JEE Main January 2025

Question Paper With Text Solution

24 January | Shift-2

PHYSICS

MATRIX

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

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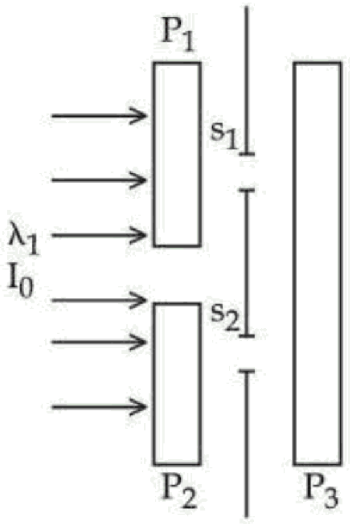
JEE MAIN JANUARY 2025 | 24 JANUARY SHIFT-2

SECTION – A

26. In a Young's double slit experiment, three polarizers are kept as shown in the figure. The transmission axes of P_1 and P_2 are orthogonal to each other. The polarizer P3 covers both the slits with its transmission axis at 45° to those of P_1 and P_2. An unpolarized light of wavelength λ and intensity I_0 is incident on P_1 and P_2. The intensity at a point after P3 where the path difference between the light waves from s_1 and s_2 is $\frac{\lambda}{3}$, is



(1) I_0 (2) $\frac{I_0}{2}$ (3) $\frac{I_0}{4}$ (4) $\frac{I_0}{3}$

Question ID : 656445493

Ans. Official answer NTA (3)

Sol.

27. The position vector of a moving body at any instant of time is given as $\vec{r} = \left(5t^2\hat{i} - 5t\,\hat{j}\right)$m. The magnitude and direction of velocity at t = 2 s is,

(1) $5\sqrt{17}$ m/s, making an angle of $\tan^{-1}4$ with +ve X axis

(2) $5\sqrt{17}$ m/s, making an angle of $\tan^{-1}4$ with –ve Y axis

(3) $5\sqrt{15}$ m/s, making an angle of $\tan^{-1}4$ with +ve X axis

(4) $5\sqrt{15}$ m/s, making an angle of $\tan^{-1}4$ with –ve Y axis

Question ID : 656445479

Ans. Official answer NTA (2)

Sol.

28. The energy E and momentum p of a moving body of mass m are related by some equation. Given that c represents the speed of light, identify the correct equation:

(1) $E^2 = p^2c^2 + m^2c^4$ (2) $E^2 = pc^2 + m^2c^2$ (3) $E^2 = p^2c^2 + m^2c^2$ (4) $E^2 = pc^2 + m^2c^4$

Question ID : 656445476

Ans. Official answer NTA (1)

Sol.

29. Young's double slit inteference apparatus is immersed in a liquid of refractive index 1.44. It has slit separation of 1.5 mm. The slits are illuminated by a parallel beam of light whose wavelength in air is 690 nm. The fringe-width on a screen placed behind the plane of slits at a distance of 0.72 m, will be:

(1) 0.33 mm (2) 0.63 mm (3) 0.23 mm (4) 0.46 mm

Question ID : 656445492

Ans. Official answer NTA (3)

Sol.

30. A small uncharged conducting sphere is placed in contact with an identical sphere but having 4×10^{-8} C charge and then removed to a distance such that the force of repulsion between them is 9×10^{-3} N. The distance between them is (Take $\frac{1}{4\pi\varepsilon_0}$ as 9×10^9 in SI units):

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

Question ID : 656445487

Ans. Official answer NTA (4)

Sol.

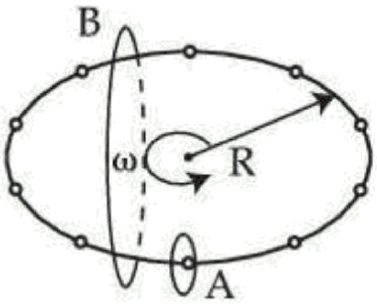
31. A solid sphere is rolling without slipping on a horizontal plane. The ratio of the linear kinetic energy of the centre of mass of the sphere and rotational kinetic energy is:

(1) 3/4 (2) 5/2 (3) 2/5 (4) 4/3

Question ID : 656445478

Ans. Official answer NTA (2)

Sol.

32. 

:

N equally spaced charges each of value q, are placed on a circle of radius R. The circle rotates about its axis with an angular velocity ω as shown in the figure. A bigger Amperian loop B encloses the whole circle where as a smaller Amperian loop A encloses a small segment. The difference between enclosed currents, $I_A - I_B$, for the given Amperian loops is:

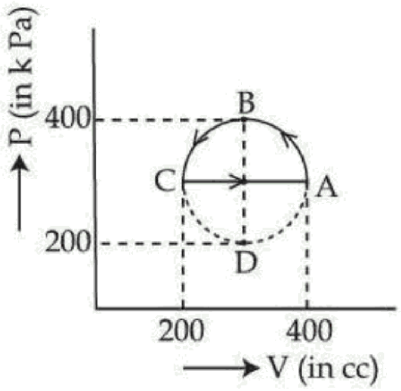
(1) $\frac{2\pi}{N}q\omega$ (2) $\frac{N^2}{2\pi}q\omega$ (3) $\frac{N}{2\pi}q\omega$ (4) $\frac{N}{\pi}q\omega$

Question ID : 656445489

Ans. Official answer NTA (3)

Sol.

33. The magnitude of heat exchanged by a system for the given cyclic process ABCA (as shown in figure) is (in SI unit) :

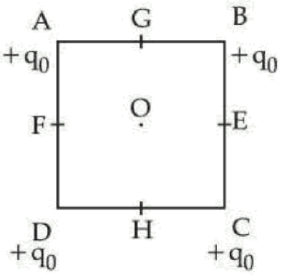


(1) 5 π (2) Zero (3) 40 π (4) 10 π

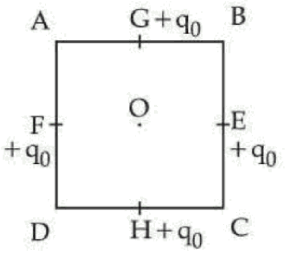
Question ID : 656445482

Ans. Official answer NTA (1)

Sol.

34. 

Configuration (1)



Configuration (2)

:

In the first configuration (1) as shown in the figure, four identical charges (q_0) are kept at the corners A, B, C and D of square of side length 'a'. In the second configuration (2), the same charges are shifted to mid points G, E, H and F, of the square. If $K = \frac{1}{4\pi\varepsilon_0}$, the difference between the potential energies of configuration (2) and (1) is given by:

(1) $\frac{Kq_0^2}{a}\left(3-\sqrt{2}\right)$ (2) $\frac{Kq_0^2}{a}\left(3\sqrt{2}-2\right)$ (3) $\frac{Kq_0^2}{a}\left(4\sqrt{2}-2\right)$ (4) $\frac{Kq_0^2}{a}\left(4-2\sqrt{2}\right)$

Question ID : 656445488

Ans. Official answer NTA (2)

Sol.

35. A photograph of a landscape is captured by a drone camera at a height of 18 km. The size of the camera film is 2 cm × 2 cm and the area of the landscape photographed is 400 km^2. The focal length of the lens in the drone camera is:

(1) 2.5 cm (2) 0.9 cm (3) 1.8 cm (4) 2.8 cm

Question ID : 656445491

Ans.

Ans. Official answer NTA (3)

36. The output of the circuit is low (zero) for:

(A) X = 0, Y = 0 (B) X = 0, Y = 1 (C) X = 1, Y = 0 (D) X = 1, Y = 1

Choose the correct answer from the options given below:

(1) A, B and C only (2) B, C and D only (3) A, B and D only (4) A, C and D only

Question ID : 656445495

Ans. Official answer NTA (2)

Sol.

37. A solid sphere and a hollow sphere of the same mass and of same radius are rolled on an inclined plane. Let the time taken to reach the bottom by the solid sphere and the hollow sphere be t_1 and t_2, respectively, then:

(1) $t_1 = t_2$ (2) $t_1 > t_2$ (3) $t_1 = 2t_2$ (4) $t_1 < t_2$

Question ID : 656445480

Ans. Official answer NTA (4)

Sol.

38. Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The magnetic field in that region is along the direction of velocity of the electron. In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is false but R is true

(4) Both A and r are true and R is the correct expalanation of A

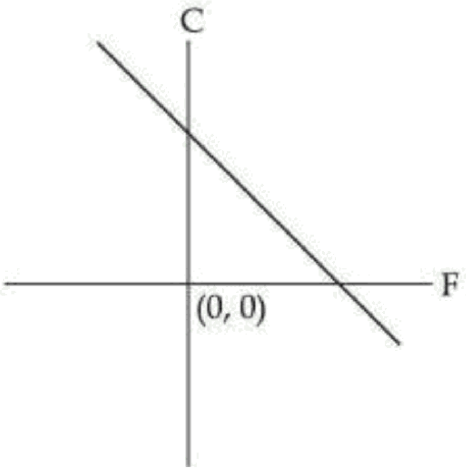
Question ID : 656445485

Ans. Official answer NTA (4)

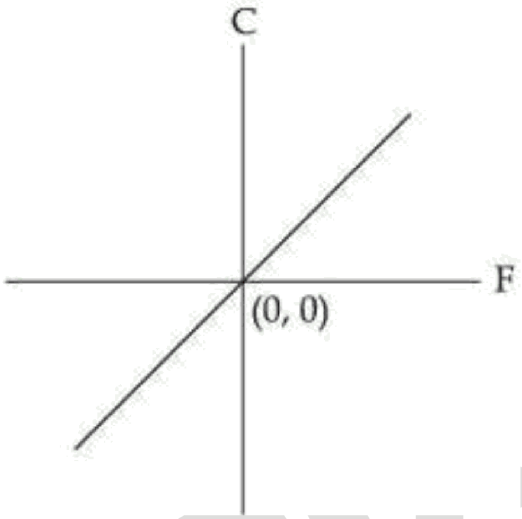
Sol.

39. Which of the following figure represents the relation between Celsius and Fahrenheit temperatures ?

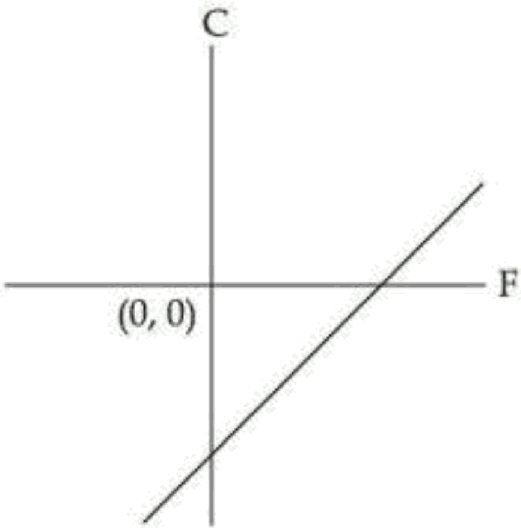
(1)



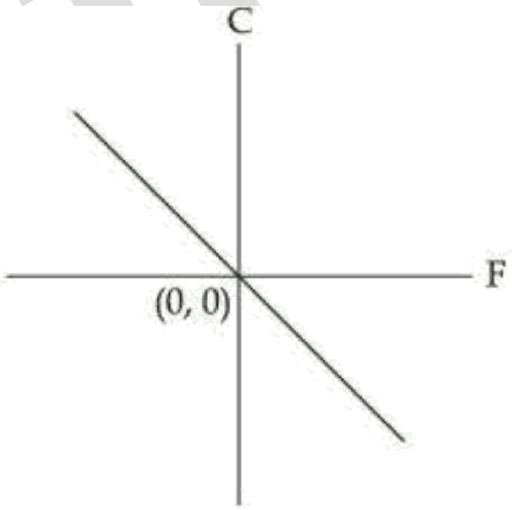
(2)



(3)



(4)

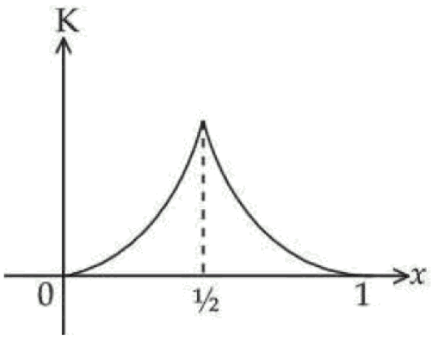


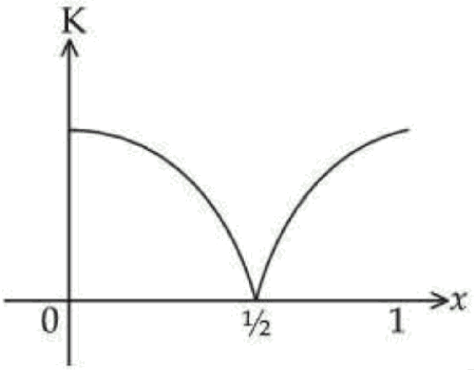
Question ID : 656445477

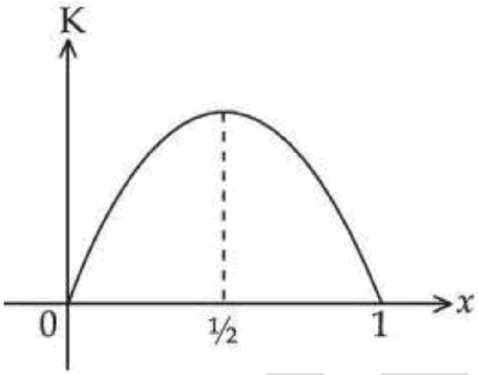
Ans. Official answer NTA (3)

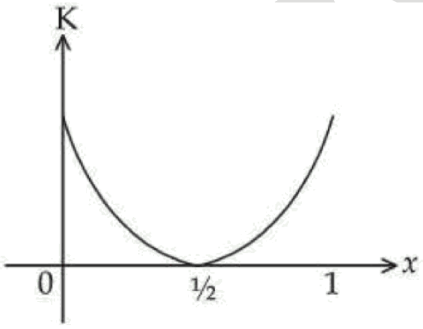
Sol.

40. A particle oscillates along the x-axis according to the law, $x(t) = x_0 \sin^2\left(\frac{t}{2}\right)$ where x_0 = 1 m. The kinetic energy (K) of the particle as a function of x is correctly represented by the graph:

(1) 

(2) 

(3) 

(4) 

Question ID : 656445484

Ans. Official answer NTA (3)

Sol.

41. Arrange the following in the ascending order of wavelength (λ) :

(A) Microwaves (λ_1) (B) Ultraviolet rays (λ_2)

(C) Infrared rays (λ_3) (D) X-rays (λ_4)

Choose the most appropriate answer from the options given below:

(1) $\lambda_4 < \lambda_2 < \lambda_3 < \lambda_1$ (2) $\lambda_4 < \lambda_3 < \lambda_1 < \lambda_2$ (3) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$ (4) $\lambda_3 < \lambda_4 < \lambda_2 < \lambda_1$

Question ID : 656445490

Ans. Official answer NTA (1)

Sol.

42. In photoelectric effect, the stopping potential (V_0) v/s frequency (v) curve is plotted.

(h is the Planck's constant and ϕ_0 is work function of metal):

(A) V_0 v/s v is linear

(B) The slope of V_0 v/s ν curve $= \frac{\phi_0}{h}$

(C) h constant is related to the slope of V_0 v/s ν line

(D) The value of electric charge of electron is not required to determine h using the V_0 v/s ν curve

(E) The work function can be estimated without knowing the value of h

Choose the correct answer from the options given below:

(1) C and D only

(2) A, B and C only

(3) D and E only

(4) A, C and E only

Question ID : 656445494

Ans. Official answer NTA (4)

Sol.

43. The temperature of a body in air falls from 40° C to 24°C in 4 minutes. The temperature of the air is 16°C. The temperature of the body in the next 4 minutes will be:

(1) $\frac{14}{3}$°C

(2) $\frac{42}{3}$°C

(3) $\frac{28}{3}$°C

(4) $\frac{56}{3}$°C

Question ID : 656445481

Ans. Official answer NTA (4)

Sol.

44. Given below are two statements. One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**:

Assertion (A) : In an insulated container, a gas is adiabatically shrunk to half of its initial volume. The temperature of the gas decreases.

Reason (R) : Free expansion of an ideal gas is an irreversible and an adiabatic process. In the light of the above statements, choose the correct answer from the options given below:

(1) A is false but R is true

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is true but R is false

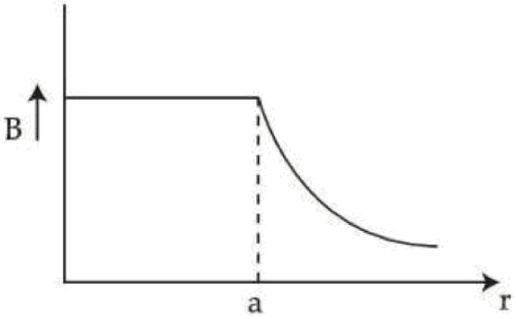
(4) Both A and R are true and R is the correct explanation of A

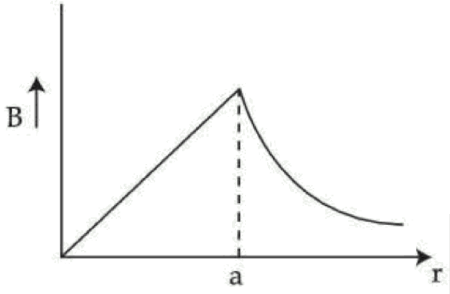
Question ID : 656445483

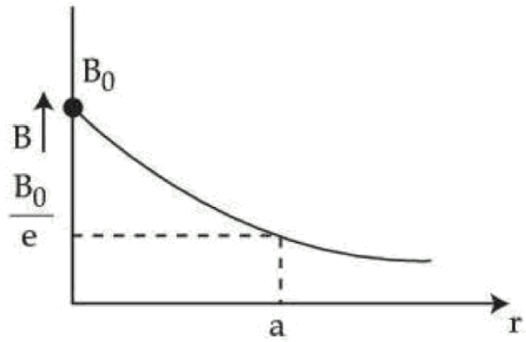
Ans. Official answer NTA (1)

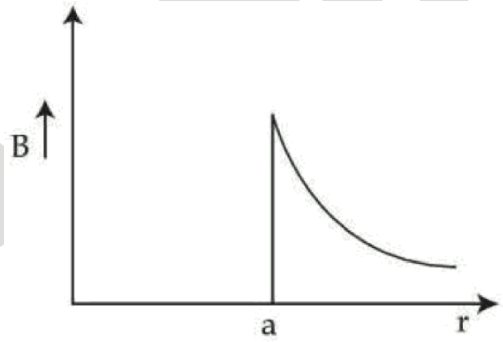
Sol.

45. A long straight wire of a circular cross-section with radius 'a' carries a steady current I. The current I is uniformly distributed across this cross-section. The plot of magnitude of magnetic field B with distance r from the centre of the wire is given by :

(1) 

(2) 

(3) 

(4) 

Question ID : 656445486

Ans. Official answer NTA (2)

Sol.

SECTION – B

46. The ratio of the power of a light source S_1 to that the light source S_2 is 2. S_1 is emitting 2×10^{15} photons per second at 600 nm. If the wavelength of the source S_2 is 300 nm, then the number of photons per second emitted by S_2 is _____ $\times 10^{14}$.

Question ID : 656445500

Ans. Official answer NTA (5)

Sol.

47. The increase in pressure required to decrease the volume of a water sample by 0.2% is P $\times 10^5$ Nm^{-2}. Bulk modulus of water is 2.15×10^9 Nm^{-2}. The value of P is _____.

Question ID : 656445498

Ans. Official answer NTA (43)

Sol.

48. A tightly wound long solenoid carries a current of 1.5 A. An electron is executing uniform circular motion inside the solenoid with a time period of 75 ns. The number of turns per metre in the solenoid is _____.

[Take mass of electron $m_e = 9 \times 10^{-31}$ kg, charge of electron $|q_e| = 1.6 \times 10^{-19}$ C,

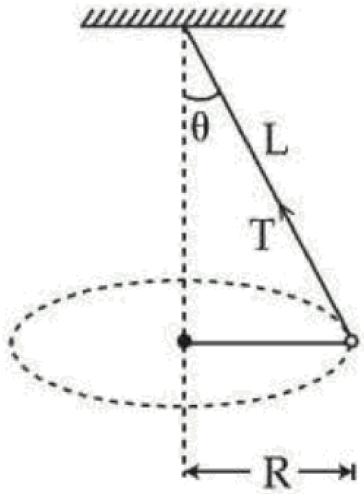
$\mu_0 = 4\pi \times 10^{-7} \frac{N}{A^2}, 1\text{ ns} = 10^{-9}\text{ s}$]

Question ID : 656445499

Ans. Official answer NTA (250)

Sol.

49.



A string of length L is fixed at one end and carries a mass of M at the other end. The mass makes $\left(\frac{3}{\pi}\right)$ rotations per second about the vertical axis passing through end of the string as shown. The tension in the string is _____ML.

Question ID : 656445496

Ans. Official answer NTA (36)

Sol.

50. Acceleration due to gravity on the surface of earth is 'g'. If the diameter of earth is reduced to one third of its original value and mass remains unchanged, then the acceleration due to gravity on the surface of the earth is _____g.

Question ID : 656445497

Ans. Official answer NTA (9)

Sol.