JEE Main 2023 Question Paper Solution

Date & Shift: April 8 Shift 1   **Memory-Based Questions**

JEE Main 2023 Physics Question Paper

Question 1. For an electron and a proton (m_p = 1847 m_e) with same de-broglie wavelength , the ratio of linear momentum is equal to?

A. 1:2
B. 2:1847
C. 1:1
D. $\sqrt{1847}$: 1

Solution.
The de Broglie wavelength is given by λ = h/p, where h is the Planck's constant and p is the momentum. Since the de Broglie wavelength is the same for both the electron and the proton, we can equate their respective momentum as:
p_electron = h/λ

p_proton = h/λ

Now, we can find the ratio of their linear momentum:

p_proton/p_electron = (h/λ)/(h/λ) = 1/1 = 1:1

Therefore, the ratio of linear momentum between the electron and the proton is 1:1.

Answer. C

Question 2. Two forces of magnitude A and A/2 act perpendicular to each other. The magnitude of the resultant force is equal to:

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

Solution.
We can use the Pythagorean theorem and the formula for the magnitude of the resultant force of two perpendicular forces to solve this problem.

According to the Pythagorean theorem, the square of the hypotenuse (i.e., the magnitude of the resultant force) of a right triangle is equal to the sum of the squares of the other two sides (i.e., the magnitudes of the two perpendicular forces). Therefore, we have:

Resultant force squared = A^2 + (A/2)^2
Resultant force squared = 5A^2/4

Resultant force = √(5A^2/4) = √5/2 * A

According to the formula for the magnitude of the resultant force of two perpendicular forces, the magnitude of the resultant force is equal to the square root of the sum of the squares of the magnitudes of the two perpendicular forces. Therefore, we have:

Resultant force = $\sqrt{(A^2 + (A/2)^2)}$

Resultant force = $\sqrt{(5A^2/4)} = \sqrt{5}/2 * A$

Thus, the magnitude of the resultant force is $\sqrt{5}/2 * A$. Therefore, the answer is B. $\sqrt{5} A / 2$.

Answer. B

Question 3. **If the weight of an object on earth's surface is 400 N, then weight of the same particle at a depth R/2 from surface would be (R is radius of earth)**

    A. 100 N
    B. 300 N
    C. 200 N
    D. 250 N

Answer. C

Question 4. Two projectiles u1 and u2, with speed of 40 m/s and 60 m/s respectively are thrown at a certain angle, u1 with 30° and u2 with 60°, what is the ratio of range?

Solution.

The horizontal range of a projectile depends on its initial speed and the angle at which it is launched. The formula for the range R of a projectile launched at an angle θ with an initial speed u is:

$$R = u^2 \sin(2\theta) / g$$

where g is the acceleration due to gravity.

For the first projectile, $u_1 = 40$ m/s and $\theta_1 = 30$ degrees. Therefore, the range R_1 of the first projectile is:

$$R_1 = (40 \text{ m/s})^2 \sin(2*30°) / g = 80 \text{ m}$$

For the second projectile, $u_2 = 60$ m/s and $\theta_2 = 60$ degrees. Therefore, the range R_2 of the second projectile is:

$$R_2 = (60 \text{ m/s})^2 \sin(2*60°) / g = 180 \text{ m}$$

The ratio of the ranges is:

$$R_2 / R_1 = 180 \text{ m} / 80 \text{ m} = 9/4$$

Therefore, the ratio of the ranges of the two projectiles is 9:4.

Answer. 9/4

Question 5. An air bubble having volume 1 cm³ at depth 40 m inside water comes to the surface. What will be the volume of the bubble at the surface?

   A. 5 cm³
   B. 2 cm³
   C. 4 cm³
   D. 3 cm³

Answer. A

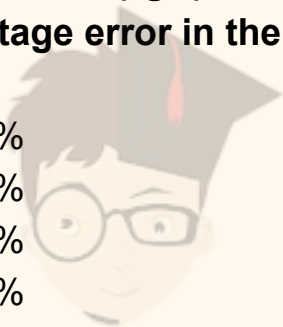**Question 6. The height of the antenna is 98 m. The radius of Earth is 6400 km. The area up to which it will transmit signal is:**

    A. 3642 km²
    B. 3942 km²
    C. 11200 km²
    D. 22400 km²

Answer. B

Question 7. If mass, radius of cross-section and height of a cylinder are (0.4 + 0.01) g, (6 + 0.03) m and height (8 + 0.04) m. The maximum percentage error in the measurement of density of cylinder is?

    A. 1%
    B. 4%
    C. 8%
    D. 7%

Answer. B

Question 8. If the velocity of a charged particle has the component both in and perpendicular to the direction of the magnetic field then the path traced by the charged particle will be?

    A. Circular
    B. Straight line
    C. Cycloid
    D. Helical

Solution.

The path traced by a charged particle with a velocity component both parallel and perpendicular to a magnetic field will be helical.

When a charged particle moves in a magnetic field, it experiences a magnetic force that is perpendicular to both the direction of motion and the direction of the magnetic field. The force causes the particle to move in a circular path, with the radius of the circle depending on the velocity and the strength of the magnetic field.

However, if the charged particle has a component of velocity parallel to the magnetic field, then it will move along the magnetic field lines. This component of motion will cause the circular motion to become helical, resulting in a path that looks like a corkscrew.

So, if a charged particle has both perpendicular and parallel components of velocity with respect to a magnetic field, the resulting path will be helical

Answer. D

Question 9. Two different lenses are used in telescope because

- A. Magnification is increased
- B. Focal length is increased
- C. More light is captured
- D. Spherical aberration is increased

Solution.
Two different lenses are used in a telescope to increase the effective focal length of the system while maintaining a reasonable level of image quality. The objective lens, or primary lens, is typically a large lens with a long focal length that captures light from a distant object and forms a real image. The eyepiece lens, or secondary lens, is a smaller lens placed near the focal point of the objective lens and is used to magnify the real image formed by the objective lens.

By using two lenses, the effective focal length of the telescope is increased, allowing for greater magnification of distant objects. This also enables the observer to see finer details of the object being observed. Additionally, using two lenses reduces spherical aberration, which can occur when using a single lens with a large aperture, leading to a clearer and more detailed image.

Answer. A

Question 10. A train is moving with a speed of 10 m/s towards a platform and blows a horn with frequency 400 Hz. Find the frequency heard by a passenger standing on the platform. Take speed of sound = 310 m/s.

A. 405 Hz
B. 425 Hz
C. 380 Hz
D. 413 Hz

Solution.
The frequency heard by the passenger on the platform will be different from the actual frequency of the horn due to the Doppler effect, which is the change in frequency of a wave in relation to an observer who is moving relative to the source of the wave.

The formula for the frequency observed due to Doppler effect is:

$$f' = f (v + u) / (v + vs)$$

Where:
f = actual frequency of the horn
f' = frequency observed by the passenger

v = speed of sound

u = speed of the train towards the platform

vs = speed of the passenger towards the train (assumed to be zero in this case)

Given,

actual frequency of horn, f = 400 Hz

speed of sound, v = 310 m/s

speed of train, u = 10 m/s

speed of the passenger towards the train, vs = 0

Substituting these values in the formula, we get:

f' = 400 (310 + 10) / (310 + 0)

f' = 413 Hz (approx)

Therefore, the frequency heard by the passenger on the platform is 413 Hz (Option D).

Answer. D

JEE Main 2023 Chemistry Question Paper

Question 1. Xef_4 + Sbf_5 → $[XeFm]^{+n}$ $[SbFp]^{q-}$. Find the value of m + n + p+ qũ?

Answer. 11

Question 2. Extraction of which one of the following metals involves concentration of the ore by leaching?

A. Copper
B. Magnesium
C. Aluminum
D. Potassium

Answer. C

Question 3. How many factors will contribute to a major role in covalent character of a compound.

A. Polarising power of cation
B. Polarisability of the anion
C. Distortion caused by catio
D. Polarisability of cation

Solution.
All of the factors you listed can contribute to the covalent character of a compound. The extent to which each factor contributes depends on the specific compound and its chemical properties.

The polarising power of a cation refers to its ability to pull electron density towards itself, which can result in partial covalent bonding between the cation and the anion. Similarly, the polarisability of an anion refers to its ability to be distorted by an oppositely charged ion, which can lead to partial covalent bonding.

The distortion caused by a cation also contributes to covalent character, as it can lead to the formation of partial covalent bonds between the cation and anion.

Finally, the polarisability of a cation can also play a role in covalent character, as a highly polarisable cation can form partial covalent bonds with the anion due to the distortion it causes in the anion.

Therefore, all of these factors can contribute to the covalent character of a compound, and their relative importance depends on the specific compound and its chemical properties.

Answer. A, B, C

Question 4. Consider the reaction $Cu^{2+} + X^- \rightarrow Cu_2X_2 + X_2$
X_2 will be predominantly ?

    A. Cl_2
    B. Br_2
    C. I_2
    D. All halogens are possible

Answer. C

Question 5. Read the following two statements
Statement I: Ionic radius of Li^+ is greater than Mg^{++}
Statement II: Lithium and magnesium can't form superoxide

    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.

Answer. A

Question 6. Which of the following elements is most reactive?

    A. Ca
    B. Mg

C. Sr

D. K

Solution.

Out of the given options, potassium (K) is the most reactive element. Potassium is a highly reactive alkali metal, while calcium (Ca), magnesium (Mg), and strontium (Sr) are also reactive metals but less so than potassium. Reactivity generally increases as you move down a group in the periodic table, so potassium, which is located in group 1, is more reactive than the other elements listed.

Answer. D

Question 7. Select the correct order of electronegativity of the elements : B, C, At, S

A. B > C > S > At

B. S > C > B > At

C. C > B > S > At

D. S > C > At > B

Answer. D

Question 8. 0.5 gm of an organic compound with 60%. Carbon produce _____ gm of CO2 upon complete combustion

Solution.

To solve this problem, we need to use the stoichiometry of the combustion reaction between the organic compound and oxygen. The balanced chemical equation for the combustion of organic compounds with carbon and hydrogen can be written as:

$$C_xH_y + (x + y/4) \, O_2 \rightarrow x \, CO_2 + y/2 \, H_2O$$
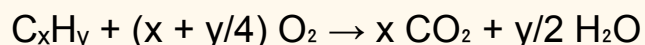
where C_xH_y is the organic compound, x and y are the coefficients for carbon and hydrogen, respectively.

Since the organic compound contains 60% carbon, we can assume that it is a hydrocarbon with only carbon and hydrogen atoms. Therefore, we can write:

The molar mass of the organic compound = 12x + 1y grams/mol
The mass of carbon in the organic compound = 0.5 gm x 60% = 0.3 gm
The number of moles of carbon in the organic compound = 0.3 gm ÷ 12 gm/mol = 0.025 mol
According to the balanced equation, 1 mole of carbon produces 1 mole of CO_2 upon complete combustion
Therefore, 0.025 mol of carbon produces 0.025 mol of CO_2
The molar mass of CO_2 is 12 + 2x16 = 44 gm/mol
Therefore, the mass of CO_2 produced = 0.025 mol x 44 gm/mol = 1.1 gm
Therefore, 0.5 gm of the organic compound with 60% carbon produces 1.1 gm of CO_2 upon complete combustion.

Answer. 1.10

Question 9. How many of the following -amino acids contain sulphur?
Lysine ; Methionine; Glutamic acid; Threonine
Arginine; Cysteine; Tyrosine; Isoleucine

Answer. 2 (Methionine and Cysteine)

Question 10. How many statements are correct:

A. If there is no relation between rate constant and temperature, then activation energy is negative.
B. If the activation energy is zero, the rate constant is temperature independent.

C. If rate constant increases with increase of temperature, activation energy is positive

D. If rate constant decreases with increase in temperature, activation energy is negative.

Answer. 3 (B,C,D)

JEE Main 2023 Mathematics Question Paper

Question 1. Consider the word INDEPENDENCE. The number of words such that all the vowels are together is?

    A. 16800
    B. 15800
    C. 17900
    D. 14800

Answer. A

Question 2. Shortest distance between lines $(x - 5) / 4 = (y - 3) / 6 = (z - 2) / 4$ and $(x - 3) / 7 = (y - 2) / 5 = (z - 9) / 6$ is ?

    A. 190/37
    B. 190/√756
    C. 37/190
    D. 756/√190

Solution.
To find the shortest distance between two skew lines, we can use the vector projection method. Here's how:

Let the first line be L1 and the second line be L2.

L1: (x - 5) / 4 = (y - 3) / 6 = (z - 2) / 4
L2: (x - 3) / 7 = (y - 2) / 5 = (z - 9) / 6

Let A and B be any two points on L1, and let C and D be any two points on L2. Then, the vector connecting A to B is parallel to L1, and the vector connecting C to D is parallel to L2.

Let's first find the direction vectors of L1 and L2:

L1 direction vector: <4, 6, 4>
L2 direction vector: <7, 5, 6>

Next, let's choose two points on L1 and L2, respectively. For simplicity, we can choose the points where all three parameters are 0.

A = (5, 3, 2)
B = (9, 9, 6)
C = (3, 2, 9)
D = (10, 7, 15)

Now, let's find the vector connecting A to B and the vector connecting C to D.

AB = <9 - 5, 9 - 3, 6 - 2> = <4, 6, 4>
CD = <10 - 3, 7 - 2, 15 - 9> = <7, 5, 6>

To find the shortest distance between L1 and L2, we need to find the component of AB that is perpendicular to CD. We can do this using vector projection:

proj_CD(AB) = (AB . CD_unit) * CD_unit
where CD_unit is the unit vector in the direction of CD, given by:
CD_unit = CD / ||CD||
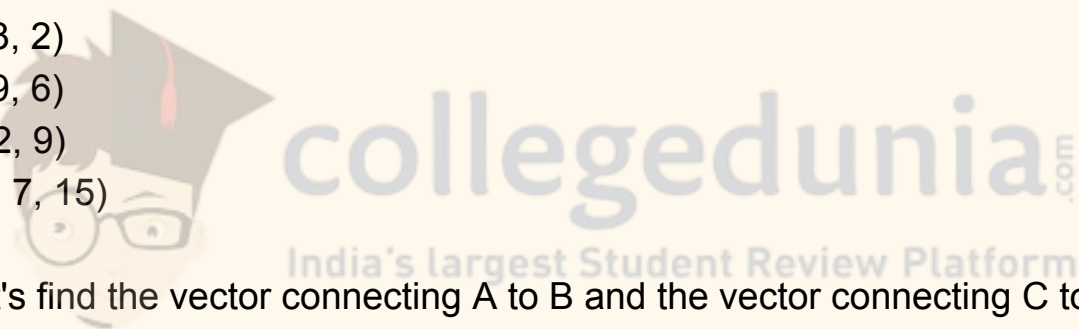
First, let's find ||CD||:
||CD|| = sqrt(7^2 + 5^2 + 6^2) = sqrt(110)

Next, let's find CD_unit:

CD_unit = CD / ||CD|| = <7/sqrt(110), 5/sqrt(110), 6/sqrt(110)>

Now, let's find the dot product AB . CD_unit:

AB . CD_unit = 47/sqrt(110) + 65/sqrt(110) + 4*6/sqrt(110) = 58/sqrt(110)

Finally, let's find the vector projection proj_CD(AB):

proj_CD(AB) = (AB . CD_unit) * CD_unit = (58/sqrt(110)) * <7/sqrt(110), 5/sqrt(110), 6/sqrt(110)> = <406/110, 290/110, 348/110>

The length of proj_CD(AB) gives us the shortest distance between L1 and L2:

||proj_CD(AB)|| = sqrt((406/110)^2 + (290/110)^2 + (348/110)^2) = 190/sqrt(756) = 10sqrt(190)/9

Therefore, the answer is 190/√756.

Answer. B

Question 3. 7 boys and 5 girls are to be seated around a circular table such that no two girls sit together is ?

   A. 126(5!)^2
   B. 720(5!)
   C. 720(6!)
   D. 720

Solution.

First, we need to find the total number of ways to seat all 12 people around the circular table, which is (12-1)! = 11! since we can fix one person's position as a reference.

Next, we need to subtract the number of ways that two or more girls sit together. We can approach this by treating the five girls as a block and permuting them first, which can be done in 5! ways. Then we can insert this block of girls in the 8 spaces between the 7 boys or at the beginning or end of the line of boys, which gives us 9 positions to place the block of girls. Once the block of girls is placed, we can permute the 7 boys in 7! ways. Therefore, the total number of ways that two or more girls sit together is 5! × 9 × 7!

Therefore, the number of ways that no two girls sit together is 11! - 5! × 9 × 7! = 126(5!)2.
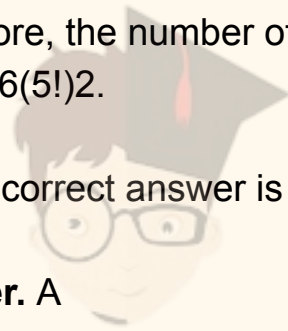
So the correct answer is 126(5!)2.

Answer. A

Question 4. Coefficient independent of x in the expansion of $(3x^2 - 1/2x^5)^7$ is ?

    A. 5103/4
    B. 5293/6
    C. 6715/3
    D. 7193/4

Answer. A

Question 5. If the coefficients of three consecutive terms in the expansion of $(1 + x)^n$ are in the ratio 1 : 5 : 20, then the coefficient of the fourth term of the expansion is?

    A. 3654
    B. 3658
    C. 3600
    D. 1000

Answer. A

Question 6. A bolt manufacturing factory has three products A, B and C. 50% and 30% of the products are A and B type respectively and remaining are C type. Then probability that the product A is defective is 4%, that of B is 3% and that of C is 2%. A product is randomly picked and found to be defective, then the probability that it is type C.

    A. 4/33
    B. 1/33
    C. 2/33
    D. 9/33

Answer. A

Question 7. Maximum value n such that (66)! is divisible by 3^n

Solution.
To find the maximum value of n such that (66)! is divisible by 3^n, we need to count the number of factors of 3 in (66)!, since each factor of 3 contributes to the divisibility by 3.

To count the number of factors of 3 in (66)!, we can use the formula:

$\lfloor 66/3 \rfloor + \lfloor 66/9 \rfloor + \lfloor 66/27 \rfloor + \lfloor 66/81 \rfloor = 22 + 7 + 2 + 0 = 31,$

where $\lfloor x \rfloor$ denotes the greatest integer less than or equal to x.

This means that (66)! is divisible by 3^31. Therefore, the maximum value of n such that (66)! is divisible by 3^n is n = 31.

Answer. 31

Question 8. Coefficient independent of x in the expansion of $(3x^2 - 1/2x^5)^7$ is?

    A. 5103/4
    B. 5293/6
    C. 6715/3
    D. 7193/4

Answer. A

Question 9. A has 5 elements and B has 2 elements. The number of subsets of A × B such that the number of elements in subset is more than or equal to 3 and less than 6, is?

    A. 602
    B. 484
    C. 582
    D. 704

Solution.
The set A × B contains a total of 5 × 2 = 10 elements. To form a subset of A × B with at least 3 and at most 5 elements, we can consider the following cases:

Case 1: Choose 3 elements from A × B

The number of ways to choose 3 elements from A × B is (10 choose 3) = 120.

Case 2: Choose 4 elements from A × B
The number of ways to choose 4 elements from A × B is (10 choose 4) = 210.

Case 3: Choose 5 elements from A × B
The number of ways to choose 5 elements from A × B is (10 choose 5) = 252.

Therefore, the total number of subsets of A × B with at least 3 and at most 5 elements is:
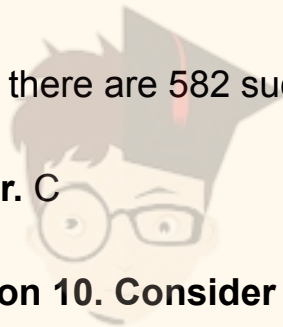
120 + 210 + 252 = 582

Hence, there are 582 such subsets.

Answer. C

Question 10. Consider the data : x, y, 10, 12, 4, 6, 8, 12. If mean is 9 and variance is 9.25, then the value of 3x − 2y is (x > y)

    A. 25
    B. 1
    C. 24
    D. 13

Answer. A