DIRECTORATE OF SCHOOL EDUCATION TAMILNADU

12NPCBW2 (2023-24)	NEET – WEEKLY TEST 2	Class : XII Time : 1.40 hrs Total Marks : 400

Answer key

12TH Physics

1. Ans : D) 8 : 9

Charge is conserved so,

$Q_1 + Q_2 = Q_3 + Q_4$

Q_1 and Q_2 are initial charges and Q_3 and Q_4 are charges after connecting them

$Q_3 = Q_4 = Q$ (they are identical)

So, $Q = \frac{10+20}{2} = 15$ C

Ratio of forces = K(10)(20) : K(15)(15)

Ratio of forces = 8 : 9

2. Ans : D) 180 ms^{-1}

Using law of conservation of energy

$E_i = E_f$

$$K\frac{q_1 q}{r_1} = K\frac{q_1 q}{r_2} + \frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2 = Kq_1q\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$v^2 = 2 \times \frac{Kq_1q}{m}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$

$v^2 = 2 \times \frac{9x\ 10^9 x\ 2\ x\ 10^{-3}\ x\ 1\ x\ 10^{-6}}{1\ x\ 10^{-3}}\left(\frac{1}{1} - \frac{1}{10}\right)$

$v^2 = 36 \times 900$

$v = \sqrt{36\ x\ 900} = 6 \times 30 = 180\ ms^{-1}$

3. Ans : A) 3.47×10^4 C

Mass of coin = 0.75 g

Atomic mass of aluminium - 26.98 g

Number of Al atoms in the coin N = $\frac{6.02\ x\ 10^{23}}{26.98}\ x\ 0.75 = 1.67\ x\ 10^{22}$

As charge number (z) Al is 13, each atom of Al contains 13 protons and 13 electrons.

Magnitude of positive and negative charges in one paisa coin

= NZe = $1.67 \times 10^{22} \times 13 \times 1.6 \times 10^{-19}$

= 3.47×10^4 C

4. Ans : B) $1.36 \times 10^4\ Nm^2C^{-1}$

r = 10 cm = 0.1 m

E = $5 \times 10^5\ NC^{-1}$

As the angle between the plane sheet and the electric fields is 60^0, angle made by the normal to the plane sheet and the electric field is $\theta = 90^0 - 60^0 = 30^0$

$\phi_E = Es\cos\theta = E \times \pi r^2 \cos\theta$

$\phi_E = 5 \times 10^5 \times 3.14 \times 0.1^2 \cos 30^0$

$\phi_E = 1.36 \times 10^4 \ Nm^2C^{-1}$

5. Ans : D) 10^{-9} C

Electric field of a point charge is $E = 24 \ NC^{-1}$

Electric potential of a point charge is $V = 12 \ JC^{-1}$

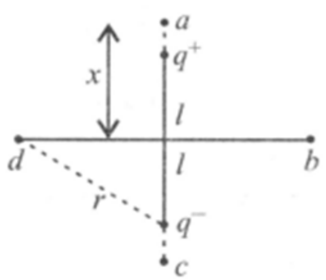
The distance PQ is $r = \frac{V}{E} = \frac{12}{24} = 0.5 \ m$

So magnitude of the charge $q^! = 4\pi\epsilon_0 Vr$

$q^! = \frac{1}{9 \ x \ 10^9} \times 12 \times 0.5 \quad = 0.667 \times 10^{-9}$ C

$q^! \approx 10^{-9}$ C

6. Ans : C) $V_a = V_c > V_b = V_d$



V_a due to q^+ charge $= \frac{1}{4\pi\varepsilon_0} . \frac{q}{(x-l)}$

V_a due to q^- charge $= \frac{1}{4\pi\varepsilon_0} . \frac{q}{(x+l)}$

$V_{a \ Total} = \frac{1}{4\pi\varepsilon_0} . \left\{ \frac{1}{(x-l)} - \frac{1}{x+l} \right\}$

$V_a = \frac{q}{4\pi\varepsilon_0} . \frac{2l}{(x^2 - l^2)} \rightarrow \frac{2ql}{4\pi\varepsilon_0 x^2}$ (if l << x) $\rightarrow \frac{p}{4\pi\varepsilon_0 x^2}$

$V_{c\ Total} = \frac{q}{4\pi\varepsilon_0} . \left\{ -\frac{1}{(x-l)} + \frac{1}{x+l} \right\} \rightarrow -\frac{2ql}{4\pi\varepsilon_0 x^2}$ (if l << x) $\rightarrow -\frac{p}{4\pi\varepsilon_0 x^2}$

$V_{d\ Total} = \frac{q}{4\pi\varepsilon_0} . \left\{ \frac{1}{r} - \frac{1}{r} \right\}$ = 0 due to +q and -q charges

$V_b = V_d$

So $V_a = V_c > V_b = V_d$

7. Ans : A) $\frac{1200}{7}$ pF

Capacitors C_2 and C_3 are connected in Series

So $C_{23} = \frac{1}{200} + \frac{1}{200} = \frac{2}{400}$ = 200pF

Now C_1 and C_{23} are Parallel

So C_{123} = 100 + 200 = 300 pF

Now C_4 and C_{123} are Series

Therefore $\frac{1}{C_{eq}} = \frac{1}{300} + \frac{1}{400} = \frac{7}{1200}$

$C_{eq} = \frac{1200}{7}$ pF

8. Ans : A) 8 μJ

Capacitors 6μF and 3μF are connected in series.

Equivalent capacitance $C' = \frac{3 \times 6}{3+6}$ = 2 μF

This is parallel with 2 μF

Equivalent capacitance,

$C = 2 + 2 = 4\mu F$

∴ Energy of the system,

$E = \frac{1}{2}CV^2 \quad = \quad \frac{1}{2}\times 4 \times 2^2 \quad = \quad 8\times10^{-6}J \quad = \quad 8\mu J$

9. Ans : C) 0, $-$2100 V

(i) No work is done in moving a unit positive charge from A to B

Because the displacement of the charge is perpendicular to the electric field

Thus, the points A and B are at the same potential

Therefore $\Delta V_{BA} = 0$

(ii) Work is done by the electric field as the positive charge moves from B to C

Thus, the point C is at lower potential than the point B

As $E = -\frac{\Delta V}{\Delta x}$

$\Delta V_{CB} = - E\,\Delta x = - 300 \times 7$

$\Delta V_{CB} = - 2100$ V

10. Ans : B) 2.5 x 10^{19} m^{-3}

Here, $\rho = 0.50\ \Omega m$

$\mu_e = 0.39\ m^2V^{-1}s^{-1}$

$\mu_h = 0.11 m^2V^{-1}s^{-1}$

The resistivity of intrinsic semiconductor is

$\frac{1}{\rho} = e\,(n_i\mu_e + n_i\mu_h)$

where n_i is the intrinsic carrier concentration

$\therefore n_i = \frac{1}{\rho e(\mu e + \mu h)}$

Substituting the given values,

we get

$n_i = \frac{1}{0.5 \, x \, 1.6 \, x 10^{-19} \, x \, (0.39 + 0.11)}$

$n_i = 2.5 \times 10^{19} m^{-3}$

11. Ans : D) 6.72 x 10^{-7} A

$E = \frac{V}{l} = \frac{2}{0.1} = 20$ V/m

A = 1 cm^2 = 1 x 10^{-4} m

$V_d = \mu_e$ E = 0.14 x 20 = 2.8 m/s

$I = neAV_d$

I = 1.5 x 10^{16} x 1.6 x 10^{-19} x 1 x 10^{-4} x 2.8

I = 6.72 x 10^{-7} A

12. C) 4 x 10^4 per m^3

Here n_i = 6 x 10^8 m^{-3}

n_e = 9 x 10^{12} m^{-3}

$n_h = \frac{n_i^2}{n_e} = \frac{(6 \, x \, 10^8)^2}{9 \, x \, 10^{12}}$

n_h = 4 x 10^4 per m^3

13. Ans : B) 10 Ω

From the given curve we have

Voltage V = 0.8 V for current I = 20 mA

Voltage V = 0.7 V for current I = 10 mA

$\Delta I =$ (20 - 10) = 10 mA = 10 x 10^{-3} A

ΔV = (0.8 - 0.7) = 0.1 V

R = $\frac{\Delta V}{\Delta I} = \frac{0.1}{10 \, x \, 10^{-3}}$

R = 10 Ω

14 . Ans : C) 36 V

Here input V_{rms} = 20 V

Peak value of input voltage

$V_0 = \sqrt{2}\ V_{rms} = \sqrt{2} \times 20 = 28.28$ V

Since the transformer is a setup transformer, having transformation ratio 1:2, the maximum value of output voltage of the transformer applied to the diode will be

$V_1 = 2 \times V_0 = 2 \times 28.28 = 56.56$ V

DC voltage = $\frac{2V_1}{\pi} = \frac{2 \, x \, 56.56}{3.14}$ = 36 V

15. Ans : B) 20 μA

$I_C = \frac{V_{CE}}{R_C} = \frac{2}{2 \, x \, 10^3} = 10^{-3}$ = 1 mA

$\beta = \frac{I_C}{I_B}$

$I_B = \frac{I_C}{\beta} = \frac{10^{-3}}{50} = 20\ \mu A$

16. Ans : A) $\bar{A}B + A\bar{B}$

The output of AND gate 1 is $\bar{A}B$

The output of AND gate 2 is $A\bar{B}$

So the output of OR gate is $Y = \bar{A}B + A\bar{B}$

17. Ans : D) 5 x 10^{14} Hz

p - n photodiode is a semiconductor diode that produces a significant current when illuminated. It is reversed biased but operated below the breakdown voltage.

Energy of radiation = Band gap energy

E = hυ = 2 eV

Or $\upsilon = \frac{2 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}} \approx 5 \times 10^{14}$ Hz

18. Ans : B) $\frac{b}{a}$

Let a be the radius of sphere A, Q_A be the charge on the sphere A and C_A be the capacitance of sphere A.

Let b be the radius of sphere B, Q_B be the charge on the sphere B and C_B be the capacitance of sphere B.

Since the spheres are connected by their potential (V) will become equal

Let E_A be the electric field of sphere A and E_B be the electric field of sphere B

Then

$$\frac{E_A}{E_B} = \frac{KQ_A}{a^2}\ x\ \frac{b^2}{KQ_B}$$

$$\frac{E_A}{E_B} = \frac{Q_A}{a^2}\ x\ \frac{b^2}{Q_B}$$

$$\frac{E_A}{E_B} = \frac{C_A V}{a^2}\ x\ \frac{b^2}{C_B V}$$

But $\frac{C_A}{C_B} = \frac{a}{b}$

$$\frac{E_A}{E_B} = \frac{aV}{a^2}\ x\ \frac{b^2}{bV}$$

$$\frac{E_A}{E_B} = \frac{b}{a}$$

19. Ans : A) $-2\sqrt{3}$ **J**

Here, 2a = 20 cm = 20 x 10^{-2} m

Charge q = ± 3 x 10-3 C,   θ = 60^0 and torque = 6 Nm

τ = PE Sinθ

E = $\frac{\tau}{Psin\theta} = \frac{\tau}{2qasin\theta}$

E = $\frac{6}{3\ x\ 10^{-3}\ x\ 20\ x\ 10^{-2}\ xsinsin\ 60^0} = \frac{10^5}{5\sqrt{3}}$ N/C

Potential energy of dipole

U = - pE cosθ = -2qaEcosθ

U = -3 x 10^{-3} x 20 x 10^{-3} x $\frac{10^5}{5\sqrt{3}}$ x cos60^0

U = $-2\sqrt{3}$ J

20. Ans : C) 1.5 x 10^{19} ms^{-2}

F = ma

or a α $\frac{1}{m}$

Therefore $\frac{a_p}{a_e} = \frac{m_e}{m_p}$

$a_p = \frac{a_e m_e}{m_p} = \frac{2.5 \ x \ 10^{22} \ x \ 9.1 \ x \ 10^{-31}}{1.67 \ x \ 10^{-27}}$

$a_p = 13.6 \times 10^{18} \approx 1.5 \times 10^{19}\ ms^{-2}$

21. Ans : B) 1 : 3

According to law of conservation of angular momentum

Angular momentum of perigee = Angular momentum of apogee

$mv_P r_P = mv_A r_A$

$\frac{v_A}{v_P} = \frac{r_P}{r_A} = \frac{2R_E}{6R_E} = \frac{1}{3}$

22. Ans : B) 0.64 cm

In equilibrium, weight of the suspended body = stretching string

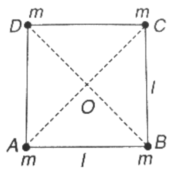
Therefore : At the earths surface, mg = kx

At height h, mg′ = kx′

$\frac{g'}{g} = \frac{x'}{x} = \frac{R_E^2}{(R_E+h)^2} = \frac{(6400)^2}{(6400+1600)^2} = \frac{(6400)^2}{(8000)^2} = \frac{16}{25}$

$x' = \frac{16}{25}x = \frac{16}{25} \ x \ 1 = \ 0.64 \ cm$

23. Ans : D) $-4\sqrt{2}\frac{Gm}{l}$



From figure

OA = OB = OC = OD = $\frac{\sqrt{l^2+l^2}}{2} = \frac{l\sqrt{2}}{2} = \frac{l}{\sqrt{2}}$

Potential at center O due to given mass configuration is

V = $\left(-\frac{Gm}{OA}\right) + \left(-\frac{Gm}{OB}\right) + \left(-\frac{Gm}{OC}\right) + \left(-\frac{Gm}{OD}\right)$

V = $-\frac{4Gm}{\frac{l}{\sqrt{2}}} = -4\sqrt{2}\frac{Gm}{l}$

24. Ans : C) 11.2 km s^{-1}

The escape velocity is independent of the mass of the body

25. Ans : C) $2E_0$

Potential energy is = 2 (total energy) = $2E_0$