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High School Teacher TGT Science PCM Previous Year Question

FREE DEMO

10 Toughest Physics, Chemistry & Math Questions (2019 – 2025)
with Full Solutions



PCM – 10 TOUGHEST PYQ

Hand-picked from 7 TGT Science PCM papers (DSE Odisha RHT 2019 $\times 2$ & 2021 $\times 2$, OSSC RHT Main 2023, OSSC LTR Mains 2024-25 and SSB 2024) – with the same step-by-step solutions you get in the full pack.

Q-1 The equation $x^2 + y^2 = 4$ is solved for all integral values of x and y . These solutions are plotted on coordinate axes. What will be the area of the figure formed by joining these points?

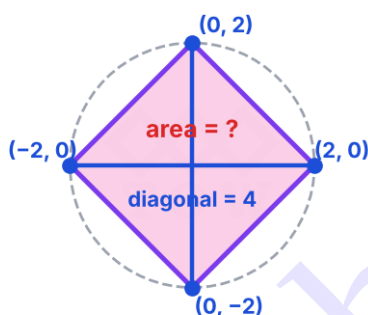
[DSE Odisha TGT SCI PCM 2019]

- (A) 8 sq. units
- (B) 4π sq. units
- (C) $4\sqrt{2}$ sq. units
- (D) $8\sqrt{2}$ sq. units

ANS- (A) 8 sq. units

Given:

$\rightarrow x^2 + y^2 = 4$ with integer x and y



Concept:

$\rightarrow x^2 \leq 4$, so x can only be $-2, -1, 0, 1, 2$; test each for an integer y

$\rightarrow$ Square with diagonal d : area = $\frac{1}{2}d^2$

Solution:

$\rightarrow x = \pm 2$ gives $y = 0$ and $x = 0$ gives $y = \pm 2$; $x = \pm 1$ gives $y^2 = 3$, not a perfect square

$\Rightarrow$ The four points are $(\pm 2, 0)$ and $(0, \pm 2)$

$\rightarrow$ Joining them makes a square whose diagonals (length 4) lie on the axes

$\rightarrow$ Area = $\frac{1}{2} \times 4 \times 4 = 8$ sq. units

$\therefore$ Ans: (A) 8 sq. units

Hint:

$\rightarrow$ Alternative: side = $\sqrt{2^2 + 2^2} = 2\sqrt{2}$, so area = $(2\sqrt{2})^2 = 8$ sq. units

Q-2 Hydroxylamine on reaction with cyclohexanone produces A. A on treatment with H_2SO_4 gives B. What is B and the name of the reaction for the conversion of A to B respectively?



[DSE Odisha TGT SCI PCM 2019]

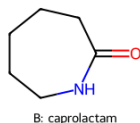
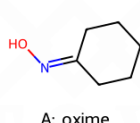
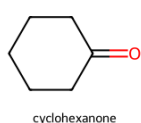
- (A) Caprolactam and Fries rearrangement
(B) Caprolactam and Beckmann rearrangement
(C) Cyclohexanone oxime and Beckmann rearrangement
(D) Cyclohexanone oxime and Fries rearrangement

ANS- (B) Caprolactam and Beckmann rearrangement

Given:

→ Cyclohexanone $C_6H_{10}O$ + hydroxylamine $NH_2OH \rightarrow A$

→ $A + H_2SO_4 \rightarrow B$



NH₂OH, then H₂SO₄ (Beckmann)

Concept:

- Ketone + NH_2OH gives an oxime (condensation, loss of water).
→ An oxime treated with acid (H_2SO_4 , PCl_5) rearranges to an amide; a cyclic oxime gives a cyclic amide (lactam). This is the Beckmann rearrangement.

Solution:

→ $C_6H_{10}O + NH_2OH \rightarrow C_6H_{10}=NOH$ (A, cyclohexanone oxime) + H_2O

$\xrightarrow{H_2SO_4}$
→ $C_6H_{10}=NOH \rightarrow B$ (ring expands, N enters the ring: 7-membered lactam $C_6H_{11}NO$)

→ B = ϵ -caprolactam, the monomer of nylon-6

→ Ans: (B) Caprolactam and Beckmann rearrangement

Why not others:

- (C), (D) These name B as the oxime, but the oxime is A; B is the lactam formed after rearrangement.
→ (A) Right product, wrong reaction: Fries rearrangement converts a phenolic ester to a hydroxy-aryl ketone, not an oxime to a lactam.

Hint:

→ Oxime to amide/lactam = Beckmann; phenyl ester to o/p-hydroxy ketone = Fries.

Q-3 A square metal wire loop of side 20 cm and resistance 2 Ohm is connected to a 3 ohm resistor. The loop is moved into a uniform magnetic field of induction, $B = 2 \text{ Wb/m}^2$ with a uniform velocity such that a steady current of 2 mA is maintained in the circuit. If the magnetic field is perpendicular to the plane of the loop, find the velocity with which the loop is introduced into the field.

[DSE Odisha TGT SCI PCM 2021]

- (A) 1.0 cm/s

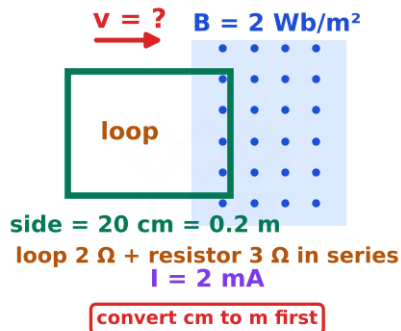


- (B) 1.5 cm/s
(C) 2.0 cm/s
(D) 2.5 cm/s

ANS- (D) 2.5 cm/s

Given:

- Side $l = 20 \text{ cm} = 0.2 \text{ m}$, loop resistance $= 2 \Omega$, extra resistor $= 3 \Omega$
→ $B = 2 \text{ Wb/m}^2$, steady current $I = 2 \text{ mA} = 0.002 \text{ A}$



Concept:

- Loop and resistor are in series, so $R = 2 + 3$
→ Induced emf $e = IR$ (Ohm's law)
→ Motional emf $e = Blv$

Solution:

- Total resistance $R = 2 + 3 = 5 \Omega$
→ $e = IR = 0.002 \times 5 = 0.01 \text{ V}$
→ $e = Blv$
 $\Rightarrow v = \frac{e}{Bl} = \frac{0.01}{2 \times 0.2} = 0.025 \text{ m/s} = 2.5 \text{ cm/s}$

∴ Ans: (D) 2.5 cm/s

Hint:

- Unit tip: $0.025 \text{ m/s} \times 100 = 2.5 \text{ cm/s}$

Q-4 A rod of mass M and length L is bent in the form of an equilateral triangle. Find the moment of inertia of the triangle about an axis passing through its centroid and perpendicular to the plane containing it.

[DSE Odisha TGT SCI PCM 2021]

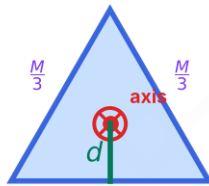
- (A) $\frac{ML^2}{2}$
(B) $\frac{ML^2}{9}$
(C) $\frac{ML^2}{27}$
(D) $\frac{ML^2}{54}$



ANS-(D) $\frac{ML^2}{54}$

Given:

- Rod of mass M and length L bent into an equilateral triangle
- Side $a = \frac{L}{3}$, mass of each side $m = \frac{M}{3}$
- Axis through the centroid, perpendicular to the plane



$I = ?$

$d = \frac{a}{2\sqrt{3}}$

side $a = \frac{L}{3}$

$\frac{M}{3}$ on each side

d is to side, not vertex

Concept:

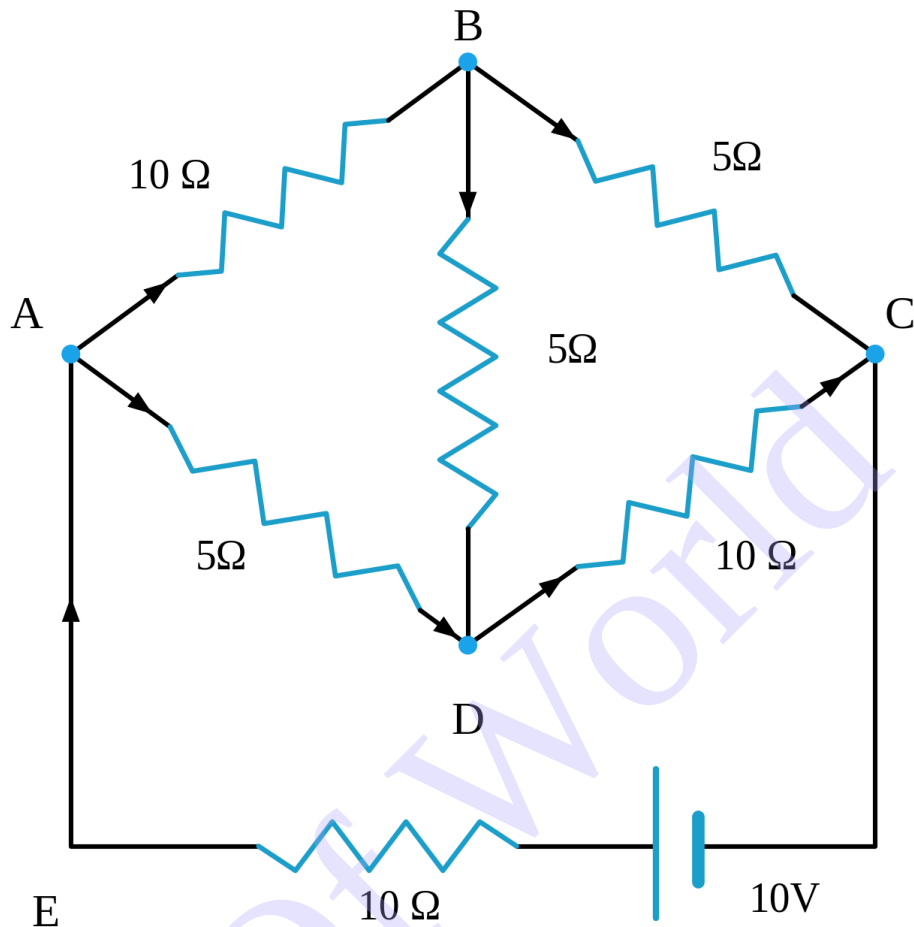
- Thin rod about a perpendicular axis through its centre: $I_{cm} = \frac{ma^2}{12}$
- Parallel axis theorem: $I = I_{cm} + md^2$
- Distance of the centroid from a side $d = \frac{a}{2\sqrt{3}}$, so $d^2 = \frac{a^2}{12}$

Solution:

- One side: $I_1 = \frac{ma^2}{12} + m \frac{a^2}{12} = \frac{ma^2}{6}$
- Three identical sides, each of mass $\frac{M}{3}$: $I = 3 \times \frac{M}{3} \times \frac{a^2}{6} = \frac{Ma^2}{6}$
- Put $a = \frac{L}{3}$: $I = \frac{M}{6} \times \frac{L^2}{9} = \frac{ML^2}{54}$
- ∴ Ans: (D) $\frac{ML^2}{54}$

Q-5 Network of resistors are arranged as shown below.





How much current is flowing through AD branch?

[OSSC RHT SCI PCM Main 2023 By TCS]

- (A) $-2/17$ A
- (B) $10/17$ A
- (C) $8/17$ A
- (D) $6/17$ A

ANS- (D) $6/17$ A

Given:

- $AB = 10\ \Omega$, $BC = 5\ \Omega$, $AD = 5\ \Omega$, $DC = 10\ \Omega$, $BD = 5\ \Omega$
- Battery 10 V in series with $10\ \Omega$, current enters at A and leaves at C
- Let current in $AB = x$, in $AD = y$, in BD (B to D) = z

Concept:

- Junction rule: current in equals current out, so $BC = x - z$ and $DC = y + z$
- Loop rule: sum of IR around a closed loop = 0 (or equals the emf)

Solution:

- Loop ABD: $10x + 5z - 5y = 0$
- ⇒ $z = y - 2x$
- Loop BCD: $5(x - z) - 10(y + z) - 5z = 0$
- ⇒ $x - 2y - 4z = 0$
- Put $z = y - 2x$: $9x - 6y = 0$



$$\Rightarrow y = \frac{3x}{2} \text{ and } z = -\frac{x}{2}$$

$$\rightarrow \text{Loop through battery, } 10 \, \Omega, A, B, C: 10 = 10(x+y) + 10x + 5(x-z)$$

$$\Rightarrow 42.5x = 10, \text{ so } x = \frac{4}{17} \text{ A}$$

$$\rightarrow \text{AD carries } y = \frac{3x}{2}$$

$$\Rightarrow y = \frac{3}{2} \times \frac{4}{17} = \frac{6}{17} \text{ A}$$

$$\therefore \text{Ans: (D) } \frac{6}{17} \text{ A}$$

Hint:

$$\rightarrow \text{Check: total current } x + y = \frac{10}{17} \text{ A, and } 10 \times \frac{10}{17} + 10 \times \frac{4}{17} + 5 \times \frac{6}{17} = 10 \text{ V } \checkmark$$

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Q-6 Find the equation of the ellipse, with major axis along the x-axis and passing through the points (4, 3) and (-1,4).

[OSSC RHT SCI PCM Main 2023 By TCS]

(A) $15x^2 + 7y^2 = 247$

(B) $7x^2 + 15y^2 = 247$

(C) $7x^2 + 15y^2 = -247$

(D) $15x^2 + 7y^2 = -247$

ANS- (B) $7x^2 + 15y^2 = 247$

Given:

$$\rightarrow \text{Ellipse } \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \text{ with the major axis along the } x\text{-axis, so } a > b$$

$$\rightarrow \text{It passes through } (4, 3) \text{ and } (-1, 4)$$

Concept:

$$\rightarrow \text{A point lies on the curve if its coordinates satisfy the equation}$$

$$\rightarrow x^2 \text{ and } y^2 \text{ are never negative, so the right side cannot be } -247$$

Solution:

$$\rightarrow \text{Options (C) and (D) have right side } -247, \text{ so they are impossible}$$

$$\rightarrow \text{Test (A) } 15x^2 + 7y^2 = 247 \text{ at } (4, 3): 15 \times 16 + 7 \times 9 = 303 \neq 247, \text{ so (A) fails}$$

$$\rightarrow \text{Test (B) } 7x^2 + 15y^2 = 247 \text{ at } (4, 3): 7 \times 16 + 15 \times 9 = 247 \checkmark$$

$$\Rightarrow \text{At } (-1, 4): 7 \times 1 + 15 \times 16 = 247 \checkmark$$

$$\rightarrow \text{Major axis along } x: a^2 = \frac{247}{7} > b^2 = \frac{247}{15} \checkmark$$

$$\therefore \text{Ans: (B) } 7x^2 + 15y^2 = 247$$



Hint:

→ Alternative: let $p = \frac{1}{a^2}$, $q = \frac{1}{b^2}$; then $16p + 9q = 1$ and $p + 16q = 1$, giving $p = \frac{7}{247}$,
 $q = \frac{15}{247}$

Q-7 An aqueous solution containing 0.01 M $FeCl_3$ and 0.06M $HClO_4$ has the same ionic strength as a solution of:

[OSSC LTR TGT PCM Mains 2024-2025]

- (A) 0.09 M NaCl
- (B) 0.04 M Na_2SO_4
- (C) 0.06 M $CuSO_4$
- (D) 0.03 M H_3PO_4

ANS- (B) 0.04 M Na_2SO_4

Given:

→ Solution 1: 0.01 M $FeCl_3$ and 0.06 M $HClO_4$

→ Find the solution among the options with the same ionic strength

Concept:

→ Ionic strength $I = \frac{1}{2} \sum c_i z_i^2$ (charge is squared)

→ Strong electrolytes dissociate fully; the weak acid H_3PO_4 gives very few ions

Solution:

► Ions: Fe^{3+} 0.01 M, Cl^- 0.03 M, H^+ 0.06 M, ClO_4^- 0.06 M

$$\Rightarrow I = \frac{1}{2} [0.01(3)^2 + 0.03(1)^2 + 0.06(1)^2 + 0.06(1)^2] = \frac{1}{2} (0.09 + 0.03 + 0.06 + 0.06) = 0.12$$

$$\Rightarrow 0.04 \text{ M } Na_2SO_4: I = \frac{1}{2} [0.08(1)^2 + 0.04(2)^2] = \frac{1}{2} (0.08 + 0.16) = 0.12$$

► Ans: (B) 0.04 M Na_2SO_4

Why not others:

→ (A) 0.09 M NaCl — 1:1 salt, $I = 0.09$

→ (C) 0.06 M $CuSO_4$ — 2:2 salt, $I = 4 \times 0.06 = 0.24$

→ (D) 0.03 M H_3PO_4 — weak acid, ionises very little, I is far below 0.12

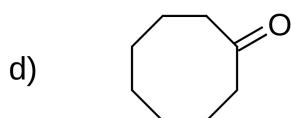
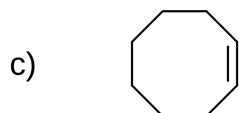
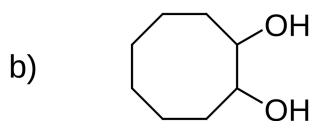
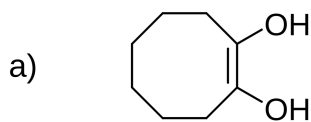
Hint:

→ Shortcut for I : 1:1 salt = c , 1:2 or 2:1 salt = $3c$, 2:2 salt = $4c$; here $3 \times 0.04 = 0.12$



Q-8 The reaction of cyclooctyne with HgSO_4 in the presence of aqueous H_2SO_4 gives:

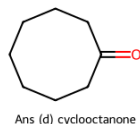
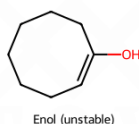
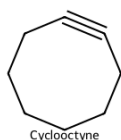
[OSSC LTR TGT PCM Mains 2024-2025]



ANS- (D) Cyclooctanone

Given:

→ Cyclooctyne (C_8H_{12}) + H_2O , with HgSO_4 / dil. H_2SO_4



HgSO_4 / aq. H_2SO_4 : alkyne → enol → ketone

Concept:

→ Hg^{2+} -catalysed hydration of an alkyne (Kucherov): H and OH add across the triple bond to give an enol, which tautomerises to a ketone.

→ The ring alkyne is symmetrical, so only one ketone is possible.

Solution:



$$\text{C}_8\text{H}_{12} + \text{H}_2\text{O} \xrightarrow[\text{aq. H}_2\text{SO}_4]{\text{HgSO}_4} \text{C}_8\text{H}_{14}\text{O} \text{ (enol, cyclooct-1-en-1-ol)}$$

$$\Rightarrow \text{Keto-enol tautomerism: } \text{C}=\text{C}-\text{OH} \rightleftharpoons \text{CH}-\text{C}=\text{O} \text{ (keto form is far more stable)}$$

$$\Rightarrow \text{Product: cyclooctanone, } \text{C}_8\text{H}_{14}\text{O}$$

► Ans: (D) cyclooctanone

Why not others:

→ (A) An ene-diol (two OH on the C=C) needs oxidation; hydration adds only one H_2O and the enol turns into a ketone.

→ (B) Cyclooctane-1,2-diol comes from an alkene with OsO_4 or cold alkaline KMnO_4 .

→ (C) Cyclooctene comes from partial reduction (H_2 / Lindlar), not from hydration.

Hint:

→ Alkyne + $\text{H}_2\text{O} / \text{HgSO}_4 / \text{H}_2\text{SO}_4 \rightarrow$ ketone (aldehyde only for ethyne).

Q-9 If the function f defined on R by

$f(x) = \begin{cases} ax^2 + b, & b \neq 0, x \leq 1 \\ bx^2 + ax + c, & x > 1 \end{cases}$ is continuous and differentiable at $x=1$, then which one of the following is true?

[SSB TGT PCM 2024]

- (A) $a=2b, c=0$
 (B) $a=b, c \in R$
 (C) $a=b, c=0$
 (D) $2a=b, c \neq 0$

ANS- (A) $a=2b, c=0$

Given:

→ $f(x) = ax^2 + b$ for $x \leq 1$ and $f(x) = bx^2 + ax + c$ for $x > 1$

→ f is continuous and differentiable at $x=1$

Concept:

→ Continuous at $x=1$: left value = right value

→ Differentiable at $x=1$: left derivative = right derivative

Solution:

→ Continuity: $a(1)^2 + b = b(1)^2 + a(1) + c$

$\Rightarrow a + b = a + b + c$, so $c=0$

→ Derivatives: left $2ax$, right $2bx + a$; at $x=1$ they are equal

$\Rightarrow 2a = 2b + a$, so $a=2b$

$\therefore$ Ans: (A) $a=2b, c=0$

Hint:

→ Check with $b=1, a=2, c=0$: left $2x^2+1$ and right x^2+2x both equal 3 at $x=1$; slopes 4 and $2+2=4$ ✓

Q-10 The lateral surface area of a cone is $1\frac{1}{3}$ times larger than its base area. If the height of the cone is 7 cm, then the surface area of the cone is:



[SSB TGT PCM 2024]

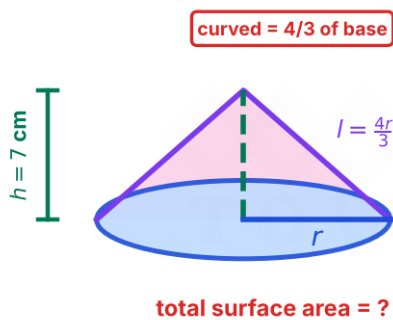
- (A) $135 \pi \text{ cm}^2$
(B) $138 \pi \text{ cm}^2$
(C) $142 \pi \text{ cm}^2$
(D) $147 \pi \text{ cm}^2$

ANS- (D) $147 \pi \text{ cm}^2$

Given:

→ Lateral (curved) area = $1 \frac{1}{3} = \frac{4}{3}$ of base area; height $h = 7 \text{ cm}$

→ Radius r , slant height l



Concept:

→ Curved area = $\pi r l$, base area = πr^2 , total surface area = $\pi r^2 + \pi r l$

→ $l^2 = r^2 + h^2$

Solution:

$$\rightarrow \pi r l = \frac{4}{3} \pi r^2$$

$$\Rightarrow l = \frac{4r}{3}$$

$$\rightarrow l^2 - r^2 = h^2: \frac{16r^2}{9} - r^2 = 49$$

$$\Rightarrow \frac{7r^2}{9} = 49, \text{ so } r^2 = 63$$

$$\rightarrow \text{Total surface area} = \pi r^2 + \frac{4}{3} \pi r^2 = \frac{7}{3} \pi r^2 = \frac{7}{3} \times 63 \pi = 147 \pi \text{ cm}^2$$

∴ Ans: (D) $147 \pi \text{ cm}^2$

Hint:

→ Check: $r = 3\sqrt{7}$ and $l = 4\sqrt{7}$, so $l^2 - r^2 = 112 - 63 = 49 = 7^2 \checkmark$





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