JEE Main 2023 Question Paper Solution

Date & Shift: April 10 Shift 1 **Memory-Based Questions**

JEE Main 2023 Physics Question Paper

Question 1. An object is placed in Front of a plane mirror 12 cm away from it. The object is kept fixed while the plane mirror is shifted towards the object by a distance of 4 cm. The length of shift in the position of the image is equal to _____ cm.

Solution. When an object is placed in front of a plane mirror, the image formed is at the same distance behind the mirror as the object is in front of it. Therefore, the distance between the object and the image is twice the distance between the object and the mirror.
Initially, the object is placed 12 cm away from the mirror. Therefore, the distance between the object and the image is 2 x 12 = 24 cm.
When the mirror is shifted towards the object by 4 cm, the distance between the object and the mirror becomes 12 - 4 = 8 cm. Therefore, the distance between the object and the image becomes 2 x 8 = 16 cm.
The shift in the position of the image is the difference between the initial and final distances between the object and the image. Therefore, the shift in the position of the image is:
24 - 16 = 8 cm
So the length of the shift in the position of the image is 8 cm.

Answer. 8 cm

Question 2. Statement (1): An LCR circuit connected to an AC source has maximum average power at resonance.
Statement (2): A resistor only circuit with zero phase difference has maximum average power.

A. (1) and (2) both are correct
B. (1) is correct but (2) is incorrect
C. (1) is incorrect but (2) is correct
D. Both (1) and (2) are incorrect

Solution. Statement (1) is correct. An LCR circuit connected to an AC source has maximum average power at resonance. At resonance, the reactive components of the circuit cancel each other out, leaving only the resistance to limit the flow of current. This results in maximum current flow and maximum power transfer to the circuit.
Statement (2) is incorrect. A resistor only circuit with zero phase difference does not necessarily have maximum average power. The power in a resistor only circuit is given by P = V^2/R, where V is the voltage across the resistor and R is its resistance. Maximum power occurs when the voltage across the resistor is at its maximum. This occurs when the circuit has a phase difference of 90 degrees, not zero.
Therefore, the correct option is (1) is correct but (2) is incorrect.

Answer. A

Question 3. A point sized object is placed 4 cm from the double convex lens of focal length 8 cm. The change in the position of the image, when the object is moved 2 cm towards the lens, is?

A. 8
B. 8/3
C. 16/3
D. 32/3

Answer. C

Question 4. The equation of progressive wave is y=5sin(6t + 0.03x). Find the speed of wave

Solution. The standard equation of the progressive is given by
$y = A \sin(\omega t + kx)$
Where
A = maximum amplitude of the wave
ω = angular frequency
k = angular wave number
Comparing given equation of progressive wave y = 5sin(6t + 0.03x) with the standard equation, we get
A = 5 unit, ω = 6 unit, and k = 0.03 unit
Now speed of the progressive wave is given by
v=k=60.03=200 unit

Answer. 200

Question 5. For an object radiating heat at 300 K, the wavelength corresponding to maximum intensity is λ. If the temperature of body is increased by 300 K, the new wavelength corresponding to maximum intensity will be

A. λ/2
B. 2λ
C. λ
D. 5λ/2

Solution. According to the Wein's displacement law, the wavelength of the maximum intensity (λ) of radiation is directly proportional to absolute temperature (T). i.e
$\lambda \propto 1/T \Rightarrow \lambda T$= constant
$\Rightarrow \lambda_1 T_1 = \lambda_2 T_2$
Given, for T1 = 300 K, λ1 = λ

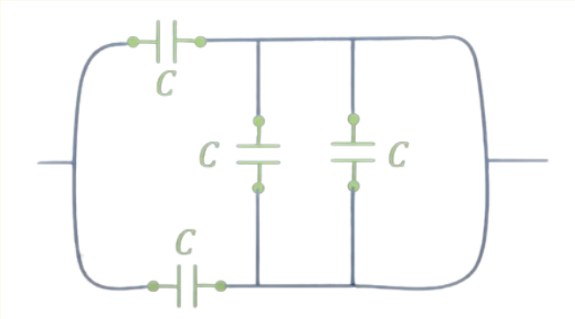
Now, if the temperature of the body is increased by 300 K, then final temperature of the body will be
T2 = 300 +300 = 600 K
Therefore, the new wavelength corresponding to maximum intensity will be,
$\lambda_2 = \lambda_1 T_1 / T_2 = (\lambda * 300) /600 = \lambda/2$

Answer. A

Question 6. Earth shrinks to 1/64 times of its initial volume. Time period of Earth rotation is found to be 24/x hrs. Find the value of x.

Solution. Initially,
Volume of the earth, $V_1 = 4/3\ \pi R_1^3$
Where, R1 is the radius of the earth
Time period of Earth rotation is T1 = 24 hrs
Angular frequency, $\omega_1 = 2\pi/T_1 = 2\pi/24 = \pi/12$
Moment of inertia of the earth about its diameter, $I_1 = 2/5MR_1^2$
Finally,
Volume of the earth, $V_2 = 4/3\ \pi R_2^3$
Given, $V_2 = V_1/64 \Rightarrow 4/3\pi R_2^3 = 4/3\pi R_1^3 / 64$
$\Rightarrow R_2^3 = R_1^3 / 64 \Rightarrow R_2^3 = (R_1/4)^3 \Rightarrow R_2 = R_1/4$
Time period of Earth rotation is T2 = 24/x hrs
Angular frequency, $\omega_2 = 2\pi/T_2 = 2\pi/(24/x) = \pi x/12$
Moment of inertia of the earth about its diameter, $I_2 = 2/5MR_2^2$
According to conservation of angular momentum,
$I1\omega1 = I2\omega2$
$\Rightarrow 2/5MR_1^2 * \pi/12 = 2/5MR_2^2 * \pi x/12$
$\Rightarrow R_1^2 = R_2^2 x \Rightarrow x = R_1^2 / R_2^2 = (4R_2)^2 / R_2^2 = 16$
Answer. 16

Question 7. Find the equivalent capacitance across points A and B in the given electric circuit.



A. C/2
B. 2C
C. 5C/3
D. 3C/4

Answer. B

Question 8. An object weighs 200N at the surface of earth. Find the weight at a depth of R/2 , where R is radius of earth

A. 100N
B. 300N
C. 50N
D. 150N

Solution. Given the weight of the object on the surface of the Earth, mg = 200 N
Where, m is the mass of the object and g is acceleration due to gravity on the surface of the earth.
The variation of acceleration due to gravity (g) with the depth (d) from the surface of the Earth is given by
gd=g1-dR
Where
gd is the acceleration due to gravity at depth d
R is the radius of the Earth
At depth d = R/2, acceleration due to gravity is given by
gd=g1-R/2R=g2

Multiplying both sides by mass of the object, then we get
mgd = mg/2
But, mg = 200 N
Therefore, Weight of the object at depth R/2 is given by
mgd = 200/2 = 100 N

Answer. A

Question 9. A particle, when projected at 15° horizontally, has a range of 50 m. Find the range when projected at 45° with horizontal.

A. 50 m
B. 100 m
C. 80 m
D. 120 m

Solution. When a particle is projected with initial velocity u at angle θ with the horizontal, then the horizontal range is given by
R=u2 sin 2g
For, θ = 15°, R = 50 m
Therefore, u2g=Rsin 2=50sin 30=100
Now, we have to find horizontal range, when the θ = 45°
Using,
R=u2 sin 2g=100sin (245)
R=100sin 90=100 m
Answer. B

Question 10. A particle of mass m moving with a velocity v collides with a particle of mass 2m at rest and sticks to it. Velocity of the combined mass equal to?

A. v
B. v/2

C. v/3
D. v/4

Solution. Given masses of the particles are, m1 = m and m2 = 2m
Initially the first particle is moving with velocity, v1 = v
And, the second particle is at rest, therefore v2 = 0
The initial momentum of the system is
pi = m1v1 + m2v2 = mv +0 = mv
Now after the collision, both the particles stick together.
The combined mass of the system is (m1 + m2)
Let V be the velocity of the combined mass, then the final momentum of the system is given by
pf = (m1 + m2)V = (m + 2m)V = 3mV
Since there is no external force acting on the system, therefore according to the law of conservation of momentum, initial momentum will be equal to final momentum. i.e.
pi = pf
⇒ mv = 3mV ⇒ V = v/3

Answer. C

JEE Main 2023 Chemistry Question Paper

Question 1. One which does not stabilize secondary and tertiary protein?

A. H-H linkage
B. S-S linkage

C. Vanderwoal's force
D. Hydrogen bonding

Solution. Among the given options, H-H linkage does not stabilize the secondary and tertiary structure of proteins. This is because H-H linkage refers to a hypothetical interaction between two hydrogen atoms, and such an interaction is not known to play a significant role in stabilizing protein structures.
On the other hand, hydrogen bonding, S-S linkage, and van der Waals forces all contribute to stabilizing the secondary and tertiary structure of proteins. Hydrogen bonding helps to stabilize the structure of protein helices and sheets, while S-S linkages are important for stabilizing the three-dimensional structure of many proteins. Van der Waals forces are weak, non-specific forces that contribute to the overall stability of protein structures, particularly in hydrophobic regions of the protein.

Answer. A

Question 2. Stabilizer used for concentrating sulphide ore

A. Fatty acids
B. Pine oil
C. Cresol
D. Xanthates

Answer. C

Question 3. Which of the following is diamagnetic with low spin?

A. $[CO(NH_3)_6]^{3+}$
B. $[COF_6]^{3-}$
C. $[COCl_6]^{3-}$

D. $[Fe(H_2O)_6]^{3+}$

Answer. A

Question 4. The compound which does not exist.

A. $BeCl_2$
B. Nao_2
C. $PbEt_4$
D. $(NH_4)_2\ BeF_4$

Solution. The compound that does not exist is Nao_2. The correct formula for the compound should be Na_2O, which is sodium oxide.
$BeCl_2$, $PbEt_4$, and $(NH_4)_2BeF_4$ are all valid chemical compounds. $BeCl_2$ is beryllium chloride, $PbEt_4$ is tetraethyllead, and $(NH_4)_2BeF_4$ is ammonium beryllium fluoride.

Answer. B

Question 5. Number of molecules and moles in 2.8375 litre of O_2 at STP.

Solution. At STP (Standard Temperature and Pressure), the temperature is 273.15 K and the pressure is 1 atm.
The molar volume of any ideal gas at STP is 22.4 L/mol. Therefore, we can use the following formula to calculate the number of moles of O_2:
n = V/VM
where n is the number of moles, V is the volume of the gas (2.8375 L), and VM is the molar volume of the gas at STP (22.4 L/mol).
n = 2.8375 L / 22.4 L/mol
n = 0.1266 mol
We can use the Avogadro's number (6.022 x 10^23) to calculate the number of molecules:
Number of molecules = n x N_A

where N_A is Avogadro's number.
Number of molecules = 0.1266 mol x 6.022 x 10^23/mol
Number of molecules = 7.614 x 10^22 molecules
Therefore, there are 0.1266 moles and 7.614 x 10^22 molecules of O2 in 2.8375 L of O2 at STP.

Answer. Number of moles = 0.1266 moles
Number of molecules = 0.7625×10^{23}

Question 6. Select the correct option :
2C0 (g) + O_2 (g) → 2CO2 (g) ; ΔH = -x KJ/mol
C (graphite) + O_2(g) → CO_2 (g) ; AH = -y KJ/mol
Then AH for , C(graphite) + 1/2 O2 (g) → CO (g) :

A. x- y/2
B. x- 2y / 2
C. x + 2y / 2
D. x - y / 2

Solution. We can use Hess's Law to calculate the enthalpy change (ΔH) for the reaction:
C(graphite) + 1/2 O2(g) → CO(g)
The enthalpy change for this reaction can be expressed as:
AH = AH(C(graphite) + O2(g) → CO2(g)) - AH(2CO(g) → 2CO2(g))
We can see that the first reaction is the reverse of the combustion of carbon to form carbon dioxide, while the second reaction is the combustion of carbon monoxide to form carbon dioxide. So, we can use the given enthalpies of combustion to calculate the enthalpy change for the desired reaction.
Multiplying the second reaction by 1/2, we get:
1/2(2CO(g) + O2(g) → 2CO2(g)) ; AH = -1/2(ΔH)
Subtracting this equation from the first equation, we get:
C(graphite) + 1/2 O2(g) → CO(g) ; AH = ΔH - (-1/2ΔH)

Simplifying this expression, we get:
AH = (3/2)ΔH
Substituting the given values of ΔH for the two reactions, we get:
AH = (-x) - (-y) = -x + y
Therefore, the correct option is (4) AH = x - y/2.

Answer. B

Question 7. The Sum of number of lone pairs in central atom in IF_5 and IF_7 is:

Solution. In IF5 (iodine pentafluoride), the central atom is iodine (I).
Iodine has 7 valence electrons (group 7 or 17), and each fluorine (F) atom has 7 valence electrons. Therefore, the total number of valence electrons in IF5 is:
1(I) x 7 valence electrons + 5(F) x 7 valence electrons = 42 valence electrons
To determine the number of lone pairs on the central atom, we need to subtract the number of electrons involved in bonding from the total number of valence electrons.
In IF5, each fluorine atom contributes 1 electron to form a single bond with the iodine atom. Therefore, there are 5 bonding pairs (I-F) in the molecule, accounting for a total of 10 electrons.
The remaining 32 valence electrons are used to complete the octet of each fluorine atom, leaving 2 electrons on iodine. Since each lone pair has 2 electrons, there is 1 lone pair on the central atom in IF5.
In IF7 (iodine heptafluoride), the central atom is also iodine (I).
Iodine has 7 valence electrons, and each fluorine atom has 7 valence electrons. Therefore, the total number of valence electrons in IF7 is:
1(I) x 7 valence electrons + 7(F) x 7 valence electrons = 56 valence electrons
In IF7, each fluorine atom contributes 1 electron to form a single bond with the iodine atom. Therefore, there are 7 bonding pairs (I-F) in the molecule, accounting for a total of 14 electrons.

The remaining 42 valence electrons are used to complete the octet of each fluorine atom, leaving no electrons on iodine. Since there are no lone pairs on the central atom in IF7, the sum of the number of lone pairs in IF5 and IF7 is 1 + 0 = 1.

Answer. 1

Question 8. Enthalpy of adsorption and enthalpy of formation of micelle are respectively

A. Positive, Positive
B. Positive, Negative
C. Negative, Positive
D. Negative, Negative

Answer. C

Question 9. How many of the following are bent in shape?
SO_2, O_3, I_3^-, N_3^-

Answer. 2

Question 10. The pressure value of a gas is 930.2 mm Hg. The volume is then reduced to 40% of its initial value at a constant temperature. Then what is the final pressure (in mmHg)

Solution. If the volume is reduced to 40% of its initial value, then the final volume is 0.4 times the initial volume. Since the temperature is constant, according to Boyle's Law, the pressure of the gas is inversely proportional to its volume. Therefore, if the volume is reduced to 0.4 times its initial value, the pressure will increase by a factor of 1/0.4 = 2.5.
So the final pressure can be calculated as:
Final pressure = Initial pressure x (Initial volume / Final volume)
Final pressure = 930.2 mmHg x (1 / 0.4)

Final pressure = 2325.5 mmHg
Therefore, the final pressure of the gas is 2325.5 mmHg (rounded to one decimal place).

Answer. 2325.5 mmHg

Question 11. Prolonged heating of ferrous ammonium sulphate is avoided to prevent :

A. Oxidation
B. Reduction
C. Hydrolysis
D. Breaking

Solution. Prolonged heating of ferrous ammonium sulfate is avoided to prevent oxidation.
Ferrous ammonium sulfate is a green crystalline solid that is used as a reducing agent in various chemical reactions. When heated, it can undergo oxidation to form ferric ammonium sulfate. This is because heating provides energy that can be used to overcome the activation energy required for the oxidation reaction to occur.
The oxidation of ferrous ammonium sulfate can be represented by the following chemical equation:
$4FeSO_4.(NH_4)_2SO_4.6H_2O + O_2 \rightarrow 2Fe_2(SO_4)_3.(NH_4)_2SO_4 + 12H_2O$
This reaction is exothermic and releases a large amount of heat. Therefore, prolonged heating can provide the energy required to drive the reaction forward, leading to the formation of ferric ammonium sulfate.
To prevent this oxidation reaction from occurring, prolonged heating of ferrous ammonium sulfate is avoided.

Answer. A

Question 12. Read the following two statements.
Statement I : Potassium dichromate is used in volumetric analysis.

Statement II : $K_2Cr_20_7$ is more soluble in water than $Na_2Cr_20_7$

A. Both statements I and II are correct.
B. Both statements I and II are incorrect.
C. Statement I is correct and II is incorrect
D. Statement I is incorrect and II is correct.

Solution. Potassium dichromate (K2Cr2O7) is commonly used in volumetric analysis as an oxidizing agent, particularly in titrations involving iron(II) salts or hydrogen peroxide. Statement I is therefore correct.
On the other hand, the statement that K2Cr2O7 is more soluble in water than Na2Cr2O7 is incorrect. In fact, the opposite is true: sodium dichromate (Na2Cr2O7) is more soluble in water than potassium dichromate. This is because the smaller size of the sodium ion allows for stronger ion-dipole interactions with water molecules than the larger potassium ion, which results in greater solubility. Therefore, Statement II is incorrect.
Hence, the correct option is Statement I is correct and II is incorrect.

Answer. C

Question 13. The degree of dissociation of monobasic acid is 0.3. By what percent is the observed depression in freezing point greater than the calculated depression in freezing point ?

Solution. The observed depression in freezing point is given by the equation:
$\Delta Tf(obs) = Kf \times m \times i$
where $\Delta Tf(obs)$ is the observed depression in freezing point, Kf is the freezing point depression constant of the solvent, m is the molality of the solution, and i is the van't Hoff factor. For a monobasic acid, the van't Hoff factor is equal to 2 (assuming complete dissociation).
The calculated depression in freezing point is given by the equation:

$\Delta T_f(calc) = K_f \times m$
where $\Delta T_f(calc)$ is the calculated depression in freezing point.
The percent difference between the observed and calculated depressions in freezing point can be calculated as follows:
% difference = $[(\Delta T_f(obs) - \Delta T_f(calc)) / \Delta T_f(calc)] \times 100$
Substituting the values, we get:
% difference = $[(K_f \times m \times i - K_f \times m) / (K_f \times m)] \times 100$
% difference = $[(2 - 1) / 1] \times 100$ (since i = 2 for a monobasic acid)
% difference = 100%
Therefore, the percent difference between the observed and calculated depressions in freezing point is 100%. This means that the observed depression is twice the calculated depression, which is expected since the degree of dissociation is 0.3, indicating that only 30% of the acid molecules dissociate into ions, leading to a lower concentration of solute particles and a smaller depression in freezing point than would be expected for a fully dissociated acid.

Answer. 30

JEE Main 2023 Mathematics Question Paper

Question 1. Find the number of integral values of x which satisfy the inequality $x^2-10x+19<6$.

A. 5
B. 11
C. 7
D. 8

Answer. C

Question 2. 3, 8, 13, ...,373 are in arithmetic series. The sum of numbers not divisible by three is

A. 9310
B. 8340
C. 9525
D. 7325

Answer. 9525

Question 3. Using the number 1, 2, 3 ... 7, total numbers of 7 digit number which does not contain string 154 or 2367 is (Repetition is not allowed)

A. 4897
B. 4898
C. 4896
D. 4899

Answer. B

Question 4. If the coefficient of x^7 in expansion of $(ax- 1/bx/^2)^{13}$ is equal to the coefficient of x^{-5} in expansion of $(ax + 1/bx^2)^{13}$, then a^4b^4 is?

Answer. 22

Question 5. From a square of side 30 cm the squares of side x cm is cut off to make a cuboid of maximum volume. The surface area of cuboid with open top is?

A. 400 cm^2
B. 464 cm^2
C. 800 cm^2
D. 900 cm^2

Answer. C

Question 6. If the number of ways in which a mixed double badminton can be played such that no couples played into a same game is 840. Then find the number of players?

Answer. 16

Question 7. The coefficient of x^7 in $(1 – 2x + x^3)^{10}$ is?

A. 5140
B. 2080
C. 4080
D. 6234

Answer. C

Question 8. The mean of the data

0-10	**10-20**	**20-30**	**30-40**	**40-50**
5	**2**	**5**	**x**	**6**

is 26 , then variance of the data is?

Answer. 815

Question 9. Two dice are rolled and sum of numbers of two dice is N then probability that $2^N < N!$ is m/n , where m and n are co-prime, then 11m – 3n is?

Answer. 85

Question 10. If the order of matrix A is 3 × 3 and |A| = 2, then the value of |3adj (|3A|A2)| is?

A. $3^{10} \cdot 2^{21}$
B. $2^{10} \cdot 3^{21}$
C. $2^{12} \cdot 3^{15}$
D. $3^{12} \cdot 2^{15}$

Answer. B