

FINAL JEE-MAIN EXAMINATION – JUNE, 2022

(Held On Wednesday 29th June, 2022)

TIME : 3 : 00 PM to 06 : 00 PM

PHYSICS

TEST PAPER WITH SOLUTION

SECTION-A

1. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s., the distance travelled by the toy in the next t s will be :
- (A) 10m (B) 20m
(C) 30m (D) 40m

Official Ans. by NTA (C)

Ans. (C)

Sol. $u = 0$, Say acceleration is a

For t s $10 = \frac{1}{2}at^2$

For 2t s $10 + x = \frac{1}{2}a(2t)^2$

$$\frac{10+x}{10} = \frac{4}{1}$$

$$x = 30 \text{ m}$$

2. At what temperature a gold ring of diameter 6.230 cm be heated so that it can be fitted on a wooden bangle of diameter 6.241 cm? Both the diameters have been measured at room temperature (27°C). (Given: coefficient of linear thermal expansion of gold $\alpha_L = 1.4 \times 10^{-5} \text{ K}^{-1}$)
- (A) 125.7°C (B) 91.7°C
(C) 425.7° (D) 152.7°C

Official Ans. by NTA (D)

Ans. (D)

Sol. $\Delta \ell = 6.241 - 6.230 = 0.011 \text{ cm}$

$$\Delta \ell = \ell \alpha \Delta \theta$$

$$0.011 = 6.230 \times 1.4 \times 10^{-5}(\theta - 27)$$

$$\theta - 27 = \frac{0.011 \times 10^5}{6.230 \times 1.4}$$

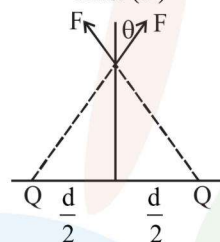
$$\theta \approx 153.11 \text{ nearest is } 152.7^\circ\text{C.}$$

3. Two point charges Q each are placed at a distance d apart. A third point charge q is placed at a distance x from mid-point on the perpendicular bisector. The value of x at which charge q will experience the maximum Coulomb's force is :

- (A) $x = d$ (B) $x = \frac{d}{2}$
(C) $x = \frac{d}{\sqrt{2}}$ (D) $x = \frac{d}{2\sqrt{2}}$

Official Ans. by NTA (D)

Ans. (D)



Sol.

$$F = \frac{KQq}{\left(x^2 + \frac{d^2}{4}\right)}$$

Net force on q = $2 F \cos\theta$

$$F_{\text{net}} = \frac{2KQqx}{\left(x^2 + \frac{d^2}{4}\right)^{3/2}}$$

For maximum F_{net}

$$\frac{d F_{\text{net}}}{dx} = 0$$

$$\text{we get } x = \frac{d}{2\sqrt{2}}$$

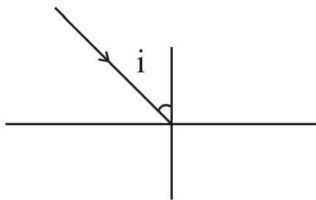
4. The speed of light in media 'A' and 'B' are $2.0 \times 10^{10} \text{ cm/s}$ and $1.5 \times 10^{10} \text{ cm/s}$ respectively. A ray of light enters from the medium B to A at an incident angle ' θ '. If the ray suffers total internal reflection, then

- (A) $\theta = \sin^{-1}\left(\frac{3}{4}\right)$ (B) $\theta > \sin^{-1}\left(\frac{2}{3}\right)$
(C) $\theta < \sin^{-1}\left(\frac{3}{4}\right)$ (D) $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

Official Ans. by NTA (D)

Ans. (D)

Sol. $\sin i_c = \frac{n_r}{n_d} = \frac{C_d}{C_r} = \frac{1.5 \times 10^{10}}{2 \times 10^{10}}$



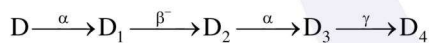
$\sin i_c = \frac{3}{4}$

$i_c = \sin^{-1}\left(\frac{3}{4}\right)$

for TIR $\theta > i_c$

$\theta > \sin^{-1}\left(\frac{3}{4}\right)$

5. In the following nuclear reaction,



Mass number of D is 182 and atomic number is 74. Mass number and atomic number of D_4 respectively will be__.

- (A) 174 and 71 (B) 174 and 69
(C) 172 and 69 (D) 172 and 71

Official Ans. by NTA (A)

Ans. (A)

Sol. Say for D_4 Atomic No = Z

Mass Number = A

$A = 182 - 4 - 4 = 174$

$Z = 74 - 2 + 1 - 2 = 71$

6. The electric field at the point associated with a light wave is given by

$E = 200 [\sin(6 \times 10^{15})t + \sin(9 \times 10^{15})t] \text{ Vm}^{-1}$

Given : $h = 4.14 \times 10^{-15} \text{ eVs}$

If this light falls on a metal surface having a work function of 2.50 eV, the maximum kinetic energy of the photoelectrons will be :

- (A) 1.90 eV (B) 3.27 eV
(C) 3.60 eV (D) 3.42 eV

Official Ans. by NTA (D)

Ans. (D)

Sol. For maximum KE we will take

higher frequency $\left(f = \frac{9 \times 10^{15}}{2\pi} \text{ Hz}\right)$

$K_{\max} = hf - \phi$

$= \frac{9 \times 10^{15} \times 4.14 \times 10^{-15}}{2\pi} - 2.50$

3.43 eV nearest is 3.42 eV

7. A capacitor is discharging through a resistor R. Consider in time t_1 , the energy stored in the capacitor reduces to half of its initial value and in time t_2 , the charge stored reduces to one eighth of its initial value. The ratio t_1/t_2 will be :

- (A) 1/2 (B) 1/3
(C) 1/4 (D) 1/6

Official Ans. by NTA (D)

Ans. (D)

Sol. In t_1 time energy becomes half so charge will become $\frac{1}{\sqrt{2}}$ time

$q = Q_0 e^{-\frac{t_1}{RC}} = \frac{Q_0}{\sqrt{2}}$

and $q = Q_0 e^{-\frac{t_2}{RC}} = \frac{Q_0}{8} = \left(\frac{Q_0}{\sqrt{2}}\right)^6$

$t_2 = 6t_1$

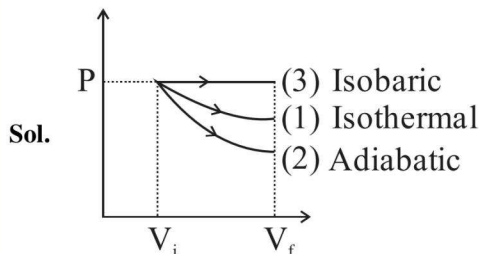
$\frac{t_1}{t_2} = \frac{1}{6}$

8. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal. W_2 if the process is purely adiabatic and W_3 if the process is purely isobaric. Then, choose the correct option

- (A) $W_1 < W_2 < W_3$ (B) $W_2 < W_3 < W_1$
(C) $W_3 < W_1 < W_2$ (D) $W_2 < W_1 < W_3$

Official Ans. by NTA (D)

Ans. (D)



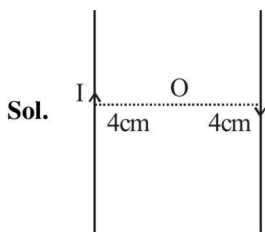
Area under curve is work

$W_2 < W_1 < W_3$

9. Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is $300 \mu\text{T}$. The equal current flowing in the two conductors is :
- (A) 30A in the same direction.
 (B) 30A in the opposite direction.
 (C) 60A in the opposite direction.
 (D) 300A in the opposite direction.

Official Ans. by NTA (B)

Ans. (B)



$$B \text{ at } O = 2 \frac{\mu_0 I}{2\pi r}$$

$$\frac{2 \times 4\pi \times 10^{-7} I}{2\pi \times 4 \times 10^{-2}} = 3 \times 10^{-4} \text{T}$$

$I = 30\text{A}$ in opp. direction

10. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate new time period of the satellite will be :
- (A) 40 hours (B) 36 hours
 (C) 30 hours (D) 25 hours

Official Ans. by NTA (B)

Ans. (B)

Sol.

$$T = \frac{2\pi}{\sqrt{GM}} r^{3/2}$$

$$\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2} = \left(\frac{1}{3}\right)^{3/2}$$

$$T_2 = T_1 \cdot 3\sqrt{3} = 21\sqrt{3} \text{ hours}$$

$$\approx 36 \text{ hours}$$

11. The TV transmission tower at a particular station has a height of 125 m. For doubling the coverage of its range, the height of the tower should be increased by :

- (A) 125 m (B) 250 m
 (C) 375 (D) 500 m

Official Ans. by NTA (C)

Ans. (C)

Sol. Range $d = \sqrt{2Rh}$

$$d_2 = 2d_1$$

$$\sqrt{2Rh_2} = 2\sqrt{2Rh_1}$$

$$h_2 = 4h_1 = 500 \text{ m}$$

$$\Delta h = 500 \text{ m} - 125 \text{ m} = 375 \text{ m}$$

12. The motion of a simple pendulum executing S.H.M. is represented by following equation.

$Y = A \sin(\pi t + \phi)$, where time is measured in second.

The length of pendulum is :

- (A) 97.23 cm (B) 25.3 cm
 (C) 99.4 cm (D) 406.1 cm

Official Ans. by NTA (C)

Ans. (C)

Sol. $\omega = \sqrt{\frac{g}{\ell}} = \pi$

$$\frac{g}{\ell} = \pi^2 \Rightarrow \ell = \frac{g}{\pi^2}$$

$$\ell = \frac{980}{\pi^2} \approx 99.4 \text{ cm}$$

13. A vessel contains 16g of hydrogen and 128 g of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is :

- (A) 72×10^5 (B) 32×10^5
 (C) 27×10^4 (D) 54×10^4

Official Ans. by NTA (C)

Ans. (C)

Sol. No of moles of $\text{H}_2 = 8$ moles

No of moles of $\text{O}_2 = 4$ moles

Total moles = 12 moles

At STP 1 mole occupy = $22.4\ell = 22.4 \times 10^3 \text{ cm}^3$

12 moles will occupy = $12 \times 22.4 \times 10^3 \text{ cm}^3$

$\approx 26.8 \times 10^4 \text{ cm}^3$

14. Given below are two statements :

Statement I: The electric force changes the speed of the charged particle and hence changes its kinetic energy: whereas the magnetic force does not change the kinetic energy of the charged particle.

Statement II: The electric force accelerates the positively charged particle perpendicular to the direction of electric field. The magnetic force accelerates the moving charged particle along the direction of magnetic field. In the light of the above statements, choose the most appropriate answer from the options given below:

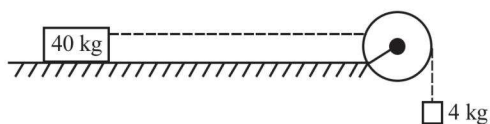
- (A) Both Statement I and Statement II are correct.
- (B) Both Statement I and Statement II are incorrect.
- (C) Statement I is correct but Statement II is incorrect.
- (D) Statement I is incorrect but Statement II is correct.

Official Ans. by NTA (C)

Ans. (C)

Sol. Electric field can change speed and kinetic energy but magnetic field can not change speed ΔKE . Because magnetic force is always \perp to velocity.

15. A block of mass 40 kg slides over a surface, when a mass of 4 kg is suspended through an inextensible massless string passing over frictionless pulley as shown below. The coefficient of kinetic friction between the surface and block is 0.02. The acceleration of block is. (Given $g = 10 \text{ ms}^{-2}$.)



- (A) 1 ms^{-2}
- (B) $1/5 \text{ ms}^{-2}$
- (C) $4/5 \text{ ms}^{-2}$
- (D) $8/11 \text{ ms}^{-2}$

Official Ans. by NTA (D)

Ans. (D)

Sol. For 4 kg block

$$4g - T = 4a$$

For 40 kg block

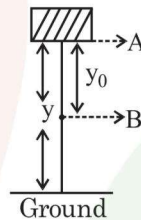
$$T - 40g \times 0.02 = 40a$$

Adding both eq.

$$40 - 8 = 44a$$

$$a = \frac{32}{44} = \frac{8}{11} \text{ m/s}^2$$

16. In the given figure, the block of mass m is dropped from the point 'A'. The expression for kinetic energy of block when it reaches point 'B' is :



- (A) $\frac{1}{2} mgy_0^2$
- (B) $\frac{1}{2} mgy^2$
- (C) $mg(y - y_0)$
- (D) mgy_0

Official Ans. by NTA (D)

Ans. (D)

Sol. Work done by gravity = $K_B - K_A$

$$mgy_0 = K_B - 0$$

$$K_B = mgy_0$$

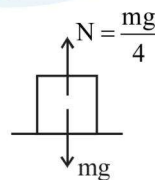
17. A block of mass M placed inside a box descends vertically with acceleration 'a'. The block exerts a force equal to one-fourth of its weight on the floor of the box. The value of 'a' will be :

- (A) $\frac{g}{4}$
- (B) $\frac{g}{2}$
- (C) $\frac{3g}{4}$
- (D) g

Official Ans. by NTA (C)

Ans. (C)

Sol.



$$mg - N = ma$$

$$a = g - \frac{g}{4}$$

$$a = \frac{3g}{4}$$

18. If the electric potential at any point (x, y, z) in space is given by $V = 3x^2$ volt. The electric field at the point $(1, 0, 3)$ m will be :
- (A) 3 Vm^{-1} , directed along positive x-axis.
 (B) 3 Vm^{-1} , directed along negative x-axis.
 (C) 6 Vm^{-1} , directed along positive x-axis.
 (D) 6 Vm^{-1} , directed along negative x-axis.

Official Ans. by NTA (D)

Ans. (D)

Sol. $E_x = -\frac{\partial V}{\partial x} = -6x$

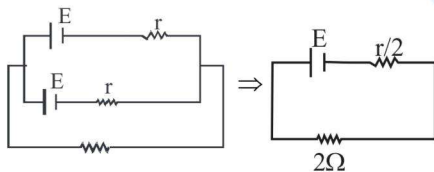
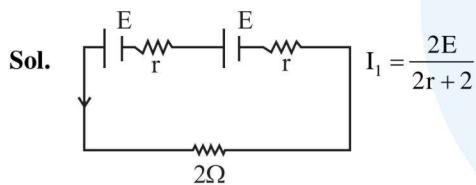
At $(1, 0, 3)$

$$\vec{E} = -6V / \text{m } \hat{i}$$

19. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2Ω . The value of internal resistance of each cell is :
- (A) 2Ω (B) 4Ω (C) 6Ω (D) 8Ω

Official Ans. by NTA (A)

Ans. (A)



$$I_2 = \frac{E}{\frac{r}{2} + 2} = \frac{2E}{r + 4}$$

$$I_1 = I_2$$

$$2r + 2 = r + 4$$

$$2r - r = 2\Omega \Rightarrow r = 2\Omega$$

20. A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?
- (A) 25 m (B) 50 m
 (C) 100 m (D) 200 m

Official Ans. by NTA (B)

Ans. (B)

Sol. $R = \frac{u^2 \sin 2\theta}{g}$ $R_{\max} = \frac{u^2}{g} = 100$

$$H_{\max} = \frac{u^2}{2g} = \frac{100}{2} = 50\text{m}$$

SECTION-B

1. The vernier constant of Vernier callipers is 0.1 mm and it has zero error of (-0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be $____ \times 10^{-2}$ cm.

Official Ans. by NTA (180)

Ans. (180)

Sol. Measured diameter = MSR + VSR \times VC

$$= 1.7 + 0.01 \times 5$$

$$= 1.75$$

$$\text{Corrected} = \text{Measured} - \text{Error}$$

$$= 1.75 - (-0.05)$$

$$= 1.80 \text{ cm}$$

$$= 180 \times 10^{-2} \text{ cm}$$

$$180$$

2. A small spherical ball of radius 0.1 mm and density 10^4 kg m^{-3} falls freely under gravity through a distance h before entering a tank of water. If after entering the water the velocity of ball does not change and it continues to fall with same constant velocity inside water, then the value of h will be ____ m.

(Given $g = 10 \text{ ms}^{-2}$, viscosity of water = $1.0 \times 10^{-5} \text{ N-sm}^{-2}$).

Official Ans. by NTA (20)

Ans. (20)

- Sol.** Speed after falling through height h should be equal to terminal velocity

$$\sqrt{2gh} = \frac{2r^2(d-\rho)g}{9\eta}$$

$$\sqrt{2gh} = \frac{2 \cdot 10^{-8} (10000 - 1000) \times 10}{9 \cdot 10^{-5}}$$

$$= \frac{2}{9} \times 10^{-8} \frac{9 \times 10^4}{10^{-5}} = 20$$

$$2 \times 10 \times h = 400$$

$$h = 20 \text{ m}$$

3. In an experiment to determine the velocity of sound in air at room temperature using a resonance is observed when the air column has a length of 20.0 cm for a tuning fork of frequency 400 Hz is used. The velocity of the sound at room temperature is 336 ms^{-1} . The third resonance is observed when the air column has a length of ____ cm.

Official Ans. by NTA (104)

Ans. (104)

- Sol.** For first resonance

$$\ell_1 + e = \frac{\lambda}{4}$$

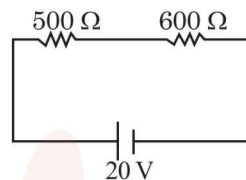
$$\lambda = \frac{336}{400} \times 100 \text{ cm} = 84 \text{ cm} \Rightarrow \frac{\lambda}{4} = 21 \text{ cm}$$

$$e = 21 - 20 = 1 \text{ cm}$$

For third resonance

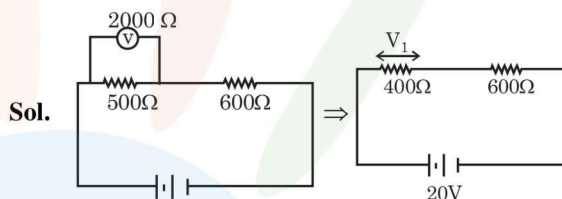
$$\ell_3 + e = \frac{5\lambda}{4} = 105 \text{ cm} \Rightarrow \ell_3 = 104 \text{ cm}$$

4. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000Ω is used to measure the potential difference across 500Ω resistor, the reading of the voltmeter will be ____ V.



Official Ans. by NTA (8)

Ans. (8)



$$I = \frac{20}{1000} \text{ A}$$

$$V_1 = I \times 400 = \frac{20}{1000} \times 400$$

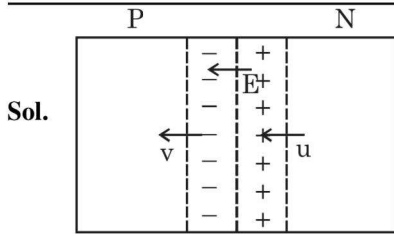
$$= 8 \text{ V}$$

5. A potential barrier of 0.4 V exists across a p-n junction. An electron enters the junction from the n-side with a speed of $6.0 \times 10^5 \text{ ms}^{-1}$. The speed with which electron enters the p side will be $\frac{x}{3} \times 10^5 \text{ ms}^{-1}$ the value of x is _____.

(Given mass of electron = $9 \times 10^{-31} \text{ kg}$, charge on electron = $1.6 \times 10^{-19} \text{ C}$.)

Official Ans. by NTA (14)

Ans. (14)



Sol.

Work done by Electric field = $K_f - K_i$

$$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = -1.6 \times 10^{-19} \times 0.4$$

$$\frac{1}{2}9 \times 10^{-31}(v^2 - u^2) = -0.64 \times 10^{-19}$$

$$u^2 - v^2 = \frac{2 \times 0.64 \times 10^{12}}{9}$$

$$v^2 = \left(36 - \frac{128}{9}\right) \times 10^{10}$$

$$v = \frac{14}{3} \times 10^5 \text{ m/s}$$

$$x = 14$$

6. The displacement current of $4.425 \mu\text{A}$ is developed in the space between the plates of parallel plate capacitor when voltage is changing at a rate of 10^6 Vs^{-1} . The area of each plate of the capacitor is 40 cm^2 . The distance between each plate of the capacitor is $x \times 10^{-3} \text{ m}$. The value of x is,

(Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$)

Official Ans. by NTA (8)

Ans. (8)

Sol. Displacement Current = Conduction Current

$$= \frac{dq}{dt}$$

$$I_d = \frac{\epsilon_0 A}{d} \frac{dV}{dt}$$

$$d = \frac{8.85 \times 10^{-12} \times 4 \times 10^{-3} \times 10^6}{4.425 \times 10^{-6}}$$

$$= 8 \text{ mm}$$

$$X = 8$$

7. The moment of inertia of a uniform thin rod about a perpendicular axis passing through one end is I_1 . The same rod is bent into a ring and its moment of inertia about a diameter is I_2 . If $\frac{I_1}{I_2}$ is $\frac{x\pi^2}{3}$, then the value of x will be _____.

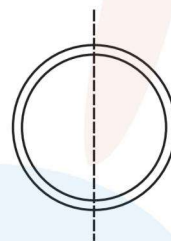
Official Ans. by NTA (8)

Ans. (8)

Sol.

$$I_1 = \frac{ml^2}{3}$$

$$l = 2\pi r \Rightarrow \frac{l}{r} = 2\pi$$



$$\frac{I_1}{I_2} = \frac{2}{3} \left(\frac{l}{r}\right)^2$$

$$= \frac{2}{3} \times 4\pi^2 = \frac{8\pi^2}{3}$$

$$x = 8$$

8. The half life of a radioactive substance is 5 years. After x years a given sample of the radioactive substance get reduced to 6.25% of its initial value of x is _____.

Official Ans. by NTA (20)

Ans. (20)

Sol. $T_{1/2} = 5 \text{ year}$

$$N = N_0 \left(\frac{1}{2}\right)^{\text{No of half lives}}$$

$$\frac{N}{N_0} = \frac{1}{16} = \left(\frac{1}{2}\right)^4$$

$$\text{Time} = 4 \text{ half lives} = 20 \text{ years}$$

9. In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-3} cm. If the distance between the slits is 1 mm, then the wavelength of the light will be _____nm.

Official Ans. by NTA (600)

Ans. (600)

Sol. $\beta = \frac{\lambda D}{d}$

$$\Delta\beta = \frac{\lambda}{d} \Delta D$$

$$\lambda = \frac{\Delta\beta \cdot d}{\Delta D}$$

$$= \frac{3 \times 10^{-5} \times 1 \times 10^{-3}}{5 \times 10^{-2}}$$

$$= 60 \times 10^{-8} = 600 \times 10^{-9} \text{ m}$$

$$= 600 \text{ nm}$$

10. An inductor of 0.5 mH, a capacitor of 200 μF and a resistor of 2Ω are connected in series with a 220 V ac source. If the current is in phase with the emf, the frequency of ac source will be $___ \times 10^2$ Hz.

Official Ans. by NTA (5)

Ans. (5)

- Sol.** If Current is in phase with emf then the frequency

of source = $\frac{1}{2\pi\sqrt{LC}}$ (Resonant frequency)

$$\frac{1}{2\pi\sqrt{\frac{1}{2} \times 10^{-3} \times 2 \times 10^{-4}}}$$

$$= \frac{1}{2\pi} \times \sqrt{10} \times 1000 = 500 \text{ Hz}$$