop is stationary.

For a particular experiment, a p.d. of 5100 V was required to hold a drop of mass 1.20×10^{-14} kg stationary.



(a) Add to the diagram to show the electric field lines between the plates.

(3)

(b) State whether the charge on the oil drop is positive or negative.

(1)

.....

(c) Complete the free-body force diagram to show the forces acting on the oil drop. You should ignore upthrust.

(2)



(d) (i) Calculate the magnitude of the charge on the oil drop.

(4)

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Charge =

(ii) Calculate the number of electrons that would have to be removed or added to a neutral oil drop for it to acquire this charge.

(2)

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.....
.....

Number of electrons =

(Total for Question = 12 marks)