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**10 Toughest Subject Content Questions (2018 – 2024) with Full
Solutions**



SUBJECT CONTENT – 10 TOUGHEST PYQ

Hand-picked from 4 OAVS TGT Science papers (2018, 2019, 2021 and 2024) – Physics, Chemistry & Biology – with the same step-by-step solutions you get in the full pack.

Q-1 A solid sphere of radius R has a concentric cavity of radius r . When it is dropped in water, half of its volume is submerged in water. Find the relative density of the material of the sphere.

[OAVS TGT SCIENCE 2018]

(A) $\frac{2R^3}{R^3 - r^3}$

(B) $\frac{R^3}{2(R^3 - r^3)}$

(C) $\frac{R}{R - r}$

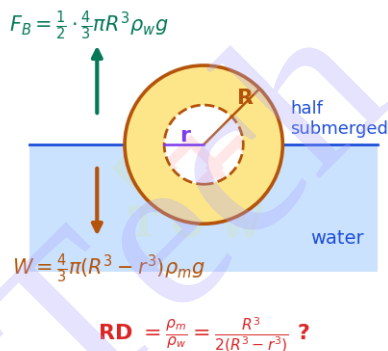
(D) $\frac{R^3}{R^3 - r^3}$

ANS- (B) $\frac{R^3}{2(R^3 - r^3)}$

Given:

→ Outer radius = R , cavity radius = r

→ Submerged volume = $\frac{1}{2} \times$ total volume



Concept:

→ Weight of sphere = Buoyant force

→ $\rho_m \times V_{\text{material}} = \rho_w \times V_{\text{submerged}}$

Solution:

➤ $\rho_m \times \frac{4}{3}\pi(R^3 - r^3) = \rho_w \times \frac{1}{2} \times \frac{4}{3}\pi R^3$

➤ Relative density = $\frac{\rho_m}{\rho_w} = \frac{R^3}{2(R^3 - r^3)}$

➤ Ans: (B) $\frac{R^3}{2(R^3 - r^3)}$



Q-2 A convex lens of focal length 20 cm and a concave lens of focal length 5 cm are separated by a certain distance. A parallel beam of light is incident on the convex lens and the light emerging out from the concave lens is also a parallel beam of light. Find the distance between the two lenses.

[OAVS TGT SCIENCE 2018]

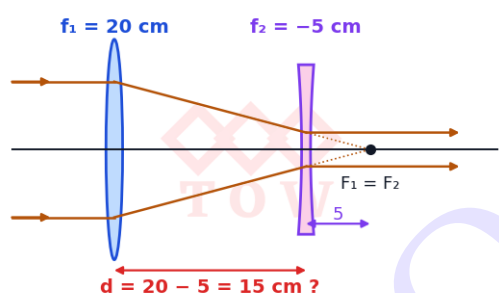
- (A) 20 cm
- (B) 25 cm
- (C) 5 cm
- (D) 15 cm

ANS- (D) 15 cm

Given:

→ Convex: $f_1 = +20\text{ cm}$, concave: $f_2 = -5\text{ cm}$

→ Incident and emergent beams both parallel



Concept:

→ Focus of the first lens must coincide with that of the second: $d = f_1 + f_2$

Solution:

- $d = 20 + (-5)$
- $d = 15\text{ cm}$
- Ans: (D) 15 cm

Q-3 A uniform chain of mass 2 kg and length 2 m is placed on a smooth horizontal table such that $\frac{1}{4}$ th of its length is hanging from the edge of the table. Find the work done in pulling the hanging part on to the table ($g = 10\text{ m/s}^2$).

[OAVS TGT SCIENCE 2018]

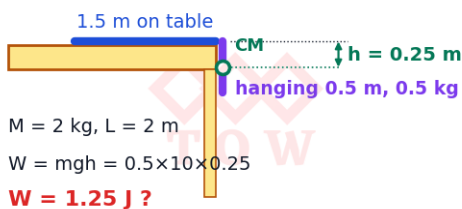
- (A) 10 J
- (B) 5 J
- (C) 1.25 J
- (D) 2.5 J

ANS- (C) 1.25 J



Given:

→ $M = 2 \text{ kg}$, $L = 2 \text{ m}$, hanging part = $\frac{1}{4}L = 0.5 \text{ m}$, $g = 10 \text{ m/s}^2$



Concept:

→ $W = m_{\text{hang}} g h_{\text{cm}}$ — the centre of mass of the hanging part lies at $\frac{L}{8}$ below the edge

Solution:

➤ $m_{\text{hang}} = \frac{1}{4} \times 2 = 0.5 \text{ kg}$, $h_{\text{cm}} = \frac{0.5}{2} = 0.25 \text{ m}$

➤ $W = 0.5 \times 10 \times 0.25 = 1.25 \text{ J}$

➤ Ans: (C) 1.25 J

Q-4 How many molecules of iron and water (steam) react to form one molecule of ferrosoferric oxide with release of hydrogen gas?

[OAVS TGT Science 2019]

- (A) 4 and 3 respectively
(B) 4 molecules of both
(C) 3 molecules of both
(D) 3 and 4 respectively

Ans- (D) 3 and 4 respectively

Given:

→ Iron reacts with steam to form ferrosoferric oxide (Fe_3O_4) and hydrogen gas.



Atom	Left	Right
Fe	3	3 ✓
H	$4 \times 2 = 8$	$4 \times 2 = 8$ ✓
O	4	4 ✓

Concept:

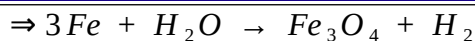
→ Balance the equation so that the number of atoms of each element is equal on both sides.

Solution:

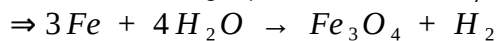
➤ Skeletal equation: $\text{Fe} + \text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + \text{H}_2$

➤ Balance Fe: 3 Fe atoms are needed on the left.

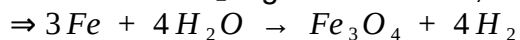




► Balance O: Fe_3O_4 has 4 O atoms, so 4 H_2O are needed.



► Balance H: 4 H_2O give 8 H atoms, i.e., 4 H_2 molecules.



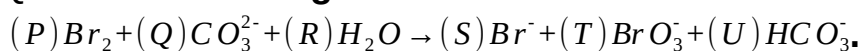
► Ans: (D) 3 and 4 respectively

Hint:

→ Balance the metal first, then oxygen, and hydrogen last.

→ Do not confuse 4 H_2O (reactant) with 4 H_2 (product) — both are 4 here.

Q-5 Consider the given redox reaction.



The value of $P+2T+U+Q-S-R$ is:

[OAVS TGT Science 2021]

(A) 11

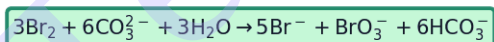
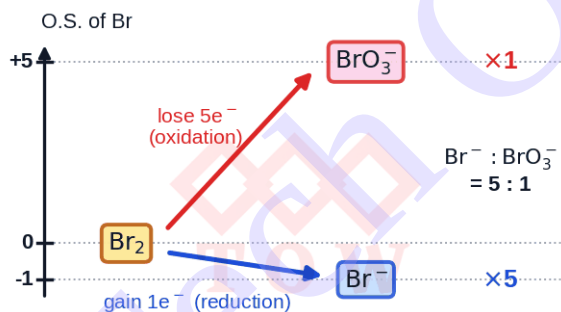
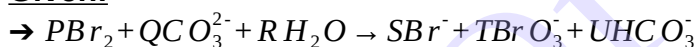
(B) 9

(C) 13

(D) 12

ANS- (B) 9

Given:



$$P+2T+U+Q-S-R = 3+2+6+6-5-3 = 9$$

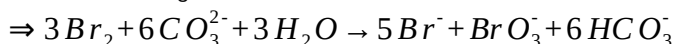
Concept:

→ Br_2 disproportionates in alkaline (carbonate) medium: Br goes from 0 to -1 (reduction) and from 0 to +5 (oxidation).

Solution:

► Gain of $1e^-$ per Br^- and loss of $5e^-$ per BrO_3^-

$$\Rightarrow Br^- : BrO_3^- = 5 : 1$$



$$\Rightarrow P = 3, Q = 6, R = 3, S = 5, T = 1, U = 6$$

$$\Rightarrow P+2T+U+Q-S-R = 3+2+6+6-5-3 = 9$$

► Ans: (B) 9

Hint:



→ Check the charge: left side = $6 \times (-2) = -12$; right side = $-5 - 1 - 6 = -12$.

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Q-6 The type of hybridisation exhibited by carbon atoms in allene (C_3H_4) is/are:

[OAVS TGT Science 2021]

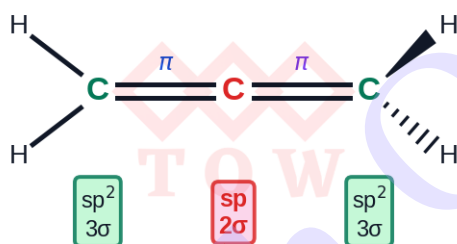
- (A) only sp^2
- (B) sp and sp^2
- (C) sp and sp^3
- (D) sp^2 and sp^3

ANS- (B) sp and sp^2

Given:

→ Allene: $CH_2=C=CH_2$ (propa-1,2-diene), a cumulated diene

two π bonds at 90° (H pairs in crossed planes)



Allene = C_3H_4 , not C_4H_6

Concept:

→ A carbon with one double bond is sp^2 ; a carbon with two double bonds is sp .

Solution:

► Terminal carbons ($CH_2=$): 3 σ bonds → sp^2

⇒ Central carbon ($=C=$): 2 σ bonds → sp

► Ans: (B) sp and sp^2

Why not others:

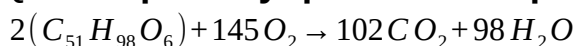
→ (A) only sp^2 — ignores the central sp carbon.

→ (C), (D) sp^3 — allene has no carbon with four single bonds.

Hint:

→ In a cumulated diene ($C=C=C$) the central carbon is always sp and the two end carbons are sp^2 .

Q-7 Respiratory quotient of tripalmitin (fatty acid) is:



[OAVS TGT Science 2021]

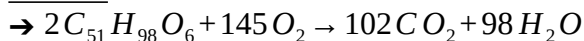
(A) 0.9



- (B) 1.4
(C) 0.4
(D) 0.7

ANS- (D) 0.7

Given:



Concept:

$\rightarrow RQ = \text{volume of } CO_2 \text{ evolved} \div \text{volume of } O_2 \text{ consumed}$

$$\rightarrow RQ = \frac{V_{CO_2}}{V_{O_2}}$$

Solution:

$$\rightarrow RQ = \frac{102}{145}$$

$$\Rightarrow RQ = 0.70$$

$\rightarrow$ Ans: (D) 0.7

Hint:

$\rightarrow RQ \approx 1$ for carbohydrates, about 0.9 for proteins, about 0.7 for fats, and more than 1 for organic acids.

Q-8 What is the hydrogen concentration in the methanoic acid solution of 0.25 molarity if the dissociation constant of methanoic acid in water is 1.8×10^{-4} ?

[OAVS TGT SCIENCE 2024]

- (A) $6.708 \times 10^{-3} M$
(B) $8.1 \times 10^3 M$
(C) $7.5 \times 10^4 M$
(D) $3.124 \times 10^{-2} M$

ANS- (A) $6.708 \times 10^{-3} M$

Given:

$\rightarrow$ Methanoic acid $HCOOH$: $C = 0.25 M$, $K_a = 1.8 \times 10^{-4}$

Concept:

$\rightarrow$ For a weak acid, $[H^+] = \sqrt{K_a \times C}$

Solution:

$$\rightarrow [H^+] = \sqrt{1.8 \times 10^{-4} \times 0.25}$$

$$\Rightarrow \sqrt{4.5 \times 10^{-5}}$$

$$\Rightarrow [H^+] = 6.708 \times 10^{-3} M$$

$\rightarrow$ Ans: (A) $6.708 \times 10^{-3} M$

Hint:

$\rightarrow$ Degree of dissociation $\alpha = \sqrt{\frac{K_a}{C}} \approx 0.027$ (2.7%), so the approximation $1 - \alpha \approx 1$



holds.

Q-9 Which of the following half reactions will occur on the cathodic area during rusting of iron?

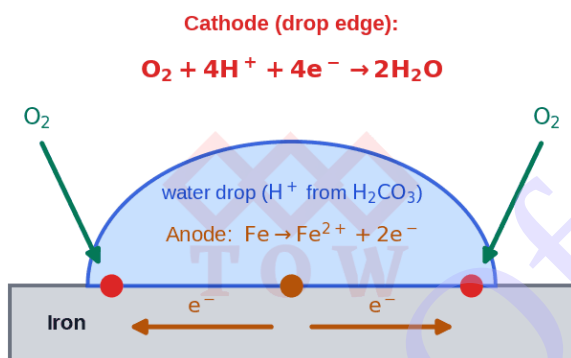
[OAVS TGT SCIENCE 2024]

- (A) $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$
(B) $Fe \rightarrow Fe^{2+} + 2e^-$
(C) $Fe^{2+} + 2e^- \rightarrow Fe$
(D) $H_2O \rightarrow H^+ + OH^-$

ANS- (A) $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Given:

→ Rusting of iron in moist air (electrochemical corrosion)



AN-OX (anode oxidation) · RED-CAT (cathode reduction)

Concept:

→ Anode (oxidation): iron dissolves; cathode (reduction): O_2 is reduced in the presence of H^+ (from H_2CO_3 in moisture).

Solution:

- Anode: $Fe \rightarrow Fe^{2+} + 2e^-$
⇒ Cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$
⇒ Overall: $2Fe + O_2 + 4H^+ \rightarrow 2Fe^{2+} + 2H_2O$
➤ Ans: (A) $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Why not others:

- (B) Oxidation of Fe takes place at the anode, not the cathode.
→ (C) $Fe^{2+} + 2e^- \rightarrow Fe$ is the reverse of rusting.
→ (D) $H_2O \rightarrow H^+ + OH^-$ is ionisation of water; no electrons are involved.

Hint:

→ Fe^{2+} is further oxidised to rust, $Fe_2O_3 \cdot xH_2O$.

Q-10 Which of the following compounds is of AB_2L_2 type?

[OAVS TGT SCIENCE 2024]

- (A) NH_2^-
(B) ICl_2^-

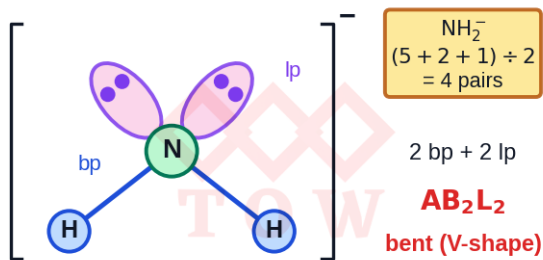


- (C) ClF_3
(D) XeF_4

ANS- (A) NH_2^-

Given:

→ $AB_2L_2 = 2$ bond pairs + 2 lone pairs on the central atom (bent shape)



like H_2O : 2 bp + 2 lp = bent

Concept:

→ VSEPR: electron pairs = (valence e^- of central atom + monovalent atoms – positive charge + negative charge) $\div 2$

Solution:

➤ NH_2^- : $\frac{5 + 2 + 1}{2} = 4$ pairs → 2 bp + 2 lp → AB_2L_2 (bent)

➤ Ans: (A) NH_2^-

Why not others:

→ (B) ICl_2^- : $\frac{7 + 2 + 1}{2} = 5$ → AB_2L_3 (linear)

→ (C) ClF_3 : $\frac{7 + 3}{2} = 5$ → AB_3L_2 (T-shaped)

→ (D) XeF_4 : $\frac{8 + 4}{2} = 6$ → AB_4L_2 (square planar)

Hint:

→ H_2O is the most common AB_2L_2 example (bent, 104.5°).





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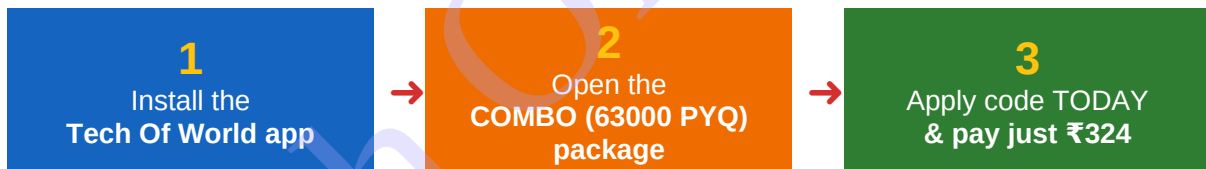
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