MHT-CET 2021 Question Paper

25^{th} September 2021

1. If oxygen molecule has r.m.s velocity 'c' ms^{-1} then r.m.s. velocity of hydrogen molecule will be (molecular masses of oxygen and hydrogen are 32×10^{-3} kg and 2×10^{-3} kg respectively, Boyle's law is obeyed)

(A) 8c (B) $\frac{1}{8}c$

(C) $\frac{1}{4}c$ (D) 4c

2. Two equal charges each of charge '2q' are placed at a distance '2x' apart and third charge –4q is placed at the midpoint. The potential energy of the system is

(A) $\frac{-7q^2}{4\pi\varepsilon_0 x}$ (B) $\frac{-14q^2}{4\pi\varepsilon_0 x}$

(C) $\frac{-14q^2}{4\pi\varepsilon_0 x^2}$ (D) $\frac{-7q^2}{4\pi\varepsilon_0 x^2}$

3. An electron with speed 'v' and a photon with speed 'c' have the same de Broglie wavelength. If the kinetic energy and momentum of the electron is E_e and P_e and that of the photon is E_{ph} and P_{ph} respectively, then the correct statement is

(A) $\frac{P_e}{P_{ph}} = \frac{v}{2c}$ (B) $\frac{P_e}{P_{ph}} = \frac{2c}{v}$

(C) $\frac{E_e}{E_{ph}} = \frac{v}{2c}$ (D) $\frac{E_e}{E_{ph}} = \frac{2c}{v}$

4. The change in angular momentum of the electron when it jumps from 4^{th} orbit to 1^{st} orbit in hydrogen atom is (h = Planck's constant)

(A) $\frac{h}{\pi}$ (B) $\frac{(1.5)h}{\pi}$

(C) $\frac{3h}{\pi}$ (D) $\frac{h}{4\pi}$

5. The resistances in the two gaps of a balanced meter bridge are 10 Ω and 30 Ω respectively. If the resistances are interchanged, the balance point shifts by

(A) 25 cm (B) 50 cm

(C) 30 cm (D) 66.67 cm

6. The co-efficient of linear expansion of brass and steel are α_b and α_s respectively. Let I_b and I_s be the lengths of brass and steel rod respectively at 0°C. The difference in lengths of brass and steel roads (I_b and I_s) will remain the same at all temperatures if

(A) $\alpha_b I_s = \alpha_s I_b$ (B) $\alpha_b I_s = \alpha_s I_b^2$

(C) $\alpha_b^2 I_b = \alpha_s^2 I_s$ (D) $\alpha_b I_b = \alpha_s I_s$

7. In double slit experiment, when a glass plate of refractive index 1.5 and of thickness 't' is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass plate is

(A) 2λ (B) λ

(C) $\frac{\lambda}{3}$ (D) $\frac{\lambda}{2}$

8. The difference between refractive index of glass with respect to air and liquid with respect to air is $\frac{1}{5}$. The velocity of light in liquid is [μ_g and μ_l are refractive indices of glass and liquid respectively. v_g and v_l are velocities of light in glass and liquid respectively]

(A) $10\mu_g (v_l - v_g)$ (B) $5\mu_g (v_l - v_g)$

(C) $2\mu_g (v_l - v_g)$ (D) $6\mu_g (v_l - v_g)$

9. A bullet of mass 'm' moving with velocity 'v' is fired into a wooden block of mass 'M'. If the bullet remains embedded in the block, the final velocity of the system (block with bullet) is

(A) $\frac{mv}{M-m}$ (B) $\frac{M+m}{mv}$

(C) $\frac{mv}{M+m}$ (D) $\frac{M-m}{mv}$

10. A metal rod of length 'ℓ' rotates about one of its ends in a plane perpendicular to a magnetic field of induction 'B'. If the e.m.f. induced between the ends of the rod is 'e', then the number of revolution made by the rod per second is

(A) $\frac{e}{B\pi\ell^2}$ (B) $\frac{\pi\ell^2}{eB}$

(C) $\frac{e}{B\pi^2\ell}$ (D) $\frac{B^2}{e\pi\ell}$

11. A circular coil carrying current has radius 'R'. At a point 'P' on the axis of the coil, the value of magnetic induction is $\left(\frac{1}{8}\right)^{th}$ of its value at the centre of the coil. The distance of point 'P' from the centre of the coil is

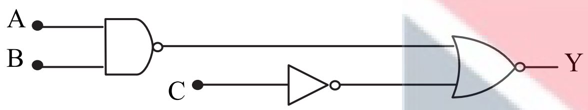
(A) $\frac{R}{2\sqrt{3}}$ (B) $\left(\frac{2}{\sqrt{3}}\right)R$

(C) $\frac{R}{\sqrt{3}}$ (D) $\sqrt{3}R$

12. A wire of length 8 m has resistance of 20 Ω and it is connected in series with a battery of e.m.f. 6 V and external resistance 10 Ω. The potential gradient along the wire in $\frac{V}{m}$ is

(A) 0.5 (B) 1.5 (C) 0.75 (D) 0.2

13. In the following combination of logic gates, which one of the sets of inputs (A, B and C respectively) will give output (Y) as '1'?



(A) 1, 1, 0 (B) 1, 0, 1
(C) 0, 1, 1 (D) 1, 1, 1

14. Soluble substance such as a detergent is mixed with water, surface tension of water
(A) remains constant.
(B) first increases and then decreases.
(C) decreases.
(D) increases.

15. The half life of a radioactive substance is 20 minutes. The approximate time interval $(t_2 - t_1)$ between the time t_2 when $\left(\frac{2}{3}\right)^{rd}$ of it is decayed and time t_1 when $\left(\frac{1}{3}\right)^{rd}$ of it has decayed is (in minutes)

(A) 7 (B) 20 (C) 14 (D) 28

16. In Young's double slit experiment, 8th maximum with wavelength 'λ_1' is at a distance 'd_1' from the central maximum and 6th maximum with wavelength 'λ_2' is at a distance 'd_2' from the central maximum. Then $\frac{d_1}{d_2}$ is equal to

(A) $\frac{4\lambda_1}{3\lambda_2}$ (B) $\frac{4\lambda_2}{3\lambda_1}$

(C) $\frac{3\lambda_1}{4\lambda_2}$ (D) $\frac{3\lambda_2}{4\lambda_1}$

17. A capacitor of capacity 'C' has charge 'Q' and energy stored is 'E'. If the charge is increased to 3Q, the energy stored is 'E_1', the relation between 'E_1' and 'E' is

(A) $E_1 = \frac{E}{6}$ (B) $E_1 = 3E$

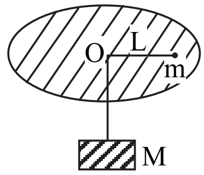
(C) $E_1 = \frac{E}{3}$ (D) $E_1 = 9E$

18. A series combination of n_1 capacitors each of value C_1 is charged by a source of potential difference 4V. Another parallel combination of n_2 capacitors each of value C_2 is changed by a source of potential difference V. Total energy stored in both the combinations is same. The value of C_2, in terms of C_1 is

(A) $\frac{2C_1n_2}{n_1}$ (B) $\frac{16C_1n_2}{n_1}$

(C) $\frac{2C_1}{n_1n_2}$ (D) $\frac{16C_1}{n_1n_2}$

19. The figure shows two masses 'm' and 'M' connected by a light string that passes through a small hole 'O' at the centre of the table. M is moved round in a horizontal circle with O as the centre. The frequency with which 'm' should be revolved so that 'M' remains stationary is



(A) $\frac{1}{\pi}\sqrt{\frac{ML}{mg}}$ (B) $\frac{1}{\pi}\sqrt{\frac{Mg}{mL}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{ML}{mg}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{Mg}{mL}}$

20. Two bodies 'A' and 'B' have their moments of inertia 'I' and '2I' respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momenta (of body A to that of B) will be in the ratio

(A) $1 : \sqrt{2}$ (B) $1 : 2$

(C) $2 : 1$ (D) $\sqrt{2} : 1$

21. An electron is moving with a velocity 10^7 m/s, parallel to infinitely long straight wire, carrying a current of 10 A. If the electron is at a perpendicular distance of 4 cm from the wire, the force acting on the electron is ($\mu_0 = 4\pi \times 10^{-7}$ SI units, $e = 1.6 \times 10^{-19}$ C)

(A) 8×10^{-17} N (B) 6×10^{-16} N
(C) 5×10^{-17} N (D) 3×10^{-17} N

22. A flywheel of mass 50 kg and radius of gyration about its axis of rotation is 0.6 m. It is acted upon by a constant torque of 18 Nm. Its angular velocity at t = 8 second is (Initially flywheel is at rest)
(A) 36 rad s^{-1} (B) 4 rad s^{-1}
(C) 8 rad s^{-1} (D) 18 rad s^{-1}

23. Let 'E_a' be the magnitude of electric field due to electric dipole in its axial plane at a distance '2x' from the centre of the dipole and 'E_q' is the magnitude of electric field in the equatorial plane at a distance '4x' from the centre of the dipole. Then the relation between E_a and E_q will be [Length of dipole is very short as compared to distance x]
(A) $E_a = 8E_q$ (B) $E_a = \frac{E_q}{16}$
(C) $E_a = \frac{E_q}{16}$ (D) $E_a = 16E_q$

24. A semiconductor with band gap energy of 3.31 × 10^{-19} J is used to fabricate a p-n junction photo diode. It can detect the signal of wavelength
[Planck's constant = 6.62 × 10^{-34} Js, velocity of light c = 3 × 10^8 ms^{-1}]
(A) 6400 Å (B) 6800 Å
(C) 7000 Å (D) 6000 Å

25. Two identical pieces of metal wire are used to make a circular loop and a square loop. Same current is passed through both the loops. The ratio of magnetic dipole moment associated with the circular loop to that of the square loop is
(A) $\frac{4}{\pi}$ (B) $\frac{2}{\pi}$
(C) $\frac{\pi}{2}$ (D) 4π

26. A circular coil carrying current of radius 5 cm has 500 turns of a wire. The approximate value of the coefficient of self induction of the coil will be ($\mu_0 = 4\pi \times 10^{-7}$ SI units)
(A) 50 × 10^{-3} millihenry.
(B) 25 millihenry.
(C) 25 × 10^{-3} millihenry.
(D) 50 millihenry.

27. A gas at pressure 'P_0' is contained in vessel. If the masses of all the molecules are halved and their speeds are doubled, the resulting pressure 'P' is equal to
(A) 4 P_0 (B) $\frac{P_0}{2}$
(C) P_0 (D) $2P_0$

28. Which one is the wrong statement from the following?
(A) The resistance of an intrinsic semiconductor decreases with increase in temperature.
(B) A p-n junction diode is used in a rectifier.
(C) Electrons are the majority carriers in n-type semiconductor.
(D) To get p-type semiconductor, silicon should be doped with a pentavalent impurity.

29. A current of 2A is passed through winding of a long solenoid having 500 turns. If the magnetic flux linked with each turn is 4 × 10^{-3} Wb, the self inductance of the solenoid is
(A) 1.5 H (B) 2 H
(C) 0.5 H (D) 1 H

30. A sonometer wire is vibrating in the second overtone. The number of nodes and antinodes formed respectively are
(A) 3, 4 (B) 4, 3
(C) 3, 2 (D) 2, 3

31. The period of an earth's satellite is 5 hour. If the distance between the earth and the satellite is increased to 4 times its original value, then the new period of the satellite will be
(A) 30 hour (B) 40 hour
(C) 80 hour (D) 20 hour

32. The frequency of two tuning forks A and B are respectively 1.5% more and 2.5% less than that of the tuning fork C. When forks A and B are sounded together, 12 beats are produced in 1 second. The frequency of tuning fork C is
(A) 300 Hz (B) 240 Hz
(C) 200 Hz (D) 360 Hz

33. A perfect gas has volume 'V' and pressure 'P'. According to kinetic theory of gases, if the total translational kinetic energy of all the molecules of the gas is equal to $\frac{3}{2}$ PV, the gas is
(A) polyatomic only.
(B) diatomic only.
(C) monoatomic only.
(D) monoatomic, diatomic and polyatomic.

34. The weight of a body of mass 20 kg at a depth half way to centre of earth is (g = 10 m/s^2) (Earth is a sphere of uniform mass density)
(A) 75 N (B) 100 N
(C) 25 N (D) 50 N

35. Photoelectrons are emitted from two similar metal plates when wavelengths 'λ_1' and 'λ_2' are incident on them. ($\lambda_1 = 1.5\lambda_2$) if maximum kinetic energy of emitted photoelectrons is 'E_1' and 'E_2' respectively then

(A) $E_1 < \frac{2E_2}{3}$.(B) $E_1 = \frac{E_2}{4}$

(C) $E_1 < \frac{E_2}{3}$ (D) $E_1 = \frac{2E_2}{3}$

36. An object of mass 40 gram moves uniformly along a circular path with linear speed of 20 ms^{-1}. If the angular speed of object is 4 $rads^{-1}$, the centripetal force acting on it will be

(A) 1.6 N (B) 12.8 N

(C) 6.4 N (D) 3.2 N

37. A police car travels towards a stationary observer at a speed of 20 ms^{-1}. The siren on the car emits a sound of frequency 320 Hz. If the speed of sound is 340 ms^{-1} then frequency recorded by the observer will be

(A) 170 Hz (B) 320 Hz

(C) 340 Hz (D) 640 Hz

38. When open pipe is closed from one end then 3rd overtone of closed pipe is higher in frequency by 150 Hz than second overtone of open pipe. The fundamental frequency of open end pipe will be (Neglect end correction)

(A) 300 Hz (B) 150 Hz

(C) 75 Hz (D) 225 Hz

39. A gas is suddenly expanded such that its final volume becomes four times its initial volume. If the specific heat at constant volume $C_v = 2R$, then the ratio of initial pressure to final pressure will be

(A) 3 : 4 (B) 8 : 1

(C) 4 : 3 (D) 8 : 3

40. The bob of a simple pendulum performs S.H.M. in air with period 'T' and in water with period 'T_1'. Relation between 'T' and 'T_1' is

(Neglect friction due to water, density of the bob is $\frac{9}{8} \times 10^3$ kg/m^3, density of water = 1000 kg/m^3)

(A) $T_1 = T$ (B) $T_1 = 3T$

(C) $T_1 = 4T$ (D) $T_1 = 2T$

41. A mass 'm_1' performs S.H.M. with amplitude 'A' which is connected to horizontal spring. While mass 'm_1' is passing through mean position another mass 'm_2' ($m_2 < m_1$) is placed on it so that both masses move together with amplitude 'A_1'. The ratio of $\left(\frac{A_1}{A}\right)$ is

(A) $\left[\frac{m_1}{m_1+m_2}\right]^{\frac{1}{2}}$ (B) $\left[\frac{m_1}{m_1+m_2}\right]$

(C) $\left[\frac{m_2}{m_1+m_2}\right]^{\frac{1}{2}}$ (B) $\left[\frac{m_2}{m_1+m_2}\right]$

42. Water rises in a capillary tube upto height 'h' so that the upward force due to surface tension is balanced by the force due to the weight of the water column. If this force is 90 dyne and surface tension of water is 6×10^{-2} $\frac{N}{m}$ then the inner circumference of the capillary is

(A) 15×10^{-2} m (B) 1.5×10^{-2} m

(C) 0.75×10^{-2} m (D) 0.5×10^{-2} m

43. Light takes time t_1 to travel a distance 'X' in vacuum and time t_2 to travel a distance 10X in a medium. What is the critical angle of the medium?

(A) $\sin^{-1}\left(\frac{5t_1}{6t_2}\right)$ (B) $\sin^{-1}\left(\frac{t_1}{10t_2}\right)$

(C) $\sin^{-1}\left(\frac{10t_1}{t_2}\right)$ (D) $\sin^{-1}\left(\frac{10t_2}{t_1}\right)$

44. In series LCR circuit, C = 2 μF, L = 1 mH and R = 10 Ω. What is the ratio of energies stored in the inductor and the capacitor when the maximum current flows in the circuit?

(A) $\frac{5}{1}$ (B) $\frac{3}{1}$

(C) $\frac{2}{1}$ (D) $\frac{4}{1}$

45. The e.m.f.s. are given as $e_1 = E_0 \sin(100\pi t)$ and $e_2 = E_0 \sin\left(100\pi t + \frac{\pi}{3}\right)$. We conclude that

(A) e_1 leads e_2 by 90°.

(B) e_2 lags behind e_1 by 45°.

(C) e_1 achieves its maximum value $\frac{1}{300}$ second before e_2.

(D) e_2 achieves its maximum value $\frac{1}{300}$ second before e_1.

46. The distance of a point on the screen from two slits in Young's double slit experiment is 1.8×10^{-5} m and 1.23×10^{-5} m. If λ (wavelength used) = 6000 Å, the fringe number formed at that point is

(A) 8^{th} dark. (B) 9^{th} dark.
(C) 10^{th} dark. (D) 11^{th} dark.

47. A mass attached to a spring performs S.H.M. whose displacement is $x = 3 \times 10^{-3} \cos(2\pi t)$ m. The time taken to obtain maximum speed for the first time is

(A) 0.40 s (B) 0.25 s
(C) 0.8 s (D) 0.50 s

48. An ideal gas is compressed isothermally until its pressure becomes four times the initial and then allowed to expand adiabatically to regain its original volume. The ratio of final pressure to initial pressure is $[\gamma = \frac{C_p}{C_v} = 1.5]$

(A) 3 : 2 (B) 2 : 3
(C) 2 : 1 (D) 1 : 2

49. Same current is passing in two a.c. circuits. First circuit contains only inductance and the other contains only a capacitor. What is the effect on the values of the current in the two circuits, if the frequency of the alternating e.m.f. is increased?

(A) Decreases in both the circuits.
(B) Increases in both the circuits.
(C) Increases in the 1^{st} circuit and decreases in the other.
(D) Decreases in the 1^{st} circuit and increases in the other.

50. Water rises upto height 'x' in a capillary tube immersed vertically in water. When the whole arrangement is taken to a depth 'd' in a mine, the water level rises upto height 'y'. If 'R' is the radius of the earth then ratio x : y is

(A) $\left(1-\frac{d}{R}\right)$ (B) $\left(1-\frac{d}{4R}\right)$
(C) $\left(1-\frac{2d}{R}\right)$ (D) $\left(1-\frac{d}{2R}\right)$