MHT CET 2024 Question Paper (April 27 - Shift 2)

Ques 1. A rocket of initial mass 6000kg ejects gases at a constant rate of 16 kg/s with the constant relative speed of 11 km/s what is the acceleration of the rocket one minute after the blast.

Ans. A = 34.92 m/s^2

Solu. Analysis of the Rocket Motion:

We can solve this problem using the concept of thrust and the rocket equation. Here's the breakdown:

1. Thrust: The rocket generates thrust by ejecting hot gases at a high velocity relative to the rocket itself. This creates a forward force according to Newton's third law of motion (for every action, there is an equal and opposite reaction).
2. Rocket Equation: This equation relates the thrust generated by the rocket to the change in its mass and the exhaust velocity. A simplified form of the equation is:

    a = v_e * dm/dt / (m - dm*t)

3. where:
    - a: acceleration of the rocket (m/s^2)
    - v_e: exhaust velocity of the gases relative to the rocket (m/s)
    - dm/dt: rate of mass ejection (kg/s) (negative because mass is decreasing)
    - m: instantaneous mass of the rocket (kg)
    - t: time elapsed since the blast (s)

Solving for Acceleration:

We are given the following values:

- Initial mass (m_0) = 6000 kg
- Rate of mass ejection (dm/dt) = -16 kg/s (negative sign as mass is decreasing)
- Exhaust velocity (v_e) = 11 km/s = 11000 m/s (converted from km/s to m/s for consistency)
- Time (t) = 60 s (one minute)

Step 1: Calculate Instantaneous Mass (m):

After one minute (t = 60 s), the mass of the rocket (m) becomes:

$m = m_0 - (dm/dt) * t$ $m = 6000 \text{ kg} - (-16 \text{ kg/s}) * 60 \text{ s}$ $m = 5040 \text{ kg}$

Step 2: Apply the Rocket Equation:

$a = (11000 \text{ m/s}) * (-16 \text{ kg/s}) / (5040 \text{ kg})$ $a \approx 34.92 \text{ m/s}^2$

Therefore, the acceleration of the rocket after one minute is approximately 34.92 m/s^2.

Ques 2. A coil has a resistance of 30 ohm and inductive reactance of 20 ohm at 50 Hz frequency. If an AC source of 200 volt 100 Hz is connected across the coil then how much current will be in the coil?

Ans. I = 4A

Solu. Given: Resistance, R = 30 Ω Inductive reactance at 50 Hz, X_{L50} = 20 Ω Voltage, V = 200 V Frequency of source, f = 100 Hz

We need to find the current (I) flowing through the coil.

1. Find Inductance (L): $L = X_{L50} / (2 \pi f)$

$L = 20\ \Omega / (2 \pi \times 50 \text{ Hz})$

$L = 1 / (5 \pi)$ H

2. Find Inductive Reactance (X_L) at 100 Hz: $X_L = 2 \pi f L$

$X_L = 2 \pi \times 100 \text{ Hz} \times 1 / (5 \pi) \text{ H}$

$X_L = 40\ \Omega$

3. Calculate Impedance (Z): $Z = \sqrt{(R^2 + X_L^2)}$

$Z = \sqrt{(30^2\ \Omega + 40^2\ \Omega)}$

$Z = \sqrt{(2500\ \Omega^2)}$

$Z = 50\ \Omega$

4. Find Current (I) using Ohm's Law: I = V / Z

$I = 200\ V / 50\ \Omega$
$I = 4\ A$
Therefore, the current flowing through the coil is 4 A.

Ques 3. The first member of the Paschen series in the hydrogen spectrum is of wavelength 18800 angstrom. What is the short wavelength limit of the Paschen series?

Ans. 8.20×10^{-7}

Solu. 1. Rydberg Formula:

$1 / \lambda_{min} = R_H (1/n_f^2 - 1/n_i^2)$

where:

- λ_{min}: Short wavelength limit (meters)
- R_H: Rydberg constant for hydrogen (approximately $1.09737 \times 10^7\ m^{-1}$)
- n_f: Lower energy level (n = 3 for Paschen series) ○ n_i: Infinity (represents the ground state for the series limit)

2. Calculation:

   $1 / \lambda_{min} = (1.09737 \times 10^7\ m^{-1}) (1/3^2 - 1/\infty^2)$

   Since $1/\infty$ is zero, the equation simplifies to:

   $1 / \lambda_{min} = (1.09737 \times 10^7\ m^{-1}) (1/9)$

3. Solve for λ_{min}: $\lambda_{min} = 1 / ((1.09737 \times 10^7\ m^{-1}) \times (1/9))$ $\lambda_{min} \approx 8.20 \times 10^{-7}$ meters

Therefore, the short wavelength limit of the Paschen series in the hydrogen spectrum is approximately 8.20×10^{-7} meters

Ques 4. Find the solubility product of $BaOH_2$?
Where ($S = 1.73 \times 10^{-14}$)

Ans. 20.7×10^{42}

Ques 5. Which of the following is ferromagnetic:

A. Zinc

B. **Copper**
C. **Magnease**
D. **Cromium**

Ans. Cromium

Solu. Ferromagnetism is a property exhibited by certain materials that are strongly attracted to magnets and can be magnetized themselves. Among the given options, only chromium exhibits ferromagnetic properties. Zinc and copper are not ferromagnetic. They are considered diamagnetic, meaning they are weakly repelled by magnets.

Magnesium is also not ferromagnetic. It is considered paramagnetic, which means it is weakly attracted to magnets.
Chromium, on the other hand, is ferromagnetic. It can be magnetized and retains its magnetization when the external magnetic field is removed. Therefore, the correct answer is Chromium.

Ques 6. What is the Oxidation state of Fe in Fe_3O_4?

Ans. 8/3

Solu. The oxidation state of iron (Fe) in Fe3O4 is indeed +8/3, but it's a bit of a special case. Here's why:
Fe3O4 Composition:
Fe3O4 isn't a simple ionic compound where each element has a well-defined oxidation state. It's considered a mixed oxide, containing both $Fe^{2}+$ (ferrous) and Fe^{3+} (ferric) ions.
Average Oxidation State:
While Fe^{3+} has an oxidation state of +3 and $Fe^{2}+$ has an oxidation state of +2, Fe3O4 has an overall neutral charge. To determine the average oxidation state of iron (Fe) in Fe3O4, we can use the following approach:

1. Let x be the average oxidation state of Fe.

2. Since there are 3 Fe atoms per formula unit, the total oxidation state contribution from Fe is 3x.
3. Oxygen (O) has an oxidation state of -2. There are 4 O atoms, so their total contribution is -4 × 2 = -8.
4. To maintain electrical neutrality, the sum of all oxidation states must be zero.

Therefore, we can set up the equation:

$3x - 8 = 0$

Solving for x:

$x = 8 / 3$

Conclusion:

The average oxidation state of iron (Fe) in Fe_3O_4 is +8/3. This doesn't imply a single Fe atom has this specific oxidation state. Instead, it represents the weighted average due to the presence of both Fe^{2+} and Fe^{3+} ions in the crystal structure.

Ques 7. Convert 72 degree Celsius to Fahrenheit.

Ans. 161.6 F

Solu. 72 degrees Celsius is equal to 161.6 degrees Fahrenheit. Here's the conversion formula used:

°F = (°C x 9/5) + 32

Following this formula:

°F = (72°C x 9/5) + 32 °F = (129.6) + 32 °F = 161.6

Therefore, 72 degrees Celsius is equivalent to 161.6 degrees Fahrenheit.

Ques 8. Menstrual blood is not clot due to the presence of ______?

Ans. Fibrinolysins

Solu. Menstrual blood does not clot due to fibrinolysins, which are enzymes that dissolve blood clots by breaking down fibrin. This prevents the formation of clots in menstrual blood, allowing it to flow freely during menstruation.

Ques 9. The mitral valve is also known as ______?

Ans. Bicuspid valve

Solu. The mitral valve is indeed also known as the bicuspid valve. It is so named because it typically has two cusps or leaflets.

Ques 10. Three charges, each-q are placed at the corners of an isosceles triangle ABC of sides BC, AC and AB. D_and E are the midpoints of BC and CA. The work done in taking a charge Q from D to E is:

Ans. Zero

Solu. Imagine you have three electric charges placed at the corners of a triangle. Now, let's say you want to move another charge from one midpoint of a side of the triangle to the midpoint of another side. When you move this charge along this path, the work done (which is basically the effort needed to move the charge against any resistance) is zero. This happens because at these midpoints, the forces from the charges at the corners of the triangle cancel each other out, resulting in no net force acting on the charge being moved. So, you don't need to exert any effort (or do any work) to move the charge along this path.