

JEE Main January 2024
Question Paper With Text Solution
31 January | Shift-1

PHYSICS



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

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1. The refractive index of a prism with apex angle A is $\cot A/2$. The angle of minimum deviation is :

- (1) $\delta_m = 180^\circ - 3A$
- (2) $\delta_m = 180^\circ - 2A$
- (3) $\delta_m = 180^\circ - 4A$
- (4) $\delta_m = 180^\circ - A$

Question ID: 4058591149

Ans. Official Answer NTA (2)

Sol.

2. If the percentage errors in measuring the length and the diameter of a wire are 0.1% each. The percentage error in measuring its resistance will be :

- (1) 0.3 %
- (2) 0.1%
- (3) 0.144%
- (4) 0.2%

Question ID: 4058591154

Ans. Official Answer NTA (1)

Sol.

3. A coin is placed on a disc. The coefficient of friction between the coin and the disc is μ . If the distance of the coin from the center of the disc is r , the maximum angular velocity which can be given to the disc, so that the coin does not slip away, is :

- (1) $\frac{\mu g}{r}$
- (2) $\frac{\mu}{\sqrt{rg}}$
- (3) $\sqrt{\frac{\mu g}{r}}$
- (4) $\sqrt{\frac{r}{\mu g}}$

Question ID: 4058591137

Ans. Official Answer NTA (3)

Sol.

4. Two conductors have the same resistances at 0°C but their temperature coefficients of resistance are α_1 and α_2 . The respective temperature coefficients for their series and parallel combinations are :

- (1) $\frac{\alpha_1 + \alpha_2}{2}, \alpha_1 + \alpha_2$
- (2) $\frac{\alpha_1 + \alpha_2}{2}, \frac{\alpha_1 + \alpha_2}{2}$
- (3) $\alpha_1 + \alpha_2, \frac{\alpha_1 + \alpha_2}{2}$



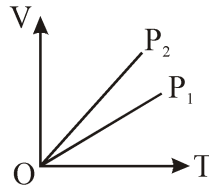
$$(4) \alpha_1 + \alpha_2, \frac{\alpha_1 \alpha_2}{\alpha_1 + \alpha_2}$$

Question ID: 4058591145

Ans. Official Answer NTA (2)

Sol.

5. The given figure represents two isobaric processes for the same mass of an ideal gas, then



(1) $P_1 > P_2$

(2) $P_2 \geq P_1$

(3) $P_1 = P_2$

(4) $P_2 > P_1$

Question ID: 4058591142

Ans. Official Answer NTA (1)

Sol.

6. When a metal surface is illuminated by light of wavelength λ , the stopping potential is 8V. When the same surface is illuminated by light of wavelength 3λ , stopping potential is 2V. The threshold wavelength for this surface is:

(1) 9λ

(2) 3λ

(3) 4.5λ

(4) 5λ

Question ID: 4058591150

Ans. Official Answer NTA (1)

Sol.

7. If the wavelength of the first member of Lyman series of hydrogen is λ . the wavelength of the second member will be

(1) $\frac{27}{32}\lambda$

(2) $\frac{32}{27}\lambda$

(3) $\frac{5}{27}\lambda$

(4) $\frac{27}{5}\lambda$

Question ID: 4058591151

Ans. Official Answer NTA (1)

Sol.



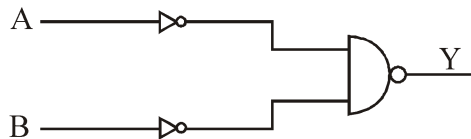
8. A force is represented by $F = ax^2 + bt^{\frac{1}{2}}$ where x = distance and t = time. The dimensions of b^2/a are :
- (1) $[ML^3 T^{-3}]$ (2) $[ML^{-1} T^{-1}]$ (3) $[MLT^{-2}]$ (4) $[ML^2 T^{-3}]$

Question ID: 4058591135

Ans. Official Answer NTA(1)

Sol.

9. Identify the logic operation performed by the given circuit.



- (1) NAND (2) OR (3) AND (4) NOR

Question ID: 4058591152

Ans. Official Answer NTA(2)

Sol.

10. The parameter that remains the same for molecules of all gases at a given temperature is :
- (1) speed (2) mass (3) momentum (4) kinetic energy

Question ID: 4058591143

Ans. Official Answer NTA(4)

Sol.

11. The relation between time 't' and distance 'x' is $t = ax^2 + \beta x$, where α and β are constants. The between acceleration (a) and velocity (v) is :

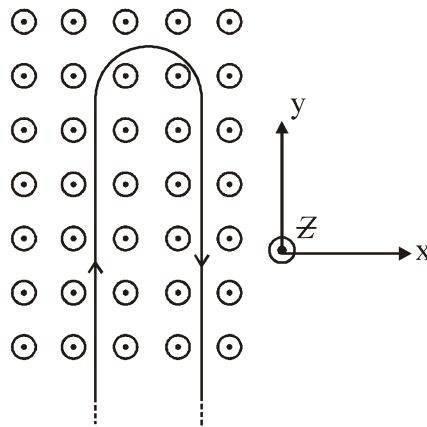
- (1) $a = -4av^4$ (2) $a = -5av^5$ (3) $a = -2av^3$ (4) $a = -3av^2$

Question ID: 4058591136

Ans. Official Answer NTA(3)

Sol.

12. A rigid wire consists of a semicircular portion of radius R and two straight sections. The wire is partially immersed in a perpendicular magnetic field $B = B_0 \hat{j}$ as shown in figure. The magnetic force on the wire if it has a current i is :



- (1) $2iBR\hat{j}$ (2) $iBR\hat{j}$ (3) $-2iBR\hat{j}$ (4) $-iBR\hat{j}$

Question ID: 4058591146

Ans. Official Answer NTA(3)

Sol.

13. A coil is placed perpendicular to a magnetic field of 5000 T. When the field is changed to 3000 T in 2 s, an induced emf of 22 V is produced in the coil. If the diameter of the coil is 0.02 m, then the number of turns in the coil is:

- (1) 70 (2) 140 (3) 35 (4) 7

Question ID: 4058591147

Ans. Official Answer NTA(1)

Sol.

14. Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on

one of the masses by the other masses is $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$, the length of the sides of the square is

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

Question ID: 4058591140

Ans. Official Answer NTA(1)

Sol.

15. In a plane EM wave, the electric field oscillates sinusoidally at a frequency of 5×10^{10} Hz and an amplitude of



50 Vm^{-1} . The total average energy density of the electromagnetic field of the wave is :

[Use $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{Nm}^2$]

- (1) $1.106 \times 10^{-8} \text{ Jm}^{-3}$
- (2) $4.425 \times 10^{-8} \text{ Jm}^{-3}$
- (3) $2.212 \times 10^{-10} \text{ Jm}^{-3}$
- (4) $2.212 \times 10^{-8} \text{ Jm}^{-3}$

Question ID: 4058591148

Ans. Official Answer NTA (1)

Sol.

16. The fundamental frequency of a closed organ pipe is equal to the first overtone frequency of an open organ pipe. If length of the open pipe is 60 cm, the length of the closed pipe will be:

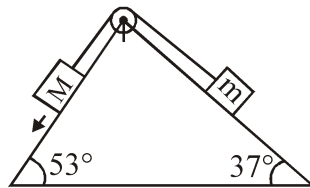
- (1) 15 cm
- (2) 45 cm
- (3) 30 cm
- (4) 60 cm

Question ID: 4058591153

Ans. Official Answer NTA (1)

Sol.

17. In the given arrangement of a doubly inclined plane two blocks of masses M and m are placed. The blocks are connected by a light string passing over an ideal pulley as shown. The coefficient of friction between the surface of the plane and the blocks is 0.25. The value of m , for which $M=10 \text{ kg}$ will move down with an acceleration of 2 m/s^2 , is: (take $g=10 \text{ m/s}^2$ and $\tan 37^\circ = 3/4$)



- (1) 2.25 kg
- (2) 6.5 kg
- (3) 4.5 kg
- (4) 9 kg

Question ID: 4058591138

Ans. Official Answer NTA (3)

Sol.

18. An artillery piece of mass M_1 fires a shell of mass M_2 horizontally. Instantaneously after the firing, the ratio of kinetic energy of the artillery and that of the shell is :



(1) $M_1 / (M_1 + M_2)$

(2) $\frac{M_2}{M_1}$

(3) $M_2 / (M_1 + M_2)$

(4) $\frac{M_1}{M_2}$

Question ID:

Ans. Official Answer NTA (2)

Sol.

19. Two charges q and $3q$ are separated by a distance ' r ' in air. At a distance x from charge q , the resultant electric field is zero. The value of x is :

(1) $\frac{r}{3(1+\sqrt{3})}$

(2) $r(1+\sqrt{3})$

(3) $\frac{r}{(1+\sqrt{3})}$

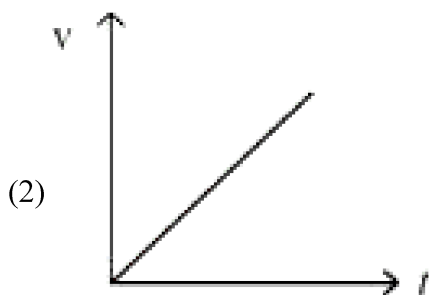
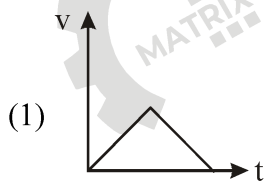
(4) $\frac{(1+\sqrt{3})}{r}$

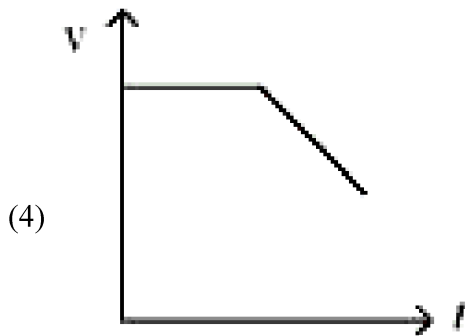
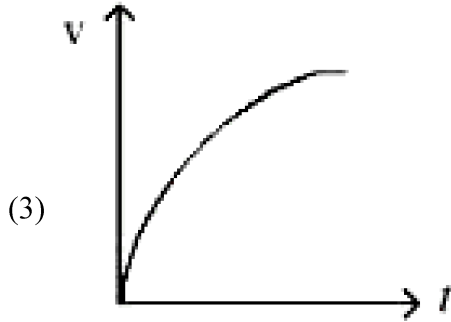
Question ID: 4058591144

Ans. Official Answer NTA (3)

Sol.

20. A small steel ball is dropped into a long cylinder containing glycerine. Which one of the following is the correct representation of the velocity time graph for the transit of the ball ?





Question ID: 4058591141

Ans. Official Answer NTA (3)

Sol.

21. A solid circular disc of mass 50 kg rolls along a horizontal floor so that its center of mass has a speed of 0.4 m/s. The absolute value of work done on the disc to stop it is _____ J.

Question ID: 4058591156

Ans. Official Answer NTA (6)

Sol.

22. A small square loop of wire of side l is placed inside a large square loop of wire of side L ($L = l^2$). The loops are coplanar and their centers coincide. The value of the mutual inductance of the system is $\sqrt{x} \times 10^{-7}$ H, where $x =$ _____.

Question ID: 4058591162

Ans. Official Answer NTA (128)

Sol.

23. An electron moves through a uniform magnetic field $\vec{B} = B_0\hat{i} + 2B_0\hat{j}T$. At a particular instant of time, the velocity of electron is $\vec{u} = 3\hat{i} + 5\hat{j}$ m/s. If the magnetic force acting on electron is $\vec{F} = 5e\hat{k}$ N, where e is the

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charge of electron, then the value of B_0 is _____ T.

Question ID: 4058591161

Ans. Official Answer NTA (5)

Sol.

24. A parallel plate capacitor with plate separation 5 mm is charged up by a battery. It is found that on introducing a dielectric sheet of thickness 2 mm, while keeping the battery connections intact, the capacitor draws 25 % more charge from the battery than before. The dielectric constant of the sheet is _____.

Question ID: 4058591159

Ans. Official Answer NTA (2)

Sol.

25. The mass defect in a particular reaction is 0.4g. The amount of energy liberated is $n \times 10^7$ kWh, where $n = 1$ _____.
(speed of light = 3×10^8 m/s)

Question ID: 4058591164

Ans. Official Answer NTA (1)

Sol.

26. A particle performs simple harmonic motion with amplitude A. Its speed is increased to three times at an instant when its displacement is $\frac{2A}{3}$. The new amplitude of motion is $\frac{nA}{3}$. The value of n is _____.

Question ID: 4058591158

Ans. Official Answer NTA (7)

Sol.

27. The depth below the surface of sea to which a rubber ball be taken so as to decrease its volume by 0.02% is _____ m.
(Take density of sea water = 10^3 kgm⁻³, Bulk modulus of rubber = 9×10^8 Nm⁻², and $g = 10$ ms⁻²)

Question ID: 4058591157

Ans. Official Answer NTA (18)

Sol.

28. A body starts falling freely from height H hits an inclined plane in its path at height h. As a result of this perfectly



elastic impact, the direction of the velocity of the body becomes horizontal. The value of $\frac{H}{h}$ for which the body will take the maximum time to reach the ground is _____.

Question ID: 4058591155

Ans. Official Answer NTA (2)

Sol.

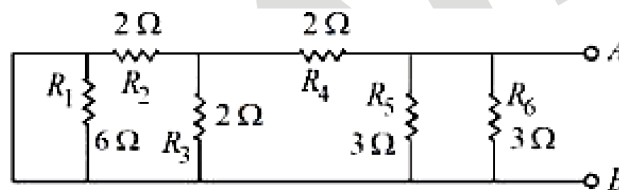
29. Two waves of intensity ratio 1 : 9 cross each other at a point. The resultant intensities at that point, when (a)

Waves are incoherent is I_1 (b) Waves are coherent is I_2 and differ in phase by 60° . If $\frac{I_1}{I_2} = \frac{10}{x}$ then, $x = \underline{\hspace{2cm}}$.

Question ID: 4058591163

Ans. Official Answer NTA (13)

Sol.

30. Equivalent resistance of the following network is _____ Ω .

Question ID: 4058591160

Ans. Official Answer NTA (1)

Sol.



MATRIX

Question Paper With Text Solution (Physics)

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