Level - I
Electric Potential

Q1.(a) Refer to text.

Q2.(d) $F \perp$ displacement.

Q3.(b) Charge flows from higher to lower potential

Q4.(b) Refer to text.

Q5.(d) " " "

Q6.(b) $V = 4 \times \frac{KQ}{r} = \frac{4 \times 9 \times 10^9 \times \frac{10}{3} \times 10^{-9}}{4\sqrt{2} \times 10^{-2}}$

$= 1500\sqrt{2}\ V$

Q7. (b) $V = -\int \vec{E} \cdot d\vec{x} = -\int_0^x (E_0 \hat{i}) \cdot (dx\,\hat{i}) = -E_0 x$

Q8. (b) Centre is equidistant from all charge. So, potential due to $2q = -$ Potential due to $-q$ & $-q$

So net $\underline{V = 0}$

Q9.(c) All points A, B, C, D & E are on an equi-potential surface. So, work done $= 0$.

Q10.(d) $V = +ve$, 0 or $-ve$ depending on whether a $+ve$ or $-ve$ charge is nearby.

Q11.(b) $E = \frac{Kq}{r^2} \leq 3 \times 10^6 \Rightarrow \cancel{9}^{3} \times \cancel{10^9}^{10^3} \times \frac{q}{5^2} \leq \cancel{3} \times 10^6$

$q \leq \frac{25}{3} \times 10^{-3} \Rightarrow q = 2 \times 10^{-3}$ (approx.)

Q12.(d) $V_1 = V_2$ after connecting

So, $\frac{\cancel{K} q}{\cancel{4}2} = \frac{\cancel{K}(120 - q)}{\cancel{6}3} \Rightarrow 3q = 240 - 2q$

$\Rightarrow q = 48\,\mu C$

So, $32\,\mu C$ flows from A to B.

Q13. (a) Motion is on an equipotential surface.

Q14. (c) " " " " " " ".

Q15. (c) $U = 3\frac{kq^2}{r} = \frac{3\times 9\times 10^9 \times (10\times 10^{-5})^2}{(0.1)}$

$= 27\,J$

Q16. (c) $V_i = 4\times\frac{1}{4\pi\varepsilon_0}\frac{Q}{\frac{a}{\sqrt{2}}} = \frac{\sqrt{2}Q}{\pi\varepsilon_0 a}$

$V_f = 0$

$\Delta V = -\frac{\sqrt{2}Q}{\pi\varepsilon_0 a}$

$W = -Q(\Delta V) = \frac{\sqrt{2}Q^2}{\pi\varepsilon_0 a}$

Q17. (b) Kinetic energies, $\frac{K_A}{K_B} = \frac{\frac{1}{2}mv_A^2}{\frac{1}{2}mv_B^2} = \frac{qV}{4qV}$

$\frac{v_A}{v_B} = \frac{1}{2}$

Q18. (d) Refer to text.

Q19. (c) At mid point of dipole, $\vec{E} \neq 0$ but $V=0$.

Q20. (a) P, L, M & N lie on equipotential surface.

So, $W=0$ for all paths except $P\rightarrow K$.

Q21. (a) $E = qV = 50\times 10^{-6} \times \frac{9\times 10^9 \times 50\times 10^{-1}}{\sqrt{2}} \times 4$

$= 45\sqrt{2} \approx 64\,J$

Q22. (b) $QE = mg \Rightarrow Q\frac{2400}{d} = \rho\left(\frac{4}{3}\pi r^3\right)g$

$Q'\frac{600}{d} = \rho\left(\frac{4}{3}\pi\left(\frac{r}{2}\right)^3\right)g = \frac{1}{8}\times Q\left(\frac{2400}{d}\right)$

$Q' = \frac{Q}{2}$

Q24.(c) After joining $V_1 = V_2$

$$\frac{\cancel{k} q}{\cancel{20}\,4} = \frac{\cancel{k}(20-q)}{\cancel{15}\,3} \Rightarrow 3q = 80 - 4q$$

$$\Rightarrow q = \frac{80}{7} C.$$

Also, $\frac{\sigma_1}{\sigma_2} = \frac{\frac{q}{4\pi(20)^2}}{\frac{20-q}{4\pi(15)^2}} = \frac{\frac{\cancel{80}\,4}{7} \Big/ 400}{\frac{\cancel{60}\,3}{7} \Big/ 225} = \frac{4 \times \cancel{225}\,75}{\cancel{3} \times 400} = \frac{3}{4}$

So, $\sigma_1 < \sigma_2$

Q25.(c) $U = \frac{kq^2}{2a} + 2 \times \frac{k(-2q^2)}{a} = -\frac{7q^2}{8\pi\varepsilon_0 a}$

Q26.(d) $U_1 = \frac{k(100)(5)\times 10^{-12}}{0.4}$ (AC = 50 cm)

$$U_2 = \frac{k(100)(5)\times 10^{-12}}{0.5}$$

$$W = \Delta U = 9 \times 10^9 \times 500 \times 10^{-12}\left(\frac{1}{0.5} - \frac{1}{0.4}\right)$$

$$= -\frac{9}{4} J$$

Q27.(a) Refer to text.

Q28.(b) $E = qV = 2e \times 10^6 = 2MeV$

Q29.(a) $V = \frac{W}{q} = \frac{10}{5} = 2V$

Q30. (c) $a = \frac{qE}{m} \Rightarrow v = \sqrt{2ay} \Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}m \times 2ay$

$$= \cancel{m} \times \frac{qE}{\cancel{m}} \times y$$

Capacitance

Q31.(c) $V = \frac{V_0}{K} = \frac{V_0}{8} \Rightarrow K = 8$

Q32.(b) $V' = \frac{V_0}{K}$, $U' = \frac{1}{2}KC \times \left(\frac{V_0}{K}\right)^2 = \frac{1}{2}\frac{CV^2}{K} = \frac{U_0}{K}$

But $Q = Q_0$. As charge is conserved.

Q33.(a) Refer to text.

Q34.(a) $E = \frac{1}{2}CV^2 = \frac{1}{\cancel{2}} \times \cancel{4}^{2} \times 10^{-6} \times (100)^2 = 0.02J$

Q35.(d) Charge flows from lower to higher potential unless $V_1 = V_2$, resulting in decrease in energy.

$V_1 = V_2 \Rightarrow \frac{Q_1}{4\pi\varepsilon_0 R_1} = \frac{Q_2}{4\pi\varepsilon_0 R_2} \Rightarrow Q_1R_2 = Q_2R_1$

Q36(a) If battery remains connected, $V' = V_0$

So, $Q' = KCV_0 = KQ_0$. $U' = \frac{1}{2}Q'V_0 = KU_0$

Q37(c) Refer to text.

Q38.(b) " " "

Q39.(b) Energy is lost as heat.

Q40.(c) Charge flows from higher potential (smaller sphere) to lower potential (larger sphere).

Q41.(c) $V' = 8V \Rightarrow \frac{4}{3}\pi r'^3 = 8 \times \frac{4}{3}\pi r^3$

$\Rightarrow r' = 2r$

So, $C' = 4\pi\varepsilon_0(2r) = 2(4\pi\varepsilon_0 r) = 2C$

Q42.(a) $E = \frac{1}{2}CV^2 = \frac{1}{2}(50 \times 10^{-13}) \times 100 = 2.5 \times 10^{-3}J$

Q43.(b) Potential Gradient = Electric Field

At breakdown, e. field is called dielectric strength

Q44.(d) $C' = KC_0 \Rightarrow K = \frac{C'}{C_0} = \frac{11\cancel{0}}{5\cancel{0}} = 2.2$

Q45.(c) Refer to text.

Q46.(d) " " "

Q47.(a) " " "

Q48.(d) " " "

Q49.(b) $C \propto \frac{1}{d}$

Q50.(b) $\underbrace{\boxed{V' = 8V}}_{\text{Volume}} \Rightarrow \frac{4}{3}\pi r'^3 = \frac{4}{3}\pi r^3 \times 8 \Rightarrow r' = 2r$

So, Potential $= \frac{K\,8q}{2r} = 4\left(\frac{kq}{r}\right)$ ~~= 4V~~

$=$ 4 × Potential of 1 drop

Q51.(b) $r' = 10r$

$V' = \frac{K(1000q)}{10r} = 100\left(\frac{kq}{r}\right) = 100V$

Q52.(b) $E' = \frac{E}{K} = \frac{E}{2}$

Q53.(a) Material must have high dielectric constant and high dielectric strength.

Q54.(b) Refer to text.

Q55.(d) Charge remains conserved.

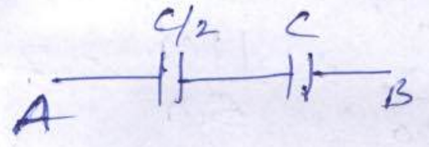
Q56.(c) Refer to text.

Q57.(b) Repeat

Q58.(C) Refer to text.

Q59.(b) $C_{eq} = 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots \infty$

$= \frac{1}{1-\frac{1}{2}} = 2\mu F$

Q60.(a)  Max voltage on $\frac{C}{2} = 100V$.

So, voltage on $C = 50V$.

As. $\frac{C_1}{C_2} = \frac{V_2}{V_1}$ in series.

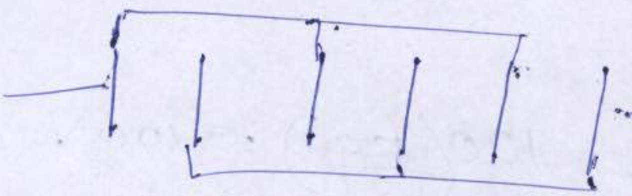
Grouping of Capacitors

Q1.(d) In series connection, potential is added algebrically.

Q2.(a) Refer to text.

Q3.(c) (n) plates for $(n-1)$ capacitors in parallel.

So, $C_{eq} = (n-1)C$

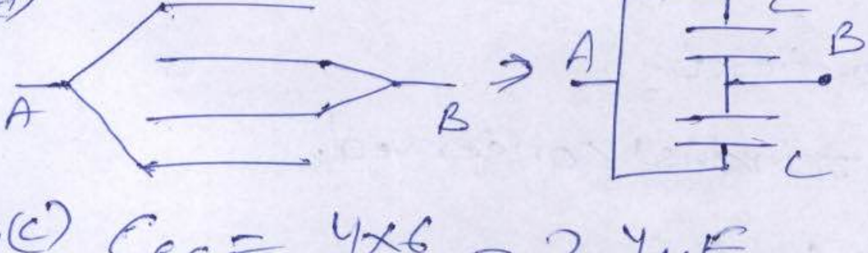


So on

Q64.(a) In (a), $\frac{1}{C_{eq}} = \frac{1}{5C} + \frac{2}{C} = \frac{11}{5C} = \frac{11}{10}$

$C_{eq} = \frac{10}{11}\mu F$

Q65.(a)



$\Rightarrow C_{eq} = 2C$
$= \frac{2\varepsilon_0 A}{d}$

Q66.(c) $C_{eq} = \frac{4\times6}{4+6} = 2.4\mu F$

$Q = 2.4 \times 500 = 1200\mu C$

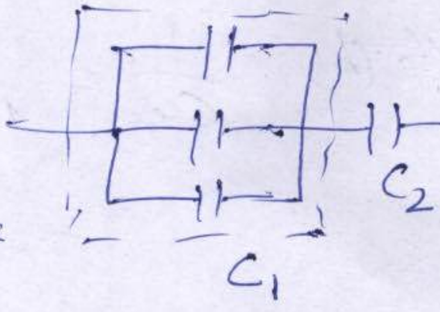
Q67.(c) $C' = C_1 + C_2 = \frac{K_1\varepsilon_0\frac{A}{2}}{d} + \frac{K_2\varepsilon_0\frac{A}{2}}{d}$

$= \frac{(K_1+K_2)\varepsilon_0 A}{2d} = \frac{3\cancel{6}\,\varepsilon_0 A}{2d} = 3C = 30\mu F$

Q 68. (d) In series, $q_1 = q_2 = q_3$

Q 69. (b) No flow of charge happens. So, energy remains conserved. But potential becomes n-times.

Q 70. (d) $C_1 = 3\mu F$



$C_2 = 1\mu F$

$$C = \frac{C_1 C_2}{C_1 + C_2} = \frac{3\times 1}{3+1} = \frac{3}{4}\mu F$$

Q 71 (d) In this Wheatstone Bridge arrangement, middle branch is ineffective.

So, $C_{eq} = 5\mu F \parallel 5\mu F$

$$= \underline{10\mu F}$$

Q 72. (a) $\frac{1}{C_s} = \frac{1}{3} + \frac{1}{9} + \frac{1}{18} \Rightarrow C_s = 2\mu F$

$C_p = 3 + 9 + 18 = 30\mu F$

$$\frac{C_s}{C_p} = \frac{1}{15}$$

Q 73. (b) ~~$C_{eq} = 4+2+4 = 10\mu F$~~

$\frac{1}{C_{eq}} = \frac{1}{4} + \frac{1}{8} + \frac{1}{4} \Rightarrow C_{eq} = \frac{8}{5}\mu F$

Energy $= \frac{1}{2} \times \frac{8}{5} \times (15)^2$

$= \frac{1}{\cancel{2}} \times \frac{\cancel{8}^{4}}{\cancel{5}} \times \cancel{15}^{3} \times 15 = 1800$ ergs

Q 74. (c) $E = \frac{1}{2} \times (2\times 10^{-6}) \times (200)^2$

$= 0.04 J$

Q75. (c) In parallel, $V_2 = V_3$

In series, $V_1 + V_2 = V$ or $V_1 + V_3 = V$

& $Q_1 = Q_2 + Q_3$

Q76. (b) $\frac{1}{C_{eq}} = \frac{1}{12} + \frac{1}{5} + \frac{1}{20}$

$= \frac{5+12+3}{60} = \frac{\cancel{20}}{\cancel{60}} \frac{1}{3}$

$C_{eq} = 3\,\mu F$

Q77. (b) In series, $Q_1 = Q_2 = Q$

So, $\frac{E_1}{E_2} = \frac{\frac{Q^2}{2C_1}}{\frac{Q^2}{2C_2}} = \frac{C_2}{C_1} = \frac{0.6}{0.3} = 2$

Q78. (b) In series, $Q_1 = Q_2 \Rightarrow C_1V_1 = C_2V_2$

$\Rightarrow \frac{V_1}{V_2} = \frac{C_2}{C_1} = \frac{6}{4} = \frac{3}{2}$

So, $V_1 = \frac{3}{5} \times 500 = 300\,V$

Q79. (c) $V_1 = V\left(\frac{C_2}{C_1+C_2}\right)$

Q80. (c)

Q81. (c) $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow C_{eq} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)^{-1}$

Q82. (c) $C_p = 2C$

$C_s = \frac{C}{2}$ $\Rightarrow \frac{C_p}{C_s} = \frac{4}{1}$

Q83. (a) $V_1 = V_2 \Rightarrow \frac{Q_1}{C_1} = \frac{Q_2}{C_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{C_1}{C_2}$

Q84. (c) No transfer of charges will happen if $V_1 = V_2$. So, no exchange of energy.

Q85. (d) For series, $C' = \frac{C}{2} = \frac{1}{2}\mu F$

For parallel, $C_{eq} = C' + C = \frac{1}{2} + 1 = 1.5 \mu F$.

Q86. (a) After connection, q is conserved.

Let charge on C_1 is q & on C_2 is $C_1 V_0 - q$

So, $V_1 = V_2 \Rightarrow \frac{q}{C_1} = \frac{C_1 V_0 - q}{C_2}$

$\Rightarrow q = \frac{C_1 V_0}{C_2} \frac{(C_1 C_2)}{C_1 + C_2}$

$q = \frac{C_1 V_0}{\cancel{C_2}}\left(\frac{C_1 \cancel{C_2}}{C_1 + C_2}\right) = \frac{C_1^2 V_0}{C_1 + C_2}$

$\cancel{\text{So, } \frac{E_1}{E_2} = \frac{\frac{1}{2} q V}{\frac{1}{2}(C_1 V_0 - q)V} = \frac{\frac{C_1 V_0}{C_2}\left(\frac{C_1 C_2}{C_1 + C_2}\right)}{C_1 V_0 - \frac{C_1^2 V_0}{C_1 + C_2}}}$

$\cancel{= \frac{\frac{C_1^2 V_0}{C_1 + C_2}}{\frac{C_1 C_2 V_0}{C_1 + C_2}}}$

So, Energy before connecting,

$E_1 = \frac{1}{2} C_1 V_0^2$

$E_2 = \frac{1}{2} q V + \frac{1}{2}(C_1 V_0 - q) V$

$= \frac{1}{2} C_1 V_0 \left(\frac{C_1 V_0}{C_1 + C_2}\right)$

So, $\frac{E_1}{E_2} = \frac{\frac{1}{2} C_1 V_0^2}{\frac{1}{2} \frac{C_1^2 V_0^2}{C_1 + C_2}} = \frac{C_1 + C_2}{C_1}$

Q87.(a) (i) Between A & B, $C_{eq_1} = 3 + \frac{1}{3} \times 3 = 4\mu F$

(ii) " A & C, $C_{eq_2} = \left(\frac{1}{2} \times 3\right) \cdot 2 = 3\mu F$

So, $\frac{C_{eq_1}}{C_{eq_2}} = \frac{4}{3}$

Q88.(c) Net charge $= C_1V_1 + C_2V_2 = Q_0$

Let charge on C_1 be q.

So, $V_1' = V_2' = V \Rightarrow \frac{q}{C_1} = \frac{C_1V_1 + C_2V_2 - q}{C_2}$

$$\left.\begin{aligned} &\Rightarrow q = \left(\frac{C_1}{C_1+C_2}\right)Q_0 \\ &\Rightarrow Q_0 - q = \frac{C_2}{C_1+C_2}Q_0 \end{aligned}\right\} \Rightarrow V = \frac{q}{C_1} = \frac{Q_0}{C_1+C_2}$$

So, loss of energy $= \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 - \frac{1}{2}(C_1+C_2)V^2$

$$= \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 - \frac{1}{2}\cancel{(C_1+C_2)}\frac{(C_1V_1+C_2V_2)^2}{(C_1+C_2)^{\cancel{2}}}$$

$$= \frac{\frac{1}{2}C_1(\cancel{C_1}+C_2)V_1^2 + \frac{1}{2}C_2(C_1+\cancel{C_2})V_2^2 - \frac{1}{2}(\cancel{C_1^2V_1^2} + \cancel{C_2^2V_2^2} + 2C_1C_2V_1V_2)}{(C_1+C_2)}$$

$$= \frac{1}{2}\frac{C_1C_2(V_1^2+V_2^2-2V_1V_2)}{(C_1+C_2)}$$

$$= \frac{1}{2}\frac{C_1C_2(V_1-V_2)^2}{(C_1+C_2)}$$

Q89.(b) $C = C_1 + C_2 = \frac{K_1\varepsilon_0 A}{2t} + \frac{K_2\varepsilon_0 A}{2t} = \frac{\varepsilon_0 A}{2t}(K_1+K_2)$

Q90.(c) $C_{eq} = \frac{C}{3} = \frac{2}{3}F$

Level - II

Electric Potential

Q1.(d) Momentum, $p = mv = \sqrt{m^2v^2}$

$= \sqrt{2m\left(\frac{1}{2}mv^2\right)} = \sqrt{2mK}$

$K = KE = qV$

So, $\frac{p_1}{p_2} = \frac{\sqrt{2m_e(eV)}}{\sqrt{2m_\alpha(2eV)}} = \sqrt{\frac{m_e}{2m_\alpha}}$

Q2.(b) $\Delta K = eV$

$= 1.6\times10^{-19}\times 50000 = 8\times10^{-15}J$

Q3.(c) $\Delta K = eV = e(1\,\text{Volt})$

$= 1eV$

Q4.(b) $\frac{Q_1}{Q_2} = \frac{C_1\cancel{V}}{C_2\cancel{V}} = \frac{\cancel{4\pi\varepsilon_0}R_1}{\cancel{4\pi\varepsilon_0}R_2}$

Q5.(c) $V = 9\times10^9\times\frac{(10+5-3+8)\times10^{-6}}{1}$

$= 1.8\times10^5 V$

Q6.(b) Due to symmetry, $E = 0$

but V = algebric sum of V due to all charges

so, $V \neq 0$

Q7.(c) $W = \Delta U = +(U_2 - U_1)$

$= \frac{kq_1q_2}{r_2} - \frac{kq_1q_2}{r_1} = 9\times10^9\times12\times10^{-6}\times8\times10^{-6}\left(\frac{1}{0.06}-\frac{1}{0.1}\right)$

$= 13J$

Q8.(a) $\vec{F} = q\vec{E}$

$W = \vec{F}\cdot\vec{r} = Q(e_1a + be_2)$

Q9.(b) $V = \frac{kq}{r} = 9\times10^9\times\frac{100\times10^{-6}}{9} = 10^5 V$

Q10. (a,d) ⇐ Correction

Q11. (b) $U = \frac{kQq}{a} + \frac{kQq}{\sqrt{2}a} + \frac{kq^2}{a} = 0$

$\Rightarrow Q = \frac{-2q}{2+\sqrt{2}}$

Q12. (c) $\frac{1}{2}mv^2 = eV \Rightarrow v = \sqrt{\frac{2eV}{m}}$

Q13. (c) Q = constant.

So, $V = \frac{Q}{4\pi\varepsilon_0 R}$. If R is doubled, V is halved.

$V = 8\,V$

Q14. (c) $\frac{1}{2}\varepsilon_0 E^2$ = Energy Density = $\frac{\text{Energy}}{V}$

$= \frac{M^1L^2T^{-2}}{L^3} = M^1L^{-1}T^{-2}$

Q15 (a) $W = U_2 - U_1$

$= \frac{k(-5)(3)\times10^{-12}}{15} + \frac{k(2)(3)\times10^{-12}}{5} - \left[\frac{k(-5)(3)\times10^{-12}}{5} + \frac{k(2)(3)\times10^{-12}}{15}\right]$

$= 2.8\,J$

Q16. (c) Refer to text.

Q17. (c) " " ".

Q18. (d) $120 = \frac{Q}{4\pi\varepsilon_0(2)}$. So. $\frac{Q}{4\pi\varepsilon_0(6)} = \frac{120}{3} = 40V$

Q19. (d) Since the distance ~~same~~ between (Q) and (-q) remains the same, V = same $\Rightarrow \Delta V = 0$

$\Rightarrow W = 0$

Q20. (a) ~~W = qV~~. Work done $(W) = qV$ = Energy

Q21. (b) $V_1 = V_2 \Rightarrow \frac{q_1}{4\pi\varepsilon_0 a} = \frac{q_2}{4\pi\varepsilon_0 b} \Rightarrow \frac{q_1}{a} = \frac{q_2}{b}$

$$\Rightarrow \frac{q_1}{q_2} = \frac{a}{b} \quad \Rightarrow \frac{\frac{q_1}{4\pi a^2}}{\frac{q_2}{4\pi b^2}} = \frac{q_1}{q_2} \times \frac{b^2}{a^2}$$

$$= \frac{a}{\cancel{b}} \times \frac{b^{\cancel{2}}}{a^{\cancel{2}}} = \frac{b}{a}$$

Q22 (a) $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

Q23 (c) $V = \frac{KQ}{r} = \frac{9\times10^{9} \times 1.6\times10^{-19}}{0.53\times10^{-10}} = 27.2\,V$

Q24 (a) $\frac{1}{2}m(v^2 - u^2) = qV$

$$\frac{1}{2}(10^{-3})\left((0.2)^2 - u^2\right) = 10^{-8}\times600$$

$$u = 22.8\,cm/s$$

Q25 (a) $\frac{2KQq}{l} + \frac{Kq^2}{l} = 0 \Rightarrow Q = -\frac{q}{2}$

Q26 (c) $V = \frac{W}{q} = \frac{2}{20} = 0.1\,V$

~~Q27. 4×10^{20}~~

Q27 (b) Energy $= \frac{4\times10^{20}}{1.6\times10^{-19}}$

$$V = \frac{\text{Energy}}{Q} = \frac{4\times10^{20}}{1.6\times10^{-19}\times0.25} = 256\,V$$

Q28 (a) $E = eV = 1.6\times10^{-19}\times100$

Q29 (c) Refer to text.

Q30 (d) $U = 8\left(\frac{1}{4\pi\varepsilon_0}\frac{(-q)(q)}{\frac{\sqrt{3}}{2}b}\right) = \frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

Q31 (c) $U = (2e)V = 2e\times200 = KE$

Q32 (c) $KE = e(1kV)$

Q33 (d) $V = \underbrace{\frac{Q}{4\pi\varepsilon_0 \left(\frac{R}{2}\right)}}_{\text{Due to central charge}} + \underbrace{\frac{(Q+q)}{4\pi\varepsilon_0 R}}_{\text{Due to outer surface}} + \underbrace{\frac{-Q}{4\pi\varepsilon_0 R}}_{\text{Due to inner surface.}}$

$= \frac{2Q}{4\pi\varepsilon_0 R} + \frac{q}{4\pi\varepsilon_0 R}$

Q34. (b) $|E| = \text{max}$

$\Rightarrow \left(\frac{dV}{dx}\right) = \text{max}$ which is for region 2.

Q35. (a) Refer to text.

Capacitance

Q36. (c) Refer to text.

Q37. (b) $C' = \frac{K\varepsilon_0 A}{2d} = 2 \times \frac{\varepsilon_0 A}{d} \Rightarrow \underline{K = 4}$

Q38. (b) Refer to text.

Q39. (a) Refer to text.

Q. 40 (d) $C' = \frac{\varepsilon_0 A}{d/2} = 2C$

So, $Q = CV = C'V' \Rightarrow V' = \frac{V}{2}$

~~To charge the capacitor upto V, energy needed.~~

$\cancel{E = \frac{1}{2}(2C)V^2 - \frac{1}{2}(2C)\left(\frac{V}{2}\right)^2}$

To charge the capacitor upto V, energy supplied by battery $= QV = CV^2$

Q41 (d) $Q = qn$ & $n\frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = n^{1/3} r$

So, $V' = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R} = \frac{1}{4\pi\varepsilon_0}\frac{qn}{n^{1/3} r} = \underline{V n^{2/3}}$

Q42. (c) Charge stored on capacitors is independent of the shape.

Q43. (b) $\Delta E = \frac{1}{2}(6\times10^{-6})\left[(20)^2-(10)^2\right]$

$= 9\times10^{-4}\,J$

Q44. (c) Thin strip will have no impact.

Q45 (a) Same as Q.41

Q46. (b)

Q47. (a) Since V = same, C = same.

So, $\frac{\varepsilon_0 A}{\cancel{d}} = \frac{\varepsilon_0 A}{d'-t+\frac{t}{K}}$

$2 = 3.6 - 2 + \frac{2}{K} \Rightarrow \frac{2}{K} = 0.4 \Rightarrow \underline{K=5}$

Q48. (b)

Q49. (a) After connection, $V_1 = V_2 = V$

$\frac{300-q}{\cancel{4\pi\varepsilon_0}(\cancel{20})_2} = \frac{q}{\cancel{4\pi\varepsilon_0}(\cancel{10})}$

$\Rightarrow q = 100\,\mu C$

$V = \frac{9\times10^9\times100\times10^{-6}}{0.1} = 9\times10^6\,V$

Q50. (c) It will be pulled into the electric field region.

Q51. (d) Refer to text.

Q52.(c) $V' = \frac{V}{K}$

Q53.(b) $\frac{\cancel{\varepsilon_0}\,\pi (0.02)^2}{d} = 4\cancel{\pi}\cancel{\varepsilon_0}(1)$

$\frac{4\times10^{-4}}{d} = 4 \Rightarrow 0.1\,mm$

Q54.(c) Refer to text.

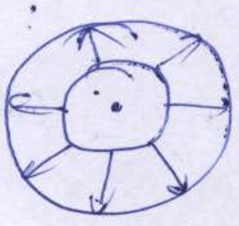
Q55.(a) $1\times10^{-6} = 4\pi\varepsilon_0 R = \frac{1}{9\times10^{9}}\times R$

$R = 9\times10^{3} = 9\,km$

Q56(d) Refer to text

Q57(b) $E = \frac{V}{d} = \frac{100}{0.001} = 100000\ V/m$

Q58(d)



In spherical capacitor, field lines spread radially outwards or inwards & hence become less dense as we move away from centre. So, field will decrease with distance.

Q59(d) For metal $k = \infty$

So, $C' = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}} = \frac{\varepsilon_0 A}{d/2} = 2C$

Q60.(b) Refer to text.

Q61.(c) " " ".

Q62.(d) " " "

Q63.(a)

Q64.(c) $C' = \frac{K\varepsilon_0 A}{2d} = 2\left(\frac{\varepsilon_0 A}{d}\right) \Rightarrow K = 4$

Q65 (b) $\because \frac{\varepsilon_0 \pi (0.02)^2}{d} = 4\pi\varepsilon_0 (0.1)$

$\Rightarrow d = 10^{-3} m$

Q66. (c) Refer to text.

Q67. (a) $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$\frac{1}{C_{eq}} = \frac{d_1}{K_1 \varepsilon_0 A} + \frac{d_2}{K_2 \varepsilon_0 A} + \frac{d_3}{K_3 \varepsilon_0 A}$

$C_{eq} = \frac{\varepsilon_0 A}{\left(\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3}\right)}$

Q68. (d) Refer to text.

Q69 (b) " " "

Q70 (c) $\because C = 4\pi\varepsilon_0 \frac{(R-x)R}{x}$

Q71. (d) Refer to text.

Q72. (a) Same as 41

Grouping of Capacitors

Q73. (c) $\frac{V_1}{V_2} = \frac{\frac{Q}{C_1}}{\frac{Q}{C_2}} = \frac{C_2}{C_1} = \frac{2}{1}$

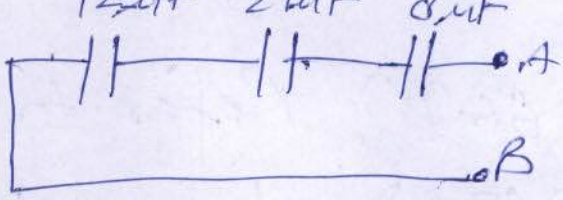
$V_1 + V_2 = 120 \Rightarrow V_1 = 80V$ & $V_2 = 40V$

Q74. (a) All 4 are in parallel

So, $C_{eq} = 4C = 32\mu F$

Q75. (d). 10 μF, 5 μF & 9 μF are in parallel.

So, $C_1 = 24\,\mu F$



$$\frac{1}{C_{eq}} = \frac{1}{12} + \frac{1}{24} + \frac{1}{8}$$

$$= \frac{2+1+3}{24} \Rightarrow C_{eq} = 4\,\mu F$$

Q76. (b) $C_{eq} = 3C$ (parallel)

Q77 (b) All three capacitor are in parallel.

So, $C_{eq} = 3\left(\frac{\varepsilon_0 A}{d}\right)$

Q78 (c) Energy = max if C = max ⇒ parallel.

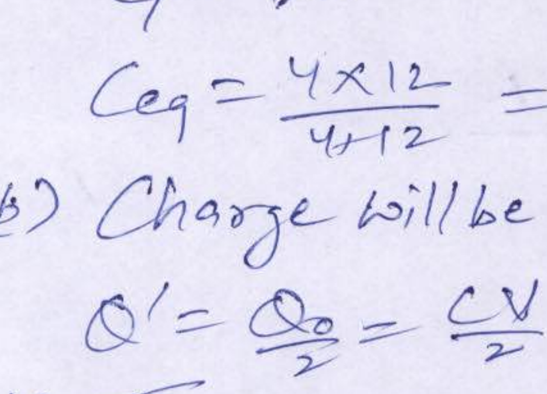
Q79. (d) $C_1 = 4\,\mu F$

$$C_{eq} = \frac{4 \times 12}{4+12} = 3\,\mu F$$

Q80. (b) Charge will be shared equally now.

$$Q' = \frac{Q_0}{2} = \frac{CV}{2}$$

Q81. (d) The arrangement is a Wheatstone Bridge.



Since the bridge is balanced, we can remove 24 μF

$$\Rightarrow C_{eq} = \frac{15 \times 30}{15+30} = 10\,\mu F$$

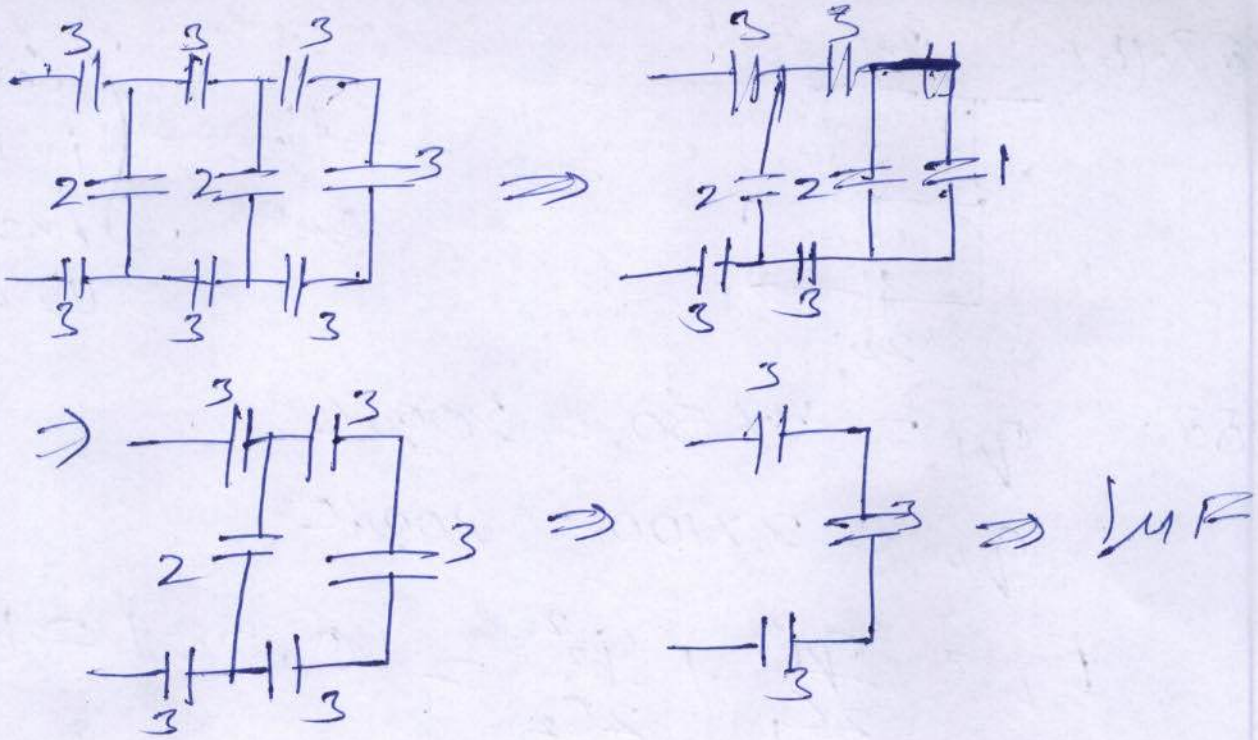
Q82. (c) ~~$q_1 = 20$~~

$Q_0 = 2 \times 200 = 400\,\mu C$

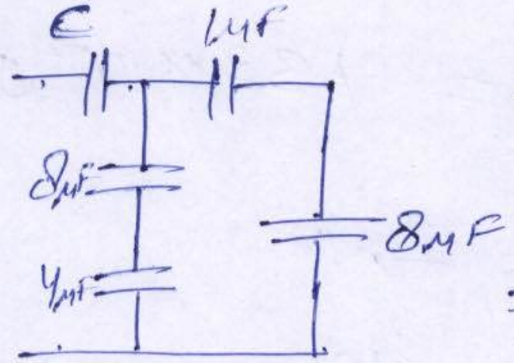
$q_1 = \frac{20 \times 2}{} = 40\,\mu C \Rightarrow q_2 = 360\,\mu C$

So, $C_2 = \frac{q_2}{V} = \frac{360}{20} = 18\,\mu F$

Q83 (a)



Q84.



$$\frac{8\times 4}{\cancel{12}\,3} + \frac{8\times 1}{9}$$

$$\Rightarrow \frac{32\times 3 + 32}{36} = \frac{32\times 4}{\cancel{36}\,9}$$

$$\frac{C\times \frac{32}{9}}{C+\frac{32}{9}} = 1 \Rightarrow \frac{32C}{9} = C + \frac{32}{9}$$

$$\Rightarrow \frac{23C}{9} = \frac{32}{9} \Rightarrow C = \frac{32}{23}\,\mu F$$

Q85 (d) $\frac{1}{C_{eq}} = \frac{d/2}{K_1\varepsilon_0 A} + \frac{d/2}{K_2\varepsilon_0 A} = \frac{d}{2\varepsilon_0 A}\left(\frac{K_1+K_2}{K_1K_2}\right)$

$$C_{eq} = \frac{2\varepsilon_0 A}{d}\left(\frac{K_1K_2}{K_1+K_2}\right)$$

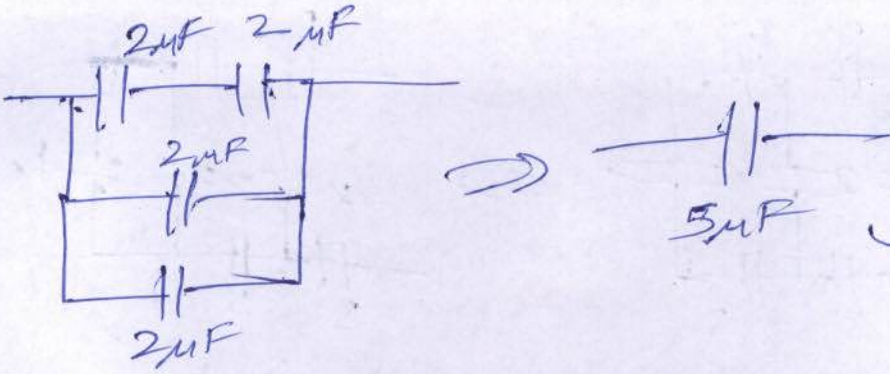
Q86 (d) $C_{eq} = \frac{4.5\times 9}{4.5+9} = 3\,\mu F$

$Q = 12\times 3 = 36\,\mu C$

So, $V_1 = \frac{36}{4.5} = 8V$

← Correction in key. Answer is (d) & not (b)

Q87. (b)



Correction in key. Answer is (b) & not (a)

Q88. $q_1 = 4 \times 50 = 200\mu C$

$q_2 = 2 \times 100 = 200\mu C$

$$E_i = \frac{q_1^2}{2C_1} + \frac{q_2^2}{2C_2} = 0.5 + 1 = 1.5 \times 10^{-2} J$$

$$E_f = \frac{(q_1+q_2)^2}{2(C_1+C_2)} = 1.33 \times 10^{-2} J.$$

Q89 (b) $C_{series} = \frac{3 \times 6}{3+6} = 2pF$

$Q_1 = 5000 \times 2 \times 10^{-12} = 10^{-8} C = Q_2$

So, in parallel, common potential

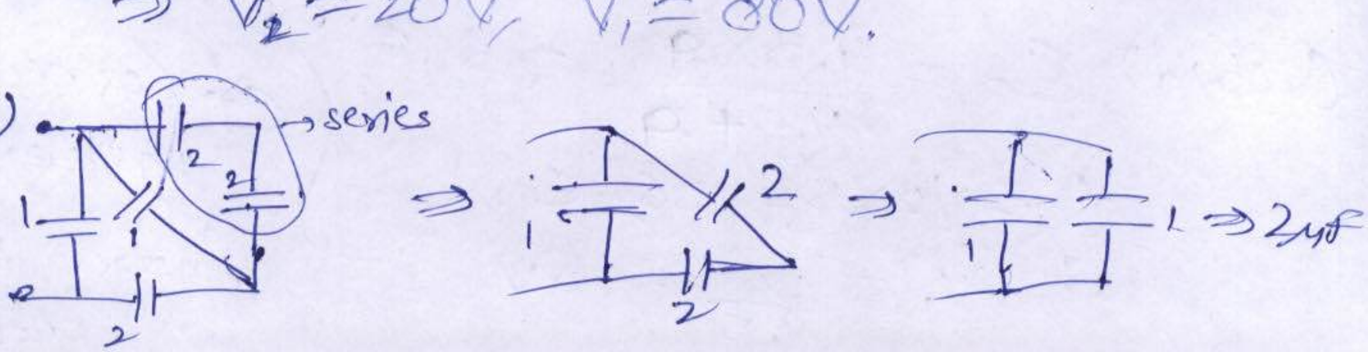
$$V = \frac{Q_1+Q_2}{C_1+C_2} = \frac{2 \times 10^{-8}}{9 \times 10^{-12}} = 2222 V$$

Q90. Since $K=4$, $C_2 = 4C$

$\Rightarrow$ So, $\frac{V_1}{V_2} = \frac{C_2}{C_1} = \frac{4}{1}$ & $V_1 + V_2 = 100V$

$\Rightarrow V_2 = 20V$, $V_1 = 80V$.

Q91 (b)



Q92 (a) $\frac{C \times 3.5}{C+3.5} = 1 \Rightarrow C \times 3.5 = C + 3.5$

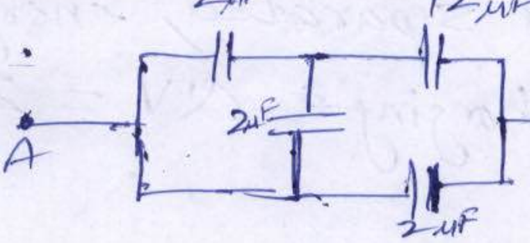
$\Rightarrow 2.5C = 3.5 \Rightarrow C = \frac{7}{5} = 1.4\mu F$

Q93. (a) Energy loss, $\Delta E = \frac{1}{2} \frac{C_1 C_2}{C_1+C_2} \cdot (V_1 - V_2)^2$

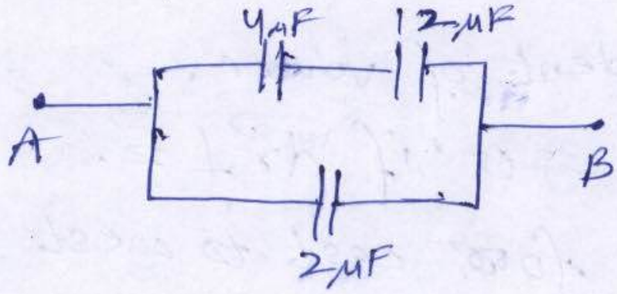
$= \frac{1}{2} \frac{C_1 C_2 V_1^2}{C_1+C_2} = \frac{C_2}{C_1+C_2} U_0 \quad (V_2 = 0)$

Q94. (d)

Q95. (c)



$\Rightarrow$



$\Rightarrow C_{eq} = \frac{4 \times 12}{4+12} + 2$
$= 5\mu F$

Assertion & Reason

Q1. (a) Refer to text.

Q2. (d) $U = -ve$ ~~for~~ if other charge is $-ve$.
V = scalar

Q3. (d) Charge sharing depends on radius of spheres.

Q4. (c) $C_p = C_1 + C_2 + C_3$ & $C_s = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)^{-1}$

Q5. (a) Refer to text.

Q6.(a) Refer to text.

Q7.(b) $C' = \frac{\cancel{3}\varepsilon_0 A}{d/2} = 6C_0$ but independent of material of plates.

Q8.(c) Refer to text. More charge flows onto plates.

Q9.(b) Refer to text.

Q10.(a) :

Q11.(a) Capacity is independent of charge on plates, but depends on size, ~~and~~ shape & medium.

Q12.(d) If plates are separated, energy increase.
Work done in charging $= QV = 2 \times$ Energy stored.

Q13.(d) Refer to text.

Q14.(d) V is independent of volume.

Q15.(b) $dV = -\vec{E} \cdot \vec{dr} = 0$ if $\vec{dr} \perp \vec{E}$.
So, $\frac{dV}{dr} = 0$ for east to west movement.

Q16.(d) $E = \frac{\sigma}{2\varepsilon_0} \Rightarrow F = \frac{Q\sigma}{2\varepsilon_0} = \frac{\sigma^2 A}{2\varepsilon_0}$

Q17.(a) Refer to text.

Q18.(c) Even without connection, capacitors still carry stored charge.

Q19.(a) ← Correction.

Q20.(c) :

PREVIOUS YEARS Q.

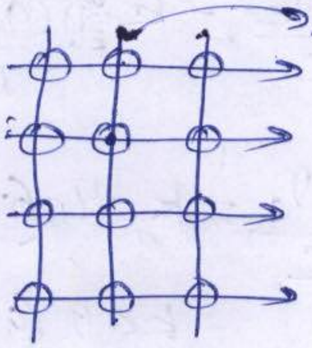
Electric Potential & Energy

Q1.(a) $V_{surface} = V_{centre}$.

Q2(a) Same as Q 24 in previous section.

Q3(a) Refer to text.

Q4.(b) Points on same equipotential surface ~~are~~ have same potential. Here equipotential surfaces are $\perp r$ to E. Field lines.



All points on this equipotential surface have same potential

Q5.(b) E. Field on surface of conductor is always $\perp r$ to surface.

Q6.(b) $V = \frac{kQ}{(10)}$, So, $V' = \frac{kQ}{(15)} = \frac{kQ}{10} \times \frac{10}{15}\frac{2}{3}$

$= V \times \frac{2}{3}$

Q7.(a) $KE = eV$

$= 1.6 \times 10^{-19} \times 100$

Q8.(c) Potential decreases along $\vec{E}$.

Q9.(a) $V_{centre} = V_{surface}$.

Q10.(a) Refer to text.

Q11.(d) Refer to Level II Q41. $C' = n^{1/3} C \Rightarrow V' = \frac{nQ}{n^{1/3} C}$

$V' = n^{2/3} V$

Q12 (c) For a dipole, $V \propto p$ (p = dipole moment $= qx$)

Q13. (a) $Q_A = \sigma(4\pi a^2)$

$Q_B = -\sigma(4\pi b^2)$

$Q_C = \sigma(4\pi c^2)$

$$V_c = \frac{kQ_A}{c} + \frac{kQ_B}{c} + \frac{kQ_c}{c}$$

$$= k\,\frac{\sigma(4\pi)(a^2-b^2+c^2)}{c} = k\sigma 4\pi \frac{\cancel{(a^2-b^2)}^{\,a-b}}{\cancel{a+b}} + \frac{k4\pi\sigma\,\cancel{(a+b)}c}{\cancel{(a+b)}}$$

$$V_B = \frac{kQ_A}{b} + \frac{kQ_B}{b} + \frac{kQ_c}{c} = k\sigma\frac{4\pi(a^2-b^2)}{b} + \frac{k4\pi c^2\sigma}{c}$$

$$V_A = \frac{kQ_A}{a} + \frac{kQ_B}{b} + \frac{kQ_c}{c} = k\sigma 4\pi(a-b+c)$$

$$= k\sigma 4\pi(a-b) + k4\pi\sigma(a+b)$$

~~So, $V_A > V_B > V_C$~~

So, $V_A = V_C \neq V_B$

Q14. (d) $U_i = \cancel{-2k\,\frac{q(-2q)}{a}} + \cancel{k\,\frac{q(-2q)(-2q)}{a}}$

$= 0$

$U_f = \cancel{2k\,\frac{q(-2q)}{2a}} + \cancel{\frac{k(-2q)(-2q)}{2a}}$

$= 0$

Since $U_i = U_f$, $W = 0$

Q15. (d) Refer to text.

Q16. (c) $\frac{2kQ(-q)}{x}+\frac{k(-q)^2}{2x}=0$

$\Rightarrow Q=+\frac{q}{4} \Rightarrow \frac{q}{Q}=4$

Q17. (c) $U=\frac{kq_1q_2}{r}=\frac{9\times10^9\times(1.6\times10^{-19})^2}{9\times10^{-15}}$

$=2.56\times10^{-14}\,J$

Q18. (d) ~~Same as 16.~~ $\frac{2kQq}{a}+\frac{kq^2}{a}=0 \Rightarrow Q=-\frac{q}{2}$

Q19. (a) $F=qE$, $W=Fy=qEy$

Q20. (a) $Q_1=\sigma(4\pi R_1^2)$, $Q_2=\sigma(4\pi R_2^2)$

$$\frac{V_1=\frac{\cancel{k}Q_1}{R_1}}{V_2=\frac{\cancel{k}Q_2}{R_2}} \Rightarrow \frac{V_1}{V_2}=\frac{Q_1}{Q_2}\times\frac{R_2}{R_1}=\frac{\cancel{\sigma}(\cancel{4\pi}R_1^2)}{\cancel{\sigma}(\cancel{4\pi}R_2^2)}\times\frac{R_2}{R_1}$$

$$=\frac{R_1}{R_2}$$

Q21. (a) $V_1=\frac{kq}{r}+\frac{kQ}{R}$

$V_2=\frac{kq}{R}+\frac{kQ}{R}$

$V_1-V_2=k\left(\frac{q}{r}-\frac{Q}{R}\right)=\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}-\frac{Q}{R}\right)$

Q22. (a) Same as 18.

Q23. (c) Level - II Q30.

Q24. (d) $q(V_2-V_1)=W=20$

$\Rightarrow 4(F-10)=\cancel{20}\;5 \Rightarrow F=15V$

Q25. (b) ~~$V = \frac{kQ}{}$~~ $\therefore V = \frac{W}{q_0} = \frac{W}{1}$

Q26. (c) Refer to text.

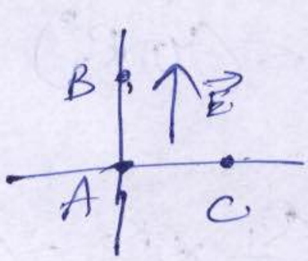
Q27. (a) Proton is pulled opposite to $\vec{E}$. So, work done is $-$ve on proton by $\vec{E}$.
Also since motion is opposite to $\vec{E}$, ~~work~~ potential increases

Q28. (c) Similar to Q11.

Q29. (b)

Q30. (b) Refer to text.

Q31. (d)



A & C lie on same equipotential surface.
$V_A = V_C > V_B$

Q32. (d)

Q33. (b) Refer to text

Q34. (b) Same as 31

Q35. (c) $\frac{k(12)}{20+x} = \frac{k(6)}{x} \Rightarrow x = \cancel{0.2}\ 20\text{cm} = 0.2\text{ m}$

Q36. (b) $\frac{k(Ze)}{9\times10^{-15}} = \frac{9\times10^{9}\times 50\times1.6\times10^{-19}}{9\times10^{-15}} = 8\times10^{6}\text{ V}$

Q37. (a) Since $V_1 = V_2$, $W = 0$

Q38. (a) $W_1 = 0$, $W_2 = q_3\left(\frac{kq_2}{0.1} - \frac{kq_2}{0.5}\right) = \Delta U$
$\Rightarrow \frac{q_3}{4\pi\varepsilon_0}(8q_2) \Rightarrow k = 8q_2$

Q39. (d) $V = \frac{kQ}{R} = 9\times10^9 \times \frac{25\times10^{-10}}{0.5} = 45\,V$

Q40. (d) $W = 0$

Capacitance & Capacitors

Q1. (C) Energy density $= \frac{1}{2}\varepsilon_0 E^2$

So, energy $= \frac{1}{2}\varepsilon_0 E^2 \times$ vol. $= \frac{1}{2}\varepsilon_0 E^2 Ad$

Q2 (d) $W = U_2 - U_1$

$= \frac{k(5)(10)\times10^{-12}}{0.5} - \frac{k(5)(10)\times10^{-12}}{1} = 9\times10^{-1}\,J$

Q3. (e) Refer to text.

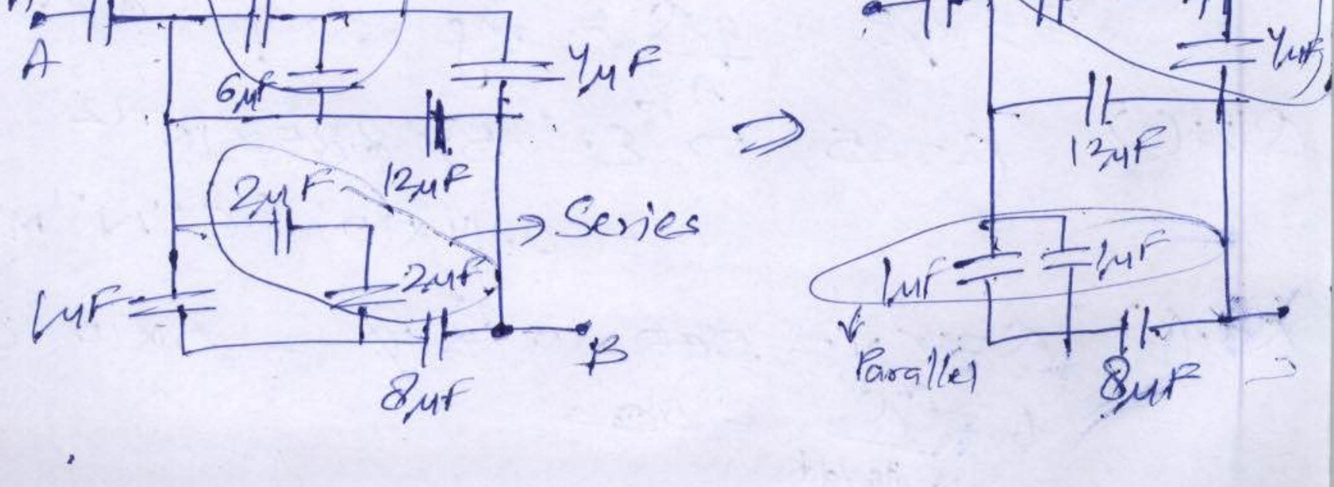
Q4. (a) $I_1 : I_2 = V_1 : V_2$ & $V_{d_1} : V_{d_2} = I_1 : I_2$
$= 1 : 2$

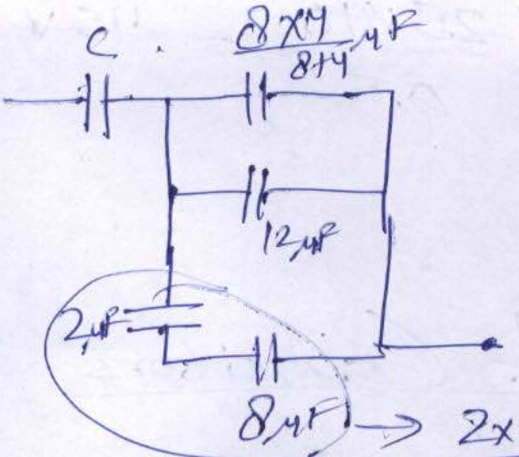
Q5. (d) Refer to current electricity module.

Q6. (a) $\frac{C\times60}{C+60} = 30 \Rightarrow C = 60\,\mu F$

Q7. (a) Refer to text

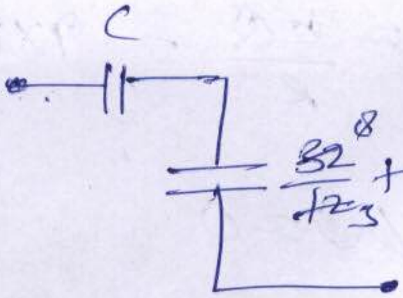
Q8.





$\rightarrow \frac{2\times8}{2+8}$

$\Rightarrow$



$\cancel{\frac{32}{12}}\frac{8}{3} + 12 + \frac{16}{10} = \frac{48.8}{3}$

$$\frac{C\times\frac{48.8}{3}}{C+\frac{48.8}{3}} = 3$$

$\Rightarrow C = 3.67\,\mu F$

No option correct.

Q9.(C) $C = \frac{Q}{V} = \frac{1}{110} = nC_0$

So $n = \frac{1}{110\times10^{-6}} = \frac{10^6}{110} = 9090$

$\boxed{\text{In Question, 1pF should be } 1\mu F}$

Q10.(d) Work done $= \frac{QV}{2} = \frac{Q^2}{2C}$

$= \frac{(8\times10^{-18})^2}{100\times10^{-6}} = \frac{64}{2}\times10^{-32} = 32\times10^{-32}\,J$

Q11.(c) $E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0}$

$F = qE = \frac{qQ}{A\varepsilon_0} = mg \Rightarrow q = 8.85\times10^{-13}\,C$

Q12.(c) $K = 5 \Rightarrow \varepsilon = 5\times8.85\times10^{-12}$

$= 0.44\times10^{-10}\,C^2N^{-1}m^{-2}$

Q13.(c) $Q = CV = 500\times10^{-6}\times10 = 5\times10^{-3}\,C$

$t = \frac{Q}{dq/dt} = 50\,s$

Q14. (c) Loss of energy happens. Refer ~~to text~~.

Q15. Option (c) & (d) are incomplete

Q16. (d) $qE = mg \Rightarrow E = \frac{mg}{q} = 32.5\ V/m$

Q17. (b) Refer to text.

Q18. (b) " " "

Q19. (C) $V = \frac{C_0 V_0}{KC_0 + C_0} \Rightarrow C_0(K+1) = \frac{C_0 V_0}{V} \Rightarrow K = \frac{V_0}{V} - 1$

Q20. (b) $\frac{1}{2}CV^2 = mgh \Rightarrow h = \frac{\frac{1}{2}(100\times10^{-6})\times(6000)^2}{50\times10}$

$= 3.6m$

Q21. (a) Thin plate doesn't change capacitance.

Q22. (b) Refer to text.

Q23. (a) $\Delta U = \frac{1}{2}C(0.5)^2 - \frac{1}{2}C(0.1)^2$

Q24. (b) $C' = \frac{5}{3}C = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}}$

$\frac{5}{3}\frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{d - t + \frac{t}{5}} \Rightarrow t = \frac{d}{2}$

Q25. (c)

Q26. (c) $\frac{\varepsilon_0 A}{3} = \frac{\varepsilon_0 A}{d' - 1 + \frac{1}{2}} \Rightarrow d' = 3.5mm$

Q27. (c) $4\pi\varepsilon_0 R = C$

Q28. (c) Refer to text.

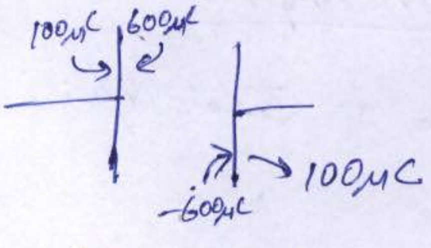
Q29. (c) Since $C' = \frac{C}{2} \Rightarrow U' = \frac{Q^2}{2C'} = 2\left(\frac{Q^2}{2C}\right) = 2U$

Q30. (c) Repeat A&R Q18

Q31. (a) Refer to text.

~~Q32. Q = 500μC + 200μC ⇒ V = 700μC / 10μF = 70V~~

Q32 (b) Final charge distribution is



So, $V = \frac{600\mu C}{10\mu F} = 60V$

Q33. (c) Refer to text.

Q34. (a) $\frac{\varepsilon_0 A}{d} = 3F \Rightarrow A = \frac{3 \times 0.005}{\varepsilon_0}$

Q35. (c) $\Delta U = \frac{1}{2}(3 \times 10^{-12})\left[(20)^2 - (10)^2\right]$

$= 9 \times 10^{-4}$ J

Q36. (b) Refer to text.

Q37. (c) " " "

Q38. (d) $\frac{\text{Energy}}{\text{Vol}} = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0\left(\frac{V}{d}\right)^2$

Q39. (b) $C' = \frac{\varepsilon_0 A}{d - \frac{d}{2} + \frac{d}{2}\left(\frac{1}{5}\right)} = \frac{5}{3}\frac{\varepsilon_0 A}{d} = 1.66\, C_0$

Q40. (b) $\frac{C \times 3C}{C + 3C} = \frac{3C}{4} = 3.75 \Rightarrow C = 5\mu F$

Q41. (a) Refer to text.

Q42. (d) $C = 4\pi K \varepsilon_0 \times R$ $(K = 81)$

Q43. (c) Repeat.

Q44. (a) $C = 4\pi\varepsilon_0 R$

Q45. (d) Refer to text.

Q46. (c) $U = CV^2 = \frac{\varepsilon_0 A}{d} \times E^2 d^2 = \varepsilon_0 E^2 A d$

Q47. (c) Repeat of A & R Q8.

Q 48. (d) $W = \frac{Q^2}{2C}$

$$W' = \frac{(2Q)^2}{2C} = 4\left(\frac{Q^2}{2C}\right) = 4W$$

Q 49. (d) Closer point will have ~~s~~ more charge density, but both plates will have same potential everywhere.

Q 50. (b) Refer to text. $t = 0$

Q 51 (d) $W = \frac{Q^2}{2C}$

Q 52 (c) Similar to Level I Q41

Q 53. (c) Refer to text.

Q 54. (c) $W = \frac{1}{2}CV^2 + \frac{1}{2}\left(\frac{C}{2}\right)V^2$

Q 55. (c) $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

Q 56. (a) $C = \frac{\varepsilon_0 A/2}{d} + \frac{4\varepsilon_0 A/2}{d} = \frac{5}{2}\frac{\varepsilon_0 A}{d} = 25\mu F$

Q 57. (d) Refer to text.

Q 58. (b) "

Q 59. (c) Both charges should be opposite

Correction

Refer to text.

Q 60. (d) " "

Q 61. (d) If q increase, V increases.

Q62. (b) $C' = \dfrac{\varepsilon_0 A}{d - t + \frac{t}{k}}$ $\quad d = 2\,mm$, $t = 1\,mm$, $k = 2$

Q63. (b) $Q = 27q$

$$C = n^{1/3} C_0 = (27)^{1/3} C = 3C \rightarrow \text{Refer to Level I Q41}$$

Q64. (c) $C' = \dfrac{\varepsilon_0 A/2}{d} + \dfrac{K \varepsilon_0 A/2}{d} = \dfrac{1}{2}(K+1)\dfrac{\varepsilon_0 A}{d}$

$$C' = \frac{(K+1)}{2} C$$

Q65. (d) Refer to text.

Q66. $\cancel{C' = C_1 + C_2 = \frac{8\varepsilon_0 A}{d/2} + \frac{4\varepsilon_0 A}{d/2} = 24}$

$$C' = \frac{C_1 C_2}{C_1 + C_2} = \frac{\frac{8\varepsilon_0 A}{d/2} \times \frac{4\varepsilon_0 A}{d/2}}{\frac{8\varepsilon_0 A}{d/2} + \frac{4\varepsilon_0 A}{d/2}}$$

$$= \frac{\frac{16\varepsilon_0 A}{d} \times \frac{8\varepsilon_0 A}{d}}{3\,\frac{24\varepsilon_0 A}{d}} = \frac{16}{3}\,\mu F \Big\} \rightarrow \text{Wrong answer}$$

Q67 (a) $V = 20$ Volt

$$C = \frac{Q}{V} = \frac{40}{20} = 2F$$

Q68. (b) C_1, C_2, C_3 are in series

$$\frac{1}{C'} = \frac{1}{C} + \frac{1}{2C} + \frac{1}{3C} = \frac{6+3+2}{6C} \Rightarrow C' = \frac{6C}{11}$$

$$\frac{q_2}{q_4} = \frac{C'V}{C_4 V} = \frac{\frac{6C}{11}}{4C} = \frac{3}{22}$$