

KVPY 2016 (Chemistry) Stream (SA)



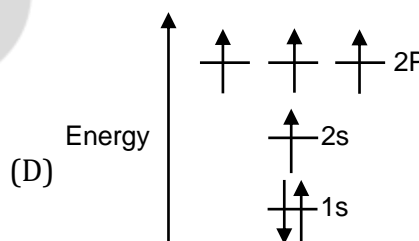
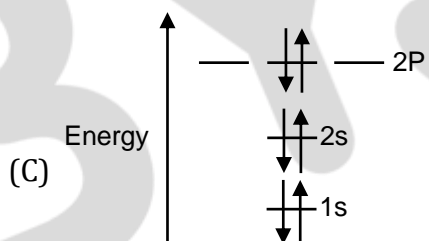
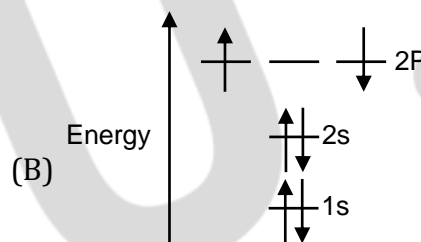
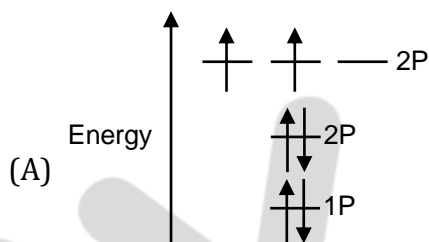
PART-I

- One mole of one of the sodium salts listed below, having carbon content close to 14.3% produces 1 mole of carbon dioxide upon heating (atomic mass Na = 23, H = 1, C = 12, O = 16). The salt is
(A) C_2H_5COONa (B) $NaHCO_3$ (C) $HCOONa$ (D) CH_3COONa
- Among formic acid, acetic acid, propanoic acid and phenol, the strongest acid in water is
(A) formic acid (B) acetic acid (C) propanoic acid (D) phenol
- According to Graham's Law, the rate of diffusion of CO , O_2 , N_2 and CO_2 follows the order:
(A) $CO = N_2 > O_2 > CO_2$ (B) $CO = N_2 > CO_2 > O_2$
(C) $O_2 > CO = N_2 > CO_2$ (D) $CO_2 > O_2 > CO = N_2$
- The major product formed when 2-butene is reacted with O_3 followed by treatment with Zn/H_2O is
(A) CH_3COOH (B) CH_3CHO (C) CH_3CH_2OH (D) $CH_2 = CH_2$
- The IUPAC name for the following compound is
 $CH_3-CH_2-CH_2-CH_2-\underset{\begin{array}{c} || \\ CH_2 \end{array}}{C}-CH_2-CH_2-CH_3$
(A) 2-propylhex-1-ene (B) 2-butylpent-1-ene
(C) 2-propyl-2-butylethene (D) Propyl-1-butylethene
- The major products obtained in the reaction of oxalic acid with conc. H_2SO_4 upon heating are
(A) CO , CO_2 , H_2O (B) CO , SO_2 , H_2O
(C) H_2S , CO , H_2O (D) $HCOOH$, H_2S , CO
- $LiOH$ reacts with CO_2 to form Li_2CO_3 (atomic mass of $Li=7$). The amount of CO_2 (in g) consumed by 1g of $LiOH$ is closest to
(A) 0.916 (B) 1.832
(C) 0.544 (D) 1.088
- The oxidation number of sulphur is +4 in
(A) H_2S (B) CS_2
(C) Na_2SO_4 (D) Na_2SO_3
- Al_2O_3 reacts with
(A) only water (B) only acids
(C) only alkalis (D) both acids and alkalis

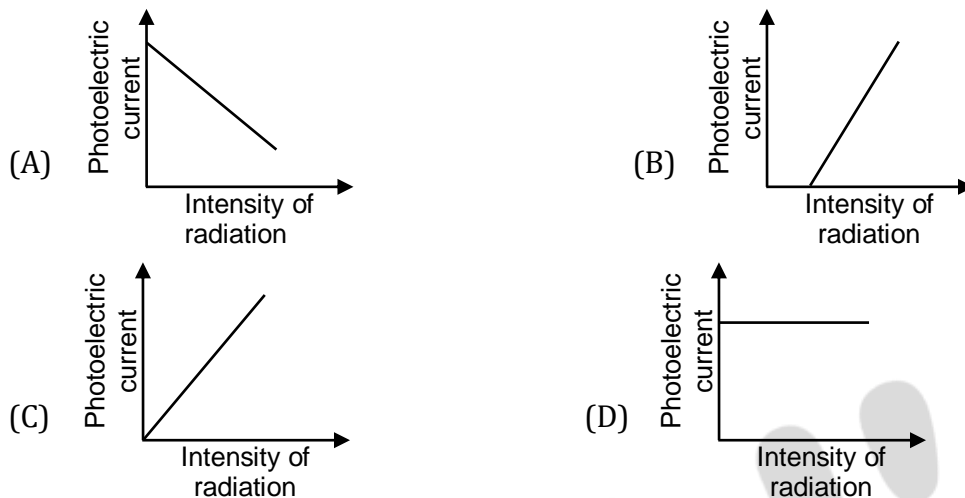
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10. The major product formed in the oxidation of acetylene by alkaline KMnO_4 is
(A) Ethanol (B) acetic acid
(C) formic acid (D) oxalic acid
11. In a closed vessel, an ideal gas at 1 atm is heated from 27°C to 327°C . The final pressure of the gas will approximately be
(A) 3 atm (B) 0.5 atm (C) 2 atm (D) 12 atm
12. Among the element Li, N, C and Be, one with the largest atomic radius is
(A) Li (B) N (C) C (D) Be
13. A redox reaction among the following is
(A) $\text{CdCl}_2 + 2\text{KOH} \rightarrow \text{Cd}(\text{OH})_2 + 2\text{KCl}$ (B) $\text{BaCl}_2 + \text{K}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{KCl}$
(C) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ (D) $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$
14. The electronic configuration which obeys Hund's rule for the ground state of carbon atom is

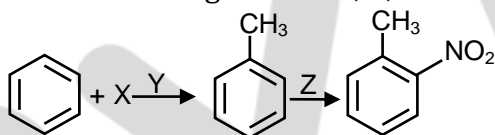


15. The graph that depicts Einstein photoelectric effect for a monochromatic source of frequency above the threshold frequency is



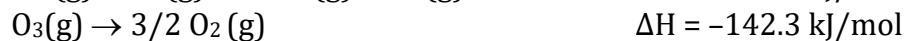
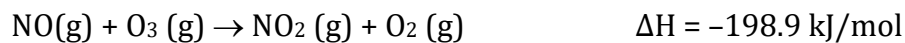
PART-II

16. In the following reactions, X, Y and Z are

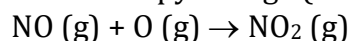


- (A) X = CH₃Cl; Y = anhydrous AlCl₃; Z = HNO₃ + H₂SO₄
 (B) X = CH₃COCl; Y = anhydrous AlCl₃; Z = HNO₃ + H₂SO₄
 (C) X = CH₃Cl; Y = conc. H₂SO₄; Z = HNO₃ + H₂SO₄
 (D) X = CH₃Cl; Y = dil. H₂SO₄; Z = HNO₃
17. 2,3-dibromobutane can be converted to 2-butyne in two-step reaction using
 (A) (i) HCl and (ii) NaH
 (B) (i) alcoholic KOH and (ii) NaNH₂
 (C) (i) Na and (ii) NaOH
 (D) (i) Br₂ and (ii) NaH

18. Given



The enthalpy change (ΔH) for the following reaction is



- (A) -304.1 kJ/mol
 (B) +304.1 kJ/mol
 (C) -403.1 kJ/mol
 (D) +403.1 kJ/mol

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19. A 1.85 g sample of an arsenic-containing pesticide was chemically converted to AsO_4^{3-} (atomic mass of As = 74.9) and titrated with Pb^{2+} to form $\text{Pb}_3(\text{AsO}_4)_2$. If 20 mL of 0.1 M Pb^{2+} is required to reach the equivalence point, the mass percentage of arsenic in the pesticide sample is closest to
(A) 8.1 (B) 2.3 (C) 5.4 (D) 3.6
20. When treated with conc. HCl, MnO_2 yields gas (X) which further reacts with $\text{Ca}(\text{OH})_2$ to generate a white solid (Y). The solid (Y) reacts with dil. HCl to produce the same gas X. the solid Y is
(A) CaO (B) CaCl_2 (C) $\text{Ca}(\text{OCl})\text{Cl}$ (D) CaCO_3

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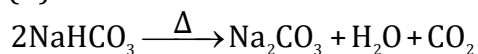
ANSWER KEY

1. (B)	2. (A)	3. (A)	4. (B)	5. (A)	6. (A)	7. (A)	8. (D)	9. (D)	10. (D)
11. (C)	12. (A)	13. (D)	14. (A)	15. (C)	16. (A)	17. (B)	18. (A)	19. (C)	20. (C)

SOLUTIONS

PART-I

1. (B)



∴ Molecular weight of $\text{NaHCO}_3 = 23 + 1 + 12 + 48 = 84 \text{ g mol}^{-1}$

Molecular weight of carbon = 12 g mol^{-1}

$$\% \text{ carbon content in } \text{NaHCO}_3 = \frac{12}{84} \times 100 = 14.28\%$$

→ The C content in other compound is not 14.3%

→ Therefore, the correct option is (B).

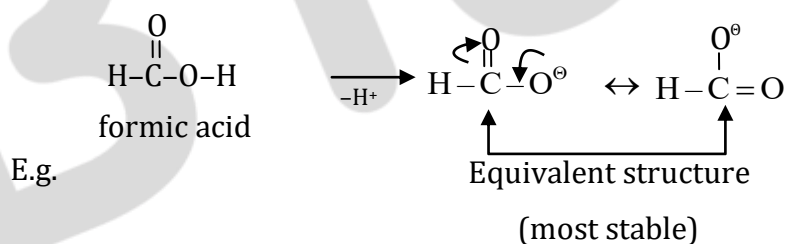
2. (A)

Formic acid is strongest acid

→ Number of C atom (⬆), + I effect (⬆) ($-\text{C}_2\text{H}_5 > -\text{CH}_3$)

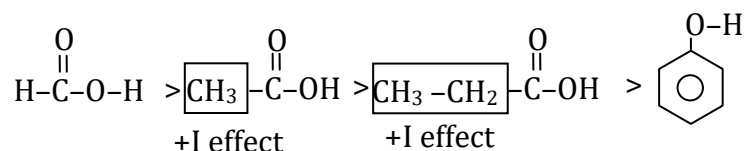
→ +I effect (⬆) acidic strength (⬇)

→ Carboxylic acids are more acidic than phenol due to equivalent resonating structure.



→ Carboxylic acid is more acidic than phenol and alcohol because conjugate base of a carboxylic acid is stabilized by two equivalent resonance structures in which the negative charge is effectively delocalized between two more electronegative oxygen atoms.

→ Hence, the overall order of acidic strength will be -



Therefore, the correct option is (A).

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3. (A)

Rate of diffusion $\propto \frac{1}{\sqrt{m}}$, $m \rightarrow$ molecular weight

\therefore Rate of diffusion \downarrow with \uparrow in molecular weight

Gas	CO	N ₂	O ₂	CO ₂
M (g mol ⁻¹)	28	28	32	44

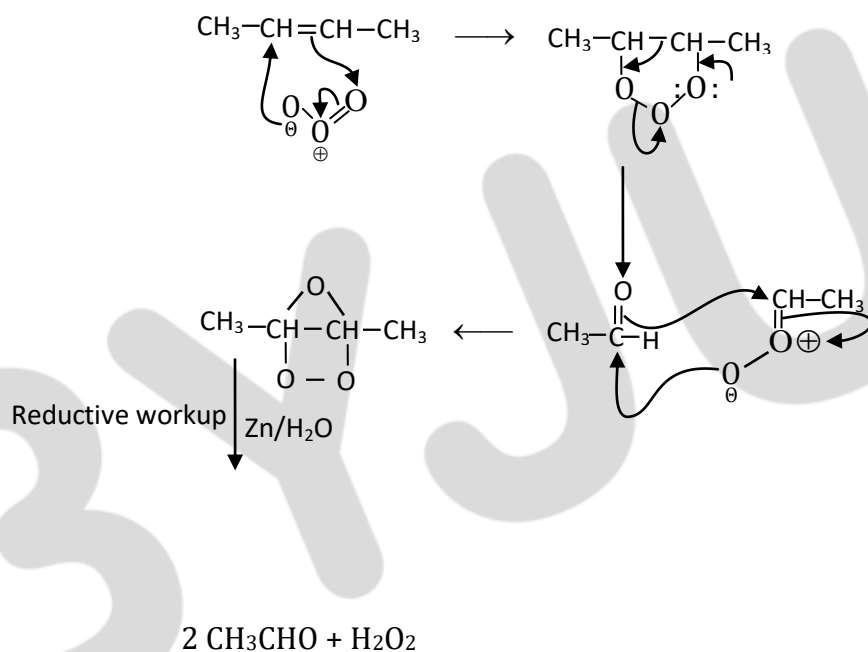
Hence, the order of molecular mass \rightarrow CO₂ > O₂ > CO=N₂

\therefore Order of diffusion CO= N₂ > O₂ > CO₂

Therefore, the correct option is (A).

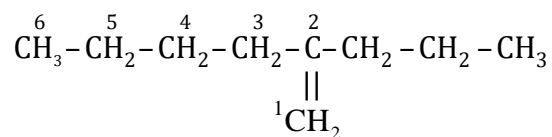
4. (B)

Reaction of 2-butene with O₂ follow as



Therefore the correct option is (B)

5. (A)



(2 propyl hex -1-ene)

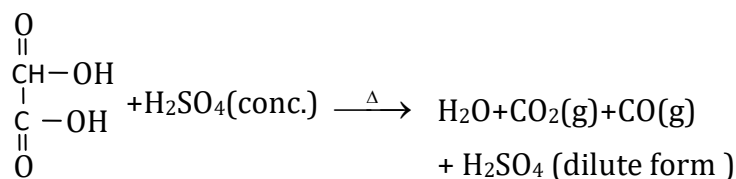
Therefore, the correct option is (A).

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6. (A)

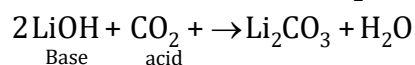
Reaction of oxalic acid with conc. H_2SO_4 upon heating follows as



Therefore, the correct option is (A).

7. (A)

Reaction of LiOH with CO_2 follows as



Hence, the moles of LiOH = moles of $\text{CO}_2 \times 2$

$$\text{moles of LiOH} = \frac{\text{weight of LiOH}}{\text{molecular wt}} = \frac{1}{24} = 0.417 \text{ moles}$$

$$\text{Hence, the moles of CO}_2 = \frac{1}{2} \times \text{moles of LiOH} = 0.0208 \text{ moles}$$

$$\text{Weight of CO}_2 = \text{moles} \times \text{molecular weight} = 0.0208 \times 44 = 0.916 \text{ g} \left\{ \begin{array}{l} \text{moles} = \frac{\text{wt}}{\text{Mw}} \end{array} \right.$$

Therefore, the correct option is (A).

8. (D)

Let, the oxidation number of S = X

$$(i) \text{H}_2\text{S} \rightarrow x + 2 \times (+1) = 0 \Rightarrow x = -2$$

$$(ii) \text{CS}_2 \rightarrow 2x + 1 \times (+4) = 0 \Rightarrow x = -2$$

$$(iii) \text{Na}_2\text{SO}_4 \rightarrow 2 \times (+1) + x + (-2) \times 4 = 0 \Rightarrow x = +6$$

$$(iv) \text{Na}_2\text{SO}_3 \rightarrow 2 \times (+1) + x + (-2) \times 3 = 0 \Rightarrow x = +4$$

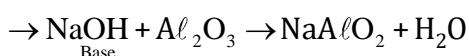
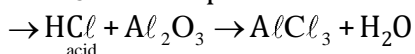
Oxidation No	
H	= +1
C	= +4
Na	= +1
O	= -2

Therefore, the correct option is (D).

9. (D)

Hint \rightarrow See the definition and key point of amphoteric oxide.

Al_2O_3 is an amphoteric oxide hence, it reacts with both acid and base as given below -

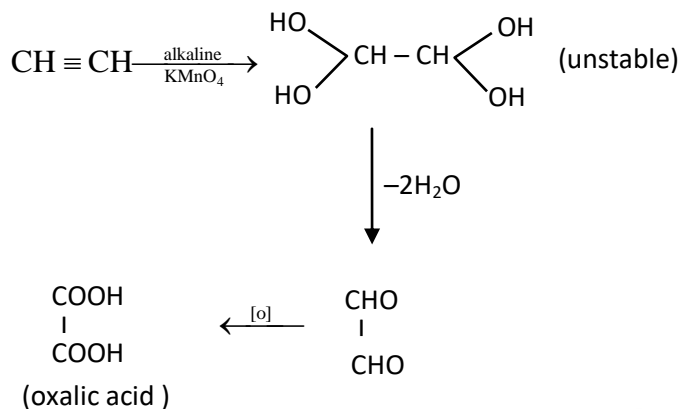


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Therefore, the correct option is (D).

10. (D)



Therefore, the correct option is (D).

11. (C)

According to the Gay-Lussac's law, at constant volume, pressure of gas is directly proportional to the absolute temperature of gas ($v, n, R \rightarrow \text{constant}$).

$$P \propto T \quad \text{or} \quad P = KT$$

$$\therefore P_1 = T_1 K, \quad P_2 = T_2 K$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$$\left\{ \begin{array}{l} P_1 \rightarrow \text{Initial pressure} \\ T_1 \rightarrow \text{Initial temperature} \\ T_2 \rightarrow \text{Final temperature} \\ P_2 \rightarrow \text{Final pressure} \end{array} \right.$$

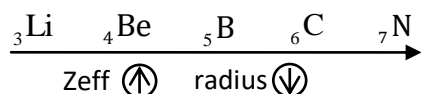
$$\Rightarrow \frac{1}{P_2} = \frac{300}{600}$$

$$\Rightarrow P_2 = 2 \text{ atm}$$

Therefore, the correct option is (C).

12. (A)

As we move, from left to right in a period, atomic radius \downarrow because $Z_{\text{eff}} \uparrow$, so the greatest radius is of lithium.

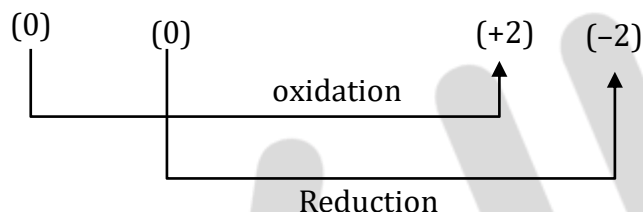
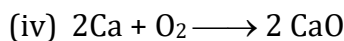
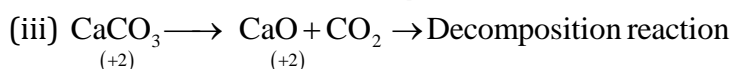
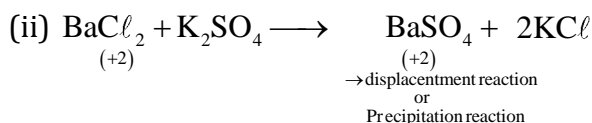
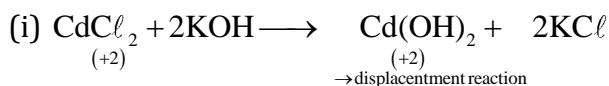


Therefore, the correct option is (A).

13. (D)

Redox Reaction →

Chemical reaction in which oxidation and reduction process takes place simultaneously known as redox reaction.



Hence, it is a redox reaction.

Therefore, the correct option is (D).

14. (A)

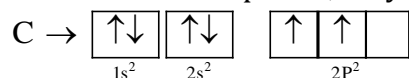
Hund's Rules →

According to Hund's rule, in the ground state of an atom/molecules, the electronic configuration with lowest energy, is the one with the highest value of spin multiplicity. This implies that low energy orbital's are first completely filled and in case of degenerate orbital's (two or more orbital's of equal energy), each orbital occupy single electron with same spin

(either, $+\frac{1}{2}(\uparrow)$ or $-\frac{1}{2}(\downarrow)$) before they pair up.

Energy of orbital's $1S < 2S < 2P$

If we see all the options, only C follows the Hund's law according above definition.



Therefore, the correct option is (A).

15. (C)

Photoelectric effect is the phenomenon of ejection of electron from the surface of a material upon irradiation with light. The ejected electron thus, gives the photo electric current. These electrons can be ejected only by supplying a minimum amount of energy

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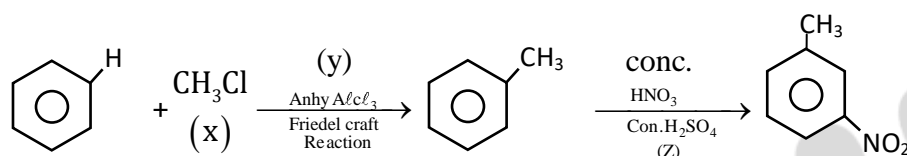
B

called threshold energy (frequency). Intensity of a monochromatic light is proportional to the number of photons with particular frequency. Since, each photon can abstract one electron at a time therefore, if the photons \uparrow , the number of photoelectrons \uparrow in the same proportion. Thus, suggests that above threshold frequency the photoelectric current and light intensity will \uparrow linearly.

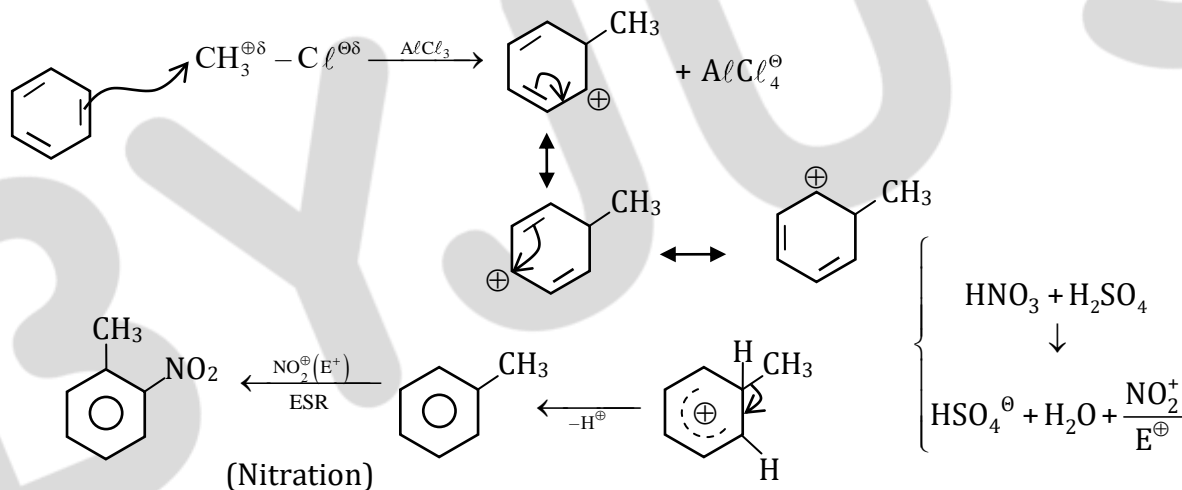
Therefore, the correct answer is (C).

PART-II

16. (A)



Mechanism \Rightarrow

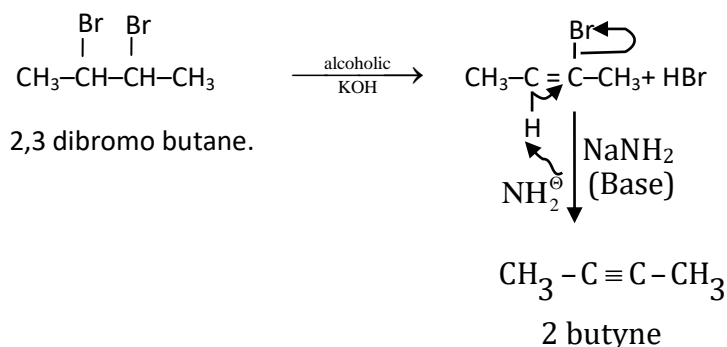


Therefore, the correct answer is (A).

17. (B)

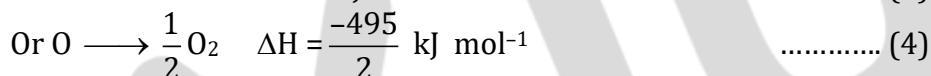
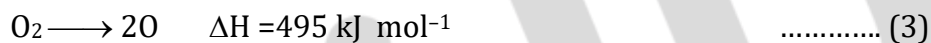
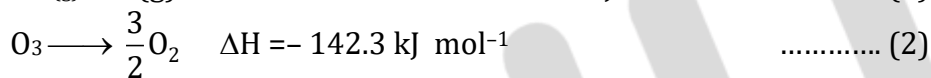
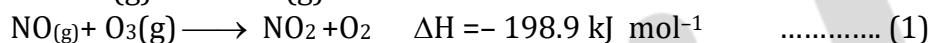
Reaction mechanism of conversion of 2,3 dibromo butane to 2 butyne follow as-

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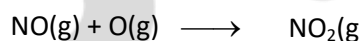
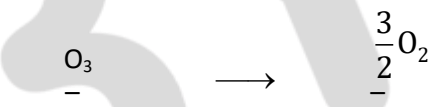
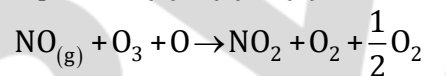


Therefore, the correct answer is (B).

18. (A)



Equation (1) - (2) + (3)



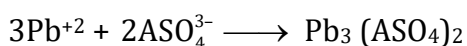
$$\begin{aligned}
 \Delta H &= (\Delta H)_1 - (\Delta H)_2 + (\Delta H)_3 \\
 &= -198.9 - (-142.3) - \frac{495}{2} \\
 &= +142.3 - 198.9 - 247.5 \\
 \Delta H &= -304.1 \text{ kJ mol}^{-1}
 \end{aligned}$$

Note: Enthalpy is a state function hence, it depends only on initial and final state, and not on path followed by the function.

Therefore, the correct answer is (A).

19. (C)

Reaction of Pb^{+2} with ASO_4^{3-} follows as



From above reaction,

$$\text{Moles of } \text{Pb}^{+2} = \frac{3}{2} \text{ moles of } \text{ASO}_4^{3-}$$

$$\Rightarrow \text{Moles of } \text{ASO}_4^{3-} = \frac{2}{3} \text{ moles of } \text{Pb}^{+2}$$

$$\text{Molarity of } \text{Pb}^{+2} = \frac{\text{moles} \times 1000}{v}$$

$$\text{Moles of } \text{Pb}^{+2} = \frac{0.1 \times 20}{1000} = 2 \times 10^{-3} \text{ moles}$$

$$\text{Hence, moles of } \text{ASO}_4^{3-} = \frac{2}{3} \times 2 \times 10^{-3} = \frac{4}{3} \times 10^{-3} \text{ moles}$$

Molecular weight of As = 74.9 g mol^{-1}

$$\therefore \text{moles} = \frac{\text{wt}}{\text{mw}} \Rightarrow \text{wt of As} = \text{moles} \times \text{mw} = 74.9 \times \frac{4}{3} \times 10^{-3}$$

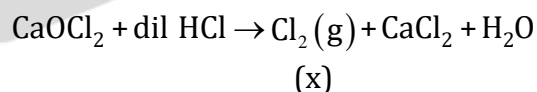
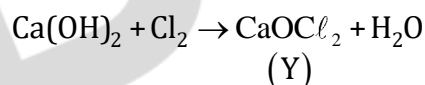
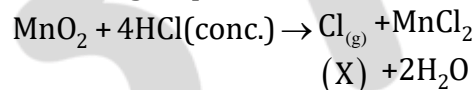
$$\text{Weight of As} = 0.09986 \text{ g}$$

$$\therefore \text{Percentage of As in sample} = \frac{0.09986}{1.85} \times 100 = 5.4\%$$

Therefore, the correct answer is (C).

20. (C)

Following steps are involved in the reaction -



Hence, here solid Y = $\text{Ca}(\text{OCl})\text{Cl}$ or CaOCl_2

Therefore, the correct answer is (C).