KEAM 2026 Engineering April 17

Question Paper (Memory-Based) with Solution PDF

Conducted by CEE Kerala

General Instructions

(i) **Duration:** The total duration of the examination is 3 hours (180 minutes).

(ii) **Total Marks:** The complete paper carries a maximum of 600 marks.

(iii) **Structure:** The paper has 3 Sections:

- **Section A:** 45 Multiple Choice Questions (Physics).
- **Section B:** 30 Multiple Choice Questions (Chemistry).
- **Section B:** 75 Multiple Choice Questions (Mathematics).

(iv) **Compulsory Questions:** All 150 questions are compulsory.

(v) Each question has four options. Only **one** option is correct.

(vi) **Correct Answer:** +4 marks.

(vii) **Incorrect Answer:** −1 (Negative marking).

(viii) **Unanswered/Marked for Review:** 0 marks.

PHYSICS

1. The electric field inside a uniformly charged spherical shell of radius R is:

(A) directly proportional to the charge within the shell

(B) inversely proportional to R^2

(C) same as that outside the shell

(D) zero

(E) maximum at the centre

Correct Answer: (D) zero

Solution:

Step 1: Understanding the Concept

According to Gauss's Law, the total electric flux through any closed surface is proportional to the enclosed electric charge. For a spherical shell, we consider a Gaussian surface inside the shell.

Step 2: Detailed Explanation

1. A uniformly charged spherical shell has all its charge distributed on its outer surface. 2. If we take a Gaussian sphere of radius $r < R$ (inside the shell), the total charge enclosed ($q_{enclosed}$) is exactly zero. 3. Applying Gauss's Law:

$$\oint E \cdot dA = \frac{q_{enclosed}}{\epsilon_0}$$

4. Since $q_{enclosed} = 0$, the electric field E must be zero at all points inside the shell.

Step 3: Final Answer

The electric field inside the shell is zero.

Quick Tip: This is the principle behind "Electrostatic Shielding" or a Faraday Cage. Inside a conductor or a charged shell, you are protected from external electric fields!

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2. The distance between two charges $q_1 = +2\mu$C and $q_2 = +8\mu$C is 15 cm. Calculate the distance from the charge q_1 to the points on the line segment joining the two charges where the electric field is zero.

(A) 1 cm

(B) 2 cm

(C) 3 cm

(D) 4 cm

(E) 5 cm

Correct Answer: (E) 5 cm

Solution:

Step 1: Understanding the Concept

The "neutral point" is the location where the electric fields produced by the two charges are equal in magnitude but opposite in direction, resulting in a net field of zero.

Step 2: Key Formula or Approach

Let the distance from q_1 be x. The distance from q_2 will be $(15-x)$. At the neutral point:

$$E_1 = E_2 \implies \frac{kq_1}{x^2} = \frac{kq_2}{(15-x)^2}$$

Step 3: Detailed Calculation

1. Substitute the values:

$$\frac{2}{x^2} = \frac{8}{(15-x)^2}$$

2. Simplify the ratio:

$$\frac{1}{x^2} = \frac{4}{(15-x)^2}$$

3. Take the square root of both sides:

$$\frac{1}{x} = \frac{2}{15-x}$$

4. Cross-multiply and solve for x:

$$15 - x = 2x \implies 15 = 3x \implies x = 5 \text{ cm}$$

Step 4: Final Answer

The distance from q_1 is 5 cm.

Quick Tip: Shortcut for the neutral point from the smaller charge q_{small}:

$$x = \frac{d}{\sqrt{\frac{q_{large}}{q_{small}}} + 1}$$

Here: $x = \frac{15}{\sqrt{\frac{8}{2}}+1} = \frac{15}{2+1} = 5$ cm.

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3. Three point charges 4q, Q, and q are placed in a straight line of length L at points 0, L/2, and L respectively. The net force on charge q is zero. The value of Q is:

(A) 4q

(B) q

(C) 0.5q

(D) 2q

(E) 3q

Correct Answer: (B) q

Solution:

Step 1: Understanding the Concept

For the net force on the third charge (q) to be zero, the force exerted by the first charge ($4q$) and the second charge (Q) must be equal in magnitude but opposite in direction.

Step 2: Key Formula or Approach

Using Coulomb's Law: $F = \frac{kq_1q_2}{r^2}$. The net force on q at position L is:

$$F_{net} = F_{4q} + F_Q = 0$$

Step 3: Detailed Calculation

1. Force due to $4q$ (at distance L):

$$F_{4q} = \frac{k(4q)(q)}{L^2}$$

2. Force due to Q (at distance $L/2$):

$$F_Q = \frac{k(Q)(q)}{(L/2)^2} = \frac{4kQq}{L^2}$$

3. Set the sum to zero:

$$\frac{4kq^2}{L^2} + \frac{4kQq}{L^2} = 0$$

4. Divide by common terms ($\frac{4kq}{L^2}$):

$$q + Q = 0 \implies Q = -q$$

Step 4: Final Answer

The value of Q is $-q$.

Quick Tip: For the system to be in equilibrium, the middle charge must always have an opposite sign to the outer charges. Since $4q$ and q are positive, Q must be negative to pull the charge q while $4q$ pushes it.

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4. A galvanometer of resistance 100 gives a full scale deflection for a current of 1 mA through it. The resistance required to convert it into a voltmeter which can read up to 2 V is:

(A) 1175

(B) 1200

(C) 1525

(D) 1900

(E) 2025

Correct Answer: (D) 1900

Solution:

Step 1: Understanding the Concept

To convert a galvanometer into a voltmeter, a high resistance (called a series resistance or

multiplier) must be connected in series with the galvanometer. This limits the current to the full-scale deflection current (I_g) when the maximum desired voltage (V) is applied.

Step 2: Key Formula or Approach

The total resistance of the voltmeter is $R_{total} = G + R$, where G is the galvanometer resistance and R is the series resistance. According to Ohm's Law:

$$V = I_g(G + R)$$

Rearranging for R:

$$R = \frac{V}{I_g} - G$$

Step 3: Detailed Calculation

1. Identify the values: - $V = 2$ V - $I_g = 1$ mA $= 10^{-3}$ A - $G = 100$ 2. Apply the formula: - $R = \frac{2}{10^{-3}} - 100$ - $R = 2000 - 100$ - $R = 1900$

Step 4: Final Answer

The resistance required is 1900 .

Quick Tip: To remember the difference: A **Voltmeter** needs high resistance in **Series** (to drop voltage), while an **Ammeter** needs low resistance in **Parallel** (to bypass current).

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5. The magnetic force acting on a charged particle carrying a charge of 3μC in a magnetic field of 5 T acting in the y-direction, when the particle velocity is $(\hat{i} + \hat{j}) \times 10^5$ ms¹, is:

(A) 0.5 N in +x direction

(B) 0.2 N in +y direction

(C) 2 N in x direction

(D) 1.5 N in +z direction

(E) 1 N in +z direction

Correct Answer: (D) 1.5 N in +z direction

Solution:

Step 1: Understanding the Concept

The magnetic force ($\vec{F}$) on a moving charge is given by the Lorentz force equation. The direction of the force is always perpendicular to both the velocity and the magnetic field vectors.

Step 2: Key Formula or Approach

The vector form of magnetic force is:

$$\vec{F} = q(\vec{v} \times \vec{B})$$

Step 3: Detailed Calculation

1. Identify the vectors: - $q = 3 \times 10^{-6}$ C - $\vec{v} = (10^5\hat{i} + 10^5\hat{j})$ m/s - $\vec{B} = 5\hat{j}$ T 2. Calculate the cross product $\vec{v} \times \vec{B}$: - $(10^5\hat{i} + 10^5\hat{j}) \times (5\hat{j})$ - $= (10^5 \times 5)(\hat{i} \times \hat{j}) + (10^5 \times 5)(\hat{j} \times \hat{j})$ - Since $\hat{i} \times \hat{j} = \hat{k}$ and $\hat{j} \times \hat{j} = 0$: - $= 5 \times 10^5\hat{k}$ 3. Calculate the force $\vec{F}$: - $\vec{F} = (3 \times 10^{-6}) \times (5 \times 10^5\hat{k})$ - $\vec{F} = 15 \times 10^{-1}\hat{k} = 1.5\hat{k}$ N

Step 4: Final Answer

The force is 1.5 N in the +z direction.

Quick Tip: You can use Fleming's Left-Hand Rule for a quick direction check, but the cross product is safer for complex velocity vectors. Remember: any component of velocity parallel to the magnetic field (like the $\hat{j}$ component here) produces zero force!

CHEMISTRY

6. Which of the following compounds has the highest boiling point?

(A) n-Butane

(B) Propan-1-ol

(C) Methoxy methane

(D) Propanal

(E) Acetone

Correct Answer: (B) Propan-1-ol

Solution:

Step 1: Understanding the Concept

Boiling points of organic compounds are determined by the strength of intermolecular forces. In order of increasing strength: Van der Waals (hydrocarbons) $<$ Dipole-Dipole (ethers, aldehydes, ketones) $<$ Hydrogen bonding (alcohols, carboxylic acids).

Step 2: Detailed Explanation

1. n-Butane: A non-polar hydrocarbon with only weak London dispersion forces. 2. Methoxy methane Acetone/Propanal: These possess dipole-dipole interactions, which are stronger than dispersion forces but weaker than hydrogen bonds. 3. Propan-1-ol: Contains a polar $-OH$ group capable of forming extensive intermolecular hydrogen bonding. This requires significantly more energy to break, leading to a much higher boiling point compared to the others of similar molecular mass.

Step 3: Final Answer

Propan-1-ol has the highest boiling point due to hydrogen bonding.

Quick Tip: When comparing molecules of similar molecular weight, look for the **Alcohol** or **Carboxylic Acid** first. The presence of a hydrogen atom bonded to Oxygen ($O-H$) almost always guarantees the highest boiling point in the set.

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7. The major product obtained in the dehydration of ethanol in the presence of H_2SO_4 at 413 K is:

(A) Ethanoic acid

(B) Ethanal

(C) Ethyne

(D) Ethane

(E) Ethoxyethane

Correct Answer: (E) Ethoxyethane

Solution:

Step 1: Understanding the Concept

The dehydration of alcohols with concentrated sulfuric acid is temperature-dependent. Different temperatures favor different reaction pathways (elimination vs. substitution).

Step 2: Key Formula or Approach

1. At 443 K: Intramolecular dehydration occurs, forming an alkene (Ethene). 2. At 413 K: Intermolecular dehydration occurs, where two molecules of alcohol combine to form an ether.

Step 3: Detailed Explanation

At the lower temperature of 413 K, the reaction follows an S_N2 mechanism:

$$2CH_3CH_2OH \xrightarrow{H_2SO_4, 413K} CH_3CH_2 - O - CH_2CH_3 + H_2O$$

The product is diethyl ether, also known as ethoxyethane. If the temperature were raised to 443 K, the product would have been ethene.

Step 4: Final Answer

The major product at 413 K is ethoxyethane.

Quick Tip: To remember this: Higher temperature (443K) has enough energy to "break" the molecule into a double bond (Ethene). Lower temperature (413K) only has enough to link two molecules together (Ether).

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8. Compound 'A' is obtained by the reaction of benzyl chloride with magnesium metal in dry ether followed by treatment with water. What is the compound 'A'?

(A) Toluene

(B) Benzyl alcohol

(C) Phenol

(D) Benzene

(E) Benzaldehyde

Correct Answer: (A) Toluene

Solution:

Step 1: Understanding the Concept

The reaction of an alkyl or aryl halide with magnesium in dry ether produces a Grignard Reagent. Grignard reagents are highly reactive and undergo protonation (acid-base reaction) when treated with water.

Step 2: Key Formula or Approach

1. Formation: $R-Cl+Mg \xrightarrow{Ether} R-MgCl$ 2. Hydrolysis: $R-MgCl+H_2O \rightarrow R-H+Mg(OH)Cl$

Step 3: Detailed Explanation

1. Formation of Grignard Reagent: Benzyl chloride ($C_6H_5CH_2Cl$) reacts with Mg to form Benzyl magnesium chloride ($C_6H_5CH_2MgCl$). 2. Treatment with water: The benzyl group ($C_6H_5CH_2^-$) acts as a strong base and picks up a proton (H^+) from water.

$$C_6H_5CH_2MgCl + H_2O \rightarrow C_6H_5CH_3 + Mg(OH)Cl$$

3. The resulting product is $C_6H_5CH_3$, which is Toluene.

Step 4: Final Answer

Compound 'A' is Toluene.

Quick Tip: Grignard reagents are extremely "thirsty" for protons. Whenever you see a Grignard reagent ($R-MgX$) reacting with **Water**, **Alcohol**, or any **Acid**, the product is always the corresponding simple alkane/arene ($R-H$).

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9. The products obtained by the ozonolysis of 2-methylbut-1-ene are:

(A) Propanone and ethanal

(B) Propanone and methanal

(C) Butanone and methanal

(D) Ethanal and propanal

(E) Butanone and methanol

Correct Answer: (C) Butanone and methanal

Solution:

Step 1: Understanding the Concept

Ozonolysis is a reaction where the double bond of an alkene is completely cleaved by ozone (O_3), followed by a reductive workup (usually Zn/H_2O). The double bond ($C=C$) is replaced by two $C=O$ bonds.

Step 2: Key Formula or Approach

To find the products, draw the structure of the alkene, "cut" the double bond in half, and add an oxygen atom to each of the two carbon atoms that were part of the double bond.

Step 3: Detailed Explanation

1. Structure of 2-methylbut-1-ene: The parent chain is but-1-ene ($CH_2=CH-CH_2-CH_3$) with a methyl group at the second carbon:

$$CH_2=C(CH_3)-CH_2-CH_3$$

2. Cleavage: - The left side of the double bond is CH_2. Adding an oxygen gives **HCHO (Methanal)**. - The right side of the double bond is $C(CH_3)-CH_2-CH_3$. Adding an oxygen to that central carbon gives **CH_3 - CO - CH_2 - CH_3 (Butanone)**.

Step 4: Final Answer

The products are Butanone and Methanal.

Quick Tip: If an alkene has a $=CH_2$ group at the end of the chain, one of the ozonolysis products will **always** be Formaldehyde (Methanal). This is a great way to eliminate options quickly!

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10. On heating an aldehyde with Fehling's reagent, a reddish-brown precipitate is obtained due to the formation of:

(A) Cupric oxide

(B) Cuprous oxide

(C) Carboxylic acid

(D) Silver

(E) Copper acetate

Correct Answer: (B) Cuprous oxide

Solution:

Step 1: Understanding the Concept

Fehling's test is used to distinguish between aldehydes and ketones. Aldehydes are easily oxidized to carboxylate ions, while the Cu^{2+} ions in the Fehling's solution are reduced.

Step 2: Key Formula or Approach

The overall redox reaction is:

$$R-CHO+2Cu^{2+}+5OH^{-}\rightarrow R-COO^{-}+Cu_2O\downarrow+3H_2O$$

Step 3: Detailed Explanation

1. Oxidation: The aldehyde ($R-CHO$) is oxidized to a carboxylate ion ($R-COO^{-}$). 2. Reduction: The deep blue complex of Cu^{2+} (Cupric ions) is reduced to Cu^{+} (Cuprous ions). 3. Precipitation: The cuprous ions combine with oxygen to form Cuprous oxide (Cu_2O), which is an insoluble solid with a characteristic reddish-brown (brick red) color.

Step 4: Final Answer

The reddish-brown precipitate is due to the formation of Cuprous oxide.

Quick Tip: Remember the oxidation states: **Cupric** is Cu^{2+} (Blue solution), while **Cuprous** is Cu^{+} (Red solid). The change from +2 to +1 is what indicates a positive test for an aldehyde.

MATHEMATICS

11. The 25th term of 9, 3, 1, $\frac{1}{3}$, $\frac{1}{9}$, ... is:

(A) $\frac{1}{3^{24}}$

(B) $\frac{1}{3^{25}}$

(C) $\frac{1}{3^{23}}$

(D) $\frac{1}{3^{22}}$

(E) $\frac{1}{3^{26}}$

Correct Answer: (D) $\frac{1}{3^{22}}$

Solution:

Step 1: Understanding the Concept

The given sequence is a Geometric Progression (GP) because the ratio between consecutive terms is constant. We need to find the specific term using the general formula for a GP.

Step 2: Key Formula or Approach

The n-th term of a GP is given by:

$$a_n = a \cdot r^{n-1}$$

Where: a is the first term. r is the common ratio. n is the term number.

Step 3: Detailed Calculation

1. Identify the values: - First term $(a) = 9$ - Common ratio $(r) = 3/9 = 1/3$ - Term number $(n) = 25$ 2. Apply the formula: - $a_{25} = 9 \cdot (1/3)^{25-1}$ - $a_{25} = 3^2 \cdot (1/3)^{24}$ - $a_{25} = 3^2 \cdot \frac{1}{3^{24}}$ - $a_{25} = \frac{1}{3^{24-2}} = \frac{1}{3^{22}}$

Step 4: Final Answer

The 25th term is $\frac{1}{3^{22}}$.

Quick Tip: Always express the first term as a power of the common ratio's base if possible. Here, writing 9 as 3^2 makes simplifying the exponents much faster!

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12. Five digit number is formed using the digits 0, 1, 2, 3, 4, and 5 without repetitions. Number of five digit numbers which are divisible by 10 is:

(A) 360

(B) 240

(C) 120

(D) 480

(E) 520

Correct Answer: (C) 120

Solution:

Step 1: Understanding the Concept

For a number to be divisible by 10, its last digit (units place) must be 0. Since we are forming a 5-digit number without repetition, once 0 is fixed at the end, we arrange the remaining digits in the other places.

Step 2: Detailed Calculation

1. Digits available: 0, 1, 2, 3, 4, 5 (Total 6 digits). 2. Constraint (Divisibility by 10): The units place is fixed with the digit '0'. (1 way) 3. Filling the remaining 4 places: - We need to choose and arrange 4 digits from the remaining 5 digits 1, 2, 3, 4, 5. - The number of ways to fill the 1st place: 5 options. - The number of ways to fill the 2nd place: 4 options. - The number of ways to fill the 3rd place: 3 options. - The number of ways to fill the 4th place: 2 options. 4. Total Numbers: $5 \times 4 \times 3 \times 2 \times 1 = 120$.

Step 3: Final Answer

The number of five-digit numbers divisible by 10 is 120.

Quick Tip: In permutation problems with constraints, **always** fill the constrained position first. Fixing '0' at the end also conveniently removes the worry of '0' being at the start of the 5-digit number.

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13. Let U be the universal set and let A and B be any two subsets of U. If n(U) = 25, n(A) = 14, n(A∩B) = 6 and n(A∪B) = 20, then n(B) is equal to:

(A) 12

(B) 13

(C) 14

(D) 15

(E) 16

Correct Answer: (B) 13

Solution:

Step 1: Understanding the Concept

We use the Principle of Inclusion-Exclusion for two sets and the definition of a complement set. B' (or B^c) represents all elements in the Universal set U that are not in B.

Step 2: Key Formula or Approach

1. $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ 2. $n(B') = n(U) - n(B)$

Step 3: Detailed Calculation

1. Find $n(B)$: - $20 = 14 + n(B) - 6$ - $20 = 8 + n(B)$ - $n(B) = 20 - 8 = 12$ 2. Find $n(B')$: - $n(B') = n(U) - n(B)$ - $n(B') = 25 - 12 = 13$

Step 4: Final Answer

The value of $n(B')$ is 13.

Quick Tip: A quick way to visualize this is using a Venn Diagram. If the entire "B" circle contains 12 elements, everything outside that circle (within the Universal box) must be $25 - 12$.

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14. A straight line passing through (6,1,3) meets the line $\frac{x-1}{2} = \frac{y}{1} = \frac{z-2}{3}$ at Q. If the lines are perpendicular to each other, then the coordinates of Q are:

(A) (2, 1, 3)

(B) (1, 2, 3)

(C) (3, 1, 5)

(D) (2, -1, 3)

(E) (-1, 2, 3)

Correct Answer: (C) (3, 1, 5)

Solution:

Step 1: Understanding the Concept

Point Q lies on the given line, so its coordinates can be expressed in terms of a scalar parameter r. Since the line joining $(6,1,3)$ and Q is perpendicular to the given line, the dot product of their direction vectors must be zero.

Step 2: Expressing Q and the Direction Vector

1. Let the given line be $L : \frac{x-1}{2} = \frac{y}{1} = \frac{z-2}{3} = r$. 2. Coordinates of any point Q on L: $(2r+1, r, 3r+2)$. 3. Let point P be $(6,1,3)$. The direction vector of PQ is: $\vec{d_{PQ}} = (2r+1-6, r-1, 3r+2-3) = (2r-5, r-1, 3r-1)$.

Step 3: Applying Perpendicularity Condition

The direction vector of the given line L is $\vec{d_L} = (2,1,3)$. Since $PQ \perp L$:

$$(2r-5)(2) + (r-1)(1) + (3r-1)(3) = 0$$

$$4r - 10 + r - 1 + 9r - 3 = 0$$

$$14r - 14 = 0 \implies r = 1$$

Substituting $r = 1$ into the coordinates of Q: $Q = (2(1)+1, 1, 3(1)+2) = (3,1,5)$.

Step 4: Final Answer

The coordinates of Q are (3, 1, 5).

Quick Tip: To verify your answer quickly in an exam, check if the point you chose (3, 1, 5) actually satisfies the line equation: $\frac{3-1}{2} = \frac{1}{1} = \frac{5-2}{3}$. Since $1 = 1 = 1$, it is a point on the line. Then check the dot product with the direction ratios $(2,1,3)$.

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15. The three vertices of a triangle are (0,0), (3,1) and (1,3). If this triangle is inscribed in a circle, then the equation of the circle is:

(A) $2x^2 + 2y^2 - 2x - 6y = 0$

(B) $x^2 + y^2 - 3x - y = 0$

(C) $x^2+y^2-x-3y=0$

(D) $2x^2+2y^2-6x-2y=0$

(E) $2x^2+2y^2-5x-5y=0$

Correct Answer: (E) $2x^2+2y^2-5x-5y=0$

Solution:

Step 1: Understanding the Concept

A circle passing through the vertices of a triangle is its circumcircle. The general equation of a circle is $x^2+y^2+2gx+2fy+c=0$. We substitute the three points into this equation to find the constants.

Step 2: Substituting the Points

1. Passes through (0,0): $0^2+0^2+2g(0)+2f(0)+c=0 \implies c=0$. 2. Passes through (3,1): $3^2+1^2+2g(3)+2f(1)=0 \implies 6g+2f=-10$. 3. Passes through (1,3): $1^2+3^2+2g(1)+2f(3)=0 \implies 2g+6f=-10$.

Step 3: Solving the Equations

Subtracting the two equations: $(6g+2f)-(2g+6f)=-10-(-10)=0$. $4g-4f=0 \implies g=f$. Substitute $g=f$ into $6g+2g=-10 \implies 8g=-10 \implies g=-5/4$. Thus, $f=-5/4$. The equation is $x^2+y^2+2(-5/4)x+2(-5/4)y=0$. $x^2+y^2-\frac{5}{2}x-\frac{5}{2}y=0$. Multiplying by 2: $2x^2+2y^2-5x-5y=0$.

Step 4: Final Answer

The equation of the circle is $2x^2+2y^2-5x-5y=0$.

Quick Tip: If a circle passes through $(0,0)$, the constant term c in the equation $x^2+y^2+Dx+Ey+c=0$ must be zero. Also, since the points $(3,1)$ and $(1,3)$ are symmetric about the line $y=x$, the center of the circle must lie on $y=x$, meaning the coefficients of x and y will be identical.