

Name of the Student: _____

Max. Marks : 23 Marks

Time : 23 Minutes

Mark Schemes

Q1.

- (a) $Q (= CV = 330 \times 9.0) = 2970 \text{ } (\mu\text{C}) \text{ (1)}$
 $E (= \frac{1}{2}QV) = \frac{1}{2} \times 2.97 \times 10^{-3} \times 9.0 = 1.34 \times 10^{-2} \text{ J (1)}$
 [or $E (= \frac{1}{2}CV^2) = \frac{1}{2} \times 300 \times 10^{-6} \times 9.0^2 \text{ (1)} = 1.34 \times 10^{-2} \text{ J (1)}$]

2

- (b) time constant $(= RC) = 470 \times 10^3 \times 330 \times 10^{-6} = 155 \text{ s (1)}$

1

- (c) $Q (= Q_0 e^{-t/RC}) = 2970 \times e^{-60/155}$

$$= 2020 \text{ } (\mu\text{C})$$

(allow C.E. for time constant from (b))

$$V = \left(\frac{Q}{C} \right) = \frac{2020}{330} = 6.11 \text{ V (1)}$$

(allow C.E. for Q)

$$[\text{or } V = V_0 e^{-t/RC} \text{ (1)} = 9.0 e^{-60/155} \text{ (1)} = 6.11 \text{ V (1)}]$$

3

[6]**Q2.**

- (a) $Q = CV \text{ (1)}$
 $(= 4.7 \times 10^{-6} \times 6.0) = 28 \times 10^{-6} \text{ C or } 28 \text{ } \mu\text{C (1)}$

2

- (b) $E = \frac{1}{2}CV^2 \text{ (1)}$
 $= \frac{1}{2} \times 4.7 \times 10^{-6} \times 2.0^2 \text{ (1)}$
 $= 9.4 \times 10^{-6} \text{ J (1)}$
 [or $E = \frac{1}{2}QV \text{ (1)}$
 $= \frac{1}{2} \times 9.4 \times 10^{-6} \times 2.0 \text{ (1)}$
 $= 9.4 \times 10^{-6} \text{ J (1)}$]

3

- (c) time constant is time taken for V to fall to $\frac{V_0}{e} \text{ (1)}$

 $\therefore V$ must fall to 2.2 V (1)

time constant = 32 ms (1)

[or draw tangent at $t = 0$ **(1)**
 intercept of tangent on t axis is time constant **(1)**
 accept value 30 - 35 ms **(1)**
 [or $V = V_0 \exp(-t / RC)$ or $Q = Q_0 \exp(-t / RC)$ **(1)**

correct substitution **(1)**
 time constant = 32 ms **(1)**

3

(d) time constant = RC **(1)**

$$R = \frac{32 \times 10^{-3}}{4.7 \times 10^{-3}} = 6800 \, \Omega \text{ **(1)**}$$

(allow C.E. for value of time constant from (c))

2

[10]

Q3.

(a) graph to show:
 straight line from origin **(1)**
end point at 4.5 (V), 9.0 (μF) **(1)**

2

(b) (i) $\Delta W = V \Delta Q$ explained **(1)**
 energy stored or total work done in charging = area under graph or
 charge $\times$ average voltage **(1)**

energy stored = work done ($= \frac{1}{2}QV$) **(1)**

(ii) $Q = 2.0 \times 1.5 = 3.0 \, (\mu\text{C})$ **(1)**
 $E (= \frac{1}{2} QV) = \frac{1}{2} \times 3.0 \times 10^{-6} \times 1.5 = 2.25 \times 10^{-6} \text{ J}$ **(1)**
 [or $E = (\frac{1}{2} CV^2 = \frac{1}{2} \times 2.0 \times 10^{-6} \times 1.5^2 = 2.25 \times 10^{-6} \text{ J})$

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[7]