1. The bob of a simple pendulum has mass 2g and a charge of 5.0 μC. It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is: (take g = 10 m/s²)

(1) tan⁻¹(5.0)  
(2) tan⁻¹(2.0)  
(3) tan⁻¹(0.5)  
(4) tan⁻¹(0.2)

Official Ans. by NTA (3)

2. Water from a pipe is coming at a rate of 100 litres per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flow is of the order of: (density of water = 1000 kg/m³, coefficient of viscosity of water = 1 mPas)

(1) 10⁶  
(2) 10³  
(3) 10⁴  
(4) 10²

Official Ans. by NTA (3)

3. For the circuit shown, with \( R_1 = 1.0 \Omega, R_2 = 2.0 \Omega, E_1 = 2 \text{ V} \) and \( E_2 = E_3 = 4 \text{ V} \), the potential difference between the points 'a' and 'b' is approximately (in V):

(1) 2.7  
(2) 3.3  
(3) 2.3  
(4) 3.7

Official Ans. by NTA (2)

4. A 200 Ω resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be:

(1) 100 Ω  
(2) 400 Ω  
(3) 500 Ω  
(4) 300 Ω

Official Ans. by NTA (3)

5. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02 kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 m s⁻¹. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to:

(1) 10⁴ Nm⁻²  
(2) 10⁶ Nm⁻²  
(3) 10⁶ Nm⁻²  
(4) 10³ Nm⁻²

Official Ans. by NTA (3)
6. Two identical breakers A and B contain equal volumes of two different liquids at 60°C each and left to cool down. Liquid in A has density of $8 \times 10^2$ kg/m$^3$ and specific heat of 2000 J kg$^{-1}$ K$^{-1}$ while liquid in B has density of $10^3$ kg m$^{-3}$ and specific heat of 4000 J kg$^{-1}$ K$^{-1}$. Which of the following best describes their temperature versus time graph schematically? (assume the emissivity of both the beakers to be the same)

(1) $\frac{\Delta T}{5}(\hat{i} - \hat{j})$

(2) $\frac{\Delta T}{5}(\hat{i} + \hat{j})$

(3) Zero

(4) $\Delta T \hat{i} + \hat{j}$

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

7. Four particles A, B, C and D with masses $m_A = m$, $m_B = 2m$, $m_C = 3m$ and $m_D = 4m$ are at the corners of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is:

(1) $B \pi r^2 I N$

(2) $\frac{Br^2 I}{\pi N}$

(3) Zero

(4) $\frac{B \pi r^2 I}{N}$

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

8. A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B \hat{i}$. The torque on the coil due to the magnetic field is:

(1) $B \pi r^2 I N$

(2) $\frac{Br^2 I}{\pi N}$

(3) Zero

(4) $\frac{B \pi r^2 I}{N}$

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

9. Voltage rating of a parallel plate capacitor is 500V. Its dielectric can withstand a maximum electric field of $10^6$ V/m. The plate area is $10^{-4}$ m$^2$. What is the dielectric constant is the capacitance is 15 pF?

(given $\varepsilon_0 = 8.86 \times 10^{-12}$ C$^2$/Nm$^2$)

(1) 3.8

(2) 4.5

(3) 6.2

(4) 8.5

**Official Ans. by NTA (4)**
10. The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit.

![Zener diode circuit](image)

The current $I_Z$ through the Zener is:

- (1) 7 mA
- (2) 17 mA
- (3) 10 mA
- (4) 15 mA

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

11. A 20 Henry inductor coil is connected to a 10 ohm resistance in series as shown in figure. The time at which rate of dissipation of energy (joule's heat) across resistance is equal to the rate at which magnetic energy is stored in the inductor is:

![Inductor circuit](image)

- (1) $\frac{2}{\ell n^2}$
- (2) $\ell n^2$
- (3) $2\ell n^2$
- (4) $\frac{1}{2}\ell n^2$

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

12. An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the final image will be:

- (1) 40 cm from the convergent mirror, same size as the object
- (2) 20 cm from the convergent mirror, same size as the object
- (3) 20 cm from the convergent mirror, twice the size of the object
- (4) 40 cm from the convergent lens, twice the size of the object

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

13. A thin strip 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant 0.5 Nm$^{-1}$ (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillation it performs before its amplitude decreases by a factor of $e$ is $N$. If the mass of the strip is 50 grams, its resistance 10Ω and air drag negligible, $N$ will be close to:

![U shaped wire with strip](image)

- (1) 50000
- (2) 5000
- (3) 10000
- (4) 1000

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

14. A thin circular plate of mass $M$ and radius $R$ has its density varying as $\rho(r) = \rho_0 r$ with $\rho_0$ as constant and $r$ is the distance from its centre. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $I = aMR^2$. The value of the coefficient $a$ is:

- (1) $\frac{3}{2}$
- (2) $\frac{1}{2}$
- (3) $\frac{3}{5}$
- (4) $\frac{8}{5}$

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

15. Ship A is sailing towards north-east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}$ km/hr where $\hat{i}$ points east and $\hat{j}$, north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in:

- (1) 4.2 hrs.
- (2) 2.2 hrs.
- (3) 3.2 hrs.
- (4) 2.6 hrs.

**Official Ans. by NTA (4)**
16. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that \( g = 3.1 \, \text{m/s}^2 \), what will be the tensile stress that would be developed in the wire?

(1) \( 4.8 \times 10^6 \, \text{Nm}^{-2} \)
(2) \( 5.2 \times 10^6 \, \text{Nm}^{-2} \)
(3) \( 6.2 \times 10^6 \, \text{Nm}^{-2} \)
(4) \( 3.1 \times 10^6 \, \text{Nm}^{-2} \)

*Official Ans. by NTA (4)*

17. In figure, the optical fiber is \( \ell = 2 \, \text{m} \) long and has a diameter of \( d = 20 \, \mu\text{m} \). If a ray of light is incident on one end of the fiber at angle \( \theta_1 = 40^\circ \), the number of reflection it makes before emerging from the other end is close to:

(re refractive index of fibre is 1.31 and \( \sin 40^\circ = 0.64 \))

(1) 55000
(2) 57000
(3) 66000
(4) 45000

*Official Ans. by NTA (2)*

18. A solid conducting sphere, having a charge \( Q \), is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be \( V \). If the shell is now given a charge of \( -4 \, Q \), the new potential difference between the same two surfaces is:

(1) \( V \)
(2) \( 2V \)
(3) \( -2V \)
(4) \( 4V \)

*Official Ans. by NTA (1)*

19. A wire of length \( 2L \), is made by joining two wires \( A \) and \( B \) of same length but different radii \( r \) and \( 2r \) and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire \( A \) is \( p \) and that in \( B \) is \( q \) then the ratio \( p : q \) is:

(1) \( 4 : 9 \)
(2) \( 3 : 5 \)
(3) \( 1 : 4 \)
(4) \( 1 : 2 \)

*Official Ans. by NTA (4)*

20. Four identical particles of mass \( M \) are located at the corners of a square of side ‘a’. What should be their speed if each of them revolves under the influence of other’s gravitational field in a circular orbit circumscribing the square?

(1) \( \sqrt[4]{GM}a \)
(2) \( 1.41\sqrt[4]{GM}a \)
(3) \( 1.16\sqrt[4]{GM}a \)
(4) \( 1.35\sqrt[4]{GM}a \)

*Official Ans. by NTA (3)*

21. A plane electromagnetic wave travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time is \( E = 6 \, \text{V m}^{-1} \) along y-direction. Its corresponding magnetic field component, \( B \) would be:

(1) \( 6 \times 10^{-8} \, \text{T} \) along z-direction
(2) \( 6 \times 10^{-8} \, \text{T} \) along x-direction
(3) \( 2 \times 10^{-8} \, \text{T} \) along z-direction
(4) \( 2 \times 10^{-8} \, \text{T} \) along y-direction

*Official Ans. by NTA (3)
22. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3m is:

\[ \text{Distance (in m)} \]
\[ \text{Force (in N)} \]

(1) 6.5 J (2) 2.5 J (3) 4 J (4) 5 J

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

23. In SI units, the dimensions of \( \sqrt{\frac{\varepsilon_0}{\mu_0}} \) is:

(1) A\(^{-1}\)TML\(^3\) (2) A\(^2\)T\(^{-1}\)M\(^{-1}\)L\(^2\)
(3) AT\(^{-3}\)M\(^{-1}\)L\(^{-1}\) (4) AT\(^{-3}\)ML\(^{3/2}\)

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

24. Radiation coming from transitions \( n = 2 \) to \( n = 1 \) of hydrogen atoms fall on He\(^+\) ions in \( n = 1 \) and \( n = 2 \) states. The possible transition of helium ions as they absorb energy from the radiation is:

(1) \( n = 1 \rightarrow n = 4 \) (2) \( n = 2 \rightarrow n = 4 \)
(3) \( n = 2 \rightarrow n = 5 \) (4) \( n = 2 \rightarrow n = 3 \)

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

25. Two particles move at right angle to each other. Their de-Broglie wavelengths are \( \lambda_1 \) and \( \lambda_2 \) respectively. The particles suffer perfectly inelastic collision. The de-Broglie wavelength \( \lambda \) of the final particle, is given by:

(1) \( \lambda = \frac{\lambda_1 + \lambda_2}{2} \)
(2) \( \frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2} \)
(3) \( \lambda = \sqrt{\lambda_1 \lambda_2} \)
(4) \( \frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2} \)

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

26. A thermally insulated vessel contains 150g of water at 0°C. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°C itself. The mass of evaporated water will be closest to:

(Latent heat of vaporization of water \( = 2.22 \times 10^6 \text{ J kg}^{-1} \) and Latent heat of Fusion of water \( = 3.36 \times 10^5 \text{ J kg}^{-1} \))

(1) 130 g (2) 35 g
(3) 20 g (4) 150 g

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

27. An alternating voltage \( v(t) = 220 \sin 100 \pi t \text{ volt} \) is applied to a purely resistance load of 50 \( \Omega \). The time taken for the current to rise from half of the peak value to the peak value is:

(1) 2.2 ms (2) 5 ms
(3) 3.3 ms (4) 7.2 ms

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

28. The wavelength of the carrier waves in a modern optical fiber communication network is close to:

(1) 600 nm (2) 900 nm
(3) 2400 nm (4) 1500 nm

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

29. In an interference experiment the ratio of amplitudes of coherent waves is \( \frac{a_1}{a_2} = \frac{1}{3} \). The ratio of maximum and minimum intensities of fringes will be:

(1) 4 (2) 2
(3) 9 (4) 18

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

30. If \( 10^{22} \) gas molecules each of mass \( 10^{-26} \text{ kg} \) collide with a surface (perpendicular to it) elastically per second over an area 1 m\(^2\) with a speed \( 10^4 \text{ m/s} \), the pressure exerted by the gas molecules will be of the order of:

(1) \( 10^8 \text{ N/m}^2 \) (2) \( 10^4 \text{ N/m}^2 \)
(3) \( 10^3 \text{ N/m}^2 \) (4) \( 10^{16} \text{ N/m}^2 \)

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