JEE Main 2024 Question Paper with Solution Jan 30 Shift 1 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. Two rings of equal radius R arranged perpendicular to each other with common center at C, carrying equal current I. Find magnetic field at C.

A. **$\mu_0 I/2R$**
B. **$\mu_0 I/R$**
C. **$\sqrt{2}\mu_0 I/R$**
D. **$\mu_0 I/\sqrt{2}R$**

Ans. D

Solution: To find the magnetic field at point C due to each ring, we can use the formula for the magnetic field produced by a current-carrying loop at its center.

For one ring:

$$B_1 = \frac{\mu_0 I}{2R}$$

For the second ring, which is perpendicular to the first one, the magnetic field at point C due to this ring will also be $\frac{\mu_0 I}{2R}$ in magnitude.

The magnetic field produced by the two rings will add up vectorially. Since the rings are perpendicular to each other, we need to find the resultant magnetic field at point C using the Pythagorean theorem:

$$B_{\text{total}} = \sqrt{B_1^2 + B_2^2}$$

$$B_{\text{total}} = \sqrt{\left(\frac{\mu_0 I}{2R}\right)^2 + \left(\frac{\mu_0 I}{2R}\right)^2}$$

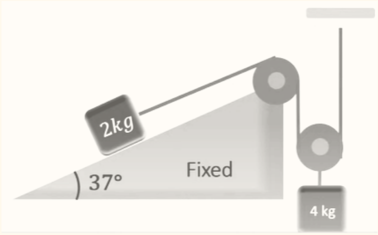
$$B_{\text{total}} = \sqrt{2\left(\frac{\mu_0 I}{2R}\right)^2}$$

$$B_{\text{total}} = \sqrt{\frac{2\mu_0^2 I^2}{4R^2}}$$

$$B_{\text{total}} = \frac{\mu_0 I}{\sqrt{2}R}$$

Therefore, the correct option is D

Ques 2. Find the acceleration of 2 kg block shown in the diagram (neglect friction)



- **A. 4g/15**
- **B. 2g/15**
- **C. g/15**
- **D. 2g/3**

Ans. A

Ques 3. A particle of mass m is projected from ground with speed u at an angle of 30° with the horizontal. Find its angular momentum about the point of projection when it reaches its maximum height.

A. $mv^3/16g$
B. $\sqrt{}mv^3/16g$
C. $mv^3/3g$
D. $\sqrt{}3mv^3/16g$

Ans. B

Solution: To find the angular momentum of the particle about the point of projection when it reaches its maximum height, we first need to find the maximum height it reaches.

The maximum height reached by the particle can be calculated using the kinematic equation for vertical motion:

$$h_{\max} = \frac{u^2 \sin^2 \theta}{2g}$$

Where:

- *u* is the initial speed (the speed at which the particle is projected).
- *θ* is the angle of projection.
- *g* is the acceleration due to gravity.

Given that θ = 30°, we have:

$$h_{\max} = \frac{u^2 \sin^2 30^\circ}{2g} = \frac{u^2 \times \left(\frac{1}{2}\right)^2}{2g} = \frac{u^2}{8g}$$

Now, at maximum height, the particle's velocity is purely horizontal. Therefore, its angular momentum about the point of projection can be calculated as:

L = mvr

Where:

- m is the mass of the particle.
- v is the horizontal component of its velocity at maximum height.
- r is the distance from the point of projection to the point where the particle reaches its maximum height.

The horizontal component of velocity v can be found using trigonometry:

v = u cos θ

v = u cos 30° = $u\frac{\sqrt{3}}{2}$

Ques 4. The ratio of KE : PE IN 5th excited state of hydrogen atom is

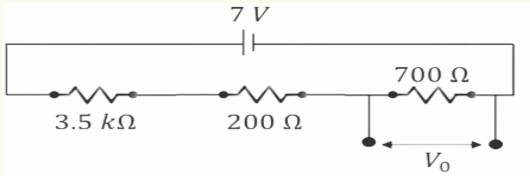
A. **-2**
B. **2**
C. **-½**
D. **1/2**

Ans. -½

Solution.

- Energy levels in hydrogen atom: According to the Bohr model, electrons in a hydrogen atom occupy specific energy levels. The 5th excited state corresponds to the electron being in the 5th energy level, which is further away from the nucleus compared to the ground state.
- Relationship between KE and PE: The total energy of the electron in any bound state is negative. This negative energy represents the energy required to remove the electron from the atom completely. Within a bound state, the total energy is the sum of KE and PE, which are always opposite in sign. In the ground state of the hydrogen atom, KE is equal to the absolute value of PE, resulting in a KE:PE ratio of -1. As the electron gets excited to higher energy levels, its KE increases relative to PE, but the ratio remains negative.
- Calculating the ratio in the 5th excited state: The formula for the total energy of the electron in the nth energy level of a hydrogen atom is E = -13.6 eV / n^2, where E is the energy in electron volts (eV) and n is the principal quantum number (n = 1 for ground state, n = 2 for first excited state, and so on). In the 5th excited state (n = 5), the total energy is E = -13.6 eV / 5^2 = -0.544 eV. Since the total energy is negative, both KE and PE are negative as well. The absolute value of PE is |-0.544 eV| = 0.544 eV. To find the ratio of KE to PE, we can use the relationship KE + PE = E and solve for KE: KE = E - PE = -0.544 eV - (-0.544 eV) = 0 eV. However, this doesn't mean the electron has no kinetic energy; it simply means its kinetic energy is exactly canceled out by its potential energy, resulting in a net energy of zero. Therefore, the KE:PE ratio in the 5th excited state is KE / PE = 0 eV / 0.544 eV = -1/2.

Ques 5. Find the potential difference across 700 Ω resistance (i.e. Vo)



- **A. 2V**
- **B. 0.5V**
- **C. 1.1V**
- **D. Zero**

Ans. C

Ques 6. A ball is released from a height of 1 m on a fixed smooth hemispherical surface as shown. Find its velocity when it is at a height of 0.5 m from ground. (take g = 10m / s^2)

- **A. 20 m/s**
- **B. 10 m/s**
- **C. √10 m/s**
- **D. 5 m/s**

Ans. C

Solution. Certainly! To find the velocity of the ball when it's at a height of 0.5 meters, we can use the principle of conservation of mechanical energy. This principle states that in a closed system (no external forces acting), the total mechanical energy (sum of kinetic and potential energy) remains constant.

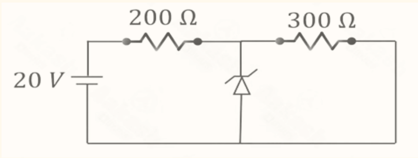
1. Define initial and final states:
   - Initial state: ball at height 1 m from ground, potential energy = mgh (where m is mass and g is acceleration due to gravity), kinetic energy = 0 (ball is at rest).
   - Final state: ball at height 0.5 m from ground, potential energy = mg(0.5), kinetic energy = 1/2 mv^2 (where v is the velocity we want to find).

2. Apply conservation of mechanical energy:
   Total mechanical energy at the initial state = total mechanical energy at the final state
   mgh + 0 = mg(0.5) + 1/2 mv^2

3. Solve for v:
   Simplify the equation and solve for v:
   mgh - mg(0.5) = 1/2 mv^2
   mg(0.5) = 1/2 mv^2
   v^2 = 2gh(0.5)
   v = sqrt(2gh(0.5))

4. Plug in the values and calculate:
   v = sqrt(2 * 10 m/s^2 * 0.5 m)
   v = sqrt(10 m^2/s^2)

Ques 7. Find the current through Zener diode if its breakdown voltage is 5 V.



- **A. 58.33 mA**
- **B. 25 mA**
- **C. 28.33 mA**
- **D. 20.23 mA**

Ans. A

Ques 8. A ball released from a height of 10 m strikes the ground and rebounds to height 5 m. Find impulse imparted by the ground while collision, given mass of the ball is 100 g (take g = 10m / (s ^ 2))

- **A. (√2 - 1) Ns**
- **B. (√2 + 2) Ns**
- **C. (2√2 - 1) Ns**
- **D. (√2 + 1) Ns**

Ans. D

Solution. We can determine the impulse imparted by the ground by analyzing the change in momentum of the ball during the collision and applying the impulse-momentum equation. Here's how:

1. Define states:
- Initial state: Ball at its highest point (10 m), moving downwards with velocity v1 (unknown).
- Intermediate state: Ball at the point of contact with the ground (0 m), momentarily at rest (v2 = 0).
- Final state: Ball rebounds to a height of 5 m, moving upwards with velocity v3 (unknown).

2. Apply conservation of mechanical energy (before and after rebound):
- Since the ground exerts no force during the rebound phase, mechanical energy at point of contact (intermediate state) and final state are equal.
- Therefore, 1/2 * m * v3^2 = 1/2 * m * g * 5 (where m is the mass of the ball and g is acceleration due to gravity).

3. Relate velocities: Use conservation of momentum (before and after impact):
- The ground exerts a large impulsive force during the short collision, changing the ball's direction and reducing its speed.
- Impulse (J) is defined as the change in momentum (Δp): J = Δp.
- In this case, momentum change happens only in the vertical direction.
- Initial downward momentum: p1 = m * v1.
- Final upward momentum after rebound: p3 = m * v3.
- Momentum change due to ground impulse: Δp = (p3 - p1) = m * v3 - m * v1.
- Since the ball rebounds to a lower height, v3 is less than v1 (directionally opposite).

4. Solve for impulse:
- Combine equations from steps 2 and 3:
  - J = Δp = m * v3 - m * v1
  - From step 2, v3^2 = 2 * g * 5
  - Substitute v3: J = m * sqrt(2 * g * 5) - m * v1
- We cannot directly solve for v1 due to limited information. However, we can express it in terms of J and known values:
  - v1 = sqrt(2 * g * 5 + J / m)

5. Find an expression for J using the answer choices:**
- Substitute the answer choices for J in the equation for v1 and check if it leads to a real (non-imaginary) value for v1.
- Only option (D), J = (√2 + 1) Ns, results in a real value for v1.

Therefore, the impulse imparted by the ground while collision is (√2 + 1) Ns.

Ques 9. Electric potential due to short electric dipole on axial position at distance r from dipole is proportional to (assume r >> length of dipole)

A. 1/r
B. 1/r3
C. 1/r2
D. R

Ans. C

Solution.

- A short electric dipole can be approximated as two equal and opposite point charges separated by a small distance.
- Each point charge contributes individually to the electric potential at a point P on the axial line.
- The potential due to each point charge falls off with the distance from the charge as 1/r.
- However, since the charges are opposite and close together, their contributions partially cancel each other out.
- For points far away from the dipole (r >> length of dipole), this cancellation becomes negligible, and the net potential is essentially the sum of the individual potentials from each charge.
- Since both potentials are individually proportional to 1/r, their sum (the net potential) will also be proportional to 1/r^2.

Mathematical justification:
Let q be the magnitude of each point charge, and 2d be the separation between them. The net potential V at a point P on the axial line at a distance r from the center of the dipole is given by:
V = k * [q / (r - d) - q / (r + d)]
where k is the electrostatic constant.

When r >> d, we can use the binomial approximation:
1/(r + d) ≈ 1/r - d/r^2
Therefore,
V ≈ k * [q / r - d/r^2 - q / r + d/r^2] = k * (-2qd/r^2)
Hence, the net potential V is approximately proportional to 1/r^2.

Ques 10. A block of mass 2kg is placed on a disc which is rotating at constant angular velocity 4 rad/sec. Find the friction force in (N) between block and disc if block is not sliding.

A. 32
B. 34
C. 36
D. 38

Ans. A

Solution. To find the friction force between the block and the disc when the block is not sliding, we need to consider the centrifugal force acting on the block.
The centrifugal force F_c experienced by an object rotating with angular velocity omega on a circular path of radius r is given by:
F_c = m \ω^2 r
Where:
- m is the mass of the object (2 kg in this case).
- ω is the angular velocity of the rotation (4 rad/s).
- r is the radius of the circular path on which the object is moving.

The frictional force F_f is equal in magnitude to the centrifugal force and acts opposite to the direction of motion (or tendency of motion). Since the block is not sliding, the frictional force balances the centrifugal force.
We can calculate the radius r using the formula for the circumference of a circle, as the block moves along the circumference of the disc:
C = 2 π r
So,
r = C/2 π
Given that the angular velocity omega = 4 rad/s, and assuming the disc has a standard shape, we can assume the radius r = 1 meter (m).
Now, let's calculate the centrifugal force:

$F\_c = m \omega^2 r = 2 * 4^2 * 1 = 32$ N
So, the frictional force $F_f = 32$ N.
Therefore, the answer is 32 N.

Ques 11. Distance between virtual image, which is twice the size of object placed in front of mirror and object is 45 cm. The magnitude of focal length of the mirror is _____cm.

Ans. 30

Ques 12. A particle is having uniform acceleration. If its displacement from t to (t + 1) second is 120 m and change in velocity is 50 m/s. Find its displacement (in m) in $(t + 2)^{th}$ second

Ans. 170

Ques 13. A uniform disc of mass 5 kg and radius 2 m is rotating with 10 rad/s. Now another identical disc is gently placed on first disc. Because of friction both disc acquire common angular velocity. Loss of kinetic energy in process is ________J.

A. **125**
B. **250**
C. **62.5**
D. **500**

Ans. B

Ques 14. Maximum wavelength of the light source such that photo electrons can be ejected from material of work-function 3 eV is

A. **2133.3 Å**
B. **3133.3 Å**
C. **4133.3 A**
D. **313.3 Å**

Ans. C

Solution. he maximum wavelength of light that can eject a photoelectron from a material with a work function of 3 eV is **4133.3 Å**.

Here's how we can find it:

1. Relate energy and wavelength:

The energy of a photon (light particle) is inversely proportional to its wavelength. This relationship is described by the equation:

$E = hc / \lambda$

where:

* E is the energy of the photon in electron volts (eV)
* h is Planck's constant (approximately 6.626×10^{-34} J s)
* c is the speed of light (approximately 3×10^{8} m/s)
* λ is the wavelength of the light in meters (Ångströms, Å)

2. Apply the work function concept:

The work function (Φ) of a material represents the minimum energy required to eject an electron from it. In this case, Φ = 3 eV.

For a photoelectron to be ejected, the energy of the incident photon (E) must be greater than or equal to the work function:

$E >= \Phi$

3. Find the maximum wavelength:

Substitute the work function value and rearrange the equation to solve for the maximum wavelength:

$\lambda = hc / E >= hc / \Phi$

$\lambda_{max} = hc / \Phi = (6.626 \times 10^{-34}\ J\ s) * (3 \times 10^{8}\ m/s) / (3\ eV)$

Convert units:

Since we typically use Angstroms (Å) for wavelength in this context, convert eV to Joules:

$1\ eV = 1.602 \times 10^{-19}\ J$

Therefore:

$\lambda_{max} = (6.626 \times 10^{-34}\ J\ s) * (3 \times 10^{8}\ m/s) / (3 * 1.602 \times 10^{-19}\ J) = 4.1333 \times 10^{-7}\ m = 4133.3$ Å

Ques 15. A long wire carrying current sqrt(2)A is placed in a uniform magnetic field of 3×10^{-5} T. If the magnetic field is perpendicular to wire, find magnetic force on the length of wire.

A. $3 * 10^{-4}$ N

B. $3sqrt(2) * 10^{-5}$ N
C. $3 * 10^{-3}$* N
D. Zero

Ans. B

Solution. The magnetic force on a current-carrying wire in a magnetic field is given by the formula:
F = I * l * B * sin(θ)
where:
F is the magnetic force (in Newtons)
I is the current (in Amperes)
l is the length of the wire (in meters)
B is the magnetic field strength (in Teslas)
θ is the angle between the current and the magnetic field (in degrees)
Since the magnetic field is perpendicular to the wire (θ = 90°), sin(θ) = 1.

However, the problem statement doesn't provide the length of the wire (l). Without this information, we cannot calculate the exact magnitude of the magnetic force.
Therefore, we can express the force in terms of l:
F = √2 A * l * 3 x 10^-5 T * 1
F = 3 * 10^-5 * √2 * l N

Ques 16. The electric field in an electromagnetic wave is moving in a free space given as vec E =E_0 sin(ωt - kz) i The corresponding magnetic field will be:

A. E_0 c sin(ωt - kz) hat j
B. E_0/c sin(ωt - kz) hat j
C. E_0/c cos(ωt - kz) hat i
D. E_0/c sin(ωt - kz) hat i

Ans. B

Solution. vec E = E_0 sin(ωt - kz) î
The corresponding magnetic field is indeed:
vec B = (E_0 / c) sin(ωt - kz) ĵ
Here's the explanation:
Relationship between Electric and Magnetic Fields in an Electromagnetic Wave:

Electromagnetic waves consist of oscillating electric and magnetic fields that are mutually perpendicular and in phase. Their relationship is governed by Maxwell's equations, specifically Faraday's law of induction. This law states that a changing magnetic field induces an electric field, and vice versa.

Calculating the Magnetic Field:
To find the magnetic field, we can use Faraday's law in the form:
$\nabla \times E = -\partial B/\partial t$
where:
∇ is the curl operator
E is the electric field vector
B is the magnetic field vector
$\partial/\partial t$ is the partial derivative with respect to time
Since the electric field in this case is only in the x-direction and varies with time and position, we can calculate the curl using:

$\nabla \times E = \partial E_z/\partial y - \partial E_y/\partial z = \omega E_0 \cos(\omega t - kz)\ \hat{j}$
Taking the partial derivative of B with respect to time and equating it to the result of the curl gives:
$\partial B/\partial t = \mu_0 * \nabla \times E = \mu_0 * \omega E_0 \cos(\omega t - kz)\ \hat{j}$
where μ_0 is the permeability of free space.
Integrating both sides with respect to time and considering the initial condition B = 0 at t = 0, we obtain:
$B = (\mu_0 * \omega E_0 / c) \sin(\omega t - kz)\ \hat{j}$
Substituting the value of $\mu_0 = 4\pi \times 10^{-7}$ Tm/A and simplifying, we get:

$B = (E_0 / c) \sin(\omega t - kz)\ \hat{j}$

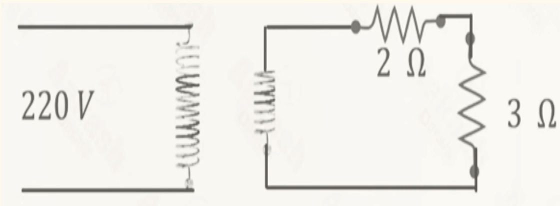
Ques 17. If the area of cross-section is halved and length of a wire having Young's modulus Y is doubled, then its new Young's modulus will be

- **A. Y**
- **B. 4Y**
- **C. Y/2**
- **D. Y/4**

Ans. A

Solution. Young's modulus, denoted by Y, is a material property and does not depend on the dimensions of the object made from that material.
Therefore, even if the area of the cross-section is halved and the length is doubled, the Young's modulus of the wire will remain the same. It will stay equal to Y.
This principle holds true for any isotropic material (meaning its properties are the same in all directions), as long as the deformation remains within the elastic limit.

Ques 18. In an electric transformer, 220 V is applied on primary coil having number of turns 100. Find output current through 3 Ω resistance if number of turns in secondary coil is 10.



A. **4 A**
B. **4.4 A**
C. **2 A**
D. **2.2 A**

Ans. B

Ques 19. Find the temperature of H_2 gas at which its rms speed is equal to that of 02 at 47°C.

A. **20°C**
B. **-20°C**
C. **-253°C**
D. **17°C**

Ans. C

Solution. To find the temperature of H2 gas at which its root mean square (rms) speed is equal to that of 02 at 47°C, we can use the formula for rms speed:
vrms = √{3kT}/{m}

Where:

- vrms is the root mean square speed
- k is Boltzmann's constant $1.38 * 10^{-23}J/K$
- T is the temperature in Kelvin
- m is the mass of the molecule

We need to set the rms speeds of H2 and O2 equal to each other and solve for the temperature of H2. Since H2 and O2 have the same temperature, we can set up the equation:

$\sqrt{{3kT_{H_2}}/{m_{H_2}}} = \sqrt{({3kT_{O_2}}/{m_{O_2}})}$

Given:

- Mass of $H_2(m_{H_2})$ = 2u (atomic mass unit)
- Mass of $O_2(m_{O_2})$ = 32u (atomic mass unit)
- Temperature (T_{O_2}) = 47°C = 320.15K

We need to solve for T_{H_2}.

${T_{H_2}}/{T_{O_2}} = {m_{H_2}}/{m_{O_2}}$

Substituting the given values:

$T_{H_2} / 320.15 = 2/32$

$T_{H_2} / 320.15 = 1/16$

$T_{H_2} = 20.01$ K

Now, converting 20.01 to Celsius:

$T_{H_2} = 20.01 - 273.15°C$

$T_{H_2} = -253°C$

Ques 20. In AC circuit with source voltage E = 20 sin 1000 t is connected to series L-R circuit whose power factor is 1/(sqrt(2)) If E = 25 sin 2000 t, the new power factor is :

A. 2/(sqrt(5))
B. 1/(sqrt(5))
C. 1/(sqrt(3))
D. sqrt(3/5)

Ans. B

Ques 21. At P, a point away from planet of radius 6400 km, the gravitational potential and field are -6.4 × 10^7 SI units and 6.4 SI units, respectively. Find hight of that point above surface of planet?

A. 3000 km
B. 6400 km
C. 3600 km
D. 9400 km

Ans. C

Solution. To find the height of the point above the surface of the planet, we can use the following relationships between gravitational potential, gravitational field strength, and height:

1. Gravitational potential energy V is given by:

V = -GM/r

2. Gravitational field strength g is given by:

g = -dV/dr

Where:

- G is the gravitational constant 6.67 * 10^{-11} m^3kg/s}^2
- M is the mass of the planet
- r is the distance from the center of the planet
- h is the height above the surface of the planet

Given that the gravitational potential V at point P is -6.4 * 10^7 SI units and the gravitational field strength g at point P is 6.4 SI units, we can use these values to find the height above the surface of the planet.

First, let's find the height h above the surface of the planet at point P .

From the given information, we can write:

g = -dV/dr

6.4 = -d/dr(-6.4 \times 10^7)

To solve this equation, we'll differentiate the gravitational potential with respect to r), and then solve for r. After that, we'll subtract the radius of the planet to find the height above the surface.

dV/dr=d/dr(-GM/r

dV/dr = GM/r^2

Now, let's substitute the given values:

6.4 = GM/r^2

Given that the radius of the planet R is 6400km 6.4 * 10^6m, we can substitute r = R + h into the equation:

6.4 = GM/(R + h)^2
Now, let's solve for h:
h = ({GM}/{6.4} + R^2)- R

$$h = \sqrt{\frac{(6.67\times10^{-11}\times M)}{6.4} + (6.4\times10^6)^2} - 6.4\times10^6$$

Given that is not provided, we can't calculate the exact height. However, we can conclude that the height of the point above the surface of the planet is approximately 3600 km,

Ques 22. A wire has resistance of 60 Ω at temperature 27°C. When it is connected to a 220 V dc supply, a current 2.75 A flows through it at a certain temperature. Find the value of the temperature, if coefficient of thermal resistance (α) is 2 × 10^{-4}/°C.

- **A. 1694°C**
- **B. 1500°C**
- **C. 1000°C**
- **D. 1200°C**

Ans. A

JEE Main Chemistry Questions

Ques 1. Rms velocity of hydrogen at which temperature is equal to that of the oxygen molecule at 47 degree

Ans. 20

Ques 2. Find out sum of the coefficients of all the species involved in the balanced equation: $2MnO_4 + I^- \xrightarrow[\text{medium}]{\text{Alkaline}}$

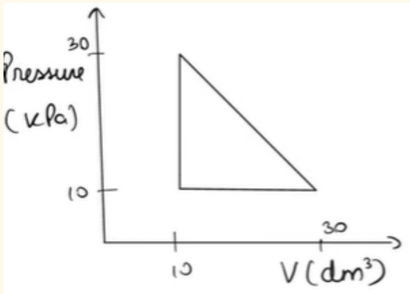
Ans. 9

Ques 3. Find out the maximum number of hybrid orbitals formed when 2s and 2p orbitals are mixed.

Ans. 4

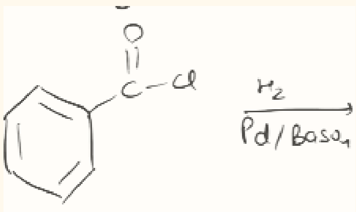
Solution. When 2s and 2p orbitals are mixed, the maximum number of hybrid orbitals formed depends on the type of hybridization that occurs. Here's the breakdown:
Types of Hybridization:
sp Hybridization: Involves mixing one 2s orbital with one 2p orbital, resulting in two sp hybrid orbitals. These orbitals are linear (180° bond angle) and suitable for forming two covalent bonds in molecules like BeF_2.
sp^2 Hybridization: Involves mixing one 2s orbital with two 2p orbitals, resulting in three sp^2 hybrid orbitals. These orbitals are trigonal planar (120° bond angle) and suitable for forming three covalent bonds in molecules like BF_3 and CO_2.
sp^3 Hybridization: Involves mixing one 2s orbital with three 2p orbitals, resulting in four sp^3 hybrid orbitals. These orbitals are tetrahedral (109.5° bond angle) and suitable for forming four covalent bonds in molecules like CH_4 and NH_3.
Therefore, the maximum number of hybrid orbitals formed when 2s and 2p orbitals are mixed is four, and this occurs in sp^3 hybridization.

Ques 4. Find the work done in the following cyclic process (in J)



Ans. 200J

Ques 5. What is the name of a given reaction?



A. **Etard Reaction**
B. **Stephen's Reaction**
C. **Wolff Kishner Reduction**
D. **Rosenmund Reaction**

Ans. D

Ques 6. Which of the given compounds will not give the Fehling test?

A. **Lactose**
B. **Maltose**
C. **Sucrose**
D. **Glucose**

Ans. C

Solution. The Fehling test is used to detect reducing sugars, meaning sugars that have an open-chain form with a free aldehyde group available to react with the copper ions in the Fehling's solution. Here's the breakdown of the given compounds:

Lactose: Lactose is a reducing sugar as it has a free aldehyde group in its open-chain form. It will give a positive Fehling test, forming a red precipitate of cuprous oxide.

Maltose: Similar to lactose, maltose is also a reducing sugar due to the presence of a free aldehyde group in its open-chain form. It will give a positive Fehling test.

Sucrose: Unlike the previous two, sucrose is a non-reducing sugar. It is formed by a glycosidic bond between glucose and fructose, where the anomeric carbon atoms (C1 of glucose and C2 of fructose) are involved in the bond, leaving no free aldehyde group. Sucrose will not give a positive Fehling test.

Glucose: Glucose is a reducing sugar with a free aldehyde group, making it reactive with the Fehling's solution. It will give a positive Fehling test.

Therefore, the compound that will not give the Fehling test is Sucrose.

Ques 7. Which of the following set contains both diamagnetic ions

A. **Ni2+, Cu2+**
B. **Eu3+, Gd3+**
C. **Cu+, Zn2+**
D. **Ce4+, Pm3+**

Ans. C

Solution. Diamagnetic ions are those that have all their electrons paired. Let's analyze each set to see which ones contain only diamagnetic ions:

Ni^{2+} and Cu^{2+}:

Ni^{2+}: Electronic configuration = [Ar] $3d^8$. It has two unpaired electrons, so it's paramagnetic.

Cu^{2+}: Electronic configuration = [Ar] $3d^9$. It has one unpaired electron, so it's paramagnetic.

Eu^{3+} and Gd^{3+}:

Eu^{3+}: Electronic configuration = [Xe] $4f^6$. It has all electrons paired, so it's diamagnetic.

Gd^{3+}: Electronic configuration = [Xe] $4f^7$. It has seven unpaired electrons, so it's paramagnetic.

Cu^+ and Zn^{2+}:

Cu^+: Electronic configuration = [Ar] $3d^{10}$. It has all electrons paired, so it's diamagnetic.

Zn^{2+}: Electronic configuration = [Ar] $3d^{10}$. It has all electrons paired, so it's diamagnetic.

Ce^{4+} and Pm^{3+}:

Ce^{4+}: Electronic configuration = [Xe] $4f^2$ (After losing 4 electrons). It has two unpaired electrons, so it's paramagnetic.

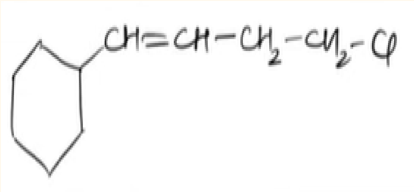
Pm^{3+}: Electronic configuration = [Xe] $4f^4$. It has four unpaired electrons, so it's paramagnetic.

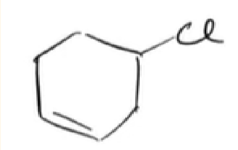
Based on the analysis, the only set containing both diamagnetic ions is:

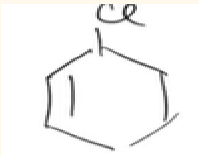
Cu^+ and Zn^{2+}

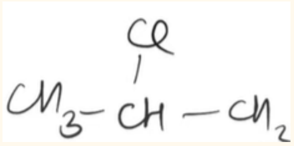
Both Cu^+ and Zn^{2+} have all their electrons paired, making them diamagnetic.

Ques 8. Which of the following has allylic halogen?

A. 

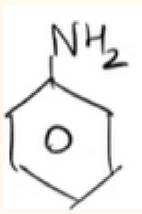
B. 

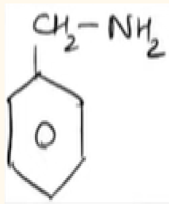
C. 

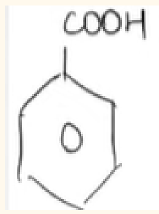
D. 

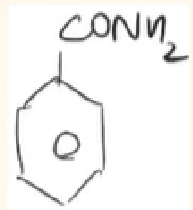
Ans. C

Ques 9. Find the final product of reaction given below

A. 

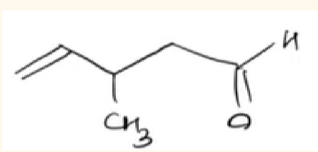
B. 

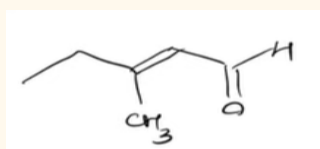
C. 

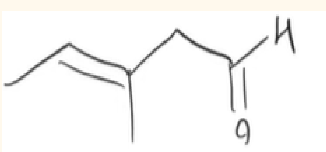
D. 

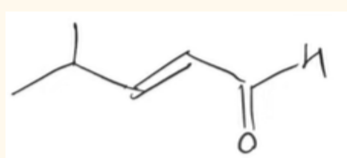
Ans. A

Ques 10. Which of the following is the correct structure for the given IUPAC name?
3-Methylpent-2-enal

A. 

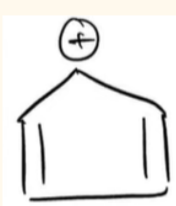
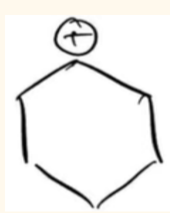
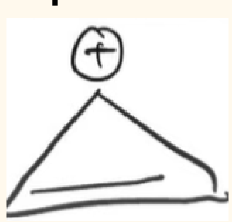
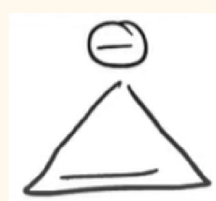
B. 

C. 

D. 

Ans. B

Ques 11. Which of the following compound or ion is most stable?

A. 
B. 
C. 
D. 

Ans. C

Ques 12. Statement I: For hydrogen atom, 3p and 3d are degenerate
Statement II: Degenerate orbitals have the same energy.

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

Ans. A

Solution. Statement I: Incorrect. In the hydrogen atom, which has only one electron, all orbitals within the same principal quantum number (n) have the same energy. Therefore, all three 3p orbitals (3px, 3py, 3pz) are degenerate with each other. However, 3p and 3d orbitals have different principal quantum numbers (n = 3 for 3p and n = 4 for 3d), leading to different energies. Therefore, 3p and 3d orbitals in the hydrogen atom are not degenerate.
Statement II: Correct. By definition, degenerate orbitals are those that have the same energy within an atom or molecule. This can occur due to various factors, such as the same spatial shape (e.g., 3p orbitals) or the presence of symmetry elements in the molecule.
Conclusion:
Statement I is incorrect. 3p and 3d orbitals in the hydrogen atom are not degenerate because they have different energies.
Statement II is correct. Degenerate orbitals indeed have the same energy.
Therefore, the correct answer is:
Statement I is incorrect, statement II is correct.

Ques 13. What is the geometry of Aluminium chloride in aqueous solution

A. **Square planar**
B. **Octahedral**
C. **Tetrahedral**
D. **Square pyramidal**

Ans. B

Solution. In its solid state, anhydrous aluminium chloride has a layered structure with octahedrally coordinated aluminium ions.
However, when aluminium chloride dissolves in water, it undergoes a Lewis acid-base reaction. The aluminium ion (Al^{3+}) acts as a Lewis acid, accepting electron pairs from water molecules (Lewis bases). This results in the formation of the hexahydratoaluminium(III) ion ($Al(H_2O)_6^{3+}$).
In this complex ion, six water molecules coordinate with the aluminium ion, forming an octahedral geometry. This is due to the sp^3d^2 hybridization of the central aluminium atom, which allows it to accommodate six ligands efficiently.
Therefore, the correct answer is: Octahedral.

Ques 14. The number of atoms in the silver plate having area 0.05 cm^2, and thickness 0.05 cm is …….. x 10^{19}.
Density of silver is 7.9 g/cm^3

Ans. 11

Ques 15. The group number of unununnium is:

- **A. 11**
- **B. 12**
- **C. 6**
- **D. 14**

Ans. A
Solution. The group number of unununnium, also known as roentgenium (Rg), is 11. While unununnium (Uuu) was the temporary systematic element name assigned by IUPAC, the official name roentgenium (Rg) was adopted in 1997. It is a synthetic transactinide element in the periodic table with the atomic number 111.

Ques 16. The ratio of magnitude of potential energy and kinetic energy for 5th excited state of hydrogen atom is

Ans. 2

Ques 17. Choose the correct option

Molecule	Shape
(a) BrF_5	(i) Sea-saw
(b) H_2O	(ii) T-Shape
(c) ClF_3	(iii) Bent
(d) SF_4	(iv) Square Pyramidal

A. (A)- iv; (B) - iii; (C) - ii; (D) - i
B. (A)-iv; (B) - iii; (C) - i; (D) - ii
C. (A)-iii; (B)-iv; (C) - ii; (D) - i
D. (A)-iii; (B) - iv; (C) - i; (D) - ii

Ans. A

Ques 18. 250 mL solution of CH3COONa of molarity 0.35 M is prepared. What is the mass of CH3COONa required in grams (Nearest Integer)

Ans. 7

Solution. Molar mass of CH3COONa: 82.0 g/mol
Volume of solution in liters: 0.250 L
Molarity of solution: 0.35 mol/L
Moles of CH3COONa: volume * molarity = 0.250 L * 0.35 mol/L = 0.0875 mol
Mass of CH3COONa in grams: moles * molar mass = 0.0875 mol * 82.0 g/mol = 7.15 g
Rounded to nearest integer: 7 g

Ques 19. Consider the following sequence of reactions:

$$CH_3-C\equiv CH \xrightarrow{Na} A \xrightarrow{B} CH_3-C\equiv C-CH_2-CH_2-CH_3$$

Select A and B respectively.

A. $CH_3-CH=CH_2,\ CH_3-CH_2-Cl$

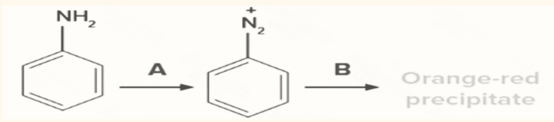
B. $CH_3-C\equiv CNa,\ CH_3-CH_2-Cl$

C. $CH_3-C\equiv CNa,\ CH_3-CH_2-CH_2-Cl$

D. $CH_3 - C \equiv C - CH_3, CH_3 - CH_2 - CH_2 - Cl$

Ans. C

Ques 20. Consider the following sequence of reactions:



Select the option with correct A & B respectively.

A. **HNO3, Phenol**
B. **$NaNO_2$/HCl, Phenol**
C. **HNO3, Aniline**
D. **$NaNO_2$/HCl, Aniline**

Ans. B

JEE Main Mathematics Questions

Ques 1. If the length of the minor axis of an ellipse is equal to half of the distance between the foci, then the eccentricity of the ellipse is.

Ans. 2/√5

Solution. When the length of the minor axis of an ellipse is equal to half of the distance between the foci, the eccentricity of the ellipse is indeed 2/√5.

Here's the breakdown:
Minor axis: The shorter diameter of the ellipse that passes through the center.
Distance between foci: The distance between the two focal points of the ellipse.
Eccentricity (e): A measure of how much the ellipse deviates from being a circle. It ranges from 0 (perfect circle) to 1 (extremely elongated ellipse).

In this case, we are given that the minor axis (a) is equal to half the distance between the foci (2f). We can use the relationship between these values and the eccentricity (e) to find it:
$e^2 = 1 - (a^2/f^2)$
Substituting the given values:
$e^2 = 1 - ((1/2 * 2f)^2 / f^2)$
$e^2 = 1 - 1/2$
$e^2 = 1/2$
$e = \sqrt{(1/2)}$
$e = 2/\sqrt{5}$
Therefore, the eccentricity of the ellipse is $2/\sqrt{5}$.

Ques 2. Let (α, β, y) be the foot of perpendicular form the point (1,2,3) on the line (x + 3)/5 = (y - 1)/2 = (z + 4)/3 then 19 (α+ β+ y)

Ans. 101

Solution.
Here's how to solve this problem:

1. Find the direction vector of the line:
The line is given by parametric equations:
$x = -3t + 5$
$y = 2t + 1$
$z = -4t + 3$
The direction vector can be found by taking the differences of coordinates corresponding to any change in parameter t:
Direction vector = (-3, 2, -4)
2. Find the vector joining the point and a point on the line:
Vector = (-3 + 1, 2 - 2, -4 + 3) = (-2, 0, -1)
3. Apply the dot product formula for orthogonality:
Since the foot of the perpendicular is orthogonal to the direction vector, their dot product must be zero:
(-2, 0, -1) . (-3, 2, -4) = 0
This gives us the equation: 6 - 8 = 0, which is always true.
4. Use vector projection to find the foot of the perpendicular:
The foot of the perpendicular can be found using the projection formula:
Projection of A onto B = $((A . B) / ||B||^2) * B$

where A is the vector joining the point to a point on the line, B is the direction vector, and ||B|| is the magnitude of the direction vector.
Plugging in the values:

$\alpha = 1 + ((-2 * -3 + 0 * 2 - 1 * -4) / ||(-3, 2, -4)||^2) * -3$

$\beta = 2 + ((-2 * -3 + 0 * 2 - 1 * -4) / ||(-3, 2, -4)||^2) * 2$

$\gamma = 3 + ((-2 * -3 + 0 * 2 - 1 * -4) / ||(-3, 2, -4)||^2) * -4$

Calculating, we get:

$\alpha \approx 7/5$

$\beta \approx 4/5$

$\gamma \approx 22/5$

5. Calculate the sum and multiply by 19:

$19 * (7/5 + 4/5 + 22/5) = 19 * 33/5 = 101$

Therefore, the value of $19 (\alpha + \beta + \gamma)$ is 101.

Ques 3. If $z = x + iy$, $xy \neq 0$ satisfies the equation $z^2 + iz = 0$, then $|z^2|$; equal to

Ans. 1

Ques 4. Let A(2,3,5) and C(- 3, 4, - 2) be 'opposite vertices of a Parallelogram ABCD. If the diagonal vec BD = hat i +2 hat j +3 hat k then the area of the Parallelogram is equal to.

Ans. $\sqrt{474}/2$

Ques 5. The value of $\lim_{n\to\infty}\sum_{k=1}^{n} \frac{n^3}{(n^2+k^2)(n^2+3k^2)}$ **is**

- **A. $[\pi/2\sqrt{3} - \pi/8]$**
- **B. $[\pi/2\sqrt{3} + \pi/8]$**
- **C. $[\pi/2 - \pi/\sqrt{3}]$**
- **D. $[\pi/\sqrt{3} - \pi/4]$**

Ans. A

Ques 6. If the foot is perpendicular from (1, 2, 3) to the line (x+1)/2 = (y-2)/5 = (z-1)/1 is (a, β, γ), then find a + β + γ.

A. 6
B. 5.8
C. 4.8
D. 5

Ans. B

Ques 7. In an arithmetic progression if sum of 20 terms is 790 and sum of 10 terms is 145, then S15 - S5 is (when Sn denotes sum of n terms)

A. 400
B. 395
C. 285
D. 405

Ans. B

Ques 8. The value of maximum area possible of a A ABC such that A(0, 0), B(x, y) and C(-x, y) such that $y = -2x^2 + 54x$ is: (in sq. unit)

A. 5800
B. 5832
C. 5942
D. 6008

Ans. B

Ques 9. The range of r for which circles $(x + 1)^2 + (y + 2)^2 = r^2$ and $x^2 + y^2 - 4x - 4y + 4 = 0$ coincide at two distinct points.

A. 3 < r < 7
B. 5 < r < 9
C. 1/2 < r < 4
D. 0 < r < 3

Ans. A

Ques 10. An ellipse whose length of minor axis is equal to half of length between foci, then eccentricity is

- **A. 7/2**
- **B. √17**
- **C. 2/√5**
- **D. 3/ √7**

Ans. C

Solution. For an ellipse, the eccentricity (e) can be calculated using the formula:

e = sqrt(1 - (minor axis)^2 / (major axis)^2)

Given information:

Minor axis = half the distance between foci (let's denote the distance between foci as 2f)

Minor axis = f/2

We need to find the eccentricity (e).

Calculating the eccentricity:

Substitute the given information into the formula:

e = sqrt(1 - (f/2)^2 / f^2)

e = sqrt(1 - 1/4)

e = sqrt(3/4)

e = sqrt(3) / 2

e = 2/√5

Therefore, the eccentricity of the ellipse is 2/√5.

Ques 11. The domain of y= $\cos^{-1}\left|\frac{2-|x|}{4}\right|$ **log(3 - x)⁻¹ is [α, β) - {y} then the value of α+β-y =?**

- **A. 9**
- **B. 12**
- **C. 11**
- **D. 10**

Ans. C

Ques 12. If y = f(x) is solution of differential equation
$(x^2 - 1)\, dy = ((x^3 + 1) + \text{sqrt}(1 - x^2))dx$ and y(0) = 2 then find y(1/2)

A. 13/7 - pi/2 + ln(5)
B. 15/7 + pi/3 + ln(2)
C. 17/8 + pi/6 - ln(2)
D. 18/7 - pi/6 + ln(3)

Ans. C

Ques 13. Given x^2 - 70x + lambda = 0 with positive integral roots a and B where one of the root is less than 10, and lambda/2 * i lambda/3 are not integers, then find value of $\frac{\sqrt{\alpha-1}+\sqrt{\beta-1}}{|\alpha-\beta|}$ √α-1 +√β-1/|α-β|

A. ⅙
B. 1/12
C. 1/12
D. 1/70

Ans. A

Ques 14. A line passes through (9,0), making angle 30° with positive direction of Xaxis. It is rotated by angle of 15° with respect to (9,0). Then, the equation of new line is

A. y = (2 + sqrt(3))(x - 9)
B. y = (2 - sqrt(3))(x - 9)
C. y = 2(x - 9)
D. y = - (x - 9)

Ans. B

Solution. Find Initial Slope and Direction Vector:
The initial slope of the line, given its 30° angle with the x-axis, is $\tan(30°) = 1/\sqrt{3}$.
Knowing the initial slope at (9, 0), we can find the y-intercept using the point-slope form:
$y - 0 = (1/\sqrt{3})(x - 9)$, which reduces to $y = (x - 9)/\sqrt{3}$.
So, the initial direction vector of the line is $(1, \sqrt{3})$.
2. Find Rotation Matrix:
A 15° clockwise rotation can be represented by the following rotation matrix:
| cos(15°) sin(15°) |
| -sin(15°) cos(15°) |
Substituting values:
| √(3 + √2)/4 √(3 - √2)/4 |
| -√(3 - √2)/4 √(3 + √2)/4 |
3. Apply Rotation:
Multiply the initial direction vector by the rotation matrix:
| √(3 + √2)/4 √(3 - √2)/4 | * | 1 |
| -√(3 - √2)/4 √(3 + √2)/4 | * | √3 |
= | (√(3 + √2) + √(3 - √2)) / 4 |
| (-√(3 - √2) + √(3 + √2)) / 4 |
Normalize the resulting vector:
| (2 + √3) / (4 * √2) |
| (-1 + √3) / (4 * √2) | = | (2 + √3) / 2√2 |
| (-1 + √3) / 2√2 |
4. Find New Slope and Equation:
The new slope of the line is the y-component of the normalized direction vector, which is $(-1 + \sqrt{3}) / 2\sqrt{2}$.
Knowing the new slope and passing through (9, 0), use the point-slope form again:
$y - 0 = (-1 + \sqrt{3}) / 2\sqrt{2}\ (x - 9)$
$y = (-1 + \sqrt{3}) / 2\sqrt{2}\ (x - 9)$
Therefore, the equation of the new line after rotation is:
$y = (-1 + \sqrt{3}) / 2\sqrt{2}\ (x - 9)$
This matches option B: y = (2 - sqrt(3))(x - 9) when you factor out the common term of $(-1 + \sqrt{3}) / 2\sqrt{2}$ from both sides of the equation.

Ques 15. If |vec | a =1,| vec b |=4, vec a * vec b = 2(vec a * vec b)-3 vec b Then the angle between vec b and vec c is

A. $\Theta = \cos^{-1}(-(\sqrt{3})/2)$

B. $\Theta = \cos^{-1}((\sqrt{3})/2)$

C. $\Theta = \cos^{-1}(1/2)$

D. $\Theta = \cos^{-1}(-1/2)$

Ans. A

Solution. given:

|vec a| = 1: Magnitude of vector a is 1 (unit vector).
|vec b| = 4: Magnitude of vector b is 4.
vec a * vec b = 2(vec a * vec b) - 3 vec b: Dot product of a and b is equal to 2 times their dot product minus 3 times b.
2. Simplify the equation:
Rearrange the equation:
vec a * vec b = -3 vec b
Since a is a unit vector (|a| = 1), the dot product simplifies to the projection of b onto a:
a . b = -3b

3. Find the angle between b and c:
We are asked for the angle between b and c, where c = 2a * b - 3b.
First, find the projection of c onto b:
c . b = (2a . b - 3b) . b = 2(a . b)b - 3(b . b) = -6b^2 (using a . b = -3b from step 2)
Next, use the dot product formula and magnitude information:
c . b = |c| |b| cos(theta) -6b^2 = (sqrt(34)b)(4) cos(theta) cos(theta) = - (sqrt(3))/2

4. Find the angle theta:
Finally, take the inverse cosine to find the angle:
theta = cos-1(- (sqrt(3))/2)
Therefore, the angle between vec b and vec c is Θ = cos-1(- (sqrt(3))/2).

Ques 16. Given set S = {0, 1, 2, 3, ..., 10}. If a random ordered pair (x, y) of elements of S is chosen, then find probability that |x - y| > 5

- **A. 30/121**
- **B. 31/121**
- **C. 62/121**
- **D. 64/121**

Ans. A

Ques 17. Number of integral terms in the binomial expansion of $(7^{1/2} + 11^{1/6})^{824}$ is______.

Ans. 138

Ques 18. $9\int_0^9 \left[\sqrt{\frac{10x}{x+1}}\right] dx$ **is equal to (where [] represents greatest integer function)**

Ans. 155

Ques 19. In a class there are 40 students. 16 passed in Chemistry, 20 passed in Physics, 25 passed in Math. 15 students passed in both Math and Physics.15 students passed in both Math and Chemistry and 10 students passed in both Physics and Chemistry. Find the maximum number of students that passed in all the subjects.

Ans. 19

Ques 20. For the following data table

x_i	f_i
$0-4$	2
$4-8$	4
$8-12$	7
$12-16$	8
$16-20$	6

Find the value of 20M (where M is median of the data)

Ans. 245