JEE MAIN 2023

Paper with Solution

PHYSICS | 31st Jan 2023 _ Shift-2

Umeed Rank Ki Ho Ya Selection Ki, JEET NISCHIT HAI!

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JEE MAIN+ADVANCED

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Percentage (%) Ratio

Student Qualified in NEET

(2022)
4837/5356 = 90.31%
(2021)
3276/3411 = 93.12%

Student Qualified in JEE ADVANCED

(2022)
1756/4818 = 36.45%
(2021)
1256/2994 = 41.95%

Student Qualified in JEE MAIN

(2022)
4818/6653 = 72.41%
(2021)
2994/4087 = 73.25%

NITIN VIIJAY (NV Sir)
Founder & CEO

SECTION - A

1. Given below are two statements:
Statement I: In a typical transistor, all three regions emitter, base and collector have same doping level.
Statement II: In a transistor, collector is the thickest and base is the thinnest segment.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both Statement I and Statement II are correct
(2) Statement I is incorrect but Statement II is correct
(3) Statement I is correct but Statement II is incorrect
(4) Both Statement I and Statement II are incorrect

Sol. **(2)**

Emitter	Base	Collector
Moderate Size	Thin	Thick
Maximum Doping	Minimum Doping	Moderate Doping

2. If the two metals *A* and *B* are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8eV and 2.2eV. Then choose the correct option.
(1) Both metals A and B will emit photo-electrons
(2) Metal *A* will not emit photo-electrons
(3) Metal B will not emit photo-electrons
(4) Both metals A and B will not emit photo-electrons

Sol. **(2)**

$$E = \frac{hc}{\lambda} = \frac{1240}{350} = 3.54eV$$

If $E > \phi$, photo electrons will emit.
A will not emit and B will emit.

3. Heat energy of 735 J is given to a diatomic gas allowing the gas to expand at constant pressure. Each gas molecule rotates around an internal axis but do not oscillate. The increase in the internal energy of the gas will be :
(1) 525 J (2) 441 J (3) 572 J (4) 735 J

Sol. **(1)**

At constant Pressure,
$Q = nCpdT = 735J$

$$\Delta U = nCvdT = \frac{735}{\left(Cp/Cv\right)} = \frac{735}{8}$$

$$\Delta U = \frac{735}{\left(7/5\right)} = 525J$$

4. Match List I with List II

LIST I		LIST II	
A.	Angular momentum	I.	$[ML^2 T^{-2}]$
B.	Torque	II.	$[ML^{-2} T^{-2}]$
C.	Stress	III.	$[ML^2 T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1} T^{-2}]$

Choose the correct answer from the options given below:

(1) A - III, B - I, C - IV, D – II (2) A - II, B - III, C - IV, D – I

(3) A - IV, B - II, C - I, D – III (4) A - I, B - IV, C - III, D – II

Sol. **(1)**

$L = mvr = [M^1L^2T^{-1}]$

$\tau = rF = [M^1L^2T^{-2}]$

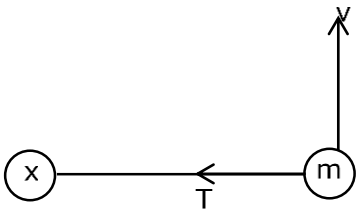
$\text{Stress} = \frac{F}{A} = [M^1L^{-1}T^{-2}]$

$\text{Pressure Gradient} = \frac{dp}{dx} = [M^1L^{-2}T^{-2}]$

5. A stone of mass 1 kg is tied to end of a massless string of length 1 m. If the breaking tension of the string is 400 N, then maximum linear velocity, the stone can have without breaking the string, while rotating in horizontal plane, is :

(1) 40 ms^{-1} (2) 400 ms^{-1} (3) 20 ms^{-1} (4) 10 ms^{-1}

Sol. **(3)**



$T = \frac{mv^2}{\ell}$

$400 = \frac{1 \times v^2}{1}$

$V = 20 \text{ m/s}$

6. A microscope is focused on an object at the bottom of a bucket. If liquid with refractive index $\frac{5}{3}$ is poured inside the bucket, then microscope have to be raised by 30 cm to focus the object again. The height of the liquid in the bucket is :

(1) 12 cm (2) 50 cm (3) 18 cm (4) 75 cm

Sol. **(4)**

$d_{app} = \frac{d}{\mu} = \frac{h}{\left(\frac{5}{3}\right)}$

Shift = $h\ \frac{-3h}{5} = 30$

$h = 75$ cm

7. The number of turns of the coil of a moving coil galvanometer is increased in order to increase current sensitivity by 50%. The percentage change in voltage sensitivity of the galvanometer will be :

(1) 0% (2) 75% (3) 50% (4) 100%

Sol. **(1)**

$$\alpha_V = \frac{NAB}{KR}\alpha\frac{N}{R}$$

$$\alpha_I = \frac{NAB}{K}\alpha\ N$$

$N\uparrow, \alpha_I\uparrow, \frac{N}{R} \rightarrow$ Constant

$\Delta\alpha_V = 0$

8. A body is moving with constant speed, in a circle of radius 10 m. The body completes one revolution in 4s. At the end of 3rd second, the displacement of body (in m) from its starting point is:

(1) 15π (2) $10\sqrt{2}$ (3) 30 (4) 5π

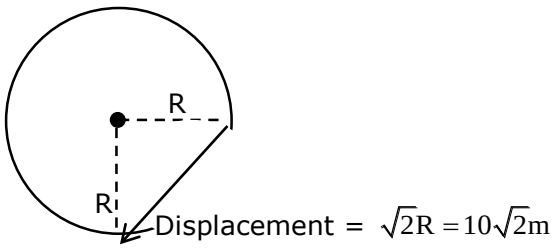
Sol. **(2)**

$$w = \frac{2\pi}{T} = \frac{2\pi}{4} = \frac{\pi}{2}\ \text{rad/s}$$

$\theta = wt$

$$\theta = \frac{\pi}{2}\times 3$$

$$\theta = \frac{3\pi}{2}\ \text{rad}$$



9. The H amount of thermal energy is developed by a resistor in 10 s when a current of 4 A is passed through it. If the current is increased to 16 A, the thermal energy developed by the resistor in 10 s will be :

(1) $\frac{H}{4}$ (2) 16H (3) 4H (4) H

Sol. **(2)**

$H = I^2Rt$

$$\frac{H_1}{H_2} = \left(\frac{I_1}{I_2}\right)^2 = \left(\frac{4}{16}\right)^2$$

$H_2 = 16H_1$

10. A long conducting wire having a current I flowing through it, is bent into a circular coil of N turns. Then it is bent into a circular coil of n turns. The magnetic field is calculated at the centre of coils in both the cases. The ratio of the magnetic field in first case to that of second case is:

(1) n: N (2) n^2: N^2 (3) N^2: n^2 (4) N: n

Sol. **(3)**

Length Remains Same.

$\ell = N(2\pi r_1) = n(2\pi r_2)$

$$\frac{B_1}{B_2} = \frac{\left(N\frac{\mu_0 I}{2r_1}\right)}{\left(n\frac{\mu_0 I}{2r_2}\right)} = \frac{N}{n}\left(\frac{r_2}{r_1}\right) = \frac{N}{n}\left(\frac{N}{n}\right)$$

$$\frac{B_1}{B_2} = \left(\frac{N}{n}\right)^2$$

11. A body weight W, is projected vertically upwards from earth's surface to reach a height above the earth which is equal to nine times the radius of earth. The weight of the body at that height will be :

(1) $\frac{W}{100}$ (2) $\frac{W}{91}$ (3) $\frac{W}{3}$ (4) $\frac{W}{9}$

Sol. **(1)**

$$g_h = \frac{g}{\left(1+\frac{h}{R}\right)^2}$$

h = 9R

$$g_h = \frac{g}{(1+9)^2} = \frac{g}{100}$$

$$w_h = \frac{mg}{100} = \frac{w}{100}$$

12. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of 3rd orbit will be

(1) $\frac{R}{3}$ (2) 3R (3) 2.25R (4) 9R

Sol. **(3)**

$$R \alpha \frac{n^2}{z}$$

$$\frac{R_1}{R_2} = \left(\frac{n_1}{n_2}\right)^2 = \left(\frac{2}{3}\right)^2$$

$$R_2 = \frac{9R}{4} = 2.25R$$

13. A hypothetical gas expands adiabatically such that its volume changes from 08 litres to 27 litres. If the ratio of final pressure of the gas to initial pressure of the gas is $\frac{16}{81}$. Then the ratio of $\frac{Cp}{Cv}$ will be.

(1) $\frac{1}{2}$ (2) $\frac{4}{3}$ (3) $\frac{3}{2}$ (4) $\frac{3}{1}$

Sol. **(2)**

For Adiabatic process,

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$\left(\frac{8}{27}\right)^{\gamma} = \frac{16}{81}$$

$$\left(\frac{2}{3}\right)^{3\gamma} = \left(\frac{2}{3}\right)^{4}$$

$$3\gamma = 4$$

$$\gamma = \frac{4}{3} = \frac{Cp}{Cv}$$

14. For a solid rod, the Young's modulus of elasticity is $3.2 \times 10^{11} Nm^{-2}$ and density is 8×10^3 kg m^{-3}. The velocity of longitudinal wave in the rod will be.

(1) 145.75×10^3 ms^{-1} (2) 18.96×10^3 ms^{-1}

(3) 3.65×10^3 ms^{-1} (4) 6.32×10^3 ms^{-1}

Sol. **(4)**

$$V = \sqrt{\frac{Y}{\rho}}$$

$$V = \sqrt{\frac{3.2\times10^{11}}{8\times10^3}} = \sqrt{0.4\times10^8}$$

$$V = \sqrt{40\times10^6}$$

$$V = 6.32\times10^3 \ \frac{m}{s}$$

15. A body of mass 10 kg is moving with an initial speed of 20 m/s. The body stops after 5 s due to friction between body and the floor. The value of the coefficient of friction is: (Take acceleration due to gravity $g = 10$ ms^{-2})

(1) 0.3 (2) 0.5 (3) 0.2 (4) 0.4

Sol. **(4)**

v = u + at

$$0 = 20 - \mu g(5)$$

$$\mu = \frac{2}{5} = 0.4$$

16. Given below are two statements :

Statement I : For transmitting a signal, size of antenna (l) should be comparable to wavelength of signal (at least $l = \frac{\lambda}{4}$ in dimension)

Statement II : In amplitude modulation, amplitude of carrier wave remains constant (unchanged).

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Statement **I** is correct but Statement II is incorrect

(2) Both Statement I and Statement II are correct

(3) Statement I is incorrect but Statement II is correct

(4) Both Statement I and Statement II are incorrect

Sol. **(1)**

Statement –1 is correct.

In Modulation Amplitude of carrier wave is increased.

17. An alternating voltage source $V = 260\sin(628t)$ is connected across a pure inductor of 5mH. Inductive reactance in the circuit is :

(1) 0.318Ω (2) 6.28Ω (3) 3.14Ω (4) 0.5Ω

Sol. **(3)**

$\omega = 628 \ \text{rad/s}$

$X_L = \omega L = 628 \times 5 \times 10^{-3}$

$X_L = 3.14\Omega$

18. Under the same load, wire A having length 5.0 m and cross section 2.5×10^{-5} m^2 stretches uniformly by the same amount as another wire B of length 6.0 m and a cross section of 3.0×10^{-5} m^2 stretches. The ratio of the Young's modulus of wire A to that of wire B will be :

(1) 1: 1 (2) 1: 10 (3) 1: 2 (4) 1: 4

Sol. **(1)**

By Hooke's Law,

$$Y = \frac{FL}{A\Delta L}$$

F, $\Delta L \rightarrow$ Same

$$\frac{Y_1 A_1}{L_1} = \frac{Y_2 A_2}{L_2}$$

$$\frac{Y_1}{Y_2} = \frac{3\times10^{-5}}{2.5\times10^{-5}} \times \frac{5}{6} = \frac{1}{1}$$

19. Match List I with List II

LIST I		LIST II	
A.	Microwaves	I.	Physiotherapy
B.	UV rays	II.	Treatment of cancer
C.	Infra-red light	III.	Lasik eye surgery
D.	X-ray	IV.	Aircraft navigation

Choose the correct answer from the options given below:

(1) A – IV, B - III, C - I, D – II (2) A – IV, B – I, C - II, D – III

(3) A - III, B - II, C - I, D – IV (4) A - II, B - IV, C - III, D – I

Sol. **(1)**

Theoritical

20. Considering a group of positive charges, which of the following statements is correct?

(1) Both the net potential and the net electric field cannot be zero at a point.

(2) Net potential of the system at a point can be zero but net electric field can't be zero at that point.

(3) Net potential of the system cannot be zero at a point but net electric field can be zero at that point.

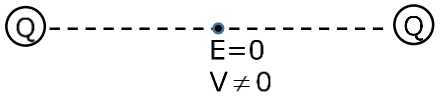
(4) Both the net potential and the net field can be zero at a point.

Sol. **(3)**

Electric field is a Vector Quantity.

Electric Potential is a Scalar Quantity.

Eg.



SECTION - B

21. A series LCR circuit consists of $R = 80\Omega, X_L = 100\Omega$, and $X_C = 40\Omega$. The input voltage is 2500 $\cos(100\pi t)$V. The amplitude of current, in the circuit, is _____A.

Sol. **(25)**

$R = 80\Omega$, $X_L = 100\ \Omega$, $X_c = 40\ \Omega$

$$Z = \sqrt{R^2 + (x_L - X_C)^2}$$

$$Z = \sqrt{80^2 + 60^2} = 100\Omega$$

$$I_0 = \frac{V_0}{Z} = \frac{2500}{100} = 25A$$

22. Two bodies are projected from ground with same speeds 40 ms^{-1} at two different angles with respect to horizontal. The bodies were found to have same range. If one of the body was projected at an angle of 60°, with horizontal then sum of the maximum heights, attained by the two projectiles, is _____m. (Given g = 10 ms^{-2})

Sol. **(80)**

In Range is same.

$$\alpha + \beta = 90°$$

$$\alpha = 60°$$

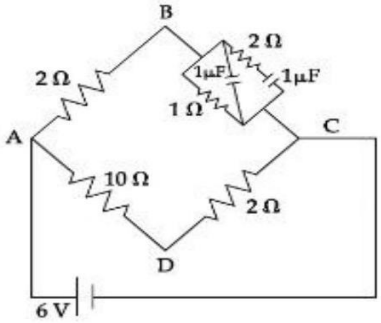
$$\beta = 30°$$

$$H_1 + H_2 = \frac{u_1^2 \sin^2 60°}{2g} + \frac{u_2^2 \sin^2 30°}{2g}$$

$$= \frac{u^2}{2g}\left(\frac{3}{4} + \frac{1}{4}\right) \qquad [u_1 = u_2]$$

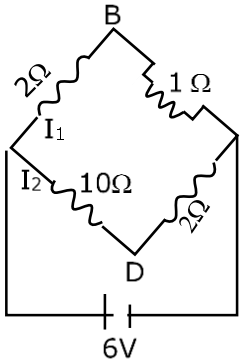
$$H_1 + H_2 = \frac{(40)^2}{20} = 80m$$

23. For the given circuit, in the steady state, $|V_B - V_D|$ = _____V.



Sol. **(1)**

At steady state, C $\rightarrow$ open Circuit



$$I_1 = \frac{6}{3} = 2A$$

$$I_2 = \frac{6}{12} = \frac{1}{2}A$$

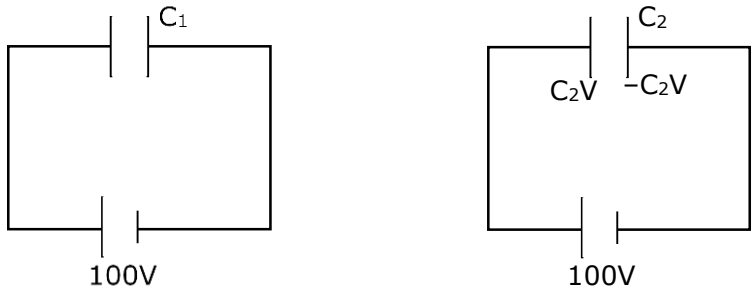
$$V_B + 2I_1 - 10I_2 = V_D$$

$$V_B - V_D = 5 - 4 = 1V$$

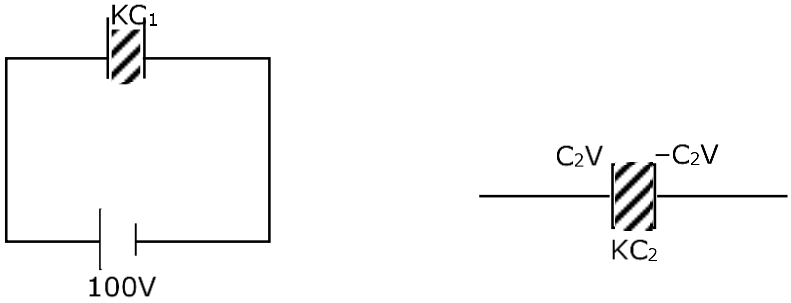
24. Two parallel plate capacitors C_1 and C_2 each having capacitance of $10\mu F$ are individually charged by a 100 V D.C. source. Capacitor C_1 is kept connected to the source and a dielectric slab is inserted between it plates. Capacitor C_2 is disconnected from the source and then a dielectric slab is inserted in it. Afterwards the capacitor C_1 is also disconnected from the source and the two capacitors are finally connected in parallel combination. The common potential of the combination will be _____V. (Assuming Dielectric constant = 10)

Sol. **(55)**

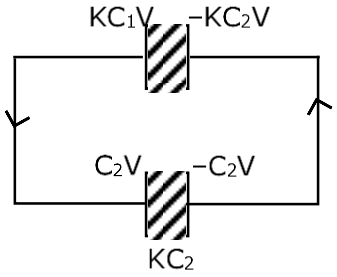
1.



2.



3.



By charge conservation

$Q_1 = Q_2$

$KC_1V + C_2V = (KC_1+KC_2)\,V_{common}$

$$V_{common} = \frac{(K+1)CV}{2KC} = \frac{K+1}{2K}V$$

$$V_{common} = \frac{11}{20}\times 100 = 55V$$

25. Two light waves of wavelengths 800 and 600 nm are used in Young's double slit experiment to obtain interference fringes on a screen placed 7 m away from plane of slits. If the two slits are separated by 0.35 mm, then shortest distance from the central bright maximum to the point where the bright fringes of the two wavelength coincide will be _____ mm.

Sol. **(48)**

d = 0.35 mm, D = 7m

To Coincide, $n_1\left(\frac{\lambda_1 D}{d}\right) = n_2\left(\frac{\lambda_2 D}{d}\right)$

$$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{6}{8} = \frac{3}{4}$$

3rd Maxima of λ_1 and 4th Maxima of λ_2 will coincide.

$$Y = \frac{3\lambda_1 D}{d} = \frac{3\times 800\times 10^{-9}\times 7}{35\times 10^{-5}}$$

$Y = 3 \times 160 \times 10^{-4}$ m

Y = 48mm

26. A ball is dropped from a height of 20 m. If the coefficient of restitution for the collision between ball and floor is 0.5, after hitting the floor, the ball rebounds to a height of _____ m

Sol. **(5)**

$V = \sqrt{2g(20)}$

$eV = \sqrt{2gh}$

$$\frac{1}{e} = \sqrt{\frac{20}{h}}$$

$$h = 20e^2 = 20\left(\frac{1}{2}\right)^2$$

h = 5m

27. If the binding energy of ground state electron in a hydrogen atom is 13.6eV, then, the energy required to remove the electron from the second excited state of Li^{2+} will be : $x \times 10^{-1}$eV. The value of x is____.

Sol. **(136)**

$$BE = 13.6 \times \frac{z^2}{n^2}$$

$$BE = 13.6 \times \left(\frac{3}{3}\right)^2 = 13.6eV$$

$$BE = 136 \times 10^{-1}\ eV$$

$$x = 136$$

28. A water heater of power 2000 W is used to heat water. The specific heat capacity of water is 4200 J kg^{-1} K^{-1}. The efficiency of heater is 70%. Time required to heat 2 kg of water from 10°C to 60°C is _____s.
(Assume that the specific heat capacity of water remains constant over the temperature range of the water).

Sol. **(300)**

$P_{used} = 0.7 \times 2000 = 1400W$

$$P = \frac{ms\Delta T}{t}$$

$$t = \frac{2 \times 4200 \times 50}{1400}$$

$$t = 300\ sec$$

29. Two discs of same mass and different radii are made of different materials such that their thicknesses are 1 cm and 0.5 cm respectively. The densities of materials are in the ratio 3: 5. The moment of inertia of these discs respectively about their diameters will be in the ratio of $\frac{x}{6}$. The value of x is _____.

Sol. **(5)**

$$M_1 = M_2$$

$$S_1\left(\pi R_1^2 t_1\right) = S_2\left(\pi R_2^2 t_2\right)$$

$$\frac{R_1^2}{R_2^2} = \frac{5}{3} \times \frac{0.5}{1} = \frac{5}{6}$$

$$I = \frac{MR^2}{4}$$

$$\frac{I_1}{I_2} = \left(\frac{R_1}{R_2}\right)^2 = \frac{5}{6}$$

30. The displacement equations of two interfering waves are given by $y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$ cm, $y_2 = 5[\sin\omega t + \sqrt{3}\cos\omega t]$cm respectively. The amplitude of the resultant wave is _____ cm.

Sol. **(20)**

$$y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

$$y_2 = 10\left[\sin\omega t \times \frac{1}{2} + \frac{\sqrt{3}}{2}\cos\omega t\right]$$

$$y_2 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

y_1 and y_2 are in same phase

$A_r = A_1 + A_2 = 20$ cm

मोशन है, तो भरोसा है।

#RankBhiSelectionBhi

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Class 10th to 11th Moving

Target: JEE/NEET 2024
Enthuse & प्रयास Batch
Class 11th to 12th Moving

Target: JEE/NEET 2024
Dropper & प्रयास Batch
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