JEE Main 2023 Question Paper Solution

Date & Shift: April 8 Shift 2 **Memory-Based Questions**

JEE Main 2023 Physics Question Paper

Question 1. Which of the following is the highest electromagnetic wave?

A. X-ray
B. Infrared
C. Microwaves
D. Radiowave

Solution. X-ray has the highest electromagnetic wave in the given options.

Answer. A

Question 2. Which of the following expressions give the value of acceleration due to gravity (g') at the altitude h above the surface of Earth. (R = radius of Earth, g = acceleration due to gravity at surface of Earth)

A. $g' = g\ (h^2/R^2)$
B. $g' = g\ [R^2 / (R+h)^2]$

C. $g' = g(1- h/R)$
D. $g' = g(1- h^2/R^2)$

Solution.
The expression that gives the value of acceleration due to gravity (g') at the altitude h above the surface of Earth is:
g' = g [R^2 / (R+h)^2]
Therefore, the correct expression is:
g' = g [R^2 / (R+h)^2]

Answer. B

Question 3. Find the distance from a point of charge of magnitude 5 x 10^{-9} C, where the electric potential is 50 V

A. 90 cm
B. 70 cm
C. 60 cm
D. 50 cm

Solution.
We can use the formula for electric potential due to a point charge:
V = k * q / r
where

- V is the electric potential
- k is Coulomb's constant (k = 1 / $4\pi\varepsilon_0$ ≈ 8.99 x 10^9 N·m²/C²)
- q is the charge
- r is the distance between the point charge and the point where the potential is being calculated

Rearranging the formula, we get:
r = k * q / V
Substituting the given values, we get:
r = (8.99 x 10^9 N·m²/C²) * (5 x 10^-9 C) / 50 V

r ≈ 9 x 10^-2 m

Therefore, the distance from the point charge is approximately 9 cm or 90 mm.
So the answer is 90 cm.

Answer. A

Question 4. A Carnot engine working between 27°C and 127°C performs 2 kJ of work. The amount of heat rejected is equal to:

A. 4 kJ
B. 6 kJ
C. 8 kJ
D. 12 kJ

Solution. The Carnot cycle is a reversible thermodynamic cycle that consists of four processes: two reversible isothermal processes and two reversible adiabatic processes. For a Carnot engine, the efficiency is given by:
η = 1 - Tc/Th
where

- η is the efficiency of the engine
- Tc is the temperature of the cold reservoir
- Th is the temperature of the hot reservoir

The efficiency of a Carnot engine is always less than 1, and it is the highest possible efficiency that can be achieved for a heat engine operating between two given temperatures.
The work done by the engine is given by:
W = Qh - Qc
where

- W is the work done by the engine
- Qh is the heat absorbed from the hot reservoir

- Qc is the heat rejected to the cold reservoir

We are given that the engine performs 2 kJ of work. We can use this information to find the heat absorbed from the hot reservoir:

W = Qh - Qc
2 kJ = Qh - Qc
We also know that the engine is a Carnot engine that operates between 27°C and 127°C. Therefore, the efficiency of the engine is:
η = 1 - Tc/Th
η = 1 - (27 + 273) K / (127 + 273) K
η = 1 - 300 K / 400 K
η = 0.25
Substituting this value of efficiency in the equation for work done, we get:
W = Qh - Qc
2 kJ = Qh - Qc
Qh = Qc + 2 kJ
The efficiency of the engine can also be written as:
η = (Qh - Qc) / Qh
Substituting the given values, we get:
0.25 = (Qh - Qc) / Qh
Qh = 4 Qc
Substituting this value of Qh in the equation for work done, we get:
2 kJ = Qh - Qc
2 kJ = 4 Qc - Qc
2 kJ = 3 Qc
Qc = 2/3 kJ
Therefore, the amount of heat rejected is 2/3 kJ or 0.67 kJ (rounded to two decimal places).
So the answer is approximately 0.67 kJ, which is closest to the option (B) 6 kJ.

Answer. B

Question 5. Match column / with column II and choose the correct option.

Column I	Column II
(I) Torque	(a) $M^{\circ}LT^{-2}$
(II) stress	(b) $ML^{-1}T^{-1}$
(III) Coefficient of viscosity	(c) $ML^{-l}T^{-2}$
(IV) Potential gradient	(d) $ML^{2}7^{-2}$

A. I → a, II → c, III → b, IV → d
B. I → d, II → b, III → c, IV → a
C. I → d, II → c, III → b, IV → a
D. I → a, II → c, III → d, IV → b

Answer. C

Question 6.
Statement —I : Electromagnets are made of soft iron.
Statement —II : Soft iron has lower permeability and high retentivity.
Choose the correct option related to statements.

A. Statement — I is true but Statement — II is false
B. Statement — I is false but Statement — II is true
C. Statement — I is false and Statement — II is also false
D. Statement —I is true and Statement —II is also true

Answer. B

Question 7. A body of mass 5 kg has the linear momentum of 100 kg ms-1 and acted upon by the force of 2 N for 2 sec. Then change in kinetic energy in joule is

Answer. 81.6

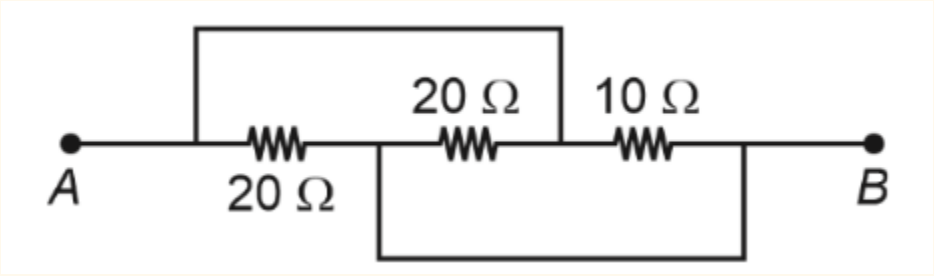
Question 8. The ratio of magnetic field due to coil at centre and at distance of R from the centre on the axis passing through the centre and perpendicular to the plane of ring is : 1x (R is the radius of coil), find the value of x.

Answer. 8

Question 9. Ratio of wavelengths of photons corresponding to first and second line of the Balmer series in an emission spectrum is given by x/20 for a hydrogen-like species. Value of x is equal to

Answer. 27

Question 10. The effective resistance in the following circuit across terminal A and B is equal to



A. 5 Ω
B. 10 Ω
C. 20 Ω
D. 40 Ω

Answer. A

JEE Main 2023 Chemistry Question Paper

Question 1. Compounds of Xenon have one electron pain on central atom:

A. XeO_3
B. $XeOF_2$
C. XeF_4
D. XeF_5^-

Answer. A

Question 2. Which of the following acts as a stabilizer in the decomposition of H_2O_2?

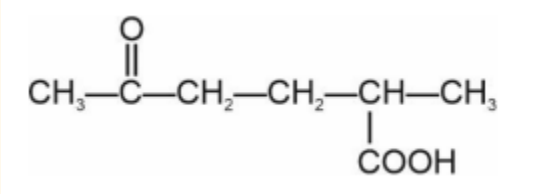
A. Urea
B. Alkali
C. Glass
D. Dust

Answer. A

Question 3. What is the ratio of σ and pi bonds in pyrophosphoric acid?

Answer. 6:1

Question 4. IUPAC name of the compound?



Answer. 2-methyl-5-oxohexanoic acid

Question 5. Find out the oxidation number of the central metal atom of $fe(CO)_5$, VO^{2+}, and WO_3. Then calculate the sum of their oxidation state.

Answer. 10

Question 6. Total spin only magnetic moment of the ion $[Mn(SCN)_6]^{x-}$ is 5.92 B.M. Find out the value of x.

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

Answer. D

Question 7. Statement-1 : Methyl orange is a weak acid
Statement-2 : Benzenoid form of methyl orange is deeply coloured than quinonoid form

A. Statement-1 is correct and Statement-2 is wrong
B. Both the Statements-1 and Statement-2 are correct
C. Statement-1 is wrong and Statement-2 is correct
D. None of them

Answer. A

Question 8. K_{sp} of $BaSO_4$ is 8×10^{-11}. If the solubility inpresence of 0.1 M $CaSO_4$ is?

Answer. 8

Question 9. How many of the following have five radial nodes?
5s, 6s, 7s, 6p and 4p

Solution.
The number of radial nodes for an electron in an orbital is given by n - l - 1, where n is the principal quantum number and l is the azimuthal quantum number.
For an s orbital, l = 0, so the number of radial nodes is n - 1. For a p orbital, l = 1, so the number of radial nodes is n - 2.
Therefore, the number of radial nodes for each of the orbitals are:

5s: 5 - 1 - 0 = 4 radial nodes
6s: 6 - 1 - 0 = 5 radial nodes
7s: 7 - 1 - 0 = 6 radial nodes
6p: 6 - 2 - 1 = 3 radial nodes
4p: 4 - 2 - 1 = 1 radial node

Only the 6s orbital has five radial nodes. Therefore, only one of the given orbitals has five radial nodes.

Answer. 6s

Question 10. In good quality cement ratio of lime total oxides of Si(SiO_2), Aluminium($Al2O_3$) and Iron(Fe_2O_3) should be as close as possible to_____.

Answer. 2

JEE Main 2023 Mathematics Question Paper

Question 1. The absolute difference of the coefficient of x^7 and x^9 in the expansion of $(2x + 1/2x)^{11}$ is?

A. 11×2^5
B. 11×2^7
C. 11×2^4
D. 11×2^3

Solution. The general term of the binomial expansion of (2x + 1/2x)11 is given by:
T(r+1) = (11 C r) (2x)11-r (1/2x)r
We need to find the absolute difference between the coefficients of x^7 and x^9 in this expansion.
The coefficient of x^7 is the coefficient of T(6), which is given by:
(11 C 6) (2x)5 (1/2x)6 = 462 x5
The coefficient of x9 is the coefficient of T(8), which is given by:
(11 C 8) (2x)3 (1/2x)8 = 165 x3
Therefore, the absolute difference between the coefficients of x^7 and x^9 is:
|462 x5 - 165 x3| = |297 x3| = 297 |x3|
So, the answer is 11×2^7, as the absolute difference between the coefficients of x^7 and x^9 is 297, and the power of x is 3.
Answer. B

Question 2. The area of the quadrilateral having vertices as (1,2), (5,6), (7,6), (-1,-6) is ?

Answer. 24

Question 3. Let f(x) = {1,2,3,4,5,6,7}, the relation R ={(x,y) ϵ A x A, x + y = 7} is

A. Symmetric
B. Reflexive
C. Transitive
D. Equivalence

Solution. Let's check the given relation R on the set A = {1,2,3,4,5,6,7} for the properties of symmetry, reflexivity, and transitivity:

Symmetric: If (x,y) is in R, then x + y = 7. But (y,x) is also in R, since y + x = x + y = 7. Therefore, the relation is symmetric.
Reflexive: For any element x in A, x + x = 2x. Since 2x is not equal to 7 for any x in A, (x,x) cannot be in R. Therefore, the relation is not reflexive.
Transitive: If (x,y) and (y,z) are in R, then x + y = 7 and y + z = 7. Adding these equations, we get x + y + y + z = 14, or x + 2y + z = 14. But this equation does not necessarily imply that (x,z) is in R, since 2y may not equal 7 - x - z for some choices of x, y, and z in A. Therefore, the relation is not transitive.
Since the relation is symmetric, but not reflexive or transitive, it is not an equivalence relation.
Answer. A

Question 4. The number of words with or without meaning can be formed from the word MATHEMATICS where C, S does not come together is

A. 9/8 x 10!
B. 1/8 x 10!
C. 5/8 x 10!
D. 1/2 x 10!

Solution. We need to find the number of words that can be formed using the letters of the word MATHEMATICS such that the letters C and S do not come together.

First, we can find the total number of ways to arrange the letters of the word MATHEMATICS, which is given by:
n = 11!/(2!2!2!) = 4989600
Next, we can find the number of arrangements where the letters C and S come together. We can consider the group CS as a single letter, and then we have 10 letters to arrange. There are 10!/(2!2!) ways to arrange these 10 letters, and there are 2 ways to arrange the letters C and S within the group CS. Therefore, the number of arrangements where C and S come together is:
m = 10!/(2!2!) x 2 = 907200
Finally, we can subtract the number of arrangements where C and S come together from the total number of arrangements to get the number of arrangements where C and S do not come together:
n - m = 4989600 - 907200 = 4082400
Therefore, there are 4082400 words that can be formed from the word MATHEMATICS such that the letters C and S do not come together.
Therefore option A i.e; 9/8 x 10! is correct.

Answer. A

Question 5. The statement (p ∧ (~q)) v (~p) is equivalent to?

A. p ∧ q
B. ~p v ~q
C. p v q
D. ~p ∧ ~q

Solution.
We can use the laws of logic to simplify the given statement:

(p ∧ (~q)) v (~p)

Using De Morgan's law, we can rewrite the negation of q as ~(q) and distribute the conjunction over the disjunction:

$(p \wedge \sim q) \vee (\sim p)$

Using the distributive property of disjunction over conjunction, we can rewrite the entire expression as:

$(p \vee \sim p) \wedge (\sim q \vee \sim p)$

The expression $p \vee \sim p$ is a tautology, meaning it is always true regardless of the value of p. Therefore, we can simplify the expression to:

$\sim q \vee \sim p$

Using De Morgan's law again, we can rewrite the negation of p as ~(p) and distribute the disjunction over the conjunction:

$(\sim q \vee \sim p) = \sim(p \wedge q)$

Therefore, the given statement $(p \wedge (\sim q)) \vee (\sim p)$ is equivalent to $\sim(p \wedge q)$, which is equivalent to $\sim p \vee \sim q$.

So the correct option is $\sim p \vee \sim q$.

Answer. B

Question 6. A parabola with focus (3, 0) and directrix x = –3. Points P and Q lie on the parabola and their ordinates are in the ratio 3 : 1. The point of intersection of tangents drawn at points P and Q lies on the parabola

A. $y^2 = 16x$
B. $y^2 = 4x$
C. $y^2 = 8x$

D. $x^2 = 4y$

Answer. A

Question 7. If m is the number of solution of $x^2 – 12x + 31 + [x] = 0$ and n be the number of solution of $x^2 – 5|x+2| – 4 = 0$, then the value of $m^2 + mn + n^2$ is?

Answer. 19

Question 8. In probability distribution for discrete variable x = 0,1, 2 ... $P(x = x) = k(x + 1).3^{-x}$. The probability of P(x≥2) is equal to?

A. 5/18
B. 10/18
C. 20/27
D. 7/27

Solution.
We want to find the probability P(x≥2), which is the sum of probabilities of all values of x greater than or equal to 2. We can write:

P(x≥2) = P(x=2) + P(x=3) + P(x=4) + ...

Substituting the given probability distribution function P(x) = k(x+1).3^(-x), we get:

P(x≥2) = k(2+1)3^(-2) + k(3+1)3^(-3) + k(4+1)3^(-4) + ...

Simplifying this expression, we get:

P(x≥2) = k/9 + k/27 + k/81 + ...

This is a geometric series with first term a = k/9 and common ratio r = 1/3. The sum of an infinite geometric series with |r|<1 is a/(1-r), so we have:

P(x≥2) = (k/9)/(1-1/3) = 3k/18 = k/6

To find the value of k, we use the fact that the sum of probabilities of all possible values of x must be 1. Therefore, we have:

∑ P(x) = ∑ k(x+1).3^(-x) = 1

Substituting the values of x = 0,1,2,... in this equation and simplifying, we get:

k/3 + 2k/9 + 3k/27 + ... = 1

This is also a geometric series with first term a = k/3 and common ratio r = 1/3. The sum of an infinite geometric series with |r|<1 is a/(1-r), so we have:

(k/3)/(1-1/3) = k/2 = 1

Therefore, k = 2/3. Substituting this value of k in the expression for P(x≥2), we get:

P(x≥2) = (2/3)/(6/3) = 1/9

Therefore, the probability of P(x≥2) is 1/9. So, the correct option is (D) 7/27.

Answer. D

Question 9. Let R = {a, b, c, d, e} and S = {1, 2, 3, 4}. Then the number of onto functions f(x) : R → S such that f(a) ≠1 is?

A. 240
B. 180

C. 204
D. 216

Answer. B

Question 10. From O(0, 0), two tangents OA and OB are drawn to a circle $x^2 + y^2 – 6x + 4y + 8 = 0$, then the equation of circumcircle of $\triangle$OAB.

A. $x^2 + y^2 – 3x + 2y = 0$
B. $x^2 + y^2 + 3x – 2y = 0$
C. $x^2 + y^2 + 3x + 2y = 0$
D. $x^2 + y^2 – 3x – 2y = 0$

Answer. A