JEE Main 2023 Question Paper Solution

Date & Shift: April 15 Shift 1   **Memory-Based Questions**

JEE Main 2023 Physics Question Paper

Question 1. A has a half life of 5 years. Find the amount of life left after 15 years.

- A. 1/8 of initial value
- B. 7/8 of initial value
- C. 1/4 of initial value
- D. 3/4 of initial value

Solution. If the half-life of substance A is 5 years, then after 5 years, the amount of substance A remaining will be half of its initial amount. After another 5 years (i.e. 10 years in total), the amount of substance A remaining will be half of the amount remaining after 5 years, or one quarter of the initial amount. After another 5 years (i.e. 15 years in total), the amount of substance A remaining will be half of the amount remaining after 10 years, or one eighth of the initial amount. Therefore, the answer is 1/8 of the initial value.

So, the correct option is: 1/8 of initial value.

Answer. A

Question 2. A variable force F = 5x N acts on a body moving along x - axis. Find the work done by this force in displacing the body from x=2m to x=4m (K is constant)

    A. (205/2 K) J
    B. (105/2 K) J
    C. 52K J
    D. 51K J

Answer. B

Question 3. If the position of a particle is changing with time as r = t2 - 2t (m). Find the velocity at t = 2s.

    A. 2 m/s
    B. 3 m/s
    C. 0 m/s
    D. 4 m/s

Solution. To find the velocity at a specific time, we need to take the derivative of the position function with respect to time:
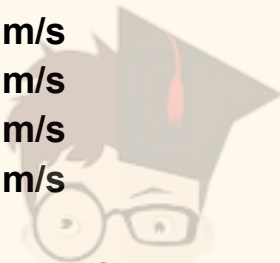
v = dr/dt

In this case, the position function is given by r = t^2 - 2t (m). Taking the derivative with respect to time, we get:

v = dr/dt = d/dt (t^2 - 2t) = 2t - 2

To find the velocity at t = 2s, we substitute t = 2 into the expression for v:

v = 2t - 2 = 2(2) - 2 = 2 (m/s)

Therefore, the velocity of the particle at t = 2s is 2 m/s, which is equivalent to option 1.

Answer. A

Question 4. If de-Broglie wavelength is λ when energy is E. Find the wavelength at E/4 (Kinetic Energy).

    A. 2λ
    B. $\sqrt{2}\lambda$
    C. λ
    D. $\lambda/\sqrt{2}$

Solution. The de Broglie wavelength of a particle is given by the formula:

$\lambda = h/p$

where h is Planck's constant and p is the momentum of the particle. The momentum of a particle with kinetic energy E is given by:

$p = \sqrt{(2mE)}$

where m is the mass of the particle.

If the de Broglie wavelength of a particle with energy E is λ, then we have:

$\lambda = h/\sqrt{(2mE)}$

To find the de Broglie wavelength of a particle with kinetic energy E/4, we first need to find the momentum of the particle. The momentum is given by:

$p = \sqrt{(2m(E/4))} = \sqrt{(mE/2)}$

The de Broglie wavelength of the particle with momentum p is then given by:
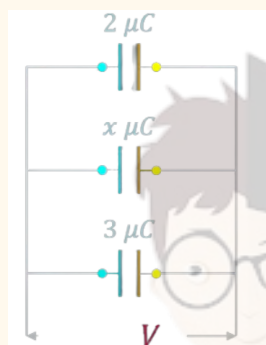
$\lambda' = h/p = h/\sqrt{(mE/2)}$

Dividing this expression by the original expression for λ, we get:

$\lambda'/\lambda = \sqrt{2}$

So, the wavelength of the particle with kinetic energy E/4 is $\sqrt{2}$ times the wavelength of the particle with kinetic energy E. Therefore, the answer is option 2: $\sqrt{2}\lambda$.

Answer. A

Question 5. If the total charge stored in capacitors is equal to 100µc, then find the value of x. (10V)

Answer. 5

Question 6. Height of the receiving and transmitting antenna in communication of a signal are 245 m and 180 m respectively. Find the maximum distance between the two antennas for proper communication.

    A. 104 km
    B. 208 km
    C. 52 km
    D. 96 km

Answer. A

Question 7. A particle is released from a height equal to radius of Earth. Find its velocity when it strikes the ground.

    A. $\sqrt{gR}$
    B. $\sqrt{gR/2}$
    C. $\sqrt{2gR}$
    D. $\sqrt{4gR}$

Answer. A

Question 8. Two identical particles each of mass m, move in circular path due to their own mutual gravitational force. Find the velocity of the particle if the radius of the circular path is a.

    A. $\sqrt{4Gm/a}$
    B. $\sqrt{Gm/2a}$
    C. $\sqrt{2Gm/a}$
    D. $\sqrt{Gm/4a}$

Answer. D

Question 9. Electric field due to a dipole at a equatorial point depends upon r^{-n} . Value of n is

Solution. At an equatorial point of a dipole, the electric field due to the dipole is given by:

E = k [p / (r^3)]

where k is the Coulomb constant, p is the dipole moment, and r is the distance from the dipole.

For an equatorial point, the distance r is equal to the distance between the two charges of the dipole, which is 2a, where a is the separation between the charges.

Therefore, the electric field at the equatorial point can be written as:

$E = k [p / (2a)^3]$

$E = (1/4\pi\varepsilon_0) [2p\sin\theta / (2a)^3]$

where θ is the angle between the axis of the dipole and the line joining the dipole to the point where the electric field is to be calculated, and ε_0 is the permittivity of free space.

Since $\sin\theta = 1$ at the equatorial point, we can simplify the above equation as:

$E = (1/4\pi\varepsilon_0) [p\sin\theta / a^3]$

$E = (1/4\pi\varepsilon_0) [p / a^3]$

Therefore, the dependence of the electric field on the distance r at an equatorial point is $1/r^3$, which is equivalent to $n = 3$. Hence, the value of n is 3.

Answer. 3

Question 10. Match the list-I with list-II and choose the correct option.

List-I	List-II
(A). Micro-wave	(p). $1\,nm - 400\,nm$
(B). Ultra violet	(q). $1\,nm - 1\,pm$
(C). X-rays	(r). $2.5\,\mu m - 750\,nm$
(D). Infrared	(s). $1\,\mu m - 1mm$

A. A - (s), B - (q), C - (r), D - (p)
B. A - (s), B - (p), C - (q), D - (r)
C. A - (p), B - (s), C - (q), D - (r)
D. A - (r), B - (q), C - (s), D - (p)

Answer. B

JEE Main 2023 Chemistry Question Paper

Question 1. Number of P-O-P bonds in H_3PO_4, P_4O_{10}, $(HPO_3)_3$

Answer. 0, 6, 3

Question 2. In which of the following cities photochemical smog is minimum?

A. New Delhi
B. Mumbai
C. J & K
D. Kolkata

Solution. Photochemical smog is formed due to the reaction of pollutants in the presence of sunlight. The major pollutants involved in the formation of photochemical smog are nitrogen oxides (NOx) and volatile organic compounds (VOCs). The reaction of NOx and VOCs in the presence of sunlight leads to the formation of ground-level ozone and other secondary pollutants.

The factors that contribute to the formation of photochemical smog include sunlight, temperature, wind, and topography. The concentration of pollutants and their sources also play an important role.

Based on these factors, it is difficult to determine which city has the minimum photochemical smog. However, in general, cities with lower levels of vehicular traffic and industrial activity tend to have lower levels of pollutants, and hence lower levels of photochemical smog.

Out of the cities listed, J & K (Jammu and Kashmir) may have lower levels of photochemical smog compared to New Delhi, Mumbai, and Kolkata, as it is a less urbanized and industrialized region. However, more detailed information about the concentration of pollutants and their sources in each city would be required to make a definitive statement about which city has the minimum photochemical smog.

Answer. C

Question 3. Calculate the ratio of radii of second and third bohr orbit of H-atoms

Solution. The radii of the Bohr orbits in hydrogen atom are given by the formula:

$r\_n = (n^2 * h^2 * \varepsilon_0) / (\pi * m * e^2)$

where r_n is the radius of the nth Bohr orbit, n is the principal quantum number, h is the Planck's constant, ε_0 is the permittivity of free space, m is the mass of the electron, and e is the charge of the electron.

The ratio of radii of the second and third Bohr orbits can be calculated by substituting n=2 and n=3 in the above formula and taking the ratio:

$r\_2 / r\_3 = [(2^2 * h^2 * \varepsilon_0) / (\pi * m * e^2)] / [(3^2 * h^2 * \varepsilon_0) / (\pi * m * e^2)] = 4/9$

Therefore, the ratio of radii of second and third Bohr orbit of H-atoms is 4/9.

Answer. 4/9

Question 4. Statement-1: According to Bohr's Model, angular momentum is Quantized for stationary orbits.
Statement-2: Bohr's Model doesn't follow Heisenberg's Uncertainty Principle.

A. Both Statement - 1 and statement - 2 are true
B. Statement - 1 is true and statement - 2 is false
C. Statement - 1 is false and statement - 2 is true
D. Both Statement - 1 and statement - 2 are false

Answer. A

Question 5. How many of the following statements are correct:
1. Conductivity (K) decreases with increase in dilution for both strong and weak electrolyte.
2. Molar conductivity increases with increase in dilution for both strong and weak electrolyte.
3. Molar conductivity increases with increase in 'α' for weak electrolyte.
4. Change in molar conductivity is same for both strong and weak electrolyte with increase in dilution.

Solution. Three statements are correct:

- Conductivity (K) decreases with increase in dilution for both strong and weak electrolytes.
- Molar conductivity increases with increase in dilution for both strong and weak electrolytes.
- Molar conductivity increases with increase in α for weak electrolytes.

Statement 4 is incorrect. The change in molar conductivity with dilution is different for strong and weak electrolytes. For strong electrolytes, the change in molar conductivity with dilution is small, whereas for weak electrolytes, the change in molar conductivity with dilution is large.

Answer. 1,2 and 3

Question 6. Lowering of vapour pressure of 30% of aqueous solution of glucose. (in mmHg)
Given: P_{H2O} = 760 mm of Hg

Answer. 729 mm Hg

Question 7. How many of the following have 10 electrons:
O^{2-}, O, Al^{3+}, Al, F, F^-, Mg^{2+}, Mg, N^{-3}

Solution. The number of electrons in an atom or ion can be determined from its atomic number and its ionic charge. The atomic number of oxygen (O) is 8, aluminum (Al) is 13, fluorine (F) is 9, magnesium (Mg) is 12, and nitrogen (N) is 7.

The following species have 10 electrons:

- F- (atomic number of F is 9 and it has gained one electron to form an ion)
- N-3 (atomic number of N is 7 and it has gained three electrons to form an ion)

Therefore, only 2 of the given species have 10 electrons.

Answer. 5 (O^{2-}, Al^{3+}, F^-, Mg^{2+}, N^{-3})

Question 8. Oxidation state of Cr in chromyl chloride is:

Solution. The chemical formula for chromyl chloride is CrO2Cl2. To determine the oxidation state of Cr in chromyl chloride, we can use the following formula:

total charge on the compound = sum of oxidation states of all the atoms in the compound

The total charge on chromyl chloride is zero because it is a neutral compound. The oxidation state of oxygen is -2 and the oxidation state of chlorine is -1. Therefore, we have:

2(-1) + 2(-2) + x = 0

Simplifying this equation, we get:

-2x = 2
x = -1

Therefore, the oxidation state of Cr in chromyl chloride is +6.

Answer. 6

Question 9. Out of the following which has maximum CFSE? (consider with sign)

    A. $[Fe(H_2O)_6]^{3+}$
    B. $[Ti(H_2O)_6]^{3+}$
    C. $[Mn(H_2O)_6]^{3+}$
    D. $[Cr(H_2O)_6]^{3+}$

Solution. The CFSE (Crystal Field Stabilization Energy) of a complex ion depends on the nature of the metal ion and the ligands that are coordinated to it.

In general, the CFSE increases with the oxidation state of the metal ion, so $[Fe(H_2O)_6]^{3+}$ and $[Cr(H_2O)_6]^{3+}$ will have higher CFSE compared to $[Mn(H_2O)_6]^{3+}$ and $[Ti(H_2O)_6]^{3+}$.

The CFSE also depends on the nature of the ligands. Among the given complexes, H2O is a weak field ligand, so the splitting of d orbitals is small and CFSE is low.

However, the sign of CFSE depends on the number of electrons in the d orbitals of the metal ion. In case of $[Fe(H2O)6]^{3+}$ and $[Cr(H2O)6]^{3+}$, the d5 and d3 configurations respectively result in high negative CFSE values. On the other hand, $[Mn(H2O)6]^{3+}$ and $[Ti(H2O)6]^{3+}$ have d4 and d1 configurations respectively, which result in positive CFSE values.

Therefore, $[Fe(H2O)6]^{3+}$ has the maximum negative CFSE among the given complexes.

Answer. A

Question 10. The ratio of silica to alumina in cement is:

A. 5.5
B. 2
C. 3
D. 1.5
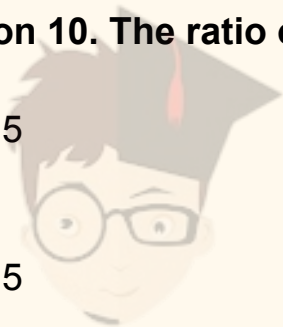
Solution. The ratio of silica to alumina in cement varies depending on the type of cement being used. However, a common ratio for Portland cement, which is the most widely used type of cement, is approximately 3:1, with three parts of calcium silicates (composed mainly of silica and lime) to one part of calcium aluminate. Other types of cement may have different ratios of silica to alumina.

Answer. C

JEE Main 2023 Mathematics Question Paper

Question 1. There are 5 black and 3 white balls in the bag. A die is rolled, we need to pick the number of balls appearing on the die. The probability that the balls are white is?

    A. 1/12
    B. 1/18
    C. 2/9
    D. ½

Answer. A

Question 2. The mean and variance of 15 observations is 20 and 64 respectively. If 55 is wrongly read as 40 as one of the observation, then the correct variance is:

    A. 243/3
    B. 167/2
    C. 118
    D. 96

Answer. C

Question 3. The number of solution of equation x|x| - 5|x+2| + 6 = 0 is?

Answer. 1

Question 4. Let $f(x) = \log(4x^2 + 11x + 9) + \sin^{-1}(4x + 3)\cos^{-1}(10x+6 / 3)$ and if domain of f(x) is [α,β], then |10(α - β)| is?

Answer. 4

Question 5. How many three digit numbers can be formed which are divisible by 3 using the digits 1, 3, 5, 8. Repetition is allowed.

Answer. 22

Question 6. Matrix A having order m has the value of its determinant as $(m)^{-n}$. The value of det n adj(adj(mA)) is

    A. $n^m \, m^{(m-n)\,(m-1)2}$
    B. $n^m \, m^{(m-n)\,(m-1)}$
    C. $n^m \, m^{(m-n)}$
    D. $n^m \, m^{(n-m)2}$

Answer. A

Question 7. Orthocentre of triangle having vertices as A (1,2), B(3,-4), C(0,6) is

    A. (-129, -37)
    B. (9, -1)
    C. (7, -3)
    D. (28, -16)

Answer. A

Question 8. Area bounded by the curve 2y2 = 3x and the line x+y = 3 outside the circle (x-3)2 + y2 = 2 and above the x-axis is A. The value of 4(π +4A) is?

Answer. 42

Question 9. If n Ɛ [10,100] and n Ɛ N, then how many such n are possible where 3n - 3 is divisible by 7?

Answer. 15

Question 10. If y = max{ √x, x² - 4, x3 + 2}, then the number of solution(s) of y = 1 is/are_____?

Answer. 0