Answers: Tute 6

1. a). Charge on each plate $Q = CV = 1.0 \times 10^{-12} \times 6.0 = 6.0 \times 10^{-12} C$

   b) $Q = 1.0 \times 10^{-3} \times 6.0 = 6.0 \times 10^{-3} C$

2. a)

$$C = (\varepsilon_0 A)/L$$

$$\therefore A = CL/\varepsilon_0 = (1.0 \times 10^{-6} \times 1.0 \times 10^{-3})/(8.85 \times 10^{-12})$$

$$\therefore A = 1.1 \times 10^{2} m^{2}$$

   b)

$$C = (k\varepsilon_0 A)/L$$

$$\therefore L = k\varepsilon_0 A/C = (4.0 \times 8.85 \times 10^{-12} \times 1.0)/(1.0 \times 10^{-6})$$

$$L = 35.4 \times 10^{-6} m$$

3. Work to transfer an increment of charge dq from the plate carrying –q to the plate carrying +q (potential difference V).

$$dW = Vdq = \frac{q}{C}dq$$

$$\therefore W = \int_0^q dW = \int_0^q \frac{q}{C}dq = \frac{q^2}{2C}$$

So _ comes as a result of calculating the total charge.

4. a) $P = \frac{dE}{dt} \cong \frac{\Delta E}{\Delta t} \therefore \Delta E = P\Delta t = 200 \times 1.0 \times 10^{-3} = 0.2 J$

   b) $\Delta E = W = \frac{1}{2}CV^2 \therefore V = \sqrt{\frac{2W}{C}} = \sqrt{\frac{2 \times 0.2}{160 \times 10^{-6}}} = 50 V$

   c) $Q = CV = 160 \times 10^{-6} \times 50 = 8 \times 10^{-3} C$

5. a) (i) no change by conservation of charge

   (ii) capacitance without dielectric $C_1 = \varepsilon_0 \frac{A}{L}$

   capacitance with dielectric $C_2 = k\varepsilon_0 \frac{A}{L}$, so k* bigger.

   (iii) $V = \frac{q}{C}$ so V decreases k*

   (iv) $W = \frac{1}{2}QV^2$ so again decreases k*

   (b) Since V is a constant, Q and C must change in the same way (i.e. Q/C = constant).

6. a) $|Q| = CV = 2.0 \times 10^{-6} \times 3.0 = 6.0 \times 10^{-6} C$

   b) $U = \frac{1}{2}QV = 1/2 \times 6.0 \times 10^{-6} \times 3.0 = 9.0 \times 10^{-6} J$

   c) $W = QV = 3.0 \times 6.0 \times 10^{-6} = 1.8 \times 10^{-6} J$

   d) $W - V = Q \therefore Q = 9.0 \times 10^{-6} J$ of heat.

7. a) $Q_{total} = Q_1 + Q_2 ; V = const. (parallel);$

$\therefore Q_{total} = C_1 V + C_2 V = V(C_1 + C_2)$

$Q_{total} = C_{total} V \ ? \ C_{total} = C_1 + C_2$

b) $C_{total} = 2 \times 10^{-6} + 4 \times 10^{-6} = 6 \times 10^{-6} F$

$Q_{total} = constant.$

8. a) $V_{total} = V_1 + V_2 = \frac{Q_{total}}{C_1} + \frac{Q_{total}}{C_2}$

$V_{total} = \frac{Q_{total}}{C_{total}} \ ? \ \frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$

b) $C_{total} = (\frac{1}{2 \times 10^{-6}} + \frac{1}{4 \times 10^{-6}})^{-1} = 1.3 \times 10^{-6} F$

9. Current i=

$i = \frac{dq}{dt} = \frac{q}{t} \therefore q = it$

$q = 0.5 \times 3600 = 1800 C$

$No. of ions = N = \frac{q_{total}}{q_{ion}} = \frac{1800}{2 \times 1.602 \times 10^{-19}} = 5.6 \times 10^{21}$

10. Current = (density of carriers)*(cross-sectional area)*(carrier charge)*(ave

$i.e. - i = \rho_{carr} A q_{carr} v_{carr}$

$\therefore i = \rho \pi r^2 q v$

$\therefore \frac{i}{q \rho \pi r^2} = v_{drift} = 3.42 \times 10^{-4} m/s$

11. Resistance= (resistivity)*(length of conductor)/(cross-sectional area)

$$R = \frac{\rho L}{A} = 2 \times \frac{0.3}{\pi \times (\frac{10^{-5}}{2})^2} = 7.6 \times 10^9 \Omega$$

12. $R = \rho \frac{L}{A} \therefore r = \sqrt{\frac{\rho L}{\pi R}} = 1.05 \times 10^{-3} m$

13. a) $I = \frac{V}{R} = \frac{12}{2} = 6A$

b) Charge transported: $Q = It = 6 \times 10 = 60C$

c) Work done on the charge in battery: $W_{batt} = -QV = -60 \times 12 = -720V$

d) Work done on the charge in resistor: $W_{resist} = +QV = 60 \times 12 = 720V$

e) Total work done: $W_{total} = W_{batt} + W_{resist} = 0$

f) Energy dissipated in resistor= 720 J

g) Chemical supplied by battery.

14. a) Current= (Voltage)/(Total Resistance)= 6/9= 0.67 A

b) Potential difference across 1Ω: 0.67*1= 0.67 V

Across 2Ω = 0.67*2 = 1.33 V and across 6Ω = 0.67*6 = 4 V

15.a) Current = (Total Voltage)/(Total Resistance)= (-1.5+1.5+1.5) / (4+6) =0.

b) Starting from the left top corner: -1.5 V, +1.5 V, +1.5 V, potential drop Ω = -0.6 V, and potential drop across 4 Ω = -0.9 V.