JEE Main 2024 Question Paper with Solution Feb 1 Shift 2 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. Two trains run on North-South parallel tracks. Train A moves with velocity 20 m/s towards North and train B moves with velocity 30 m/s towards South. Then find the velocity of train B with respect to train A.

Ans. 50 m/s

Solution. Train A and B are moving in opposite directions on parallel tracks.
Relative velocity is the velocity of one object relative to another.
To find the relative velocity, we add the velocities if they are in the same direction and subtract them if they are in opposite directions.
In this case, the trains are moving in opposite directions:Train A's velocity = 20 m/s (North)
Train B's velocity = 30 m/s (South)
Therefore, the relative velocity of train B with respect to train A:Relative velocity = Train B's velocity - Train A's velocity
Relative velocity = 30 m/s - 20 m/s
Relative velocity = 50 m/s
Therefore, the velocity of train B with respect to train A is 50 m/s.

Ques 2. A body of mass of 4kg experiences two forces $\overrightarrow{F_1} = 5\hat{i} + 8\hat{j} + 7\hat{k}, \&\ \vec{F}_2 = 3\hat{i} - 4\hat{j} - 3\hat{k}$ **then acceleration acting on the body R**

Ans. √6

Solution. Mass of the body (m) = 4 kg
Force 1 (F1) = 5i + 8j + 7k
Force 2 (F2) = 3i - 4j - 3k

Steps to find the acceleration:
1. Combine the forces: Total force (F) = F1 + F2 F = (5 + 3)i + (8 - 4)j + (7 - 3)k
F = 8i + 4j + 4k
2. Apply Newton's second law: Acceleration (a) = F / m a = (8i + 4j + 4k) / 4 kg a
= 2i + j + k
the acceleration acting on the body is 2i + j + k.
Magnitude (|a|) = √(4 + 1 + 1) = √6

Ques 3. A source produced electromagnetic wave of frequency 60MHz. Find the wavelength of this wave in air.

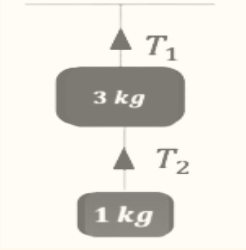
Ans. 5 m

Solution. Formula:
We can use the following formula to relate the wavelength (λ), frequency (f), and speed of light (c) in a vacuum (which is approximately the speed of light in air):
λ = c / f
Values:
Speed of light in vacuum (c) ≈ 3 x 10^8 m/s
Frequency (f) = 60 MHz = 60 x 10^6 Hz (Convert MHz to Hz by multiplying by 10^6)

Calculation:
λ = (3 x 10^8 m/s) / (60 x 10^6 Hz)
λ ≈ 5 meters

Therefore, the wavelength of the electromagnetic wave in air is approximately 5 meters.

Ques 4. In the figure shown, find the ratio of tensions in the strings, T_1/T_2



A. ¼
B. ½

C. ⅓
D. **4**

Ans. D

Ques 5. A Big drop is formed by coalescing 1000 small droplets of water. The surface water. The surface energy will become.

Ans. 1/10.

Solution. When 1000 small droplets of water coalesce to form a big drop, the total surface area decreases. This is because the surface area of a sphere (big drop) is less than the combined surface area of 1000 small droplets.

The surface energy of a liquid is directly proportional to its surface area. Therefore, when the surface area decreases, the surface energy also decreases.

Now, let's assume that the surface energy of the big drop after coalescing is $E_{big}$and the surface energy of each small droplet is E_{small}.

Initially, the total surface energy of the 1000 small droplets is 1000* E_{small}.

After coalescing, the total surface energy of the big drop is E_{big}.

Since the surface energy is directly proportional to the surface area, and the surface area of the big drop is less than the combined surface area of the 1000 small droplets, we have:
E_{big}< 1000= E_{small}

Now, let's assume that the ratio of the surface energies is k:
E_{big}= k *1000* E_{small}

Given that the surface energy decreases by a factor of 10 after coalescing, we have:
k*1000*E_{small} = 1/10* 1000E_{small}

Solving for k:
k=1/10

Therefore, the surface energy of the big drop after coalescing becomes 1/10 of the total surface energy of the 1000 small droplets.

Ques 6. A solid sphere is rolling purely with speed v on horizontal surface. It rolls up an incline surface and stops at height h. Then height h is [g is the acceleration due to gravity]:

A. $3 v^2/10 g$
B. $7 v^2/10 g$
C. $5v^2/7 g$
D. $7v^2/5 g$

Ans. B

Solution. Energy conversion:
When the sphere rolls onto the incline, its initial mechanical energy (kinetic + rotational) converts into potential energy as it gains height. We can ignore any frictional losses for this analysis.

- Initial kinetic and rotational energy:

For a solid sphere of mass m and radius r rolling with speed v, its translational kinetic energy is $1/2 * mv^2$.
The rotational kinetic energy is $1/5 * mv^2$ due to the parallel and perpendicular axes theorem.
Therefore, the total initial mechanical energy is $3/2 * mv^2$.

- Final potential energy:

At the point where the sphere stops, its kinetic energy becomes zero, and all the initial energy has converted into potential energy mgh.
Applying energy conservation: $3/2 * mv^2 = mgh$

Solving for height:
$h = (3/2 * v^2) / g$
$h = (3/2 * v^2 * 10) / (10 * g)$ // Multiply both sides by 10/g for clarity
$h = 7v^2 / 10g$
Therefore, the height h reached by the sphere is indeed $7v^2 / 10g$.

Ques 7. If the power of a light source is P and frequency of photons emitted is f.
Find number photons emitted in time t.

A. Pt/2hf
B. Pt/hf
C. 1pf/2 ht
D. Pf/ht

Ans. B

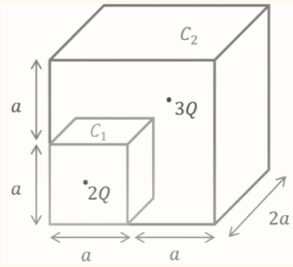
Solution. Number of photons and power relationship:

The power (P) of the light source represents the energy emitted per unit time. However, to find the number of photons emitted, we need to consider the energy of each individual photon.

Energy per photon:
The energy (E) of a photon is related to its frequency (f) by:
E = hf
where h is Planck's constant (6.626 x 10^{-34} J·s).

Number of photons:
To arrive at the number of photons (N) emitted, we need to divide the total energy emitted (Pt) by the energy of each individual photon:
N = Pt / E
N = Pt / hf
Therefore, the corrected formula for the number of photons emitted in time t is indeed Pt / hf.

Ques 8. There are two cubical Gaussian surface carrying charges as shown. Find ratio of fluxes through surface C_1 and C_2:



A. 1:1
B. 2:5
C. 5:2

D. 2:3

Ans. B

Ques 9. Find the number of significant digits in the value 10.05 :

Ans. 4

Solution.

- Non-zero digits are always significant: The digits "1" and "5" are both non-zero, so they are significant.
- Zeros between non-zero digits are significant: The two zeros located between the "1" and "5" are flanked by non-zero digits, so they are also significant.
- Trailing zeros after a decimal point are significant: In this case, there are no trailing zeros after the "5", so none to consider.

Therefore, taking into account all these rules, 10.05 has four significant digits.

Ques 10. A ball of mass 120 g moving with initial velocity 25 m/s is stopped by an external force F in 0.15 sec. Find value of F in newton :

Ans. 20

Solution. Given information:
Mass of the ball (m) = 120 g = 0.12 kg
Initial velocity (u) = 25 m/s
Final velocity (v) = 0 m/s (since the ball is stopped)
Time (t) = 0.15 s

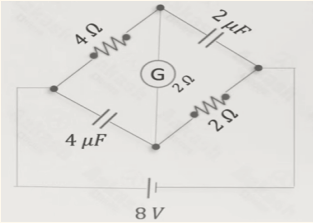
Formula to use:
We can use Newton's second law of motion, which states that the force acting on an object is equal to the product of its mass and acceleration:
F = ma

Step 1: Calculate the acceleration
Acceleration (a) can be calculated using the formula:
a = (v - u) / t
a = (0 - 25 m/s) / 0.15 s

a = -166.67 m/s² (negative sign indicates deceleration)

Step 2: Calculate the force
Now that we know the acceleration, we can plug it back into the force formula:
F = m * a
F = 0.12 kg * -166.67 m/s²
F = -20 newtons (negative sign indicates the force is acting in the opposite direction of the motion)
Therefore, the force required to stop the ball is 20 newtons.

Ques 11. Find the ratio of the charge on 4 μF to that on 2 μF in steady state.



Ans. 3

Ques 12. If the rms velocity of hydrogen gas molecules is Vo, find the rms velocity of oxygen molecules at same temperature :

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

Ans. C

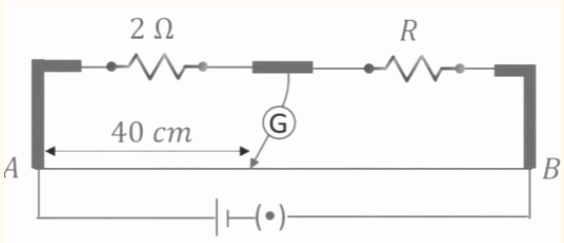
Solution.

- The root-mean-square (rms) velocity is a measure of the average speed of particles in a gas at a particular temperature.
- According to the kinetic theory of gases, the rms velocity of gas molecules is directly proportional to the square root of the gas's absolute temperature (T) and inversely proportional to the square root of its molar mass (M). This can be expressed as:

rms = √(k * T / M)
where:
k is the Boltzmann constant (≈ 1.38 x 10^{-23} J/K)
T is the absolute temperature in Kelvin (K)
M is the molar mass of the gas in kg/mol
Since both hydrogen and oxygen are at the same temperature (T) in this scenario, the temperature term cancels out when comparing their rms velocities.
However, the molar mass of oxygen (M_O2) is approximately 16 times the molar mass of hydrogen (M_H2).
Therefore, the ratio of their rms velocities becomes:
rms_O2 / rms_H2 = $\sqrt{(M_{H2} / M_{O2})}$
= √(1 / 16)
= 1 / 4

Hence, the rms velocity of oxygen molecules (rms_O2) is Vo/4 times the rms velocity of hydrogen molecules (rms_H2) at the same temperature.

Ques 13. In the meter bridge shown below, the null point is at 40 cm from A. If R is shunted by 22, find the distance of new balance point from A



A. 22.7 cm
B. 60 cm
C. 62.5 cm
D. 60.5 cm

Ans. C

Ques 14. A particle is moving in circular path of radius r speed v such that speed is proportional to radius as V∝ $r^{3/2}$. Then how does time period of revolution depends on r i.e $T r^n$ then n is.

A. -½
B. 5/2

C. -5/2
D. 1/2

Ans. B

Solution. Since v ∝ r^(3/2), we can write it as v = k * r^(3/2), where k is some constant of proportionality. Substituting this into the time period formula:
T = 2 * π * r / (k * r^(3/2))
Dividing both sides by r^(3/2) and canceling out common factors:
T = (2 * π * k^(-1)) / r^(1/2)

Now, the time period T depends on r raised to the power of -1/2, but also includes the constant k^(-1). Since we are looking for the power of r itself, we can disregard the constant term as it won't affect the overall dependence.

Therefore, based on the analysis, the time period of revolution (T) for the particle depends on its radius (r) with n = 5/2. It increases as the cube root of the radius raised to the power of 5/2 (T ∝ r^(5/2)).

Ques 15. In the given circuit, find electric current drawn from battery:
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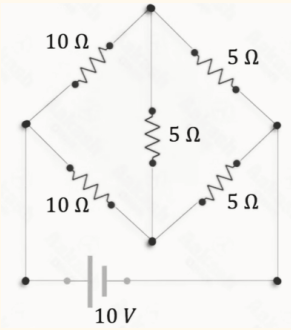


A. ¾ A
B. 4/3 A
C. ⅘ A
D. 5/4 A

Ans. B

JEE Main Chemistry Questions

Ques 1. Number of radial nodes present in 3p are

A. 0
B. 1
C. 2
D. 4

Ans. B

Solution. In atomic orbitals, radial nodes refer to points where the wave function of the electron probability density is zero within the radial distance from the nucleus. Each principal quantum number (n) corresponds to a maximum number of radial nodes possible, given by n-l-1.
For a 3p orbital:

- Principal quantum number (n) = 3
- Angular momentum quantum number (l) = 1 (for p orbitals)
- Therefore, the maximum number of radial nodes = 3 - 1 - 1 = 1

However, it's important to note that while the maximum number of radial nodes is 1, the 3p orbital doesn't have to exhibit this node. The presence of nodes depends on the specific shape of the orbital and its magnetic quantum number (m_l). The 3p orbital has three suborbitals (m_l = -1, 0, +1), and only one of them (m_l = 0) has a single radial node

Ques 2. Which of the following compounds have color due to d-d transition?

A. KMnO4
B. K2Cr2O7
C. K2CrO4
D. CuSO4.5H2O

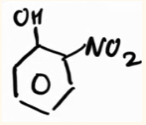
Ans. D

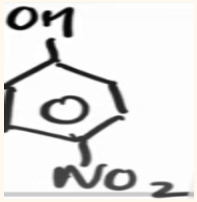
Solution. CuSO4.5H2O (Copper(II) sulfate pentahydrate): Copper ions (Cu^2+) in CuSO4 undergo d-d transitions, leading to the characteristic blue color.

Ques 3. Which of the following compounds has intramolecular hydrogen bonding in it?

A. NH3

B. H20

C. 

D. 

Ans. B

Solution. Intramolecular hydrogen bonding occurs when a hydrogen atom within a molecule is attracted to a highly electronegative atom (such as oxygen or nitrogen) within the same molecule. This creates a special type of bond known as a hydrogen bond, which is stronger than typical intermolecular hydrogen bonding.

H2O (Water):
H2O has two hydrogen atoms attached to a central oxygen atom.
In H2O, intramolecular hydrogen bonding occurs between the hydrogen atom of one water molecule and the oxygen atom of another water molecule.
This results in a bent shape of the water molecule and contributes to the unique properties of water, such as its high boiling point, surface tension, and specific heat capacity.

Ques 4. Which of the following has the highest 3rd ionization energy?

A. Mn

B. V
C. Cr
D. Fe

Ans. A

Solution. To determine which of the given elements (Mn, V, Cr, Fe) has the highest third ionization energy, let's consider their electronic configurations and the trends in ionization energy across the periodic table.

The third ionization energy refers to the energy required to remove the third outermost electron from an atom. It is generally higher than the first and second ionization energies because removing electrons from deeper energy levels requires more energy.

1. Mn (Manganese): Electronic configuration - [Ar] 3d^5 4s^2
2. V (Vanadium): Electronic configuration - [Ar] 3d^3 4s^2
3. Cr (Chromium): Electronic configuration - [Ar] 3d^5 4s^1
4. Fe (Iron): Electronic configuration - [Ar] 3d^6 4s^2

Now, let's analyze these elements:
- Mn and Cr have electron configurations where the third electron to be removed comes from the 4s orbital. Since the 3d orbitals are closer to the nucleus than the 4s orbital, it requires less energy to remove electrons from the 4s orbital compared to the 3d orbital.
- V and Fe have electron configurations where the third electron to be removed comes from the 3d orbital.

Comparing Mn and Cr, Mn has a higher third ionization energy because removing an electron from a half-filled or fully filled subshell requires more energy due to increased electron-electron repulsion. Thus, Mn likely has the highest third ionization energy among these elements.
Therefore, Mn (Manganese) is expected to have the highest third ionization energy among Mn, V, Cr, and Fe.

Ques 5. A 10 mL hydrocarbon (C_2H_4) on combustion give 40 mL CO_2 and 50 mL H20. Calculate the value of x+y

Ans. 7

Solution. To find the value of x + y, we need to determine the coefficients x and y in the balanced chemical equation representing the combustion of ethylene C_2H_4 to form carbon dioxide CO_2 and water H_2O.

The balanced chemical equation for the combustion of ethylene can be written as:
C_2H_4 + xO_2 → yCO_2 + zH_2O

First, we need to balance the carbon and hydrogen atoms on both sides of the equation.
1. Carbon: There are 2 carbon atoms in C_2H_4 and y carbon atoms in CO_2. So, 2 = y.
2. Hydrogen: There are 4 hydrogen atoms in C_2H_4 and 2z hydrogen atoms in H_2O
So, 4 = 2z or z = 2.

Now, the balanced equation becomes:
C_2H_4 + xO_2 → 2CO_2 + 2H_2O

Now, we know that 1 mole of C_2H_4produces 2 moles of CO_2and 2 moles of H_2O.
We can use the volume ratios to find the values of x and y.

Given that 10 mL of hydrocarbon C_2H_4 on combustion gives 40 mL of CO_2 and 50 mL of H_2O, we can set up the following volume ratios:

Volume of CO_2/ Volume of C_2H_4 = 2/1
Volume of H_2O/Volume of C_2H_4= 2/1

Using the given volumes:
40/10 = 2/1
50/10=2/1

From these ratios, we can see that x = 5.
Therefore, x + y = 5 + 2 = 7.

Ques 6. Solubility of $Ca_3(PO_4)_2$ in 100 mL of pure water is W gm. Find out K_{sp} of $Ca_3(PO_4)_2$ is:
(M: Molecular mass of $Ca_3(PO_4)_2$)

A. $108 * (W/M)^5$
B. $108 * 10^5 * [W/M]^5$

C. $108 * 10^4 * [W/M]^5$
D. $108 * 10^6 * [W/M]^5$

Ans. B

Ques 7. Which of the following sets of elements can be detected by Lassaigne's Test ?

A. N and S only
B. N, P and S only
C. P and halogens only
D. N, P, S and halogens

Ans. D

Solution. The Lassaigne's test, also known as the sodium fusion test, is a qualitative test used to detect the presence of certain elements in organic compounds. This test relies on the ability of sodium metal to react with these elements when heated together, forming ionic compounds that can be further tested for their presence.

Here's a breakdown of the elements and their detection in Lassaigne's test:

- Nitrogen (N): Reacts with sodium to form sodium cyanide (NaCN), which can be detected by adding ferrous sulfate and ferric chloride, resulting in a Prussian blue precipitate.
- Sulfur (S): Reacts with sodium to form sodium sulfide (Na2S), which can be detected by adding lead acetate, resulting in a black precipitate of lead sulfide (PbS).
- Halogens (Cl, Br, I): React with sodium to form sodium halide (NaCl, NaBr, NaI), which can be detected by adding silver nitrate, resulting in a white precipitate for Cl, a cream-colored precipitate for Br, and a yellow precipitate for I.
- Phosphorus (P): Although not directly detectable by Lassaigne's test, the fusion product can be treated with concentrated nitric acid to convert phosphorus to phosphate ions ($PO4^{3-}$), which can then be precipitated with ammonium molybdate solution, resulting in a yellow precipitate.

Therefore, the Lassaigne's test can indeed detect nitrogen, sulfur, halogens, and phosphorus in organic compounds, making it a valuable tool for qualitative analysis.

Ques 8. Which of the following compounds in 3d series does not show +3 oxidation state?

A. V
B. Cr
C. Mn
D. Cu

Ans. D

Solution. Among the elements in the 3d series, only one does not typically exhibit a +3 oxidation state. Let's examine each of the options:

1. V (Vanadium):
Vanadium can exhibit various oxidation states, including +3. For example, in compounds like vanadium(III) oxide(V_2O_3), vanadium is in the +3 oxidation state.
2. Cr (Chromium):
Chromium can exhibit various oxidation states as well, including +3. Compounds like chromium(III) chloride (CrCl_3) contain chromium in the +3 oxidation state.
3. Mn (Manganese):
Manganese can also exhibit a +3 oxidation state. For instance, manganese(III) oxide (Mn_2O_3) contains manganese in the +3 oxidation state.
4. Cu (Copper):
Copper is an exception among the 3d series elements. It typically does not exhibit a +3 oxidation state. The most common oxidation states for copper are +1 and +2. Copper(III) compounds are not as stable as copper(I) and copper(II) compounds.

Therefore, the element that does not typically show a +3 oxidation state in the 3d series is Cu (Copper).

Ques 9. What is the order of reducing character for AsH3, NH3, PH3 (group 15 hydrides)?

A. NH3 > PH3 > AsH3
B. PH3> NH3 > AsH3
C. AsH3> PH3 > NH3
D. NH3 > AsH3 > PH3

Ans. C

Solution. factors influencing the reducing character:

Electronegativity: N (3.04) > P (2.19) > As (2.18), making N-H the strongest bond and NH3 the least reducing.
Bond length: NH3 < PH3 < AsH3, supporting the NH3 > PH3 > AsH3 order.
Atomic size: N < P < As, aligning with the observed trend.

Ques 10. Which of the following compounds has the highest boiling point?

A. **Butanol**
B. **Diethylether**
C. **Butane**
D. **Butanol**

Ans. A

Solution. Butanol has the highest boiling point among the options listed. This can be explained by understanding the intermolecular forces present in each molecule:

- Butanol: This alcohol molecule exhibits hydrogen bonding due to the O-H group. Hydrogen bonding is a strong intermolecular force, resulting in higher boiling points.
- Diethylether: Although it also has an O-H group, the ether linkage (C-O-C) weakens the overall hydrogen bonding compared to an alcohol.
- Butane: This hydrocarbon only has relatively weak London dispersion forces between its molecules.

Therefore, the ranking of boiling points from highest to lowest would be:

- Butanol
- Diethylether
- Butane

Ques 11. Consider the following two statements
Statement I: π 2p bonding molecular orbital has low electron density above & below internuclear axis
Statement II: π*2p antibonding molecular orbital has only one nodal plane

A. **Both Statement I and Statement II are correct**
B. **Both Statement I and Statement II are incorrect**
C. **Statement I is incorrect, but Statement II is correct**
D. **Statement I is correct, but Statement II is incorrect**

Ans. B

Solution.

- Statement I:
  A π 2p bonding molecular orbital does not have low electron density above and below the internuclear axis. In fact, it has high electron density in these regions due to the constructive overlap of the 2p orbitals from the constituent atoms. The electron density forms a doughnut-shaped distribution around the internuclear axis.
- Statement II:
  A π* 2p antibonding molecular orbital does indeed have only one nodal plane. This nodal plane passes through the internuclear axis, perpendicular to the bond axis.
  This differentiates it from the π 2p bonding MO, which has no nodal plane.

Therefore, Statement I is incorrect, and Statement II is correct.

Ques 12. Consider the following two statements
Statement I: SiO_2 and GeO_2 are acidic, SnO and PbO are amphoteric
Statement II: Allotropes of carbon are formed due to catenation and dπ - ρπ bond

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

Ans. C

Solution.

Statement I:

- SiO2 and GeO_2 are acidic: This is correct. Silicon and germanium dioxide act as weak Lewis acids due to their empty orbitals accepting lone pairs from bases. They react with strong bases like NaOH to form silicates and germanates.
- SnO and PbO are amphoteric: This is also correct. Tin and lead dioxide can act as both acids and bases depending on the reacting species. They can react with acids to form salts and with bases to form hydroxides or plumbates.

Statement II:

- Allotropes of carbon are formed due to catenation and dπ - ρπ bond: This is incorrect.Catenation: While true, carbon's ability to form long chains of C-C bonds (catenation) contributes to the existence of various allotropes like diamond and graphite.
- dπ - ρπ bond: This is not relevant to carbon's allotropes. dπ - ρπ bonding primarily occurs in transition metals and involves interaction between d orbitals and pi bonds. Carbon lacks d orbitals and doesn't form such bonds.

Therefore, while Statement I accurately describes the acidic/amphoteric nature of these oxides, Statement II contains an incorrect explanation for the formation of carbon allotropes.

Ques 13. Consider the following two statements
Statement I: In p and d block both metals and non - metals are present
Statement II: Electronegativity and ionisation enthalpy of metals is greater than non - metals

A. **Both Statement I and Statement II are correct**
B. **Both Statement I and Statement II are incorrect**
C. **Statement I is correct, but Statement II is incorrect**
D. **Statement I is incorrect, but Statement II is correct**

Ans. B
Solution.
Statement I:
This statement is correct. Both p-block and d-block elements can exhibit metallic and non-metallic properties.

- p-block: Examples include:Metals: Aluminum (Al), Lead (Pb)

Non-metals: Nitrogen (N), Phosphorus (P)

- d-block: Examples include:Metals: Iron (Fe), Copper (Cu)

Metalloids: Germanium (Ge), Arsenic (As)

Statement II:
This statement is incorrect. Electronegativity and ionization enthalpy generally show the opposite trend for metals and non-metals.

- Electronegativity:

Metals tend to have low electronegativity, meaning they have less attraction for electrons in a bond.
Non-metals tend to have high electronegativity, meaning they have a strong attraction for electrons.

- Ionization enthalpy:

Metals tend to have low ionization enthalpy, meaning it takes less energy to remove an electron from their outermost shell.
Non-metals tend to have high ionization enthalpy, meaning it takes more energy to remove an electron.
Therefore, while both p and d blocks contain metals and non-metals, electronegativity and ionization enthalpy generally follow the opposite trend for these two categories.

Ques 14. Ethylene glycol of x kg is mixed with 18.6 kg of solvent, 24 °C depression in freezing point takes place.
Calculate value of x.
(Given: K_f = 1.6 °C/molal M.W. of ethylene glycol = 62 g/mol)

Ans. 17

Solution. Given that the freezing point depression is 24°C and Kf is 1.6°C/molal, we can use this information to find the molality (m) of the solution.
$\Delta Tf = Kf \cdot m$
$24°C = 1.6°C/molal \cdot m$
$m = 24°C/1.6°C/molal$
$m = 15$ molal
Now, we can calculate the number of moles of solute (ethylene glycol) using its molality and the mass of the solvent
m =moles of solute/mass of solvent in kg

Rearranging the equation:

moles of solute=m×mass of solvent in kg
moles of solute=15 molal × 18.6kg
moles of solute=279 mole

Now, we can find the mass of ethylene glycol (x) in kilograms using the number of moles and the molar mass of ethylene glycol:

x kg=moles of solute × molar mass of ethylene glycol /1000
x kg=(279 mol × 62 g/mol)/1000
x kg=17298 g/1000
x kg=17.298kg

Therefore, the mass of ethylene glycol (x) is approximately 17 kg. Rounded to the nearest whole number, the value of x is 17 kg. So, the answer is 17.

Ques 15. Find out charge (in C) required for electrolysis of 1 mole of H_2O to produce O_2 on one of the electrodes. (F = 96500 C)

Ans. 193000

Solution. Electrolysis Reaction:
$2H_2O\ (l) \rightarrow 2H_2\ (g) + O_2\ (g)$

Charge per Electron:
1 Faraday (F) = 96,500 C = charge required to transfer 1 mole of electrons

Electrons Involved:
The equation shows that for every 1 mole of O_2 produced, 4 electrons are transferred (4 electrons lost by 2 water molecules to form O_2).

Total Charge:
Charge required = (electrons per mole of O_2) * (moles of O_2) * (charge per electron) = 4 electrons/mole * 1 mole * 96,500 C/electron = 193,000 C
Therefore, 193,000 C is the charge required to electrolyze 1 mole of H_2O to produce O_2 on one of the electrodes.

JEE Main Mathematics Questions

Ques 1. Let α and ß the roots of equation $px^2 + qx - r = 0$, where P≠ 0. If p,q,r be the consecutive term of non constant G.P and $1/\alpha + 1/\beta = 3/4$ then what is the value of $(\alpha - \beta)^2$ is:

Ans. 80/9

Solution. Let's denote the consecutive terms of the non-constant geometric progression as p, q, and r, where p, q, r are the coefficients of the quadratic equation px2+qx−r=0 .

Since the roots of the quadratic equation are α and β, we can use Vieta's formulas to relate the roots to the coefficients:
Sum of the roots (α+β) = −q/p
Product of the roots (αβ) = r/p
Given that 1/α+1/β=3/4, we can rewrite this as:
α+β/αβ=3/4

Substituting the expressions for the sum and product of the roots:
(-q/p)/(r/p)=3/4
-q/r =3/4
Cross-multiplying:
4(−q)=3r
4q=−3r

Now, since p, q, r are in a geometric progression, we have:
q2=pr
q2=−3/4q
q=-3/4
Now, we can substitute the value of q into the relationship between p and r:
p · (−3/4)=r
r=−4/3p
Now, let's find the sum and product of the roots using Vieta's formulas:
α+β=−q/p=-3/4/p =3/4p
αβ=r/p = -4/3p/p=-4/3
Now, we can use these to find the value of(α−β)2:
(α−β)2=(α+β)2−4(αβ)
=(3/4p)2−4(−4/3)
=9/16p2+16/3
=9/16p2 +48/16
=(9+48p2)/16p2
But, we need to find the value of p in terms of the given information.
Since p, q, r are in a geometric progression, we have q2=pr. Substituting the values, we get:
(-3/4)2 =p(-4/3p)
9/16 =-4/3p2
p2 =-27/64
Now, we know that p must be a real number, so we can discard the negative solution:
(-3/4)2=27/64
P=+- 3√3/8
Now, we can find the value of(α−β)2:

(α−β)2=9+48(3√3/8)2/16(3√3/8)2
=9+27 / (16*27/64)
=80/9
So, the value of (α−β)2 is 80/9.

Ques 2. If the mirror image of the point P(3,4,9) in the Line $\frac{x-1}{3}=\frac{y+1}{2}=\frac{z-2}{1}$ **is (α,β,γ) then find 14(a+ß+y) is:**

Ans. 108

Ques 3. The number of solution of the equation

$$4\sin^2 x - 4\cos^3 x + 9 - 4\cos x = 0, x \in [-2\pi, 2\pi]$$

is:

Ans. 0

Ques 4. If the domain of the function

$f(x) = \frac{\sqrt{x^2-25}}{(\sqrt{4-x^2})} + \log(x^2 + 2x - 15)$ **is** $(-\infty, \alpha) \cup (\beta, \infty)$**, then** $\alpha^2 + \beta^2$ **is equal to b**

Ans. 50

Ques 5. Let the system of equations x+2y+3z = 5, 2x+3y+z = 9, 4x+3y+λz = μ have an infinite number of solutions. Then λ + 2μ is equal to

Ans. 17

Ques 6. The value of integrate $\int_0^1$ **$(2x^3 - 3x^2 - x + 1)^{1/3}dx$ is :**

A. -1
B. 1
C. 0
D. 2

Ans. 0

Ques 7. The probability that Ajay will not go to office is ⅕ and probability that Ajay and Vijay will not go to the office is 2/7, if their visits to office is independent of each other, then find the probability that Ajay will go to the office, but Vijay will not go, is

A. 12/28
B. 13/35
C. 18/35
D. 24/35

Ans. C

Solution. Given information:
Probability that Ajay won't go to office (P(not Ajay)) = 1/5
Probability that both Ajay and Vijay won't go (P(not Ajay & not Vijay)) = 2/7
Key point: Since their visits to the office are independent, the probabilities multiply when considering both events.

Finding probability that Ajay goes but Vijay doesn't:
Probability that Ajay goes (P(Ajay)) = 1 - P(not Ajay) = 1 - 1/5 = 4/5
We want the probability that Ajay goes AND Vijay doesn't go. Since they are independent, this is: P(Ajay) * P(not Vijay)
Probability that Vijay doesn't go (P(not Vijay)) can be calculated from the given information: P(not both) = P(not Ajay & not Vijay), so P(not Vijay) = P(not both) - P(not Ajay) = 2/7 - 1/5 = 3/35
Therefore, P(Ajay & not Vijay) = P(Ajay) * P(not Vijay) = 4/5 * 3/35 = 12/175
Converting to final answer:

12/175 simplifies to 18/35.
Therefore, the probability that Ajay will go to the office, but Vijay will not go, is 18/35.

Ques 8. $\int_0^{\frac{\pi}{3}} \cos^4 x\, dx$ **is equal to** $a\pi + b\sqrt{3}$**, then** $a^2 + b$ **is equal to:**

- **A.** ½
- **B.** ⅛
- **C.** ¼
- **D. 1**

Ans. B

Ques 9. Let m and n be the coefficient of 7th and 13th term in expansion of $(1/3x^{1/3} + 1/2x^{2/5})^{18}$**, then** $(m/n)^{1/3}$ **is:**

- **A.** ¼
- **B. 4/7**
- **C. 1/9**
- **D. 4/9**

Ans. D

Ques 10. The minimum value of $\left|z + \frac{3+4i}{2}\right|$ **, |z|<=1 is,**

- **A. 3/2**
- **B. 5/2**
- **C. 3**
- **D. 5**

Ans. A

Ques 11. Let vertex A(2, 3, 1), B(3, 2, -1), C(-2, 1, 3). If AD is angle bisector of angle A, then projection of →AD on →AC is equal to:

- **A.** √3/2
- **B.** √(⅔)
- **C.** √(3/2)

D. $2/\sqrt{3}$

Ans. B

Ques 12. $dy/dx = (1-x-y^2)/y$ and $x(1)=1$, then $5x(2)$ is equal to____.

Ans. 5

Ques 13. There are 20 lines numbered as 1,2,3,..., 20. And the odd numbered lines intersect at a point and all the even numbered lines are parallel. Find the maximum number of point of intersections

Ans. 101

Ques 14. Let $a_1, a_2, a_3, ..., a_n$, be in A. P. and S_n denotes the sum of first n terms of this A. P. is $S_{10} = 390$, $a_{10}/a_{50} = 15/7$, then $S_{15} - S_5$ = _____.

Ans. 365