JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 12^{th} **PAPER CODE :- CWT-2**
CHAPTER :- CAPACITANCE

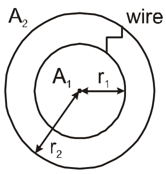
ANSWER KEY

1.	(C)	**2.**	(D)	**3.**	(C)	**4.**	(D)	**5.**	(B)	**6.**	(B)	**7.**	(C)
8.	(A)	**9.**	(A)	**10.**	(B)	**11.**	(B)	**12.**	(D)	**13.**	(B)	**14.**	(D)
15.	(C)	**16.**	(B)	**17.**	(C)	**18.**	(C)	**19.**	(A)	**20.**	(D)	**21**	0.2
22.	100	**23.**	12	**24.**	4	**25.**	2	**26.**	200	**27.**	6	**28.**	420
29.	48	**30.**	32										

SOLUTIONS

1. (C)

Sol.



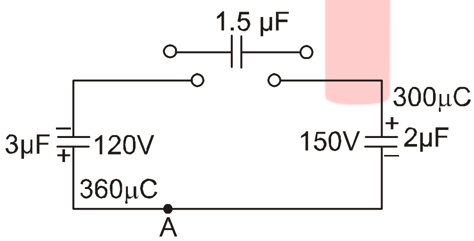
All given charge of A_1 goes to A_2
Therefore $C = 4\pi\epsilon_0 r_2$

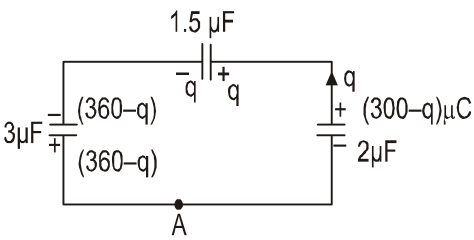
2. (D)

Sol. VA=VB So V=0, Q=CV $\Rightarrow C = \frac{Q}{V} = \infty$

3. (C)

Sol.





$$V_A + \frac{(300-q)}{2} - \frac{q}{1.5} + \frac{360-q}{3} = V_A \quad \text{..........(i)}$$

by solve this equation we get
$\Rightarrow q = 180\mu C$
Charge on $1.5\mu F$ capacitor is = $150\mu C$
Charge on $2\mu F$ capacitor is
= 300 – 180 = $120\mu C$
Therefore charge flows through A from left to right .

4. (D)

Sol. $\frac{1}{C_{eq}} = \frac{1}{20} + \frac{1}{30} + \frac{1}{15} = \frac{3+2+4}{60}$

$C_{eq} = \frac{60}{9} = \frac{20}{3}\ \mu F$

Total charge in this series conbination is

$= \frac{20}{3} \times 90 \qquad q = 600\mu C$

Potential difference between the plate of C_1

is = $\frac{q}{C_1} \qquad \frac{600}{20} = 30V$

Potential difference between the plate of C_2

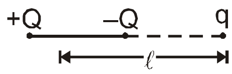
is $\frac{q}{C_2} = \frac{600}{30}\ 20V$

Potential difference between the plate of C_3

is = $\frac{q}{C_3} = \frac{600}{15} = 40V$

5. (B)

Sol. The two plates acts as a dipole



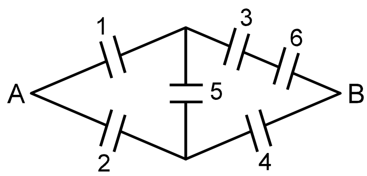
$\therefore$ Force on charge q ;
F = Eq

$= \left(\frac{2kQd}{\ell^3}\right).q \quad = \frac{Qd}{2\pi\varepsilon_0\ell^3}$.

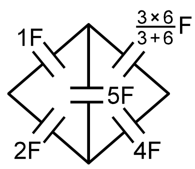
Because area of the plate is increased.

6. (B)

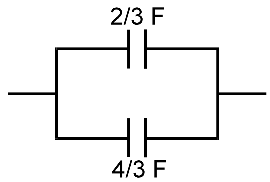
Sol. Equivalent circuit is



$\Rightarrow$



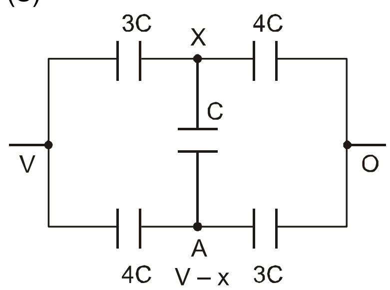
$\Rightarrow$



= 2 F

7. (C)

Sol.



$(x - V)\,3 + (x - 0)\,4 + (x - (v - x))\,1 = 0$

$3x - 3V + 4x + 2x - V = 0$

$9x = 4V \qquad x = \frac{4V}{9}$

$V_A - V_B = (V - x) - x = V - 2x$

$\Rightarrow \quad V - \frac{8V}{9} = \frac{V}{9} = 3$ volt

$\Rightarrow \quad V = 27$ volt.

8. (A)

Sol. (A) $Q_1' = Q_1 + Q_2 = 150\mu C$

$\frac{Q_1'}{Q_2'} = \frac{C_1}{C_2} = \frac{1}{2} \quad \Rightarrow \quad Q_1' = 50\mu C$

$Q_2' = 100\mu C$

$25\mu C$ charge will flow from smaller to bigger sphere .

9. (A)

10. (B)

Sol. $W = \frac{CV^2}{2} \qquad V^2 = \frac{2U}{C} = \frac{2 \times 0.16}{2 \times 10^{-6}}$

$V = 400$ Volt

11. (B)

Sol. $W = V_f - V_i = \frac{1}{2}CV_f^2 - \frac{1}{2}CV_1^2$

$= \frac{1}{2}\,C\,(40^2 - 20^2) \qquad W = 600\,C$

$W_1 = \frac{1}{2}\,C\,(50^2 - 40^2) = \frac{900}{2}\,C$

$W_1 = \frac{900}{2}\cdot\frac{W}{600} = \frac{3}{4}\,W$ **Ans**

12. (D)

Sol. $V = \frac{V_1C_1 + V_2C_2}{C_1 + C_2}$

$400 = \frac{100 \times 10 + 0}{C_1 + C_2}$

$C_1 + C_2 = 25\ \mu F$

$C_2 = 25 - 10$

$= 15\ \mu F$

13. (B)

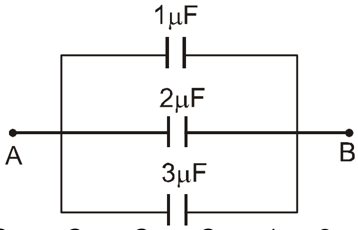
Sol. $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{(900 + 2500)\mu F\,\text{volt}}{(3+5)\mu F}$

$= \frac{3400\ \text{Volt}}{8}$

$= 455$ Volt

14. (D)

Sol. Equilent figure



$C_{eq} = C_1 + C_2 + C_3 = 1 + 2 + 3 = 6\mu F$

15. (C)

Sol. $t_1 > t_2$

$R_1C_1 > R_2C_2$ for same q_{max}

$q_{01} = q_{01} = E_1C_1 = E_2C_2$

If $R_1 > R_2$, $C_1 = C_2$ & $E_1 = E_2$.

16. (B)

Sol. $C' = \frac{\epsilon_0 A}{d/2} = \frac{2\epsilon_0 A}{d} = 2C.$

17. (C)

Sol. Now, charge remains same on the plates.

$U_0 = \frac{Q^2}{2C}$ (given)

Now energy = $U' = \frac{Q^2}{2C'} = \frac{Q^2}{2CK}$

$= \frac{U_0}{K}$

18. (C)

19. (A)

Sol. $V_{C_2} = V_{C_2} = V$

$C_1 = C$

$C_2 = KC$

$q_1 = C_1V_{C_1} = CV$

$q_2 = C_2V_{C_2} = KCV$

$q_1 < q_2$.

20. (D)

Sol. If potential difference across an isolated charged capacitor is doubled by doubling separation between plates, the energy stored is capacitor from $U = \frac{Q^2}{2C}$ becomes double of previous value.

Hence statement 1 is false.

21 $0.2\mu C$

Sol. $C' = C + C + C = 3C$ (When connect in parallel)

$\therefore q = CV = 3CV$

$\Rightarrow CV = \frac{1.8}{3} = 0.6\mu C$

After discharging

$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} = \frac{C}{3}$$

$$q = \frac{CV}{3} = q = \frac{0.6}{3} = 0.2\mu C$$

22. 100

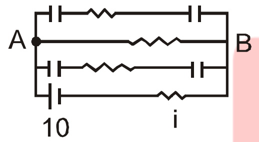
Sol. $q = CV = 500 \times 10^{-6} \times 20$

$= 10^{-2}$

$$t = \frac{q}{dq/dt} = \frac{10^{-2}}{100 \times 10^{-6}} = 10^{2} = 100 \text{ second}$$

23. $12\mu C$

Sol. Charge on each capacitor will be same. In steady state current through capacitor will be zero



current in steady state $= i = \frac{10}{5} = 2$ amp

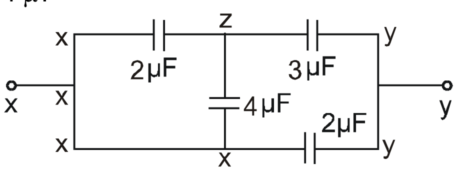
potential across AB = iR = 2 × 4 = 8 V.

Potential across each capacitor = 4 V

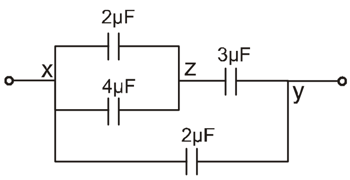
on each plate Q = CV = 3 × 4 = 12 μC

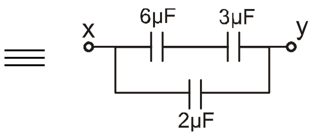
24. $4\ \mu F$

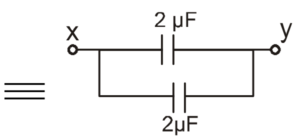
Sol.



Rearrange the circuit







$C_{eq} = 4\mu F$

25. $2\ \mu C$

Sol. In steady state no current flows through capacitor. The potential difference across capacitor and resistor of resistance R_2 is same.

$\therefore$ charge on capacitor $= CV = C \times \frac{R_2}{r + R_2} \times 3$

$= 1\mu F \times \frac{1}{5+1} \times 3 = 2\mu C.$

26. 200 μJ

Sol. **Method I**

Force between plates

$$F = \frac{Q^2}{2A\varepsilon_0} = \frac{\left(\frac{\varepsilon_0 A}{x} V\right)^2}{2A\varepsilon_0} = \frac{\varepsilon_0 A V^2}{2x^2}$$

where x is separation between plates

dW = F dx

$$W = \int_d^{2d} \frac{\varepsilon_0 AV^2}{2x^2} dx = \frac{\varepsilon_0 AV^2}{4x} = \frac{CV^2}{4} = 200\ \mu J$$

Method II

$U_\ell + W_B + W_{ext} = U_f + \text{loss}$

Process is slow so energy loss is zero work done by battery $= W_B = QE$

$Q = Q_f - Q_i = 20 - 40 = -20$

$W_B = -20 \times 20$

$\frac{1}{2} 2 \times 20^2 - 20 \times 20 + W_{ext} = \frac{1}{2} 1 \times 20^2 + 0$

$W_{ext} = 200\ \mu J$

27. 6

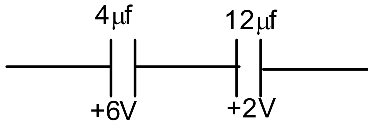
Sol. Electric field inside dielectric $\frac{\sigma}{K\varepsilon_0} = 3 \times 10^4$

$\Rightarrow \sigma = 2.2 \times 8.85 \times 10^{-12} \times 3 \times 10^4$

$= 6 \times 10^{-7}\ C/m^2$

28. 420 N

Sol.



$Q_1 = 24\mu c$, $Q_2 = 18_m c$

$Q = 42\mu c$, $E = 10^7 \times 42 \times 10^{-6}$

E = 420 N/C

29. 48

Sol. $q_3 = \frac{C_3}{C_2 + C_3} . Q$ $q_3 = \frac{3}{3+2} \times 80 = \frac{3}{5} \times 80$

$= 48\ \mu C$

30. 32

Sol. $W = \frac{1}{2} CV^2 = \frac{1}{2} \frac{q^2}{C} = \frac{1}{2} \times \frac{(8 \times 10^{-18})^2}{100 \times 10^{-6}}$

$= \frac{1}{2} \times \frac{64 \times 10^{-36}}{100 \times 10^{-6}}$

$= 32 \times 10^{-32} J$