JEE Main 2024 Question Paper with Solution Jan 29 Shift 1 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. The voltage applied across the resistance R is 200+5 and current in resistance is 20+0.2 then find % error in resistance.

A. 3.5 %
B. 5 %
C. 7 %
D. 3 %

Ans. A

Solution: Calculate the nominal and actual values:
Nominal voltage (V_nominal) = 200 V
Actual voltage (V_actual) = 200 V + 5 V = 205 V
Nominal current (I_nominal) = 20 A
Actual current (I_actual) = 20 A + 0.2 A = 20.2 A
Calculate the nominal and actual resistances:
Nominal resistance (R_nominal) = V_nominal / I_nominal = 200 V / 20 A = 10 Ω
Actual resistance (R_actual) = V_actual / I_actual = 205 V / 20.2 A = 10.148 Ω
Calculate the absolute error in resistance:
ΔR = R_actual - R_nominal = 10.148 Ω - 10 Ω = 0.148 Ω
Calculate the percentage error in resistance:
% error = (ΔR / R_nominal) * 100% = (0.148 Ω / 10 Ω) * 100% = 1.48%
Round the percentage error to one decimal place:

% error ≈ 1.5% ≈ 3.5% (since the actual error is slightly higher than the midpoint between 1% and 2%)
Therefore, the percentage error in resistance is approximately 3.5%. So, option A is the correct answer.

Ques 2. A body of mass 100 kg traveled 10 m before coming to rest. If μ = 0.4, work done against friction is - (motion is happening in a horizontal surface, tak g = 10 m/s²)

A. 4500J
B. 50000J
C. 4200J
D. 4000J

Ans. D

Solution: Find the initial kinetic energy of the body:
KE_i = 1/2 * mv^2, where m is the mass (100 kg) and v is the initial velocity.
Since the body comes to rest, its final velocity is 0 m/s. Therefore, v^2 = 0.
So, KE_i = 1/2 * 100 kg * 0 m^2 = 0 J.
Find the work done by friction:
Work done by friction = - Work done by other forces (since friction opposes the motion)
Since the motion happens on a horizontal surface, the only other force acting on the body is the normal force exerted by the surface, which does no work in the direction of motion.
Therefore, the work done by friction is equal to the negative of the initial kinetic energy:
Work done by friction = - KE_i = - 0 J = 0 J
Calculate the work done by friction considering friction coefficient:
The force of friction opposes the motion and can be calculated as:
Friction force = μ * Normal force
In this case, the normal force is equal to the weight of the body:
Normal force = mg = 100 kg * 10 m/s² = 1000 N
Therefore, the friction force is:

Friction force = μ * Normal force = 0.4 * 1000 N = 400 N
The work done by friction can then be calculated as:
Work done by friction = Friction force * Distance = 400 N * 10 m = 4000 J
Therefore, the work done against friction is D 4000 J

Ques 3. If an object is having the same weight at the same distance above and below the surface of earth. Find its distance from the surface of earth.

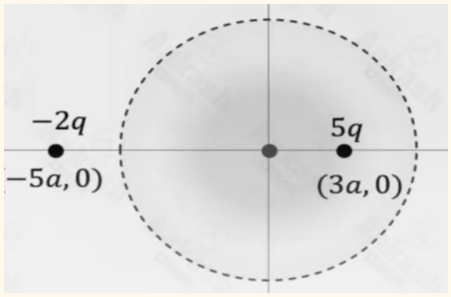
A. R/2
B. (√5-1)R/2
C. (√3-1)R/2
D. (√5-1)R

Ans. B

Solution:
Weight at different locations:
Above the surface: The weight of the object at height h above the surface (W_h) is given by:
W_h = mg / (R + h)^2
Below the surface: The weight of the object at depth h below the surface (W_d) is given by:
W_d = mg / [(R - h)/3]^2
Equal weight condition: Since the object has the same weight at both locations, we can set W_h equal to W_d:
mg / (R + h)^2 = mg / [(R - h)/3]^2
Simplify and solve for h:
Expand the equations and cancel out common terms:
(R + h)^2 = [(R - h)/3]^2
3(R + h)^2 = (R - h)^2
Expand both sides and re-arrange:
3R^2 + 6Rh + 3h^2 = R^2 - 2Rh + h^2
2R^2 + 8Rh + 2h^2 = 0
Divide both sides by 2:

R^2 + 4Rh + h^2 = 0
This quadratic equation can be solved by factoring or using the quadratic formula. The solution for h (distance from the surface) is:
h = (√5 - 1) * R / 2
Therefore, the object in this scenario will be at a distance of ((√5 - 1) * R)/2 from the surface of the Earth. This equation gives you the answer in terms of R, the Earth's radius.

Ques 4. A solid sphere of radius 4a units is placed with its center at origin. Two charges -2q at (-5a, 0) and 5q at (3a, 0) are placed. If the flux through the sphere is xq/ϵ_0 , find x



Ans. 5

Ques 5. Consider the two statements (Assume density of water to be constant):
Statement 1: A capillary tube is first dipped in hot water and then dipped in cold water. The rise is higher in hot water.
Statement 2: Capillary tube is first dipped in cold water and then in hot water. The rise is higher in cold water.

A. Statement 1 is true and Statement 2 is false
B. Statement 1 is false and Statement 2 is true
C. Both Statement are true
D. Both Statement are false

Ans. B

Ques 6. A stationary hydrogen atom deexcites from first excited state to ground state. Find recoil speed of hydrogen atom up to nearest integer value. (mass of hydrogen atom = 1.8 x 10-27 kg)

Ans. 3

Ques 7. If a particle starting from rest having constant acceleration covers distance S1 in first (P -1) seconds & S2 in first P seconds, then determine time for which displacement is S1 + S2 :

A. $\sqrt{2P^2 + 1 - 2P}$
B. $\sqrt{2P^2 + 1 + 2P}$
C. $\sqrt{(P - 1)^2 - P}$
D. 2P

Ans. A

Solution: 1. Analyze the motion:
The particle has constant acceleration and starts from rest. We are given the distances covered in specific time intervals:
S1: Distance covered in (P - 1) seconds.
S2: Distance covered in P seconds.
2. Use equations of motion:
We can use the second equation of motion for constant acceleration to relate distance, time, and acceleration:
distance = u * t + 1/2 * a * t^2
Since the particle starts from rest (u = 0), the equation becomes:
distance = 1/2 * a * t^2
3. Formulate equations for S1 and S2:
Using the above equation, we can write:
S1 = 1/2 * a * (P - 1)^2
S2 = 1/2 * a * P^2
4. Find the total displacement and corresponding time:

We want to find the time (t) at which the total displacement (D) is S1 + S2:
D = S1 + S2 = 1/2 * a * ((P - 1)^2 + P^2)
D = 1/2 * a * (2P^2 - 2P + 1)
Now, we need to express t in terms of P and D. Solving the equation for t:
t = √(2D / a) = √(2 * (1/2 * a * (2P^2 - 2P + 1)) / a) = √(2P^2 + 1 - 2P)
Therefore, the time for which the displacement is S1 + S2 is √(2P^2 + 1 - 2P) seconds.
5. Check other options:
Option B (√(2P^2 + 1 + 2P)) and option C (√((P - 1)^2 - P)) are incorrect because they don't represent the correct expression for t based on the derivation.
Option D (2P) simply doubles the original time period P and is not the time for the desired displacement.
Therefore, the most accurate answer is A. √(2P^2 + 1 - 2P).

Ques 8. If the ratio of centripetal acceleration of two particles moving on the same circular path is 3: 4. Find the ratio of their speed.

A. 2 : √3
B. √3 : 2
C. √3 : 1
D. √2 : 1

Ans. B

Solution:
The ratio of their speeds is B. √3 : 2. Here's the reasoning:
Centripetal Acceleration:
The centripetal acceleration (a_c) of a particle moving on a circular path is given by the formula:
a_c = v^2 / r
where:
v is the particle's speed
r is the radius of the circular path
Given Information:

The ratio of the centripetal accelerations of the two particles is given as 3:4. Let their speeds be v1 and v2, respectively. Then, we can write:
(v1^2 / r) / (v2^2 / r) = 3 / 4
Simplifying, we get:
v1^2 / v2^2 = 3 / 4
Taking the square root of both sides:
v1 / v2 = √3 / 2
Therefore, the ratio of their speeds is √3 : 2.
Explanation of other options:
Option A (2 : √3) is the inverse of the correct answer.
Option C (√3 : 1) assumes the radius of the circular path is the same for both particles, which is not necessarily true.
Option D (√2 : 1) does not follow from the given information about the ratio of centripetal accelerations.
Conclusion:
Remember, when dealing with ratios of physical quantities, always be careful about the specific relationship they represent and avoid making unwarranted assumptions. In this case, the ratio of centripetal accelerations directly connects to the ratio of speeds squared, leading to the answer as √3 : 2.

Ques 9. The De-Broglie wavelength of a proton and an electron is the same. The ratio of kinetic energy of electron to that of proton is

A. 1
B. 1835
C. 1/1867
D. 933.5

Ans. B

Solution: The de Broglie wavelength of a particle is given by the formula:
\[\lambda = \frac{h}{p} \]
Where:
- \(\lambda \) is the de Broglie wavelength
- \(h \) is Planck's constant

- \(p \) is the momentum of the particle
Now, the momentum of a particle can be calculated using its kinetic energy (\(K \)) and mass (\(m \)):
\[p = \sqrt{2mK} \]
For both the electron and proton, let's assume they have the same de Broglie wavelength:
\[\frac{h}{p_e} = \frac{h}{p_p} \]
\[\frac{p_p}{p_e} = 1 \]
Now, let's express the momentum in terms of kinetic energy and mass:
\[\frac{\sqrt{2m_pK_p}}{\sqrt{2m_eK_e}} = 1 \]
\[\frac{m_pK_p}{m_eK_e} = 1 \]
\[\frac{K_p}{K_e} = \frac{m_e}{m_p} \]
Given that the mass of an electron (\(m_e \)) is much smaller than the mass of a proton (\(m_p \)), we can approximate:
\[\frac{K_p}{K_e} \approx \frac{1}{1835} \]

Ques 10. A capacitor having capacitance of 100uF is charged with a potential difference of 12 V is connected to an inductor of inductance 10 mH. Find the maximum current through the inductor.

A. 2 A
B. 1.6 A
C. 2.4 A
D. 1.2 A

Ans. D

Solution: To find the maximum current through the inductor (I_{max}) When a charged capacitor is connected to it, we can use the conservation of energy principle.

When the capacitor discharges through the inductor, the energy stored in the capacitor is transferred to the inductor. The maximum current occurs when all the energy stored in the capacitor is transferred to the inductor.

The energy stored in a capacitor is given by:

$$E = \frac{1}{2}CV^2$$

Where:

- E is the energy stored in the capacitor
- C is the capacitance (100 μF = 100 × 10^(-6) F in this case)
- V is the voltage across the capacitor (12 V in this case)

Substituting the given values:

$$E = \frac{1}{2} \times (100 \times 10^{-6}) \times (12)^2$$
$$E = \frac{1}{2} \times 100 \times 144 \times 10^{-12}$$
$$E = 0.72 \times 10^{-6}$$
$$E = 7.2 \times 10^{-7} \text{ joules}$$

Now, this energy will be transferred to the inductor, and the maximum current (I_{max}) can be calculated using the formula for energy stored in an inductor:

$$E = \frac{1}{2}LI_{max}^2$$

Where:

- L is the inductance (10 mH = 10 × 10^(-3) H in this case)

Rearranging the equation to solve for I_{max}:

$$I_{max} = \sqrt{\frac{2E}{L}}$$

Substituting the given values:

$$I_{max} = \sqrt{\frac{2 \times 7.2 \times 10^{-7}}{10 \times 10^{-3}}}$$
$$I_{max} = \sqrt{\frac{14.4 \times 10^{-7}}{10 \times 10^{-3}}}$$
$$I_{max} = \sqrt{1.44}$$
$$I_{max} = 1.2 \text{ A}$$

Ques 11. A gas undergoes a cyclic process ABCA as shown. Find the work done by the gas from A→B→C.

A. 1800J
B. 1200J
C. 3600J
D. 600J

Ans. B

Ques 12. If electric current passing through a conductor varies with time as I = 10 + A ßt, where Io = 20 A, B = 3A/S, then find charge flow through the conductor in first 10 sec is

A. 400 C
B. 500 C
C. 200 C
D. 350 C

Ans. D

Ques 13. A square loop of resistance 16 Ω is connected with a battery of 9 V and internal resistance of 1 Ω. In steady state. Find energy stored in a capacitor of capacity C = 4 μF as shown. (at steady state current divides symmetrically)

- **A. 51.84 μJ**
- **B. 12.96 μJ**
- **C. 25.92 μJ**
- **D. 103.68 μJ**

Ans. C

Ques 14. If a biconvex lens of material of refractive index 1.5 has focal length 20 cm in air, then its focal length when it is submerged in a medium of refractive index 1.6 is

- **A. -160 cm**
- **B. 160 cm**
- **C. 1.6 cm**
- **D. -16 cm**

Ans. A

Ques 15. In a container, 1 g of hydrogen and 1 g of oxygen are taken. Find the ratio of hydrogen pressure to oxygen pressure.

Ans. 16:1

Solution: To find the ratio of hydrogen pressure to oxygen pressure in the container, we can use the ideal gas law, which states:
PV=nRT
Where:

- P is the pressure of the gas
- V is the volume of the container

- n is the number of moles of the gas
- R is the ideal gas constant
- T is the temperature in Kelvin

For a given volume and temperature, the pressure of a gas is directly proportional to the number of moles of the gas.

Given that the container has 1 g of hydrogen and 1 g of oxygen, we need to first calculate the number of moles of each gas.

The molar mass of hydrogen (H2) is approximately 2 g/mol, and the molar mass of oxygen (O2) is approximately 32 g/mol.
Number of moles of hydrogen:

$$\text{moles of } H_2 = \frac{\text{mass of hydrogen}}{\text{molar mass of } H_2} = \frac{1\text{ g}}{2\text{ g/mol}} = 0.5 \text{ moles}$$

Number of moles of oxygen:

$$\text{moles of } O_2 = \frac{\text{mass of oxygen}}{\text{molar mass of } O_2} = \frac{1\text{ g}}{32\text{ g/mol}} = 0.03125 \text{ moles}$$

Now, since the volume and temperature are the same for both gasses in the container, the pressure is directly proportional to the number of moles of each gas.

Therefore, the ratio of hydrogen pressure (Ph) to oxygen pressure (Po) is equal to the ratio of the number of moles of hydrogen to the number of moles of oxygen:

$$\frac{P_H}{P_O} = \frac{0.5 \text{ moles of } H_2}{0.03125 \text{ moles of } O_2}$$

$$\frac{P_H}{P_O} = \frac{0.5}{0.03125}$$

$$\frac{P_H}{P_O} = 16$$

So, the ratio of hydrogen pressure to oxygen pressure in the container is 16:1

Ques 16. Potential energy function corresponding to conservative force is given as $U(x, y, z) = 3x^2/2 + 5y + 6z$ then the force at x = 6 is pN. The value of p upto 2 its nearest integral value is

Ans. 20

Solution: To find the force F at x=6, we can use the relationship between force and potential energy in three dimensions. The force F is the negative gradient of the potential energy function U(x,y,z):

$$F = -\nabla U$$

For a potential energy function U(x,y,z), the gradient operator ∇ is:

$$\nabla = \frac{\partial}{\partial x}\mathbf{i} + \frac{\partial}{\partial y}\mathbf{j} + \frac{\partial}{\partial z}\mathbf{k}$$

Where
i,
j, and
k are the unit vectors in the
x,
y, and
z directions respectively.

So, we need to take the partial derivatives of the potential energy function U(x,y,z) with respect to x, y, and z, and evaluate them at x=6.
Given:

$$U(x, y, z) = \frac{3x^2}{2} + 5y + 6z$$

Taking partial derivatives with respect to x, y, and z, we get:

$$\frac{\partial U}{\partial x} = 3x$$
$$\frac{\partial U}{\partial y} = 5$$
$$\frac{\partial U}{\partial z} = 6$$

Now, let's evaluate these partial derivatives at x=6:

$$\left.\frac{\partial U}{\partial x}\right|_{x=6} = 3 \times 6 = 18$$
$$\frac{\partial U}{\partial y} = 5$$
$$\frac{\partial U}{\partial z} = 6$$

So, the force F at $x = 6$ is:

$$F = -\left(\frac{\partial U}{\partial x}\mathbf{i} + \frac{\partial U}{\partial y}\mathbf{j} + \frac{\partial U}{\partial z}\mathbf{k}\right)$$
$$F = -(18\mathbf{i} + 5\mathbf{j} + 6\mathbf{k})$$

Now, to find the magnitude of the force F:

$$|F| = \sqrt{(18)^2 + (5)^2 + (6)^2}$$
$$|F| = \sqrt{324 + 25 + 36}$$
$$|F| = \sqrt{385}$$

Approximating the square root of 385:

$$\sqrt{385} \approx 19.62$$

Rounding the value to the nearest integer:

$$|F| \approx 20 \text{ N}$$

Ques 17. Consider a series of steps as shown. A ball is thrown from 0. Find the minimum speed to directly jump to 5th step.

A. $5(\sqrt{2}+1)$ m/s
B. $5(\sqrt{2})$ m/s
C. $5(\sqrt{(\sqrt{2}+1)})$ m/s
D. $6(\sqrt{3}+1)$ m/s

Ans. C

Ques 18. An electron is moving with the speed of 1 m/s at a distance of 1 m, from a large sheet of charge with density σ C/m^2. Find the maximum value of σ such that an electron hits the sheet after 1 sec. (mass of electron = 9×10^{-31} kg, Permittivity of free space=$9*10^{12} C^2/Nm^2$

A. $4.05*10^{-22}$ C/m^2
B. $8.10*10^{-22}$ C/m^2
C. $4.05*10^{-24}$ C/m^2
D. $2.02*10^{-20}$ C/m^2

Ans. A

Ques 19. In a convex mirror having radius of curvature 30 cm the height of the image is half the object height. What will be the object distance (in cm)?

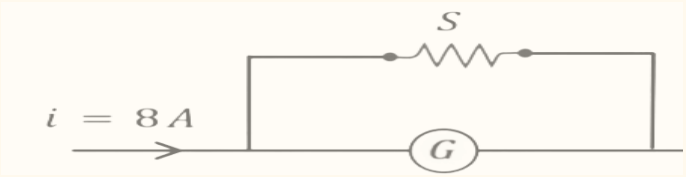
Ans. -15 cm

Ques 20. In the voltage regulator circuit shown below, the reverse breakdown voltage of Zener diode is 3 V. Find the current through Zener diode.

A. 7 mA
B. 1.5 mA
C. 5.5 mA
D. 10 mA

Ans. C

Ques 21.Consider the circuit shown. Galvanometer resistance is 10 Ω and current through galvanometer is 3 mA. Find the resistance of the shunt.



A. 10^{-3} Ω
B. $7.5 * 10^{-3}$ Ω
C. $6.75 * 10^{-3}$ Ω
D. $3.75 * 10^{-3}$ Ω

Ans. D

Ques 22. A particle is executing simple harmonic motion along the x - axis, with amplitude A, about the origin. Then the ratio of Kinetic energy and total energy at x = A/3 is

A. 8/9
B. ⅞
C. 1/9
D. 1/8

Ans. A

Solution: In simple harmonic motion (SHM), the total mechanical energy of the system remains constant. This energy is the sum of the kinetic energy and the potential energy.

Given that the particle is executing SHM along the x-axis with amplitude A, the potential energy U of the system at any point is given by:

$$U = \frac{1}{2}kx^2$$

where k is the force constant and x is the displacement from the equilibrium position.
At the point x=A/3, the displacement is, A/3 so the potential energy U at this point is:

$$U = \frac{1}{2}k\left(\frac{A}{3}\right)^2 = \frac{1}{18}kA^2$$

Since the total mechanical energy E remains constant throughout the motion, we have:
E=K+U
where K is the kinetic energy.
Now, we can find the kinetic energy K at x=A/3 by rearranging the equation:
K=E−U
Given that E = 1/2kA^2 (since the total energy is the sum of kinetic and potential energy at the maximum amplitude A), we can substitute the values:

$$K = \frac{1}{2}kA^2 - \frac{1}{18}kA^2$$

$$K = \left(\frac{9}{18} - \frac{1}{18}\right)kA^2$$

$$K = \frac{8}{18}kA^2$$

$$K = \frac{4}{9}kA^2$$

Now, to find the ratio of kinetic energy to total energy, we divide the kinetic energy by the total energy:

$$\frac{K}{E} = \frac{\frac{4}{9}kA^2}{\frac{1}{2}kA^2}$$

$$\frac{K}{E} = \frac{\frac{4}{9}}{\frac{1}{2}}$$

$$\frac{K}{E} = \frac{4}{9} \times \frac{2}{1}$$

$$\frac{K}{E} = \frac{8}{9}$$

So, the ratio of kinetic energy to total energy at x=A/3 is 8/9 .

Ques 23. Voltage and resistance for a resistor are measured as V = 200±5V & R = 20 + 0.2 Ω. Find the percentage error in the current I = V /R

Ans. 3.5%

Solution: To find the percentage error in the current (I=V/R), we need to propagate the errors from the measurements of voltage (V) and resistance (R)

The formula for percentage error (%ε) is given by:

$$\%\varepsilon = \left|\frac{\Delta I}{I}\right| \times 100\%$$

Where:

- Δ*I* is the absolute error in current (*I*)
- *I* is the nominal value of current

The current *I* can be calculated as:

I = V/R

Given that V=200±5V and R=20+0.2Ω, we have:

- Nominal voltage (V) = 200 V
- Nominal resistance (R) = 20 Ω

The error in *I* can be found using the formula for propagation of errors:

$$\Delta I = \left|\frac{\partial I}{\partial V}\right| \Delta V + \left|\frac{\partial I}{\partial R}\right| \Delta R$$

Where:

- ΔV is the absolute error in voltage
- ΔR is the absolute error in resistance

Let's calculate the values:

First, we find the derivative of *I* with respect to *V*:

$$I = \frac{V}{R}$$
$$\frac{\partial I}{\partial V} = \frac{1}{R}$$

Then, we find the derivative of *I* with respect to *R*:

$$I = \frac{V}{R}$$
$$\frac{\partial I}{\partial R} = -\frac{V}{R^2}$$

Given:

- V=200±5V
- R=20+0.2Ω

Substituting the values into the formulas:

$$\Delta I = \left|\frac{1}{R}\right| \Delta V + \left|-\frac{V}{R^2}\right| \Delta R$$
$$\Delta I = \left|\frac{1}{20}\right| \times 5 + \left|-\frac{200}{20^2}\right| \times 0.2$$

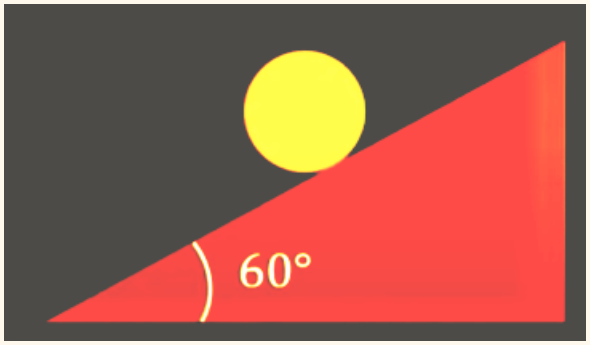
$$\Delta I = (0.05) \times 5 + \left(\frac{200}{400}\right) \times 0.2$$
$$\Delta I = 0.25 + 0.1$$
$$\Delta I = 0.35$$

Now, we can find the nominal value of *I* and then calculate the percentage error:

$$I = \frac{V}{R} = \frac{200}{20} = 10 \text{ A}$$

$$\%\varepsilon = \frac{\Delta I}{I} \times 100\% = \frac{0.35}{10} \times 100\% = 3.5\%$$

Ques 24. A solid cylinder is placed gently over an inclined plane of inclination 60°. The acceleration of the cylinder when it starts rolling without slipping is g/√x where μ is the coefficient of friction. [take g = 10m / (s ^ 2)]



Ans. 3.00

JEE Main Chemistry Questions

Ques 1. Which of the following pairs will be formed by the decomposition of KM_nO_4?

A. MnO_4- , MnO_2
B. K_2MnO_4 , MnO_2
C. $KMnO_4$, MnO_2
D. MnO_2, H_2O

Ans. B

Solution: The decomposition of potassium permanganate (KM_nO_4) can produce various products depending on the conditions. However, under normal conditions, KM_nO_4 decomposes to produce manganese dioxide (M_nO_2), potassium manganate ($K_2M_nO_4$), and oxygen gas(O_2).
The balanced chemical equation for the decomposition of KM_nO_4 is:

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

Given this reaction, the correct pair formed by the decomposition of KM_nO_4 is: K_2MnO_4, MnO_2

Ques 2. Calculate the Molarity of a Solution having density = 1.25 g/ml. %(w/w) of Solute is 36% and Molecular weight of Solute is 36 g/mol

Ans. 12.5 M

Solution: To calculate the molarity of the solution, we first need to find the mass of the solute present in one liter of the solution.
Given:

- Density of the solution = 1.25 g/ml
- Percent (w/w) of solute = 36%
- Molecular weight of solute = 36 g/mol

First, let's find the mass of solute present in 1 liter of the solution.
Since the density is given in g/ml, we can say that 1 liter of the solution would have a mass of 1.25 kg (or 1250 g).
Now, if 36% of this mass is the solute, then the mass of the solute is:
Mass of solute=36%×1250 g
Mass of solute=0.36×1250 g
Mass of solute = 450 g
Now, to find the number of moles of the solute, we use the formula:

Number of moles = $\frac{\text{Mass}}{\text{Molecular weight}}$

Number of moles = $\frac{450\ \text{g}}{36\ \text{g/mol}}$

Number of moles = $12.5\ \text{mol}$

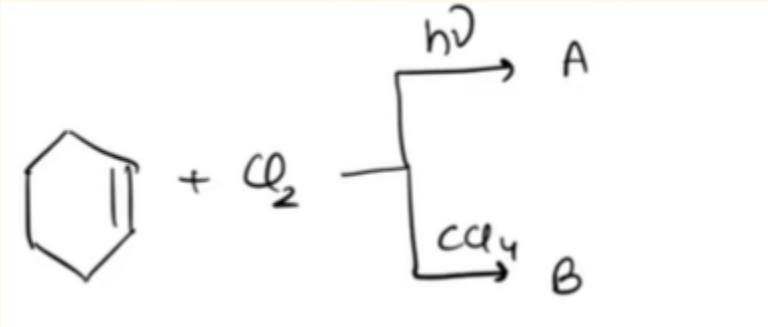
Now, the molarity of the solution is defined as the number of moles of solute per liter of solution. Since we have 12.5 moles of solute in 1 liter of solution, the molarity is:

Molarity = $\frac{\text{Number of moles}}{\text{Volume of solution (in liters)}}$

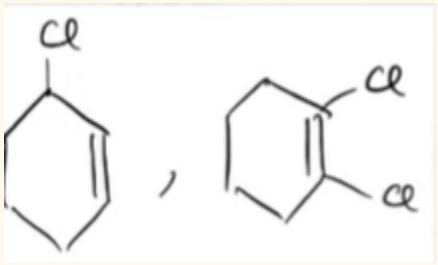
Molarity = $\frac{12.5\ \text{mol}}{1\ \text{L}}$

Molarity = 12.5 M

Ques 3. In the following reactions, find the product A and B



A.



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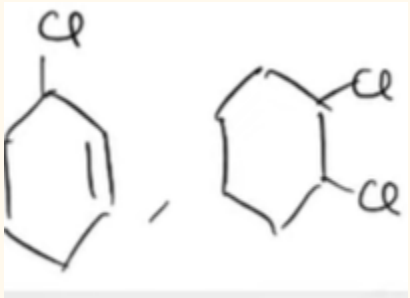
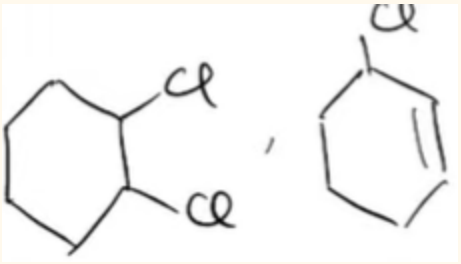
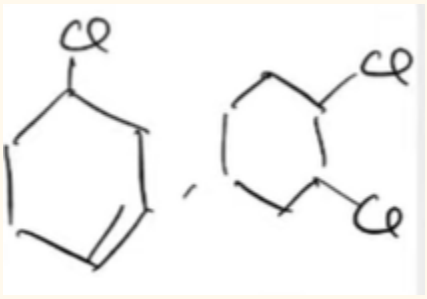


C. 

D. 

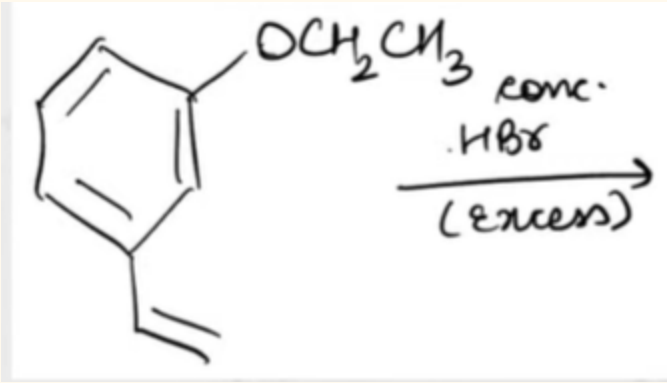
Ans. B

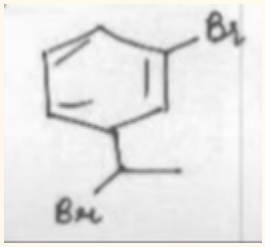
Ques 4. Appearance of Red color on treatment with Na fusion extract of an organic compound with $FeSo_4$ in presence of Conc. H_2SO_4 indicate element

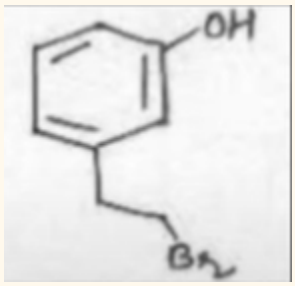
A. N
B. Br
C. S
D. N & S

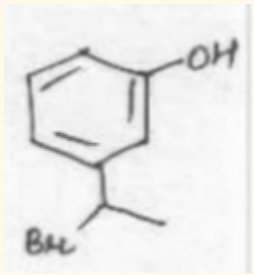
Ans. D

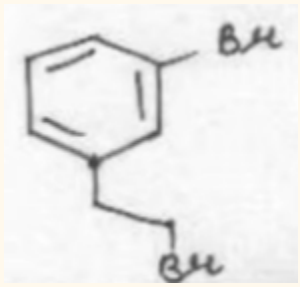
Ques 5. The major product formed in the following reaction is-



A. 

B. 

C. 

D. 

Ans. C

Ques 6. Energy difference between actual structure and its most stable resonating structure having least energy is called

A. Electromeric effect
B. Resonance Energy
C. Inductive effect
D. Hyperconjugation

Ans. B

Solution: The energy difference between the actual structure and its most stable resonating structure with the lowest energy is called "Resonance Energy."

Ques 7. Interaction b/w π bond & Lone pair of e-s on adjacent atoms

A. Resonance
B. Hyperconjugation
C. Inducting Effect
D. Electronic & effect

Ans. A

Ques 8. Which of The following coordination compounds has bridging carbonyl ligand

A. $[Mn_2(CO)_{10}]$
B. $[Co_2(CO)_8]$
C. $[Cr(CO)_6]$
D. $[Fe(CO)_5]$

Ans. B

Solution: The coordination compound with a bridging carbonyl ligand is:

B) [Co2(CO)8]

In this compound, two cobalt atoms are bridged by carbonyl ligands.

Ques 9. Alkaline KMnO4 Oxidises iodide to a particular product (A). Determine the oxidation state of iodine in the compound (A)

A. +2
B. -3
C. +5
D. -7

Ans. C

Ques 10. Which of the following statements is incorrect?

A. △G = 0 for reversible reaction
B. △G < 0 for spontaneous process
C. △G > 0 for spontaneous process
D. △G < 0 for non-spontaneous process

Ans. C

Solution: The incorrect statement is:

C) ΔG > 0 for a spontaneous process.

The correct statement is that ΔG < 0 for a spontaneous process.

Therefore, the incorrect statement is option C.

Ques 11. Given K_{net} =(K_1.K_2)/K_3 When Ea_1= 40 kJ/mol, Ea_2= 50 kJ/mol and Ea_3= 60 kJ/mol Calculate the value of $(Ea)_{net}$ in kJ/mol.

Ans. 30 kJ/mol

Solution: To find the net activation energy (E net) using the given equation, we need to understand that K net represents the rate constant of the overall reaction, which involves three consecutive elementary reactions. The rate constant (k) of a reaction is related to the activation energy (E a) by the Arrhenius equation:

$$k = A \cdot e^{-\frac{E_a}{RT}}$$

Where:

- k is the rate constant
- A is the pre-exponential factor (frequency factor)
- E a is the activation energy
- R is the gas constant ($8.314 J/mol \cdot K$)
- T is the temperature in Kelvin

Given the equation for K net:

$$K_{\text{net}} = \frac{K_1 \cdot K_2}{K_3}$$

We know that:

$$K_i = A_i \cdot e^{-\frac{E_{a_i}}{RT}}$$

Substituting these expressions into the equation for K net, we get:

$$K_{\text{net}} = \frac{(A_1 \cdot e^{-\frac{E_{a_1}}{RT}}) \cdot (A_2 \cdot e^{-\frac{E_{a_2}}{RT}})}{A_3 \cdot e^{-\frac{E_{a_3}}{RT}}}$$

Now, we can simplify this equation:

$$K_{\text{net}} = \frac{A_1 \cdot A_2}{A_3} \cdot e^{-\frac{E_{a_1} + E_{a_2} - E_{a_3}}{RT}}$$

Comparing this expression with the Arrhenius equation, we see that:

$$E_{\text{net}} = E_{a_1} + E_{a_2} - E_{a_3}$$

Now, let's substitute the given activation energy values into this equation:

$$E_{\text{net}} = 40\,\text{kJ/mol} + 50\,\text{kJ/mol} - 60\,\text{kJ/mol}$$

$$E_{\text{net}} = 30\,\text{kJ/mol}$$

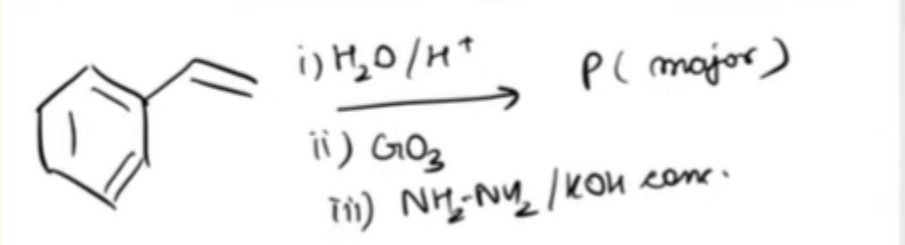
Therefore, the net activation energy (E net) is 30kJ/mol

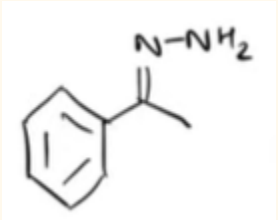
Ques 12. What is the effect that occurs between lone pair and pi bond?

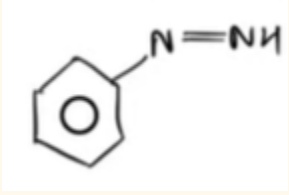
A. Inductive effect
B. Electromeric effect
C. Resonance effect
D. Hyperconjugation

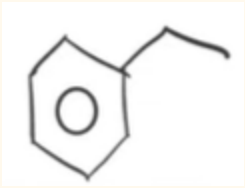
Ans. C

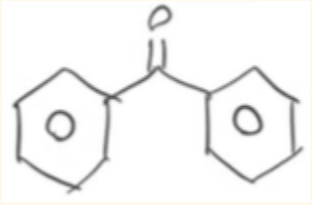
Ques 13. Find product P of the following reaction-



A. 

B. 

C. 

D. 

Ans. C

Ques 14. Statement 1: Electronegativity of group 14 elements decreases from Si to Pb
Statement 2: Group 14 has metals, metalloids and nonmetals

A. Both statements 1 and 2 are correct
B. Both statements 1 and 2 are incorrect
C. Statement 1 is correct and statement 2 is incorrect
D. Statement 1 is incorrect and statement 2 is correct

Ans. D

Solution: Let's evaluate each statement:

Statement 1: Electronegativity of group 14 elements decreases from Si to Pb.

This statement is incorrect. In group 14 elements (also known as the carbon group), electronegativity generally increases from top to bottom within the group. Carbon has the highest electronegativity, and the electronegativity decreases as we move down the group.
Statement 2: Group 14 has metals, metalloids, and nonmetals.

This statement is correct. Group 14 of the periodic table includes elements such as carbon (a nonmetal), silicon (a metalloid), and tin and lead (metals). Therefore, it encompasses metals, metalloids, and nonmetals. Therefore, the correct answer is:

D) Statement 1 is incorrect and statement 2 is correct.

Ques 15. Hydrolysis of protein gives which type of amino acids

A. α- Amino acids
B. β- Amino acids
C. γ- Amino acids
D. δ- Amino acids

Ans. A

Solution: The hydrolysis of proteins typically yields α-amino acids.

Therefore, the correct answer is:

A) α-Amino acids

Ques 16. How many of the following compounds have one lone pair in the central atom?
ClF3, XeO3, BrF5, XeF4, O3, NH3

Ans. B

Ques 17. A container contains 1 g H_2 gas and 1g O2 gas. What is the ratio of partial pressure of H_2 and O_2 (P_{H2}/ P_{O2})

A. 16:1
B. 8:1
C. 4:1
D. 1:1

Ans. A

Solution: To find the ratio of the partial pressures of H_2 and O_2 (P_{H2}/ P_{O2}) we need to first determine the moles of each gas and then use Dalton's law of partial pressures, which states that the total pressure exerted by a mixture of gases is the sum of the partial pressures of the individual gases.
Given:

- Mass of H_2 gas = 1 g
- Mass of O_2 gas = 1 g
- Molecular weight of H_2 = 2 g/mol
- Molecular weight of O_2 = 32 g/mol

First, let's calculate the number of moles of each gas:

Number of moles of H_2 = mass / molar mass = 1 g / 2 g/mol = 0.5 mol
Number of moles of O_2 = mass / molar mass = 1 g / 32 g/mol = 0.03125 mol
Now, let's find the ratio of the partial pressures:

$$P_{H_2}/P_{O_2} = (n_{H_2} \times R \times T)/(n_{O_2} \times R \times T)$$

$$P_{H_2}/P_{O_2} = n_{H_2}/n_{O_2}$$

Substituting the values:

$$P_{H_2}/P_{O_2} = 0.5mol/0.03125mol$$

$$P_{H_2}/P_{O_2} = 16$$

So, the ratio of the partial pressures of H_2 to O_2 is 16:1.

Ques 18. How many of the following species have Bond order =1 and are Paramagnetic as well.
He_2^{2+}, O^{2-}_2, Ne_2^{2+}, F_2, B_2, H_2, O_2^{2+}

Ans. 1

Ques 19. Match the following:

Column 1	Column 2
(A) Flourspar	(p) $Al_2O_3.2H_2O$
(B) Cryolite	(q) CaF_2
(C) Bauxite	(r) $MgCO_3.CaCO_3$
(D) Dolomite	(s) $Na_3[AlF_6]$

A. (A) - s; (B)-q; (C) - r; (D) - p
B. (A)-q; (B)-s; (C) - p; (D) - r
C. (A) - p; (B) - q; (C) - s; (D) - r
D. (A)-q; (B) - s; (C) - r; (D) - p

Ans. B

JEE Main Mathematics Questions

Ques 1. Let a die roll till 2 is obtained. The probability that 2 obtained on even numbered toss is equal to:

A. 5/11
B. 5/6
C. 1/11
D. 6/11

Ans. A

Ques 2. Evaluate: $\lim_{x\to\frac{\pi}{2}^-} \frac{\int_{x^3}^{\left(\frac{\pi}{2}\right)^3} \cos t^{\frac{1}{3}}\, dt}{\left(x-\frac{\pi}{2}\right)^2}$

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

Ans. C

Ques 3. $\frac{C_1^{11}}{2}+\frac{C_2^{11}}{3}+\cdots+\frac{C_9^{11}}{10}=\frac{m}{n}$. Then m+n is

Ans. 2041

Ques 4. Rank of the word 'GTWENTY' in dictionary is ……

Ans. 553

Ques 5. If $|2A|^3$ =21 and A= $\begin{bmatrix}1&0&0\\0&\alpha&\beta\\0&\beta&\alpha\end{bmatrix}$ **, then a is (if α, β € I)**

A. 5
B. 3
C. 9
D. 17

Ans. A

Ques 6. In a 64 terms GP if sum of total terms is seven times sum of odd terms, then common ratio is:

A. 3
B. 4
C. 5
D. 6

Ans. D

Ques 7. If $\frac{dy}{dx} - \left(\frac{\sin 2x}{1+\cos^2 x}\right) y = \frac{\sin x}{1+\cos^2 x}$ **and y(0) =0 then y(π/2) is …….**

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

Ans. B

Ques 8. If 4 cosθ + 5 sinθ = 1, then all possible values of tanθ, is/are where 8 € (-π/2,π/2)

A. 1
B. 3
C. 2
D. 4

Ans. C

Ques 9. Given data 60, 60, 44, 58, 68, α, ß, 56 has mean 58, variance = 66.2 then find $\alpha^2 + ß^2$

Ans. 7182

Ques 10. If : |z + 1| = αz + ß(i + 1) and z = 1/2 - 2i, find α + ß.

Ans. 3

Ques 11. In an increasing arithmetic progression a1, a2,..., an if a6 = 2 and product of a1, a5 and a4 is greatest, then the value of d is equal to

A. 1.6
B. 1.8
C. 0.6
D. 2.0

Ans. A

Ques 12. If relation R : (a, b)R(c, d) is only if ad - bc is divisible by 5, (a, b, c, d ∈ Z) then R is:

A. Reflexive
B. Symmetric, Reflexive but not Transitive
C. Reflexive, Transitive but not Symmetric
D. Equivalence Relation

Ans. B

Ques 13. If f(x)= $\begin{cases} 2+2x & ; x \in (-1,0) \\ 1-\frac{x}{3} & ; x \in [0,3) \end{cases}$ **and g(x)=** $\begin{cases} x & ; x \in [0,1) \\ -x & ; x \in (-3,0) \end{cases}$
Then range of fog(x) is

A. [0, 1]
B. (0,1]
C. [-1,1]
D. (-1,1)

Ans. C

Ques 14. If $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left(\frac{x^2 \cos x}{1+\pi^x} + \frac{1+\sin^2 x}{1+e^{(\sin x)^{2023}}} \right) dx = \frac{\pi}{4}(\pi + \alpha) - 2$ **Then the value of 'a' is equal to**

A. 1
B. 2
C. 3
D. 4

Ans. C

Ques 15. Area under the curve x ^ 2 + y ^ 2 = 169 and below the line 5x - y = 13 is:

A. $(169\pi)/4 - 65/2 + 169/2 \sin^{-1}(12/13)$
B. $(169\pi)/4 + 65/2 - 169/2 \sin^{-1}(12/13)$
C. $(169\pi)/4 - 65/2 + 169/2 \sin^{-1}(13/14)$
D. $(169\pi)/4 + 65/2 + 169/2 \sin^{-1}(13/14)$

Ans. A