JEE Main 12 April 2023 Shift 1 Memory-Based Questions

PHYSICS

1. A body is in an SHM with an amplitude A. When it is at +x = A/2, find the ratio of the kinetic energy to potential energy.
2. A circular ring is placed in a magnetic field of 0.4 T. Suddenly, its radius starts shrinking at the rate of 1 mm/s. Find the induced emf in the ring at r = 2 cm.
3. A dipole having dipole moment M is placed in two magnetic fields of strength B_1 and B_2 respectively. If the dipole oscillates 60 times in 20 seconds in B_1 magnetic field and 60 oscillations in 30 seconds in B_2 magnetic field. Find B_1/B_2.
4. A particle is thrown vertically upward with an initial velocity of 150 m/s. Find the ratio of its speed at t = 3 seconds and t = 5 seconds. (Assume g = 10m/s^2)
5. A photon of energy 12.75 eV falls on an H-atom. Find out the number of spectral lines observed.
6. A uniform sphere is rolling without slipping on a horizontal surface. The ratio of translational kinetic energy to the total kinetic energy is 5/x. Find x.
7. Assertion (A): An electric dipole is enclosed in a closed Gaussian surface. The total flux through the enclosed surface is zero.
   Reason (R): Net charge inside the enclosed surface is zero.
8. Assuming Newton's law of cooling to be valid, an object cools down from 80°C to 60°C in 5 minutes in a surrounding of temperature 20°C. What will be the time taken by the object to cool from 60°C to 40°C?
9. Find the ratio between the rms speed (V_{rms}) of Ar to the most probable speed (V_{mp}) of O2 at 27°C.
10. Find the ratio of the de-Broglie wavelength of a proton and an α-Particle, when accelerated through a potential difference of 2V and 4V respectively.
11. For a body of mass 500 kg, μ = 0.7. Find the work required for the body to move a 4 km distance if the body moves with a constant velocity of 10 m/s.
12. Identify if the following statement(s) is/are correct/incorrect.
    Statement I: A truck and a car moving with equal kinetic energy are stopped by equal retarding force. Both cover an equal distance before stopping.
    Statement II: A car moving towards the East suddenly changes its direction towards the North at the same speed. Its acceleration is zero.
13. Identify if the following statement(s) is/are correct/incorrect.
    Statement I: In an LCR circuit, by increasing frequency, the current increases first and then decreases.
    Statement II: The power factor of an LCR circuit is one.

14. If 64 identical balls made of conducting material, each having potential of 10 mV, are joined to form a bigger ball, then what will be the potential of the bigger ball in volts?
15. If a body of mass 5 kg is in equilibrium due to forces F_1, F_2 and F_3 where F_2 and F_3 are perpendicular to each other. If F_1 is removed then find the acceleration of the body. Assume F_2 = 6N and F_3 = 8N.
16. If a planet has a mass equal to 16 times the mass of the Earth, and a radius equal to 4 times that of the Earth, then calculate the ratio of escape speed of the planet to that of the Earth.
17. If in an assumed situation, two planet orbits around the sun in the same orbit. If the mass of Planet 1 is twice the mass of Planet 2, then which among the following of the two planets will be the same?
    i. Kinetic Energy
    ii. Potential Energy
    iii. Total Energy
    iv. Velocity
18. If the current flowing in a conductor at 0°C and 100°C is 2 A and 1.2 A respectively, then what will be the current in the conductor at 80°C?
19. In a closed organ pipe, the resonance consecutive frequency are in ratio 1: 3 : 5 : ... : ... : ... and the 5th harmonic frequency is 450 Hz. Assuming the velocity of sound to be 345 m/s, what will be the length of the organ pipe?
20. In an ice cube of thickness 24 cm, has a bubble trapped on a side. If the apparent sides are 12 cm and 4 cm from side 1 and side 2 respectively, then find the refractive index of the ice cube.
21. Match the pairs.
    Column I:
    A. Spring constant, B. Moment of inertia, C. Angular momentum, D. Angular speed
    Column II:
    i. $[ML^2T^0]$, ii. $[M^0L^0T^{-1}]$, iii. $[ML^0T^{-2}]$, iv. $[ML^2T^{-1}]$
22. The length of a conductor having a resistance of 160 ohms is compressed to 25% of its initial value. Calculate the new resistance.
23. Two lenses L_1 and L_2 of focal length 20 cm are placed 60 cm apart. If an object is placed at a very large distance from lens L_1, what will be the distance of the final image formed from L_1?
24. Which is more energetic - infrared waves or microwaves?

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CHEMISTRY

1. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Calculate the total number of spectral lines.
2. A gas with a molecular weight of 42 amu will have the same V_{rms} at 27°C as that of V_{mps} of which gas at 27°C.
   i. CO_2
   ii. CO
   iii. N_2O
   iv. NO_2
3. A metal chloride contains 55% chlorine by mass. If 100 mL of vapours give 0.57 g of chlorine at STP, find out the molecular mass of metal chloride. Calculate the answer to the nearest integer.
4. Arrange the following in the decreasing order of their density.
   Ce, Na, K, Rb
5. Assertion(A): Boron is the hardest element in Group 13.
   Reason(R): High lattice enthalpy due to the strong crystal lattice.
6. Calculate the change in entropy for the system in joules if an isothermal reversible process is carried out for the following data:
   P_i = 3 atm
   $V_{initial}$ = 2I
   V_{final}= 3I
   T = 350K
7. Calculate the mass of Tollen's reagent required for the following reaction:
   $C_2H_5CHO \rightarrow$ (in presence of Tollen's reagent) $\rightarrow NH_3$ (4 kg) + $C_2H_5COO^-$
8. Consider the following reactions:
   $CaCl_2 + Na_2CO_3 \rightarrow X + Y$
   and $X + Y \rightarrow$ (in presence of Z) $\rightarrow CaCl_2$
   Identify X, Y, and Z.
9. Find the number of sp^2 hybridized carbon atoms in the following peptide:
   Ala-Phe-Gly-Ala-Phe-Leu
10. Find the order of reaction for the following:
    $2\ NO + Br_2 \rightarrow 2NOBr$
    Step 1: $NO + Br_2 \Leftrightarrow NOBr_2$ (fast)
    Step 2: $NO + Br_2 \rightarrow 2NOBr$ (slow)

11. Hex-2-ene → (in presence of O_3 and H_2O_2) → A + B
    Identify A and B.

12. How many of the given metals will show a photoelectric effect when the light of 400 nm falls on the below metals?
    Metal → W (eV)
    i. Li → 2.42
    ii. Na → 2.3
    iii. K → 2.25
    iv. Mg → 3.7
    v. Cu → 4.8
    vi. Ag → 4.3

13. Identify if the following statement(s) is/are correct/incorrect.
    Statement I: In the Ellingham diagram, the change in slope for Mg to MgO reaction occurs at 1120°C.
    Statement II: Sudden change in entropy also occurs at 1120°C.

14. If the pH of 1 litre of HCI solution is 1. How much water (in litres) is to be added to make its pH 2?

15. Match the pairs.
    Column I:
    A. Electron deficient, B. Electron precise, C. Electron rich, D. Saline hydride
    Column II:
    i. MgH_2, ii. HF, iii. CH_4, iv. B_2H_6

16. Match the pairs.
    Column I:
    A. Synthetic, B. Biodegradable, C. Polyester, D. Natural
    Column II:
    i. Dracon, ii. Rubber, iii. PHBV, iv. Polyacrylonitrile

17. When the molality of $MgCl_2$ is 1m, $\alpha = 80\%$. Calculate the vapour pressure of the solution in torr, if the vapour pressure of the pure solvent is 100 torr.

18. Which of the following ions have a bond order and magnetic property similar to that of acetylide?
    i. NO^+
    ii. NO^-
    iii. O_2^+
    iv. O_2^-

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MATHEMATICS

1. $\sum k = \begin{vmatrix} \sum 1 & \sum 2k-1 & \sum 2k \\ n & n^2 & n(n+1) \\ cos^2 n & cos^2(n+1) & (n+2) \end{vmatrix}$
   Find $\sum_{k=1}^{n} \Delta(k)$
2. [${}^nC_n$ / (n + 1)] + [${}^nC_{n-1}$ / n] + [${}^nC_{n-2}$ / (n - 1)] + ... + [${}^nC_1$ / 2] + ${}^nC_0$ = 255/8
   Find n.
3. $\int_{-0.15}^{0.15}$ | $100x^2$ - 1 | dx = k/3000
   Find k.
4. 5 positive numbers a_1, a_2, a_3, a_4, and a_5 are in geometric progression. Their mean and variance are 31/10 and m/n respectively. If the mean of the reciprocals is 31/40, find m + n.
5. A circle with its centre as z_0 = 1/2 + 3i/2 exists in an argand plane. A point z_1 = 1 + i and z_2 lies outside the circle such that | z_0 - z_1 | | z_0 - z_2 | = 1. Find the largest value of $|z_2|$.
6. Find the area of the region enclosed by curve $y = x^3$ and its tangent at (-1, -1).
7. Find the number of points of discontinuity of $f(x)$ in [-2, 1] if $f(x) = |[x]| + (x - [x])1/2$.
8. Find the sum of the coefficients of the first 50 terms in the expression $(1 - x)^{100}$.
9. How many such 5-digit numbers greater than 40000 and divisible by 5 can be formed using 0, 1, 3, 5, 7, and 9 without repetition?
10. If (1 + x2) dy = y(y - x) dx and y(1) = 1, then find y(2√2).
11. If a plane 4x − 3y + z = 2 is rotated by an angle of π/2 at intersection point of another plane 3x + 11z - 4y = 12, then find the distance of P(2, 3, 4) from resultant plane.
12. If A, B, and C are the angles of ΔABC and cosA + 2cosB + cosC = 2, find cosA - cosC. Assume AB = 3 and BC = 7.
13. If ai + j + k, i + bj + k, i + j + ck are co-planar then find: [1/(1 - a) + 1/(1 - b) + 1/(1 - c)].
14. Let a = λi + j − k, b = 3i − j + 2k and c is a vector such that the cross product of (a + b + c) with c is 0, the scalar product of a with c is -17 and the scalar product of b with c is -20. Find $|c \times (\lambda i + j + k)|^2$. Assume λ > 0.
15. Let $x^2 + \sqrt{6}x + 4 = 0$ be any quadratic equation and α, β are roots of that equation then find:
$$\frac{\alpha^{34}\beta^{24} + \alpha^{32}\beta^{26} + 2\alpha^{33}\beta^{25}}{\alpha^{31}\beta^{20} + \alpha^{28}\beta^{23} + 3\alpha^{30}\beta^{21} + 3\alpha^{29}\beta^{22}}$$

16. Three numbers a, b, and c are in A.P. and they are used to make a 9-digit number using each digit thrice, such that at least 3 consecutive digits are A. P., then find out the number of such numbers.

17. Two circles having radii r_1 and r_2 touch both coordinate axes. If the line $x + y = 2$ makes intercept 2 on both circles, then find the value of $r_1^2 + r_1^2 - r_1r_2$.