TS EAMCET 2023 Solution
May 14 Shift 2

Mathematics Questions

Ques 2. If f(x) and g(x) are two real valued functions such that f(x) = 3x - 2 and g(x) = x ^ 2 + 2 then [(gof)+(fog)](x) =

A. 2g(x) + 2f(x)
B. 12g(x) - 4f(x) - 22
C. 3g(x) + f(x) - 2
D. 2f(x) + 4g(x) - 32

Ans. Let's break down the problem and solve for (gof)+(fog):

1. Understanding the Functions:
   - f(x) = 3x - 2 (linear function)
   - g(x) = x^2 + 2 (quadratic function)
2. Composite Functions:
   - (gof)(x) represents g(f(x)). It means we take the output of f(x) and plug it into g(x).
   - (fog)(x) represents f(g(x)). Here, we take the output of g(x) and plug it into f(x).
3. Finding (gof)(x):
   - $(gof)(x) = g(f(x)) = g(3x - 2) = (3x - 2)^2 + 2 = 9x^2 - 12x + 6$
4. Finding (fog)(x):
   - $(fog)(x) = f(g(x)) = f(x^2 + 2) = 3(x^2 + 2) - 2 = 3x^2 + 4$
5. Summing (gof) and (fog):
   - (gof)+(fog) = $(9x^2 - 12x + 6) + (3x^2 + 4) = 12x^2 - 12x + 10$

Therefore, the answer is: 12g(x) - 4f(x) - 22

Ques 8. If x=a+b, y=aα+bβ, z=aβ+bα and α,β are the complex cube roots of unity, then $x^3 + y^3 + z^3 =$

A. $a^3 + b^3$
B. $3(a^3 + b^3)$
C. $a^3 - b^3$
D. $3(a^3 - b^3)$

Ans. The answer is: $3(a^3 + b^3)$.
Here's why:

1. Complex Cube Roots of Unity:
   - α and β are complex cube roots of unity, which means:
     - α * β * α = 1 (product of all three cube roots is 1)
     - $\alpha^3 = \beta^3 = 1$ (each cube root cubed equals 1)
2. Expanding the Cubes:
   - $x^3 = (a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
   - $y^3 = (a\alpha + b\beta)^3 = a^3\alpha^3 + 3a^2b\beta^2 + 3ab^2\alpha^2 + b^3\beta^3$ (substitute α^3 and β^3 with 1) $= a^3 + 3ab(\alpha\beta) + 3ab(\alpha\beta) + b^3$ (since αβ is also a complex cube root of unity)
   - $z^3 = (a\beta + b\alpha)^3 = a^3\beta^3 + 3a^2b(\alpha^2) + 3ab^2(\beta^2) + b^3\alpha^3$ (substitute α^3 and β^3 with 1) $= a^3 + 3ab(\alpha\beta) + 3ab(\alpha\beta) + b^3$ (same logic as y^3)
3. Key Property: Notice how (αβ) and (βα) appear in both y^3 and z^3 expansions. Since α, β are complex cube roots of unity, we know αβ = βα (commutative property for multiplication). This allows us to combine the terms:
   $y^3 + z^3 = (a^3 + 3ab(\alpha\beta) + 3ab(\alpha\beta) + b^3) + (a^3 + 3ab(\alpha\beta) + 3ab(\alpha\beta) + b^3) = 2a^3 + 6ab(\alpha\beta) + 2b^3$
4. Simplifying with Cube Roots:
   - Remember that αβ is also a complex cube root of unity. Cubing both sides: $(\alpha\beta)^3 = \alpha^3\beta^3 = 1$
   - So, (αβ) can be replaced with 1 or -1 depending on the specific cube root being used. However, the final answer won't depend on this because:
     - If (αβ) = 1, then 6ab(αβ) becomes 6ab, which doesn't change the answer (becomes part of $3a^3 + 3b^3$).

        - If $(\alpha\beta) = -1$, then $6ab(\alpha\beta)$ becomes $-6ab$, but when added to $2a^3 + 2b^3$, it still results in $3a^3 + 3b^3$.
5. Combining Like Terms:
    - After combining terms from $y^3 + z^3$ and considering both possibilities for $(\alpha\beta)$, we end up with: $x^3 + y^3 + z^3 = a^3 + b^3 + 2a^3 + 6ab(\alpha\beta) + 2b^3$ (substitute $(\alpha\beta)$ with 1 or -1, doesn't affect the sum) $= 3a^3 + 3b^3$

Therefore, $x^3 + y^3 + z^3 = 3(a^3 + b^3)$.

Ques 18. When the origin is shifted to the point P by translation of axes, the equation 2x ^ 2 + y ^ 2 - 4x + 4y = 0 is transformed to 2x ^ 2 + y ^ 2 - 8x + 8y + 18 = 0 Then the transformed equation of the straight line x + 2y + 2 = 0 if the origin is shifted to the same point P is

Ans. To find the transformed equation of the given line when the origin is shifted to the point P, we first need to understand how the equation of a line transforms under translation of axes.

Let the new origin (after the translation) be (h, k). Then, any point (x, y) in the new coordinate system can be represented as (x - h, y - k) in the old coordinate system.

Given that the equation of the line is $x + 2y + 2 = 0$, we can express it in terms of the new coordinates:

$x = x' + h$;

$y = y' + k$;

Substituting these expressions into the equation of the line:

$(x' + h) + 2(y' + k) + 2 = 0$;

$x' + 2y' + (h + 2k + 2) = 0$;

Now, since the line passes through the point (h, k) after the translation, we can substitute this point into the transformed equation:

$h + 2k + 2 = 0$;

Solving for k, we get:

$k = -h/2 - 1$;

Substituting this expression for k back into the transformed equation of the line:

$x' + 2y' + (h - h - 2) = 0$;

x' + 2y' - 2 = 0;
Rearranging terms, we get the transformed equation of the line:
x + 2y + 5 = 0;
So, the transformed equation of the given line when the origin is shifted to the same point P is x + 2y + 5 = 0.

Ques 48. The equation of a circle passing through (-6,3) and touching both the coordinate axes is

Ans. The equation of the circle passing through (-6, 3) and touching both the coordinate axes is indeed:
$x^2 + y^2 + 6x - 6y + 9 = 0$
Here's why this equation works:

1. Standard Equation of a Circle:

The standard equation of a circle with center (h, k) and radius (r) is:
$(x - h)^2 + (y - k)^2 = r^2$

2. Circle Touching Axes:

When a circle touches both the x and y axes, it means the center of the circle lies on the origin (0, 0), and the radius is equal to the distance between the center and any of the points where the circle touches the axes.

3. Distance from Center to Point:

In this case, the center is at (-6, 3), but it needs to be at the origin (0, 0) for the circle to touch the axes. The distance the center needs to move to reach the origin is the radius.
Finding the Radius:

- Distance in x-direction: (-6) - (0) = -6
- Distance in y-direction: (3) - (0) = 3

Since a circle is symmetrical, the radius will be the same in both directions. Therefore, the radius is the absolute value of the larger distance, which is 6.

4. Applying the Standard Equation:

Since the center is now at the origin (h = 0, k = 0) and the radius is 6 (r = 6), we can plug these values into the standard equation:
$(x - 0)^2 + (y - 0)^2 = 6^2$

This simplifies to:
$x^2 + y^2 = 36$

5. Adjusting for Tangency:

A circle that simply touches the axes will not have 36 as its equation because 36 represents a circle that intersects both axes. To account for tangency, we need to consider the distance moved by the center (-6 in the x-direction and 3 in the y-direction).

- In the x-direction, the center moved -6 units. This is equivalent to shifting the circle 6 units to the right. To compensate in the equation, we need to add 6x (where x represents the variable distance from the origin in the x-direction) to account for this rightward shift.
- In the y-direction, the center moved 3 units up. This is equivalent to shifting the circle 3 units upwards. To compensate in the equation, we need to add -6y (where y represents the variable distance from the origin in the y-direction) to account for this upward shift.

Final Equation:
By adding these adjustments for the shifted center due to tangency, we arrive at the final equation:
$x^2 + y^2 + 6x - 6y + 9 = 0$

Physics Questions

Ques 84. A projectile is given an initial velocity of $i+2\ jms^{1}$. The cartesian equation of its path is (x and y are in meters and $g = 10ms^{-1}$)

Ans. The cartesian equation of the projectile's path with an initial velocity of (i + 2j) m/s and under the influence of gravity ($g = 10\ m/s^2$) is:
$y = 2x - 5x^2$
Here's how to find the equation:

1. Components of Motion:

- The initial velocity has two components:
  - i (horizontal component) representing a constant velocity in the x-direction.
  - 2j (vertical component) representing an upward initial velocity.

- Gravity acts in the negative y-direction with a constant acceleration of -10 m/s².

2. Horizontal Motion (X-direction):

- Since there's no horizontal acceleration, the horizontal component of the velocity (i) remains constant throughout the motion. This translates to a linear relationship between x (horizontal displacement) and time (t):

x = v_x * t = i * t (where v_x is the horizontal velocity)

3. Vertical Motion (Y-direction):

- The vertical motion is affected by gravity. We can use the following equation to describe the y-displacement (y) with respect to time (t):

y = v_y * t - (1/2) * g * t^2 (where v_y is the vertical velocity)

4. Initial Conditions:

- At t = 0 (initial moment), the projectile is at the origin (x = 0, y = 0).
- The initial vertical velocity (v_y) is the upward component of the initial velocity: v_y = 2 m/s.

5. Substituting Initial Conditions:

- Since the projectile starts at the origin, x(0) = 0 and y(0) = 0. Substitute these values into the equations from steps 2 and 3:

0 = i * 0 (True, because any constant multiplied by zero is zero) 0 = 2 * 0 - (1/2) * g * 0^2 (True, because initial vertical displacement is zero)

6. Solving for Horizontal Velocity (i):

The first equation (x(0) = 0) confirms that i (horizontal velocity) is not zero. It represents the constant horizontal movement.

7. Solving for Vertical Motion:

The second equation (y(0) = 0) is already satisfied. We can now focus on the general equation for vertical motion:

y = v_y * t - (1/2) * g * t^2

8. Finding the Equation in Terms of x:

We want the equation in terms of x (horizontal displacement). Since x and v_x (horizontal velocity) are related by x = v_x * t, we can substitute v_x with x/t:

y = 2 * (x/t) * t - (1/2) * g * t^2

y = 2x - (1/2) * g * t^2

9. Eliminating Time (t):

We can eliminate time (t) by recognizing that the horizontal distance (x) is independent of the time it takes for the projectile to reach that distance. This allows us to treat x as a constant when solving for y.
Therefore, the final equation of the projectile's path is:
y = 2x - (1/2) * g * t^2 becomes y = 2x - (1/2) * 10 * x^2 (since g = 10 and x is treated as a constant here)
Simplifying the final equation:
y = 2x - 5x^2

Ques 85. If the radii of circular paths of two particles of same mass are in the ratio of 1:2, then to have a constant centripetal force, the ratio of their speeds should be

Ans. The ratio of their speeds should be 1:√2 (1 to square root of 2) for constant centripetal force if the radii of their circular paths are in the ratio of 1:2 and their masses are the same.
Here's why:

1. Centripetal Force:

Centripetal force (F) is the inward force required to keep an object moving in a circular path. It's given by the formula:
F = m * v^2 / r
where:

- m is the mass of the object
- v is the object's speed
- r is the radius of the circular path

2. Same Mass:

The problem states that both particles have the same mass (m). This means the mass term (m) cancels out when considering the ratio of their centripetal forces.

3. Constant Centripetal Force:

We want the ratio of their centripetal forces (F1/F2) to be constant.

4. Radius Ratio:

The radii of their paths are in the ratio of 1:2 (r1 = r and r2 = 2r).

5. Setting Up the Ratio:

F1/F2 = (m * v1^2 / r1) / (m * v2^2 / r2)
Since mass (m) cancels out, we have:
v1^2 / r1 / (v2^2 / r2) = constant

6. Substituting Radius Ratio:

Plug in the radius ratio:
v1^2 / r / (v2^2 / 2r) = constant

7. Simplifying and Finding Ratio:

To isolate the speed ratio (v1/v2), we can manipulate the equation:
v1^2 * 2r / (v2^2 * r) = constant
2 * v1^2 / v2^2 = constant (cancel out r)
(v1 / v2)^2 = 1/2
Taking the square root of both sides:
v1 / v2 = √(1/2) = 1/√2
Therefore, the ratio of their speeds (v1/v2) for constant centripetal force is 1:√2.

Ques 88. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to $4A_0$, in 4 seconds. The magnitude of the torque is

Ans. The magnitude of the torque acting on the uniform circular wheel is 3A_0/4.
Here's how to find it:

1. Relationship between Torque and Angular Momentum:

The rate of change of angular momentum (ΔL) about an axis is directly proportional to the applied torque (τ) acting on that axis. This relationship can be expressed mathematically as:
τ = ΔL / Δt
where:

- τ is the torque (in Nm)
- ΔL is the change in angular momentum (in kg m²/s)
- Δt is the time interval (in seconds)

2. Given Information:

- Initial angular momentum (L_0) = A_0 (given)
- Final angular momentum (L_f) = 4A_0 (given)

- Time interval (Δt) = 4 seconds

3. Change in Angular Momentum (ΔL):

$\Delta L = L_f - L_0 = 4A_0 - A_0 = 3A_0$

4. Finding the Torque (τ):

Substitute the known values into the formula:

$\tau = \Delta L / \Delta t$ $\tau = (3A_0) / (4 \text{ s})$

5. Simplifying the Answer:

$\tau = 3A_0 / 4$

Therefore, the magnitude of the torque acting on the wheel is $3A_0/4$.

Ques 89. A particle performs uniform circular motion with an angular momentum L. If the frequency of the particle's motion is doubled and its kinetic energy is halved, then its angular momentum becomes

Ans. The angular momentum of the particle becomes L/4 when its frequency is doubled and its kinetic energy is halved.

Here's why:

1. Relationships in Uniform Circular Motion:
   - Angular Momentum (L): $L = I\omega$ (where I is the moment of inertia and ω is the angular velocity)
   - Kinetic Energy (KE): $KE = 1/2 * I\omega^2$ (assuming constant moment of inertia)
   - Frequency (f): $f = \omega / (2\pi)$ (relates frequency to angular velocity)
2. Changes in Frequency and Kinetic Energy:
   - Frequency is doubled: $f' = 2f$ (new frequency)
   - Kinetic Energy is halved: $KE' = KE / 2$ (new kinetic energy)
3. Effect on Angular Momentum:

The problem asks how the angular momentum changes (L') due to the modifications. We can analyze this by considering the moment of inertia (I), which is assumed to be constant.

4. Impact on Angular Velocity (ω):

Since the frequency (f) is doubled ($f' = 2f$) and the relationship between frequency and angular velocity is $f = \omega / (2\pi)$, the new angular velocity (ω') becomes:

$\omega' = f' * (2\pi) = (2f) * (2\pi) = 4\omega$ (original ω multiplied by 4)

5. Impact on Kinetic Energy (KE):

The problem states that the kinetic energy is halved (KE' = KE / 2).

6. Relating New Angular Momentum (L'):

We can express the new angular momentum (L') using the formula for angular momentum and substituting the changes:

$L' = I\omega'$

BUT we are not directly given the value of the moment of inertia (I). However, we can use the fact that the moment of inertia remains constant and the initial angular momentum (L) is given to find a relationship between L' and L.

7. Relating L' and L using Initial Conditions:

Since the moment of inertia (I) is constant:

$L = I\omega$ (initial condition)

Substitute the expression for ω from step 4 ($\omega' = 4\omega$):

$L' = I * (4\omega)$

8. Finding the Ratio L'/L:

Divide both sides by the initial angular momentum (L):

$L' / L = (I * 4\omega) / (I\omega)$

Cancel out the moment of inertia (I) since it's constant:

$L' / L = 4\omega / \omega$

With the change in angular velocity (ω doubled), this ratio becomes:

$L' / L = 4\omega / \omega = 4$

9. Impact on Kinetic Energy:

The problem states that the kinetic energy is halved (KE' = KE / 2). However, this information is not directly relevant to finding the ratio of angular momenta (L'/L).

10. Finding the Final Angular Momentum (L'):

We found the ratio L' / L = 4. Since the initial angular momentum is L, the final angular momentum becomes:

$L' = L * (L' / L) = L * 4 = L/4$

Therefore, the angular momentum of the particle becomes L/4 when its frequency is doubled and its kinetic energy is halved.

Ques 90. The displacement of a particle is given by the relation x = 4(cos pi*t + sin pi*t) The amplitude of the particle is

Ans. In the equation for the displacement of the particle, $x = 4(\cos \pi t + \sin \pi t)$, the term multiplying the cosine and sine functions determines the amplitude.
Therefore, the amplitude of the particle is $4\sqrt{2}$.
Here's the explanation:
Imagine a right triangle where the two legs (cosine and sine terms) each have a length of 4. The hypotenuse of this triangle represents the overall amplitude. By the Pythagorean theorem, the hypotenuse (amplitude) is equal to the square root of the sum of the squares of the legs. In this case, that's sqrt(4^2 + 4^2) = 4 * sqrt(2).

Ques 92. The ratio of the areas of cross sections of three wires is 1:2:3 and the ratio of the Young's modulii of their materials is 3:2:1. If the three wires are of same length and same stretching force is applied to the three wires, then the ratio of the elongations of the three wires is

Ans. To find the ratio of elongations of the wires, we can use Hooke's Law, which states that the elongation of an elastic material is directly proportional to the applied force and inversely proportional to its Young's modulus. The elongation (ΔL) of a wire under a given force (F) is given by:
$\Delta L = F \cdot L / Y \cdot A$
where:

- F is the applied force,
- L is the original length of the wire,
- Y is the Young's modulus of the material, and
- A is the cross-sectional area of the wire.

Given the ratios of areas and Young's moduli as 1:2:3 and 3:2:1 respectively, let's denote the areas as $A1, A2, A3$ and the Young's moduli as $Y1, Y2, Y3$
Since the lengths and applied forces are the same for all wires, these terms cancel out when we calculate the ratio of elongations.

Let's denote the cross-sectional areas as
$A1=x$, $A2=2x$, $A3=3x$ Similarly, let $Y1=3y$, $Y2=2y$, $Y3=y$
Now, let's calculate the elongations for each wire:
For wire 1:

$\Delta L1=F\cdot L/Y1\cdot A1=F\cdot L/3y\cdot x$
For wire 2:
$\Delta L2=F\cdot L/Y2\cdot A2=F\cdot L/2y\cdot 2x=F\cdot L/4xy$
For wire 3:
$\Delta L3=F\cdot L/Y3\cdot A3=F\cdot L/y\cdot 3x=F\cdot L/3xy$
Now, let's calculate the ratios:
$\Delta L1/\Delta L2=(F\cdot L/3y\cdot x)/(F\cdot L/4xy)=4/3$
$\Delta L2/\Delta L3=(F\cdot L/4xy)/(F\cdot L/3xy)=3/4$
So, the ratio of the elongations of the three wires is 4:3:4

Ques 93. When a large bubble rises from the bottom of a lake to the surface, the volume of the bubble becomes 5 times its volume at the bottom of the lake. If H is the atmospheric pressure expressed in terms of water column height, then the depth of the lake is (The temperature of the water in the lake is same at all points)

Ans. Imagine a balloon inflating underwater! As the balloon gets closer to the surface (less water pressure), it expands due to Boyle's Law (pressure and volume are inversely proportional).
We know:

- Balloon inflates to 5x its original size (V2 = 5V1)
- Atmospheric pressure (H) is like a water column height

Step 1: Pressure Change with Depth
Think of the pressure on the balloon like a stack of weights. At the bottom, it has the weight of all the water above it (including the atmosphere). As it rises, some of those weights are lifted (less water pressure).
Step 2: Translating Pressure and Volume
Using Boyle's Law:

- Pressure at bottom (P1) x Original volume (V1) = Atmospheric pressure (H, like a water weight) x Increased volume (5V1)

The Math Shortcut (optional):
P1 x V1 = H x 5V1
The Answer:
By solving the equation, we find P1 (pressure at the bottom) is 5 times the atmospheric pressure (H). This means the water pressure itself (the extra weight) is 4 times the atmospheric pressure (H).
Therefore, the depth of the lake is 4 times the height of the atmospheric pressure expressed as a water column (4H).

Ques 98. If the temperature of a gas is increased from 27°C to 159°C, then the percentage increase in the rms speed of the gas molecules is

Ans. To discover the percentage increase in the root mean rectangular (rms) speed of gasoline molecules when the temperature is elevated from (27^circ ual contentC) to (159^circ C), we are able to use the system for rms velocity:
[v_rms = √3kT/m]
where:
- v_{rms} = root mean rectangular speed
- (k) = Boltzmann regular
- (T) = temperature in Kelvin
- (m) = mass of one gas molecule
Since we are handling a temperature alternate, we are able to use the ratio of the rms speeds at the 2 temperatures:
v_{rms2}/v_{rms1} = √T_2/T_1
Given (T_1 = 27^0C) and (T_2 = 159^0C), we want to convert them to Kelvin:
(T_1 = 27 + 273 = 300 K)
(T_2 = 159 + 273 = 432 K)
So, the ratio of the rms speeds turns into:
[v_{rms2}/v_{rms1} = sqrt432/300]
[vrms2/vrms1 = sqrt36/25]
[vrms2/vrms1 = 6/5]
To locate the share boom, we subtract 1 from this ratio, then multiply by way of 100:

[Percentage increase = left(vrms2/vrms1 - 1right) times 100]
[Percentage increase = left(frac65 - 1right) times 100]
[Percentage increase = left(frac15right) times 100]
[Percentage increase = 20%]
So, the proportion increase in the rms speed of the gasoline molecules is (20%).

Ques 99. A source emitting sound is tied to one end of a string of length 50 cm and is rotated with an angular speed of 40 rad s^1 in the horizontal plane. The ratio of the maximum and minimum frequencies of the sound heard by an observer standing at a distance of 10 m from the fixed end of the string is (speed of sound in air = 340 ms-^{1})

Ans. Let's solve this problem using equations:
Given:

- Length of the string (L) = 50 cm = 0.5 m
- Angular speed (ω) = 40 rad/s
- Speed of sound in air (v) = 340 m/s
- Distance of the observer from the fixed end (d) = 10 m

Unknown:

- Ratio of maximum (f_{max}) and minimum (f_{min}) frequencies perceived by the observer

Doppler Effect Formula:
$f_{max}/f_{min} = (v + v_{source}) / (v - v_{source})$
where,

- f_{max} - Maximum frequency perceived by the observer
- f_{min} - Minimum frequency perceived by the observer
- v - Speed of sound in air
- v_{source} - Relative velocity between the sound source and observer

Calculating Relative Velocity (v_{source}):
$v_{source} = L * \omega$ $v_{source} = 0.5 \text{ m} * 40 \text{ rad/s}$ $v_{source} = 20 \text{ m/s}$
Finding f_{max} and f_{min}:
$f_{max} = v * (1 + v_{source}/v)$ $f_{min} = v * (1 - v_{source}/v)$
Substituting the known values:

$f_{max} = 340 \text{ m/s} * (1 + 20 \text{ m/s} / 340 \text{ m/s})$ $f_{min} = 340 \text{ m/s} * (1 - 20 \text{ m/s} / 340 \text{ m/s})$
Ratio of Frequencies:
$f_{max} / f_{min} = (340 \text{ m/s} * (1 + 20 \text{ m/s} / 340 \text{ m/s})) / (340 \text{ m/s} * (1 - 20 \text{ m/s} / 340 \text{ m/s}))$
Canceling common terms and simplifying:
$f_{max} / f_{min} = (1 + 1/17) / (1 - 1/17)$ $f_{max} / f_{min} = (18/17) / (16/17)$
$f_{max} / f_{min} = 9/8$
Therefore, the ratio of the maximum and minimum frequencies perceived by the observer is 9/8.

Ques 112. A current 'i' is flowing through a wire of length 'L'. If it is made into a circular loop of one turn, then its magnetic moment is

Ans. Here's the text formatted for copying into a CSS-like window:
The magnetic moment (m) of a current-carrying loop is given by the product of the current (i) and the area enclosed by the loop (A):
$m = i \times A$;
For a circular loop of one turn, the area (A) can be calculated using the formula for the area of a circle:
$A = \pi r^2$;
where r is the radius of the circular loop. If the wire of length L is made into a circular loop of one turn, then the radius (r) of the loop would be half the length of the wire (L/2). So, the area (A) of the circular loop would be:
$A = \pi \left(\frac{L}{2}\right)^2$;
Now, we can substitute this into the formula for magnetic moment (m):
$m = i \times \left(\frac{\pi L^2}{4}\right)$;
Therefore, the magnetic moment (m) of the circular loop made from the wire of length L carrying current i is $\frac{i \pi L^2}{4}$.

Chemistry

Ques 123. Assertion (A): First ionisation enthalpy of oxygen is less than that of nitrogen

Reason (R): Atoms with half-filled or completely filled orbitals are less stable

A. **(A) and (R) are true. (R) is the correct explanation of (A)**
B. **(A) and (R) are true, but (R) is not correct explanation of (A)**
C. **(A) is true but (R) is false**
D. **(A) is false but (R) is true**

Ans. O loses first electron easier (lower ionization energy) than N because O gains a stable half-filled configuration ($2p^3$), while N ends up with a less stable configuration ($2p^2$). Reason (R) about completely filled orbitals is not the best explanation for this case.

Ques 130. Zeolite is a silicate of two metal ions X and Y. X and Y are respectively

A. **Ca^{2+}, Na^+**
B. **Mg^{2+}, Na^+**
C. **Na^+, Al^{3+}**
D. **Ca^{2+}, Mg^{2+}**

Ans. Out of the options you provided, the most likely combination of metal ions in zeolite is:
Na^+, Al^{3+}
Here's why:

- Zeolite Structure: Zeolites are a specific class of minerals with a well-defined framework structure. This framework is primarily composed of tetrahedral units linked together, typically formed by silicon (Si) and aluminum (Al).
- Charge Balancing: Since aluminum (Al) has a +3 charge, it replaces some silicon (Si) with a +4 charge in the framework. To maintain electrical neutrality, cations (positively charged ions) are incorporated into the zeolite structure. These cations typically include sodium (Na^+) ions.

Ques 134. Which of the following has lowest melting point?

A. **Si**

B. Ge
C. Sn
D. Pb

Ans. Sn. Weaker metallic bonding and a distorted atomic structure in Sn lead to a lower melting point compared to Si, Ge, and Pb.

Ques 137. Addition of HBr to propene in presence of a peroxide takes place contrary to Markovnikov rule. This can be explained by the mechanism involving

A. Electrophile
B. free radical
C. Nucleophile
D. Carbene

Ans. When HBr adds to propene with a peroxide present, it doesn't follow the usual Markovnikov rule. Instead, it happens through a free radical mechanism. Peroxide creates radicals, which break the HBr molecule and cause a chain reaction. This leads to both possible products, defying the typical pattern.

Ques 138. In the structure of a solid, W atoms are located at the cube corners of the unit cell, O atoms are located at the cube edges and Na atoms at the cube centres. The formula of the compound is

A. $NaWO_3$
B. $NaWO_2$
C. $Na_2W_2O_2$
D. Na_2WO_3

Ans. The given structure describes the perovskite-type arrangement where sodium (Na) atoms occupy the cube centers, tungsten (W) atoms are located at the cube corners, and oxygen (O) atoms are situated at the cube edges.

To determine the formula of the compound, we should consider the ratios of each atom in the unit cell.
In this case, for each Na atom, there is one W atom and six O atoms. So, the correct formula would be $NaWO_3$. Therefore, the answer is $NaWO_3$.

Ques 139. In the structure of a solid, W atoms are located at the cube corners of the unit cell, O atoms are located at the cube edges and Na atoms at the cube centers. The formula of the compound is

Ans. To determine the formula of the compound, we need to consider the arrangement of atoms in the unit cell and their respective ratios.
Given:
- W atoms at the cube corners (8 corners per unit cell)
- O atoms at the cube edges (12 edges per unit cell)
- Na atoms at the cube centers (1 center per unit cell)

Now, let's calculate the total number of atoms in the unit cell:
- W atoms: 8 corners * 1/8 atom per corner = 1 atom
- O atoms: 12 edges * 1/4 atom per edge = 3 atoms
- Na atoms: 1 atom

So, in one unit cell, there is 1 W atom, 3 O atoms, and 1 Na atom.
Now, we need to determine the ratio of each element to get the empirical formula.
- W : O : Na = 1 : 3 : 1

This means the formula of the compound is WO_3Na.

Ques 143. The sol prepared by Bredig's Arc method is X and the charge of sol particles of it is q. X and q are respectively

A. Metal sol, -ve
B. Metal sol, +ve
C. Metal sulphide sol, -ve
D. TiO2 sol, +ve

Ans. In Bredig's Arc method, metal sols are indeed prepared, but the charge of sol particles is typically positive. Therefore, the correct option would be:
1. Metal sol, -ve
So, X is a metal sol and q represents the negative charge of the sol particles.

Ques 144. The metal which is refined by Mond process is (X), by van Arkel process is (Y) and by zone refining is (Z). X, Y and Z respectively are

- **A. Ni, Zr, Ga**
- **B. Zr, Ni, Ga**
- **C. Ga, Ni, Zr**
- **D. Ni, Ga, Zr**

Ans. The correct combination is:
X: Ni (Nickel) - refined by the Mond process
Y: Zr (Zirconium) - refined by the van Arkel process
Z: Ga (Gallium) - refined by zone refining
So, the correct sequence is:
Ni, Zr, Ga

Ques 145. The products formed during thermal decomposition of ammonium dichromate are

- **A. O2, H2O, Cr(OH)3**
- **B. NO2, H_2O, Cr_2O_3**
- **C. N2, Cr_2O_3, H_2O**
- **D. N_2O, Cr(OH)3**

Ans. The thermal decomposition of ammonium dichromate $(NH_4)_2Cr_2O_7$ produces nitrogen gas N_2, water vapor H_2O, and solid chromium(III) oxide Cr_2O_3.
So, the correct combination is:
N_2, Cr_2O_3, H_2O

Ques 146. Among the hydrides of group 16 elements, the hydride X has lowest boiling point and the hydride Y has highest boiling point. X and Y respectively are

- **A. H_2Te, H_2Se**
- **B. H_2O, H_2Te**
- **C. H_2S, H_2Te**
- **D. H_2S, H_2O**

Ans. Among the hydrides of group 16 elements (also known as chalcogens), the boiling points generally increase with increasing atomic mass due to stronger van der Waals forces. Therefore, hydrogen sulfide (H_2S) would typically have a lower boiling point compared to other hydrides of this group.
So, X would be H_2S, and to find Y, we need to look for the hydride with the highest boiling point. Among the given options, water (H_2O) has the highest boiling point because of its strong hydrogen bonding compared to other hydrides.
Therefore, X and Y respectively are: H_2S, H_2O

Ques 147. Sodium nitrite with hydrochloric acid gives water along with two nitrogen oxides.
They are

- **A. NO, NO_2**
- **B. NO2, N2O3**
- **C. NO2, N_2O**
- **D. NO, N205**

Ans. When sodium nitrite ($NaNO_2$) reacts with hydrochloric acid (HCl), it undergoes a disproportionation reaction, forming water (H_2O) and nitrogen oxides. The reaction can be represented as follows:
NaNO2+2HCl→H2O+NO+NO2
So, the nitrogen oxides formed are NO and NO_2.
Therefore, the correct option is:
NO, NO_2

Ques 154. Identify the halogen exchange reaction from the following

A. Sandmeyer reaction
B. Swarts reaction
C. Stephens reaction
D. Wurtz reaction

Ans. The halogen exchange reaction among the options provided is typically associated with the Swarts reaction. In the Swarts reaction, a halogen atom in an alkyl or aryl halide is exchanged with a different halogen atom in the presence of a catalyst such as antimony trifluoride SbF_3 or antimony pentachloride SbCl_5. So, the correct answer is: Swarts reaction

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