JEE Main 2023 Question Paper Solution

Date & Shift: April 13 Shift 1 **Memory-Based Questions**

JEE Main 2023 Physics Question Paper

Question 1. If the height of the tower used for L.D.S is increased by 21% then percentage change in range is?

A. 10%
B. 21%
C. 19%
D. 42%

Solution. The range of the L.D.S. (Laser Distance Sensor) is given by:

Range $\propto$ sqrt(Height)

This means that the range of the L.D.S. is directly proportional to the square root of the height of the tower.

If the height of the tower is increased by 21%, then the new height is:

New Height = Old Height + 0.21 x Old Height = 1.21 x Old Height

So the percentage change in height is 21%.

Now, using the formula above, we can write:

New Range ∝ sqrt(New Height)
New Range ∝ sqrt(1.21 x Old Height)
New Range ∝ sqrt(1.21) x sqrt(Old Height)
New Range ∝ 1.1 x sqrt(Old Height)

Therefore, the new range is 1.1 times the square root of the old range, which is an increase of:

Percentage change in range = (New Range - Old Range) / Old Range x 100%
Percentage change in range = [(1.1 x sqrt(Old Height)) - sqrt(Old Height)] / sqrt(Old Height) x 100%
Percentage change in range = (0.1 / sqrt(Old Height)) x 100%

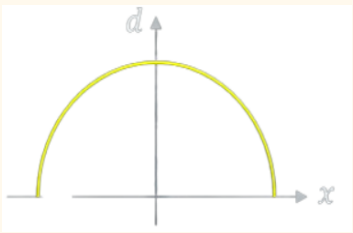
Substituting the value of the percentage change in height, we get:

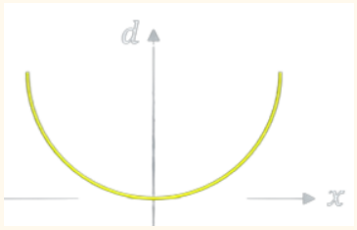
Percentage change in range = (0.1 / sqrt(Old Height)) x 100% = (0.1 / sqrt(1/1.21)) x 100%
Percentage change in range = 10%

Therefore, the percentage change in range is 10%.

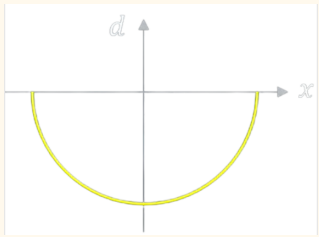
Answer. A

Question 2. Select the correct graph showing the difference (d) between total energy and potential energy of a particle in linear SHM with position x of the particle (x = 0 is the mean position)

A. 

B. 

C. 

D. 

Answer. A

Question 3. A dipole of charge 0.01C and separation 0.4mm, is placed in an electric field of strength 10 dyne/CC , Find the maximum torque exerted on the dipole in the field.

A. 4×10^{-9} Nm
B. 2×10^{-10} Nm
C. 4×10^{-10} Nm
D. 2×10^{-9} Nm

Answer. C

Question 4. Two bodies having the same linear momentum have a ratio of kinetic energy as 16:9. Find the ratio of masses of these bodies.

A. 9/16
B. 4/3
C. 3/4

D. 16/9

Answer. A

Question 5. What is the center of gravity of a semi-circular disc of radius (R)?

A. $2R/\pi$
B. $4R/3\pi$
C. R/2
D. 3R/8

Answer. B

Question 6. Pressure for polytropic process P varies with volume V as $P = av^{-3}$, find out the bulk modulus.

A. 3V
B. 3P
C. P
D. V

Solution. The bulk modulus (K) is defined as the ratio of the increase in pressure (ΔP) to the resulting decrease in volume (ΔV), when a material is subjected to an external pressure. Mathematically, it is expressed as:

K = -V(ΔP/ΔV)

For a polytropic process where P = av^-3, we can write:

dP/dV = (-3av^-4) = (-3P/V)

Using the above relation, we can rewrite the bulk modulus as:

K = -V(ΔP/ΔV) = -V(dP/dV) = -V(-3P/V) = 3P

Therefore, the bulk modulus is 3 times the pressure, i.e., K = 3P.

Answer. B

Question 7. The work function for two metals are 9eV and 4.5eV. Find the approx. difference between their threshold wavelength.(use hc = 1240 eV - nm)

A. 138 nm
B. 130 nm
C. 112 nm
D. 145 nm

Solution. The threshold wavelength, λ, can be calculated using the equation:

λ = hc / (energy of photon - work function)

For the first metal, the threshold wavelength is:

λ1 = hc / (energy of photon - work function1)

For the second metal, the threshold wavelength is:

λ2 = hc / (energy of photon - work function2)

Subtracting the two equations, we get:

λ1 - λ2 = hc / (energy of photon - work function1) - hc / (energy of photon - work function2)

Simplifying the equation, we get:

λ1 - λ2 = hc / energy of photon * ((work function2 - work function1) / (energy of photon - work function1) * (energy of photon - work function2))

Plugging in the given values, we get:

λ1 - λ2 = (1240 eV-nm) / energy of photon * ((4.5 eV - 9 eV) / ((energy of photon - 9 eV) * (energy of photon - 4.5 eV)))

To approximate the difference, we can assume that energy of photon is much larger than 9 eV and 4.5 eV, so we can neglect those terms in the denominator.

λ1 - λ2 ≈ (1240 eV-nm) / energy of photon * ((4.5 eV - 9 eV) / (energy of photon * energy of photon))

λ1 - λ2 ≈ - (1240 eV-nm) * 4.5 / (energy of photon)^3

We can use energy of photon = 10 eV (which is much larger than both work functions) to get an approximate value:

λ1 - λ2 ≈ - (1240 eV-nm) * 4.5 / (10 eV)^3

λ1 - λ2 ≈ -1.38 nm

Rounding off, we get an approximate difference of 138 nm. Therefore, the answer is option A) 138 nm.

Answer. A

Question 8. If a wire of resistance R is connected across Vo, then power is Po. The wire is cut into two equal parts and connected with Vo individually, then the sum of power dissipated is P1, then Po/Pi is 1/x. Find the value of x.

Solution. When the wire of resistance R is connected across Vo, the power dissipated can be calculated using the formula:

P = V^2/R

Substituting Vo for V, we get:

Po = Vo^2/R

When the wire is cut into two equal parts and connected individually across Vo, the equivalent resistance of each part is R/2. The power dissipated in each part can be calculated using the same formula:

P' = V^2/(R/2) = 2V^2/R

The total power dissipated when the two parts are connected in parallel is the sum of the power dissipated in each part:

P1 = 2P' = 4V^2/R

We can write Po/P1 as:

Po/P1 = (Vo^2/R)/(4V^2/R) = Vo^2/(4V^2)

Simplifying, we get:

Po/P1 = 1/4 = 1/x

Therefore, x = 4.

Answer. 4

Question 9. A particle is performing SHM having position x = A cos 30°, and A = 40 cm. If its kinetic energy at this position is 200 J, the value of force constant in (kN/m) is?

Solution. The position of the particle performing SHM is given by:

$x = A \cos(\omega t + \varphi)$

where A is the amplitude, ω is the angular frequency, t is time, and φ is the phase constant.

In this case, $x = A \cos 30°$, which means $\varphi = 30°$.

The kinetic energy of the particle is given by:

$K = (1/2)\, m\, \omega^2\, A^2 \sin^2(\omega t + \varphi)$

At the position $x = A \cos 30°$, the velocity of the particle is zero, so its kinetic energy is also zero. Therefore, we can write:

$0 = (1/2)\, m\, \omega^2\, A^2 \sin^2(30° + \varphi)$

Substituting the given values, we get:

$200\ J = (1/2)\, m\, \omega^2\, (40\ cm)^2 \sin^2(30° + 30°)$

$200\ J = (1/2)\, m\, \omega^2\, (40\ cm)^2\, (1/2)$

Simplifying, we get:

$m\, \omega^2 = 10$

The force constant of a particle undergoing SHM is given by:

$k = m\omega^2$

Substituting the value of mω^2, we get:

k = 10/m

We need to convert the mass in grams to kilograms to get the force constant in kN/m. Let's assume the mass of the particle is 1 gram:

k = 10 / (1 g) = 10,000 N/m

Converting to kN/m, we get:

k = 10 kN/m

Therefore, the value of the force constant is 10 kN/m.

Answer. 10

Question 10. For the given radioactive decay $^{298}_{94}X \rightarrow {}^{294}_{92}X + {}^{4}_{2}\alpha + Q$ - value, binding energy per nucleon of X, Y and α are a, b and c. The Q - value is equal to

A. 294b + 4c - 298a
B. 92b + 2c - 94a
C. 294b + 4c + 298a
D. 92b + 2c + 94a

Answer. A

JEE Main 2023 Chemistry Question Paper

Question 1. Which of the following free radicals helps in depletion of the ozone layer?

A. NO
B. Cl
C. OH
D. CH_3

Solution. The free radical that helps in depletion of the ozone layer is Cl (chlorine) free radical. Therefore, the correct option is B) Cl.

Answer. B

Question 2. In which of the following options the species changes from paramagnetic to diamagnetic and bond order increases.

A. $N_2 \rightarrow N_2^+$
B. $O2 \rightarrow O2^+$
C. $NO \rightarrow NO^+$
D. $O_2 \rightarrow O^+$

Answer. C

Question 3. Radius of the 2nd orbit of He^+ is r_0. Radius of the 4th orbit of Be^{3+} is xr_0. Find x.

Answer. 2

Question 4. What happens when lyophilic sol is added to lyophobic sol. prevention from coagulation precipitation emulsion electrophoresis

A. Prevention from coagulation
B. Precipitation
C. Emulsion
D. Electrophoresis

Answer. A

Question 5. 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 given organic compound is 40% , the percentage of H will be?

Answer. 9.34%

Question 6. Which of the following shows an incorrect method of refining?

A. Zinc:Liquation
B. Copper:Electrolysis
C. Titanium:Van Arkel Method
D. Nickel:Mond's Process

Answer. A

Question 7. For the 1st order reactions, the ratio of $t_{50\%}$ to $t_{87.5\%}$ will be:

Answer. 3

Question 8. The pair of lanthanides will exceptionally high 3rd ionisation enthalpy than neighbouring elements:

A. Lu and Yb
B. Eu and Gb
C. Eu and Yb
D. Dy and Yb

Solution. The electronic configuration of the lanthanides is characterized by the gradual filling of the 4f orbitals. The 3rd ionization energy of a lanthanide element corresponds to the removal of an electron from the 2+ ion to form the 3+ ion. Among the given options, the pair of lanthanides that will have an exceptionally high 3rd ionization enthalpy than the neighboring elements is:

Eu and Yb

This is because Eu and Yb have a half-filled and completely filled 4f subshell, respectively. The 4f electrons in these elements are shielded by the 5s and 5p electrons, which are farther away from the nucleus and have a higher principal quantum number. Therefore, the 4f electrons experience less effective nuclear charge, making it easier to remove an electron and lower the ionization enthalpy. However, once the 4f subshell is half-filled or completely filled, the additional electron experiences a higher effective nuclear charge due to poor shielding, making it harder to remove and resulting in a higher 3rd ionization energy. Therefore, Eu and Yb will have an exceptionally high 3rd ionization enthalpy compared to their neighboring elements.

Answer. C

Question 9. If $(1+1/x)^{1/2} v_{av} = v_{rms}$, then x is:

Answer. 6

Question 10. Incorrect statement about Borazine is:

A. It has banana shape bonds
B. It has electron delocalisation
C. It reacts with water
D. Cyclic in nature

Solution. The incorrect statement about Borazine is:

It has banana shape bonds.

Borazine is an inorganic compound with the chemical formula B3N3H6. It is also known as inorganic benzene because its structure resembles that of benzene, with alternating boron and nitrogen atoms instead of carbon atoms. Borazine is a cyclic compound with a six-membered ring consisting of alternating boron and nitrogen atoms.

Borazine has planar, hexagonal ring structure and each boron atom is bonded to two nitrogen atoms and one hydrogen atom, while each nitrogen atom is bonded to one boron atom and two hydrogen atoms. It has a flat, circular structure with three delocalized π-electrons and an alternating single and double bond system similar to that of benzene.

Borazine is a stable compound that is not reactive towards water. However, it can react with strong oxidizing agents and reduce them.

Answer. A

JEE Main 2023 Mathematics Question Paper

Question 1. Find the sum of series:
$2*2^2 - 2*3^2 + 2*4^2 + ….$(20 terms)

A. 462
B. -462
C. 460
D. -460

Answer. D

Question 2. Let the number of matrices of order 3 x 3 are possible using the digits [0, 1, 2, 3, … , 10) is m^n, then (m + n) is ___. (where m is a prime number)

Answer. 20

Question 3. Remainder when 2^{2022} is divided by 15 is equal to__

Solution. To find the remainder when 22022 is divided by 15, we can use the concept of modular arithmetic.

We know that a number is congruent to its remainder when divided by a positive integer. Therefore, we can write:

$22022 \equiv r \pmod{15}$

where r is the remainder we need to find.

We can simplify the left-hand side of the congruence by using the concept of modular exponentiation. We know that:

a^b ≡ (a^(b mod φ(m))) (mod m)

where a and b are positive integers, m is a positive integer greater than 1, and φ(m) is the Euler totient function of m.

In this case, we can take a = 2, b = 2022, and m = 15. We have:

φ(15) = φ(3 x 5) = φ(3) x φ(5) = 2 x 4 = 8

2022 ≡ 6 (mod 8)

Therefore:

2^2022 ≡ 2^6 ≡ 64 ≡ 4 (mod 15)

Substituting this back into the original congruence, we get:

22022 ≡ 4 (mod 15)

Therefore, the remainder when 22022 is divided by 15 is 4.

Answer. 4

Question 4. The number of 7 digits numbers made using 1,2,3,4 whose sum of digits is 12 is?

A. 413
B. 311
C. 308
D. 393

Answer. A

Question 5. If dy/dx = y+7 and y(0) = 0, then the value of y(1) is?

A. 7(e - 1)
B. 2(e - 1)
C. 7e
D. None of these

Solution. The given differential equation is:

dy/dx = y + 7

We can solve this first-order linear differential equation using the integrating factor method.

Multiplying both sides of the equation by the integrating factor e^x, we get:

e^x dy/dx + e^x y = e^x (-7)

The left-hand side of this equation can be simplified using the product rule of differentiation:

(d/dx)(e^x y) = e^x dy/dx + e^x y

Therefore, we can write:

(d/dx)(e^x y) = e^x (-7)

Integrating both sides with respect to x from 0 to 1, we get:

∫[0,1] (d/dx)(e^x y) dx = ∫[0,1] e^x (-7) dx

Using the fundamental theorem of calculus and simplifying, we get:

e^1 y(1) - e^0 y(0) = -7(e^1 - e^0)

Since y(0) = 0, we can simplify further:

e y(1) = -7(e - 1)

Therefore, the value of y(1) is:

y(1) = (-7/e) + 7

y(1) = 7(e - 1)/e

Hence, the answer is option A: 7(e - 1).

Answer. A

Question 6. If g(x) = √x+1 & f(g(x)) = 3-√x+1 then f(0) = ?

Solution. We have g(x) = √(x+1) and f(g(x)) = 3-√(x+1).

To find f(0), we need to find the value of x such that g(x) = 0, since f(g(x)) is given in terms of g(x).

We have:

g(x) = √(x+1) = 0

Solving for x, we get:

x = -1

Therefore, g(−1) = √0 = 0.

Now, we can find f(g(−1)):

f(g(−1)) = f(0) = 3-√(−1+1) = 3

Therefore, f(0) = 3.

Answer. 3

Question 7. Find area bounded by the curves y = max{sin x, cos x} and x-axis between x = -π and x = π

A. 2 + √2
B. √2
C. 1 + √2
D. 2√2

Answer. D

Question 8. For the data:

x_i	1	3	5	7	9
f_i	4	24	28	a	8

If the mean of data is 5 and mean deviation about mean is M and variance is σ^2 , then $3a/M+\sigma^2$ is?

Answer. 8

Question 9. The integral $\int_0^\infty$ 6/(e^{3x} + 6e^{2x} + 11e^x + 6) dx

A. ln 32
B. ln 27
C. ln 32/27
D. ln 27/32

Solution. First, we factor the denominator:

e3x + 6e2x + 11ex + 6 = (e3x + 3e2x) + (3e2x + 9ex) + (2ex + 6) = e2x(e+x+3) + 3ex(e+x+3) + 2(e+x+3) = (e2x+3ex+2)(e+x+3)

So, the integral becomes:

∫∞0 6/(e3x + 6e2x + 11ex + 6) dx = ∫∞0 2/(e2x+3ex+2) dx - ∫∞0 2/(e(x+3)+3) dx

Now, we substitute y = ex, dy/dx = e^x:

∫∞0 2/(e2x+3ex+2) dx = ∫∞1 2/(y^2+3y+2) * (1/y) dy = ∫∞1 2/(y+1)(y+2) dy = ln(3) - ln(2) = ln(3/2)

∫∞0 2/(e(x+3)+3) dx = 2/3 ∫∞3 1/(u+1) du = 2/3 ln(4/3)

Therefore,

∫∞0 6/(e3x + 6e2x + 11ex + 6) dx = ln(3/2) - 2 ln(4/3) = ln(3/2) - ln(8/9) = ln(27/16) = ln(32/27)

So, the answer is ln(32/27).

Answer. C

Question 10. Plane P_3 is passing through (1,1,1) and line of intersection of P_1 and P_2 where P_1: 2x - y + z = 5 and P_2: x + 3y + 2z + 2 = 0. Then distance of (1,1,10) from P_3 is:

A. 53/85
B. √85
C. 52/√85
D. 53

Solution. First, we find the equation of line of intersection of planes P1 and P2:
P1: 2x - y + z = 5
P2: x + 3y + 2z + 2 = 0

Taking cross product of the normal vectors of P1 and P2, we get the direction ratios of the line of intersection:
<2,-1,1> x <1,3,2> = <7,-4,7>

Therefore, the parametric equation of the line of intersection is:
x = 2t - 1
y = -t - 1
z = -2t

Now, we find the equation of plane P3 that passes through (1,1,1) and the line of intersection:
The normal vector of plane P3 will be perpendicular to both the line and the vector <2,-1,1> which is parallel to plane P1.
Therefore, the normal vector of P3 will be perpendicular to both <7,-4,7> and <2,-1,1>, which is given by their cross product:

<7,-4,7> x <2,-1,1> = <3,21,15>

Therefore, the equation of plane P3 is:
3(x-1) + 21(y-1) + 15(z-1) = 0
3x + 21y + 15z = 57

Now, we find the distance between point (1,1,10) and plane P3:
The distance between a point (x0,y0,z0) and a plane Ax + By + Cz + D = 0 is given by:
d = |Ax0 + By0 + Cz0 + D| / sqrt(A^2 + B^2 + C^2)

Substituting the values, we get:
d = |3(1) + 21(1) + 15(10) - 57| / sqrt(3^2 + 21^2 + 15^2)
d = 52/√85

Therefore, the answer is option (c) 52/√85.

Answer. C