# JEE Main January 2025

## Question Paper With Text Solution

## 22 January | Shift-1

# PHYSICS

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

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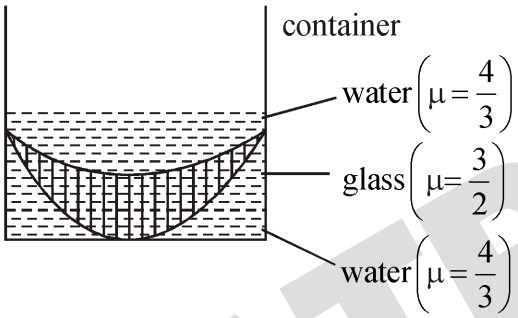
# JEE MAIN JANUARY 2025 | 22 JANUARY SHIFT-1

## SECTION – A

Question ID : 656445117

1. In the diagram given below, there are three lenses formed. Considering negligible thickness of each of them as compared to $|R_1|$ and $|R_2|$, i.e., the radii of curvature for upper and lower surfaces of the glass lens, the power of the combination is




(1) $-\frac{1}{6}\left(\frac{1}{|R_1|}-\frac{1}{|R_2|}\right)$ (2) $-\frac{1}{6}\left(\frac{1}{|R_1|}+\frac{1}{|R_2|}\right)$ (3) $\frac{1}{6}\left(\frac{1}{|R_1|}-\frac{1}{|R_2|}\right)$ (4) $\frac{1}{6}\left(\frac{1}{|R_1|}+\frac{1}{|R_2|}\right)$

**Ans.** Official answer NTA (1)

**Sol.**

Question ID : 656445102

2. Given below are two statements :

**Statement I :** In a vernier callipers, one vernier scale division is always smaller than one main scale division.

**Statement II :** The vernier constant is given by one main scale division multiplied by the number of vernier scale divisions.

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

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

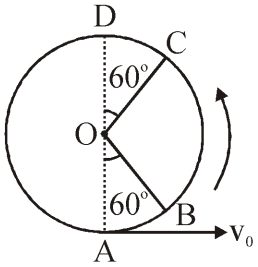
(4) Statement I is false but Statement II is true

**Ans.** Official answer NTA (1)

**Sol.**

Question ID : 656445103

3. A bob of mass m is suspended at a point O by a light string of length l and left to perform vertical motion (circular) as shown in figure. Initially, by applying horizontal velocity $v_0$ at the point 'A', the string becomes slack when, the bob reaches at the point 'D '. The ratio of the kinetic energy of the bob at the points B and C is _____ .



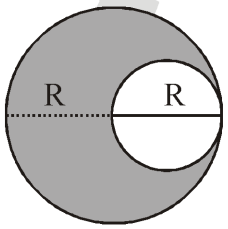

(1) 1 (2) 3 (3) 4 (4) 2

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445104

4. A uniform circular disc of radius 'R' and mass 'M' is rotating about an axis perpendicular to its plane and passing through its centre. A small circular part of radius R/2 is removed from the original disc as shown in the figure. Find the moment of inertia of the remaining part of the original disc about the axis as given above.




(1) $\frac{7}{32}MR^2$ (2) $\frac{13}{32}MR^2$ (3) $\frac{9}{32}MR^2$ (4) $\frac{17}{32}MR^2$

**Ans.** Official answer NTA (2)

**Sol.**

Question ID : 656445108

5. A closed organ and an open organ tube are filled by two different gases having same bulk modulus but different densities $\rho_1$ and $\rho_2$ respectively. The frequency of $9^{th}$ harmonic of closed tube is identical with $4^{th}$ harmonic of open tube. If the length of the closed tube is 10 cm and the density ratio of the gases is $\rho_1 : \rho_2 = 1:16$, then the length of the open tube is :

(1) $\frac{20}{7}$cm (2) $\frac{20}{9}$cm (3) $\frac{15}{9}$cm (4) $\frac{15}{7}$cm

**Ans.** Official answer NTA (2)

**Sol.**

Question ID : 656445113

6. Given below are two statements :

**Statement-I :** The equivalent emf of two nonideal batteries connected in parallel is smaller than either of the two emfs.

**Statement-II :** The equivalent internal resistance of two nonideal batteries connected in parallel is smaller than the internal resistance of either of the two batteries.

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

(1) Statement-I is true but Statement-II is false

(2) Statement-I is false but Statement-II is true

(3) Both Statement-I and Statement-II are false

(4) Both Statement-I and Statement-II are true

**Ans.** Official answer NTA (2)

**Sol.**

Question ID : 656445115

7. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

**Assertion-(A) :** If Young's double slit experiment is performed in an optically denser medium than air, then the consecutive fringes come closer.

**Reason-(R) :** The speed of light reduces in an optically denser medium than air while its frequency does not change.

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

(1) (A) is false but (R) is true

(2) (A) is true but (R) is false

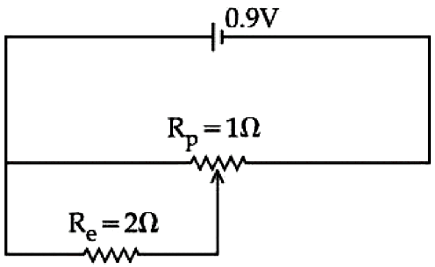
(3) Both (A) and (R) are true and (R) is the correct explanation of (A)

(4) Both (A) and (R) are true but (R) is not the correct explanation of (A)

**Ans.** Official answer NTA (3)

**Sol.**

Question ID : 656445114

8. 


Sliding contact of a potentiometer is in the middle of the potentiometer wire having resistance $R_P = 1\Omega$ as shown in the figure. An external resistance of $R_e = 2\Omega$ is connected via the sliding contact. The electric current in the circuit is :

(1) 0.9A (2) 0.3 A (3) 1.35A (4) 1.0A

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445107

9. An amount of ice of mass $10^{-3}$ kg and temperature $-10^{\circ}C$ is transformed to vapour of temperature $110^{\circ}C$ by applying heat. The total amount of work required for this conversion is,

(Take, specific heat of ice $= 2100 Jkg^{-1}K^{-1}$, specific heat of water $= 4180 Jkg^{-1}K^{-1}$, specific heat of steam $= 1920 Jkg^{-1}K^{-1}$, Latent heat of ice $= 3.35 \times 10^5 Jkg^{-1}$ and Latent heat of steam $= 2.25 \times 10^6\ Jkg^{-1}$)

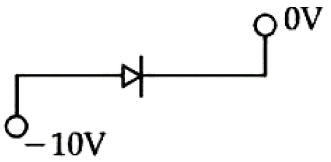
(1) 3022 J (2) 3003 J (3) 3024 J (4) 3043 J

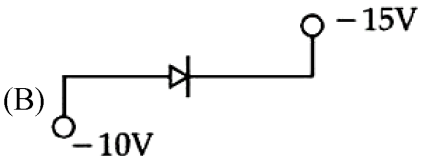
**Ans.** Official answer NTA (4)

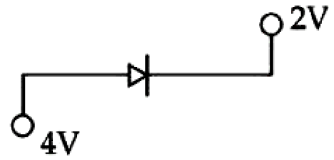
**Sol.**

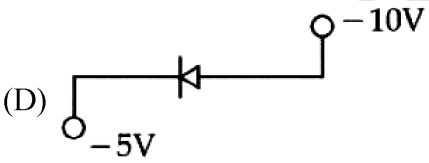
Question ID : 656445120

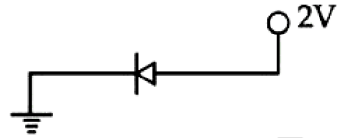
10. Which of the following circuits represents a forward biased diode ?

(A) 


(B) 


(C) 


(D) 


(E) 


Choose the correct answer from the options given below :

(1) (B), (C) and (E) only

(2) (A) and (D) only

(3) (B), (D) and (E) only

(4) (C) and (E) only

**Ans.** Official answer NTA (1)

Question ID : 656445110

11. An electron is made to enter symmetrically between two parallel and equally but oppositely charged metal plates, each of 10 cm length. The electron emerges out of the electric field region with a horizontal component of velocity $10^6$ m / s . If the magnitude of the electric field between the plates is 9.1 V/cm, then the vertical component of velocity of electron is

(mass of electron = $9.1 \times 10^{-31}$ kg and charge of electron = $1.6 \times 10^{-19}$ C)

(1) $1\times10^6$ m / s (2) 0 (3) $16\times10^6$ m / s (4) $16\times10^4$ m / s

**Ans.** Official answer NTA (3)

**Sol.**

Question ID : 656445119

12. An electron in the ground state of the hydrogen atom has the orbital radius of $5.3 \times 10^{-11}$ m while that for the electron in third excited state is $8.48 \times 10^{-10}$ m. The ratio of the de Broglie wavelengths of electron in the ground state to that in the excited state is

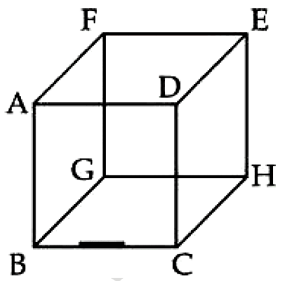
(1) 16 (2) 9 (3) 4 (4) 3

**Ans.** Official answer NTA (3)

**Sol.**

Question ID : 656445112

13. A line charge of length $\frac{'a'}{2}$ is kept at the center of an edge BC of a cube ABCDEFGH having edge length 'a' as shown in the figure. If the density of line charge is $\lambda$ C per unit length, then the total electric flux through all the faces of the cube will be _____ . (Take, $\in_0$ as the free space permittivity)



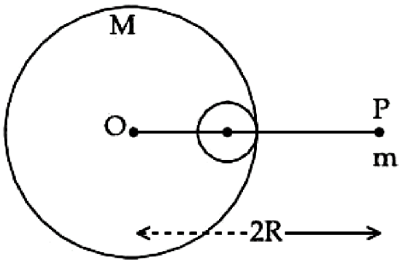

(1) $\frac{\lambda a}{16\epsilon_0}$ (2) $\frac{\lambda a}{4\epsilon_0}$ (3) $\frac{\lambda a}{2\epsilon_0}$ (4) $\frac{\lambda a}{8\epsilon_0}$

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445105

14. A small point of mass m is placed at a distance 2 R from the centre 'O ' of a big uniform solid sphere of mass M and radius R. The gravitational force on ' m ' due to M is $F_1$. A spherical part of radius R /3 is removed from the big sphere as shown in the figure and the gravitational force on m due to remaining part of M is found to be $F_2$. The value of ratio $F_1 : F_2$ is




(1) 16 : 9 (2) 11 : 10 (3) 12 : 11 (4) 12 : 9

**Ans.** Official answer NTA (3)

**Sol.**

Question ID : 656445109

15. A parallel-plate capacitor of capacitance 40 μF is connected to a 100 V power supply. Now the intermediate space between the plates is filled with a dielectric material of dielectric constant K =2. Due to the introduction of dielectric material, the extra charge and the change in the electrostatic energy in the capacitor, respectively, are

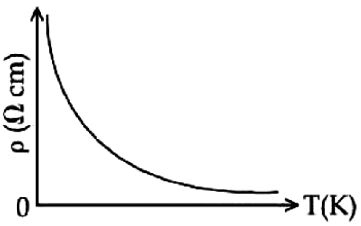
(1) 2 mC and 0.2 J (2) 2 mC and 0.4 J (3) 4 mC and 0.2 J (4) 8 mC and 2.0 J

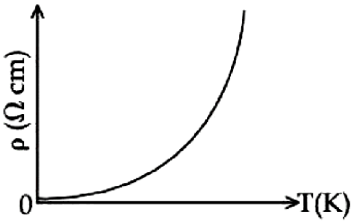
**Ans.** Official answer NTA (3)

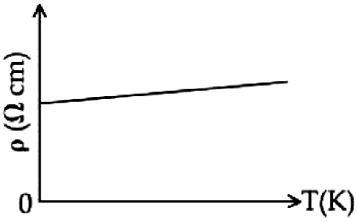
**Sol.**

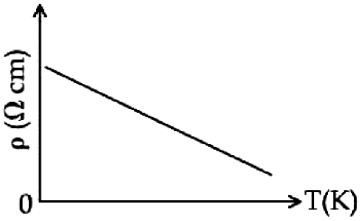
Question ID : 656445111

16. Which of the following resistivity $(\rho)$ v / s temperature (T) curves is most suitable to be used in wire bound standard resistors ?

(1) 


(2) 


(3) 


(4) 


**Ans.** Official answer NTA (3)

**Sol.**

Question ID : 656445118

17. The work functions of cesium (Cs) and lithium (Li) metals are 1.9 eV and 2.5 eV , respectively. If we incident a light of wavelength 550 nm on these two metal surfaces, then photo-electric effect is possible for the case of

(1) Neither Cs nor Li (2) Both Cs and Li (3) Li only (4) Cs only

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445101

18. If B is magnetic field and $\mu_0$ is permeability of free space, then the dimensions of $(B/\mu_0)$ is

(1) $ML^2T^{-2}A^{-1}$ (2) $LT^{-2}A^{-1}$ (3) $MT^{-2}A^{-1}$ (4) $L^{-1}A$

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445116

19. Given is a thin convex lens of glass (refractive index μ) and each side having radius of curvature R. One side is polished for complete reflection. At what distance from the lens, an object be placed on the optic axis so that the image gets formed on the object itself ?

(1) $\mu R$ (2) $R/(2\mu-1)$ (3) $R/(2\mu-3)$ (4) $R/\mu$

**Ans.** Official answer NTA (2)

**Sol.**

Question ID : 656445106

20. Two spherical bodies of same materials having radii 0.2 m and 0.8 m are placed in same atmosphere. The temperature of the smaller body is 800 K and temperature of the bigger body is 400 K . If the energy radiated from the smaller body is E, the energy radiated from the bigger body is (assume, effect of the surrounding temperature to be negligible),

(1) 64 E (2) 16 E (3) 256 E (4) E

**Ans.** Official answer NTA (4)

**Sol.**

## SECTION – B

Question ID : 656445121

21. The position vectors of two 1 kg particles, (A) and (B), are given by

$\vec{r}_A = \left(\alpha_1 t^2 \hat{i} + \alpha_2 t \hat{j} + \alpha_3 t \hat{k}\right) m$ and $\vec{r}_B = \left(\beta_1 t \hat{i} + \beta_2 t^2 \hat{j} + \beta_3 t \hat{k}\right) m$, respectively;

$\left(\alpha_1 = 1 m/s^2, \alpha_2 = 3n\ m/s, \alpha_3 = 2\ m/s, \beta_1 = 2\ m/s, \beta_2 = -1 m/s^2, \beta_3 = 4p\ m/s\right)$, where t is time, n and p are constant. At $t = 1s, \left|\overrightarrow{V_A}\right| = \left|\overrightarrow{V_B}\right|$ and velocities $\vec{V}_A$ and $\vec{V}_B$ of the particles are orthogonal to each other. At t = 1 s, the magnitude of angular momentum of particle (A) with respect to the position of particle (B) is $\sqrt{L}$ $kgm^2 s^{-1}$. The value of L is _____.

**Ans.** Official answer NTA (90)

**Sol.**

Question ID : 656445125

22. The driver sitting inside a parked car is watching vehicles approaching from behind with the help of his side view mirror, which is a convex mirror with radius of curvature R = 2 m. Another car approaches him from behind with a uniform speed of 90 km/hr. When the car is at a distance of 24 m from him, the magnitude of the acceleration of the image of the car in the side view mirror is 'a'. The value of 100a is _____ $m/s^2$.

**Ans.** Official answer NTA (8)

**Sol.**

Question ID : 656445123

23. Two soap bubbles of radius 2 cm and 4 cm, respectively, are in contact with each other. The radius of curvature of the common surface, in cm , is _____.

**Ans.** Official answer NTA (4)

**Sol.**

Question ID : 656445122

24. A particle is projected at an angle of $30^o$ from horizontal at a speed of 60 m/s. The height traversed by

the particle in the first second is $h_0$ and height traversed in the last second, before it reaches the maximum height, is $h_1$. The ratio $h_0 : h_1$ is _____.

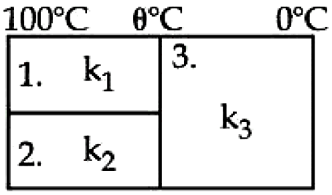
[Take, $g = 10\,m/s^2$]

**Ans.** Official answer NTA (5)

**Sol.**

Question ID : 656445124

25. Three conductors of same length having thermal conductivity $k_1$, $k_2$ and $k_3$ are connected as shown in figure.




Area of cross sections of 1st and 2nd conductor are same and for 3rd conductor it is double of the 1st conductor. The temperatures are given in the figure. In steady state condition, the value of θ is _____.

(Given : $k_1 = 60\ Js^{-1}m^{-1}K^{-1}, k_2 = 120\ Js^{-1}m^{-1}K^{-1}, k_3 = 135\ Js^{-1}m^{-1}K^{-1}$)

**Ans.** Official answer NTA (40)

**Sol.**