JEE Main 13 April 2023 Shift 1 Memory-Based Questions

PHYSICS

1. A beaker is half-filled with oil at the bottom ($\mu_{oil} = 2$) and half with water at the top ($\mu_{water} = 4/3$). Find the apparent depth of the oil.
2. A dipole of charge 0.01 C and separation 0.4 mm, is placed in an electric field of strength 10 dyne/C, Find the maximum torque exerted on the dipole in the field.
3. A line charge of linear change density λ and a large non-conducting sheet of charge density σ are placed parallel to each other. Point A is at a distance $3/\pi$ from the line charge and Point B is at a distance of $4/\pi$ from the line charge. Find the ratio of the electric field at A to that at B.
4. A particle is performing SHM having a position $x = A \cos 30°$ and an amplitude A = 40 cm. If its kinetic energy at this position is 200 J, then find the value of force.
5. A point R is at (5/8, 3/8, 1/8) and a plane mirror is placed on the xy plane. Find the distance between the image formed by the mirror and the object.
6. A solid sphere rolls on a horizontal plane. The ratio of its angular momentum about COM to its total energy is $\pi/22$. Find its angular frequency.
7. Calculate the bulk modulus in terms of P if the Pressure for the polytropic process (P) varies with volume V as $P = a/v^3$.
8. Calculate the percentage error in the measurement of kinetic energy if $m = 5 \pm 0.2$ and $v = 20 \pm 0.4$.
9. Find the centre of gravity of a semicircular disc of radius R.
10. For an input signal (diagram given) supplied across a logic gate (diagram given), identify the output signal (diagrams given).
11. For the given radioactive decay $^{298}_{94}X \rightarrow {}^{294}_{92}Y + {}^{4}_{2}\alpha + Q$. If the binding energy per nucleon of X, Y and α is a, b and c, then find Q.
12. Four resistance circuit combinations are represented diagrammatically. Arrange them in the increasing order of their power consumption.
13. If a particle is moving in a uniform circular motion of radius 1 m is having velocity 3j m/s at point B. What will be the velocity and acceleration at diametrically opposite points A?
14. If a wire of resistance R is connected across a voltage V_0, then the power obtained is P_0. If the wire is cut into two equal parts and connected with V_0 individually, then the sum of power dissipated is P_1. If P_0/P_1 is 1/x, find the value of x.
15. If in a lake with a refractive index of 4/3, a fish is swimming at a speed of 8 m/s. A bird is flying over the lake at a speed of 12 m/s. What will be the speed of the bird as seen by the fish?

16. If the energy of He^{+} in 2^{nd} orbit is -13.6 eV, then what will be the energy of Be^{3+} in the 4^{th} orbit?
17. If the height of the tower used for an L.D.S. is increased by 21% then what will be the percentage change in range?
18. Select the correct graph showing the difference (d) between the total energy and the potential energy of a particle in linear SHM with position x of the particle (x = 0 is the mean position).
19. The work functions for two metals are 9 eV and 4.5 eV. Find the approximate difference between their threshold wavelength. Take hc = 1240 eV-nm.
20. Train A of length is moving at a speed of 108 km/hr. Another train B of length 41 is moving parallel to train A with a speed of 72 km/hr. They both move through a tunnel of length 601 and train B takes 35 sec more time than train A to pass through the tunnel, if they enter the tunnel simultaneously, find the length (in m) of the tunnel.
21. Two bodies having the same linear momentum have a ratio of the kinetic energy of 16:9. Find the ratio of masses of these bodies.
22. Water is flowing inside a conical type tube having ratio of area of cross-section 6:1. if the speed of water outlet through smaller area is 60 m/s, then the pressure difference across these two cross-sections is m x 10^4 Pa, find the value of m, assuming the water to be an incompressible fluid with a density of kg/m^3.
23. Which of the following shows the current changing linearly with time?
    i. Linearly varying electric field
    ii. Permanent magnet
    iii. Antenna signal
    iv. Constant electric field

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CHEMISTRY

1. A solution is isotonic with glucose having a concentration of 0.05 M at a certain temperature. If the volume of the solution is 1 litre, then find the molar mass of the solute in g/mol if 12 g of solute is mixed to form the solution.
2. An organic compound on combustion gives 0.22 g of CO_2 and 0.126 g of H_2O. If the percentage of C in a given organic compound is 40%, what will be the percentage of H?
3. Calculate the value of x to the nearest integer if $(1 + 1/x)^{1/2}V_{av} = V_{rms}$.
4. CH_3-$(CH_2)_4$-CH_3 → (in presence of Anhy. $AICI_3$, HCI, heat) → Major product
   Identify the major product obtained.
5. Consider a reaction.
   $A_2(g) + B_2(g) \rightarrow 2AB(g)$
   If ΔH^0_f of A_2, AB and B_2 are in the ratio 1 : ½: 1 and ΔH of the reaction is -200 kJ/mol, find $\Delta H^0(A_2)$ in kJ/mol.
6. For the first-order reactions, find the ratio of $t_{50\%}$ and $t_{87.5\%}$.
7. Identify the highest dipole moment for the given compounds.
8. Identify the incorrect statement regarding the product given in the following reaction:
   $Be(OH)_2 + Sr(OH)_2 \rightarrow$ Product
   i. Be is tetrahedrally bonded in the product
   ii. Be forms cationic part
   iii. It is an acid-base reaction
   iv. $Be(OH)_2$ acts as a Lewis acid
9. Identify x if the radius of the second orbit of He^+ is r_0 and the radius of the fourth orbit of Be^{3+} is xr_0.
10. If the energy of 1st Bohr's orbit of hydrogen (E_1) is -2.18×10^{-18} J, then find the energy of the 3rd Bohr's orbit for hydrogen.
11. In which of the following options do the species change from paramagnetic to diamagnetic and bond order increases?
    i. $O_2 \rightarrow O_2^{2+}$
    ii. $O_2 \rightarrow O^{2+}$
    iii. $NO \rightarrow NO^+$
    iv. $N_2 \rightarrow N^{2+}$
12. Match the pairs.
    Column I:
    A. Nylon-6, B. Natural Rubber, C. Vulcanized Rubber, D. Neoprene

Column II:
i. Caprolactum, ii. Chloroprene, iii. Isoprene, iv. Sulphur containing rubber

13. Match the pairs.
Column I:
A. Troposphere, B. Stratosphere, C. Mesosphere, D. Thermosphere
Column II:
i. About 10 to 15 km above the mean sea level
ii. Up to 10 km from the mean sea level
iii. About 85 to ~700 km above the mean sea level
iv. About 50 to 85 km above the mean sea level

14. Select the correct option regarding products A and B.
Glyceraldehyde → (in presence of I. HCN, II. H_3O^+, III. HNO_3) → A + B
i. Both are optically active
ii. Both are optically inactive
iii. One is optically active and another is optically inactive
iv. None of these

15. Which of the following are the pairs of lanthanides with exceptionally high 3^{rd} ionisation enthalpy than neighbouring elements?
i. Lu and Yb
ii. Eu and Gb
iii. Eu and Yb
iv. Dy and Yb

16. Which of the following can be observed when lyophilic sol is added to lyophobic sol?
i. Prevention from coagulation
ii. Precipitation
iii. Emulsion
iv. Electrophoresis

17. Which of the following shows the incorrect method of refining?
i. Zinc: Liquation
ii. Copper: Electrolysis
iii. Titanium: Van Arkel Method
%v. Nickel: Mond's Process

18. Which one of the following is the best method for the removal of the hardness of water?
i. Boiling
ii. Treatment with washing soda
iii. Permutit process
iv. Synthetic resin method

19. Which free radical is primarily responsible for the depletion of the ozone layer?

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MATHEMATICS

1. $sin^{-1}\left(\frac{x+1}{\sqrt{x^2+2x+2}}\right) - sin^{-1}\left(\frac{x}{\sqrt{x^2+1}}\right) = \frac{\pi}{4}$
   Find $\sin\left((x^2+x+5)\frac{\pi}{2}\right) - \cos\left((x^2+x+5)\pi\right)$
2. $\int_0^\infty [\ 6\ dx / (e^{3x} + 6e^{2x} + 11e^x + 6)\ ] = ?$
3. a = 2i + 3j + 5k
   b = 3i + 3j + 7k
   c = 7i + 8j + 9k
   If a x b = c + d, find |d|.
4. f(x) = x - sin2x + (sin3x)/3, x ∈ [0, π]. Find the maximum value of f(x).
5. Find area bounded by the curves y = max {sin x, cos x} and x-axis between x = -π and x = π.
6. Find f(3) if 3 f(x) + 2 f(1/x) = -10 + 1/x.
7. Find the negation of [((A ∧ (B ∨ C)) ⇒ (B ∧ C) ⇒ A].
8. Find the number of seven digits numbers that can be made using the digits 1, 2, 3, and 4 such that the sum of the digits of the resulting number is 12.
9. Identify if the following statement(s) is/are correct/incorrect.
   Statement I: $\lim_{n\to\infty} [\ (1/n^2)\ (\ 1 + 2 + 3 + ... + n\ ) = 1$
   Statement II: $\lim_{n\to\infty} [\ (1/n^{16})\ (\ 1^{15} + 2^{15} + 3^{15} + ... + n^{15}\ ) = 1/16$
10. If $dy/dx = 6e^x + e^{2x} + e^{3x}$, then find y(2) - y(0).
11. If dy/dx = y + 7 and $y_1(x)$ and $y_2(x)$ are two solutions of this differential equation such that y(0) = 1 and y(1) = 1, then find the number of solutions for $y_1(x) = y_2(x)$.
12. If $g(x) = (x + 1)^{1/2}$ and $f(g(x)) = 3 - (x + 1)^{1/2}$, then find f(0).
13. If Plane P_3 is passing through (1, 1, 1) and the line of intersection of P_1 and P_2 where P1 = 2x - y + z = 5 and P2 = x + 3y + 2z + 2 = 0, then find the distance of (1, 1, 10) from P_3.
14. If the mean of the following data is 5 and the mean deviation about the mean is M and the variance is σ^2, then find [3α/(M + σ^2)].
    $x_i \rightarrow f_i$
    1 → 4
    3 → 24
    5 → 28
    7 → α
    9 → 8

15. If the number of total possible symmetric matrices using the digits {0, 1, 2, 3, ..., 10} is m^n where m is a prime number, find m + n.
16. Let there be 10 A.P.s whose first terms are (1,2, 3 ... 10) respectively and whose common differences are (1,3,5, ...) respectively and S_i denotes the sum of 10 terms of i^{th} A.P., then find the summation of S_i from i = 1 to i = 10.
17. What will be the remainder of 4^{2022} when divided by 15?
18. Σ (2 x 2^2 - 2 x 3^2 + 2 x 4^2 - ... 20 terms) = ?