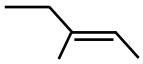
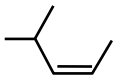
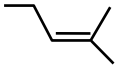
KVPY-SA 2017 (CHEMISTRY)

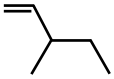
PART-I

1. The structure of 3-methylpent-2-ene is

(A) 

(B) 

(C) 

(D) 

2. The stability of carbanions

I II III IV

follows the order

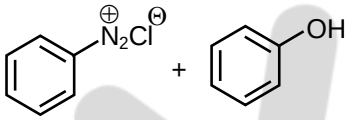
(A) III < IV < I < II

(B) I < II < IV < III

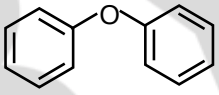
(C) III < II < I < IV

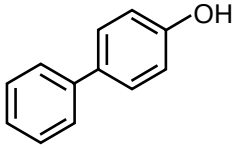
(D) IV < III < II <I

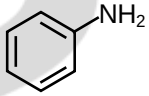
3. In the following reaction

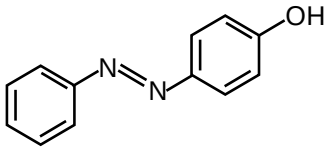


The major product is

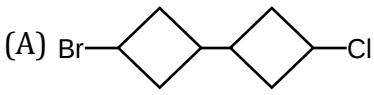
(A) 

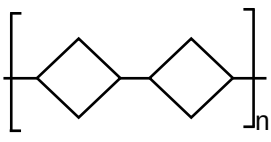
(B) 

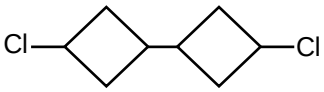
(C) 

(D) 

4. In the reaction of 1-bromo-3-Chlorocyclobutane with two equivalents of sodium in ether, the major product is

(A) 

(B) 

(C) 

(D) 

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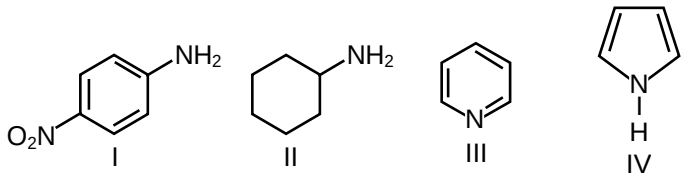
5. The order of basicity of



in water is

(A) IV < III < I < II
(B) II < I < IV < III
(C) IV < I < III < II
(D) II < III < I < IV

6. The first ionisation energy of Na, B, N and O atoms follows the order

(A) B < Na < O < N
(B) Na < B < O < N
(C) Na < O < B < N
(D) O < Na < N < B

7. Among P_2O_5, As_2O_3, Sb_2O_3 and Bi_2O_3 the most acidic oxide is

(A) P_2O_5
(B) As_2O_3
(C) Sb_2O_3
(D) Bi_2O_3

8. Among K, Mg, Au and Cu, the one which is extracted by heating its ore in air is

(A) K
(B) Mg
(C) Au
(D) Cu

9. The metal ion with total number of electrons same as S_2- is

(A) Na^+
(B) Ca^{2+}
(C) Mg^{2+}
(D) Sr^{2+}

10. X g of Ca [atomic mass = 40] dissolves completely in concentrated HCl solution to produce 5.04 L of H_2 gas at STP. The value of X is closest to

(A) 4.5
(B) 8.1
(C) 9.0
(D) 16.2

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11. A 20 g object is moving with velocity 100 ms^{-1}. The de Broglie wavelength (in m) of the object is [Planck's constant h = 6.626 × 10^{-34} J s]

(A) 3.313 × 10^{-34} (B) 6.626 × 10^{-34}

(C) 3.313 × 10^{-31} (D) 6.626 × 10^{-31}

12. In a closed vessel at STP, 50 L of CH_4 is ignited with 750 L of air (containing 20% O_2). The number of moles of O_2 remaining in the vessel on cooling to room temperature is closest to

(A) 5.8 (B) 2.2

(C) 4.5 (D) 6.7

13. CO_2 is passed through lime water. Initially the solution turns milky and then becomes clear upon continued boubbling of CO_2. The clear solution is due to the formation of

(A) $CaCO_3$ (B) CaO

(C) $Ca(OH)_2$ (D) $Ca(HCO_3)_2$

14. The maximum number of electrons that can be filled in the shell with the principal quantum number n = 3 is

(A) 18 (B) 9

(C) 8 (D) 2

15. The atomic radii of Li, F, Na and Si follow the order

(A) Si > Li > Na > F (B) Li > F > Si > Na

(C) Na > Si > F > Li (D) Na > Li > Si > F

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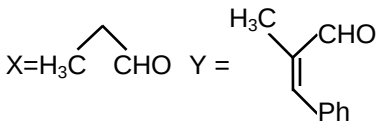
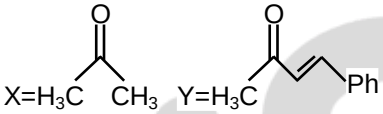
PART-II

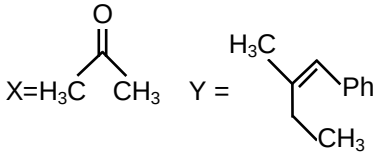
16. The reaction of an alkene X with bromine produce a compound Y, which has 22.22% C, 3.71% H and 74.07% Br. The ozonolysis of alkene X gives only one product. The alkene X is: [Given: atomic mass of C = 12; H = 1; Br = 80]

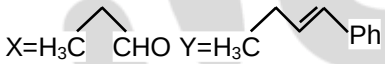
(A) Ethylene
(B) 1-butene
(C) 2-butene
(D) 3-hexene

17. In the following reaction $H_3C - C \equiv C - H \xrightarrow[H_3O^+]{Hg^{2+}} X \xrightarrow[PhCHO]{dil.\ NaOH} Y$; X and Y, respectively, are

(A) 

(B) 

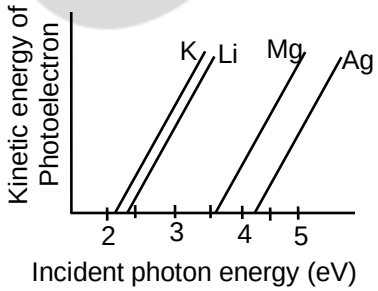
(C) 

(D) 

18. $KMnO_4$ reacts with H_2O_2 in an acidic medium. The number of moles of oxygen produced per mole of $KMnO_4$ is

(A) 2.5
(B) 5
(C) 1.25
(D) 2

19. The photoelectric behaviour of K, Li, Mg and Ag metals is shown in the plot below. If light of wavelength 400 nm is incident on each of these metals, which of them will emit photoelectrons?



(A) K
(B) K and Li
(C) K, Li and Mg
(D) K, Li, Mg and Ag

20. A piece of metal weighing 100 g is heated to 80°C and dropped into 1 kg of cold water in an insulated container at 15°C. If the final temperature of the water in the container is 15.69°C. If the final temperature of the water in the container is 15.69°C, the specific heat of the metal in J/g °C is

(A) 0.38
(B) 0.24
(C) 0.45
(D) 0.13

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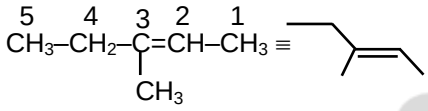
ANSWER KEY

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

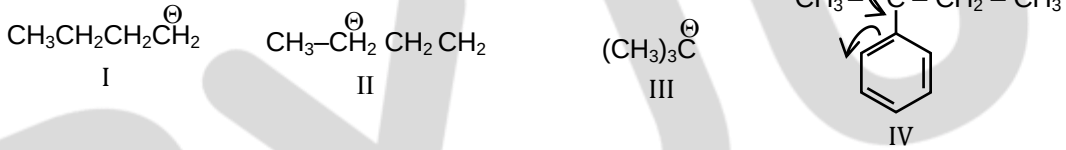
SOLUTIONS

PART-I

1. (A)

3-methylpent-2-ene = 

2. (C)



I II III IV

1° 2° 3° 3°

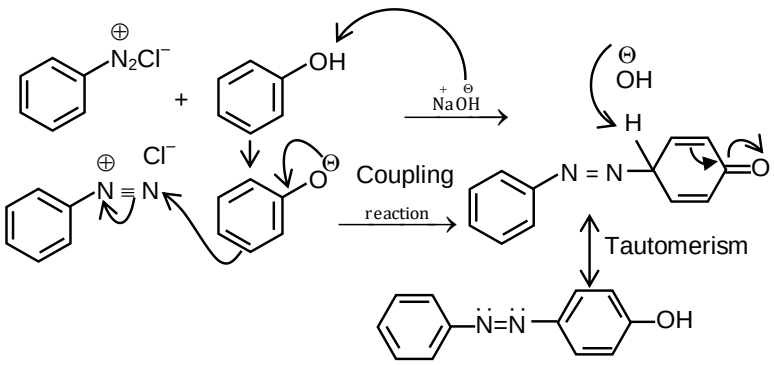
(Stabilized by resonance)

And more the +I effect / hyper conjugation effect, less will be the stability of carbanion.

$\therefore$ 1° > 2° > 3° (stability of carbanion)

Hence overall order IV > I > II > III

3. (D)



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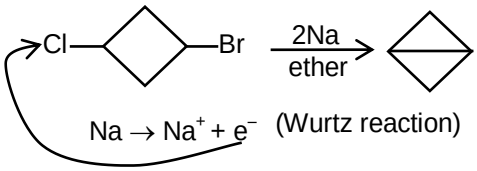
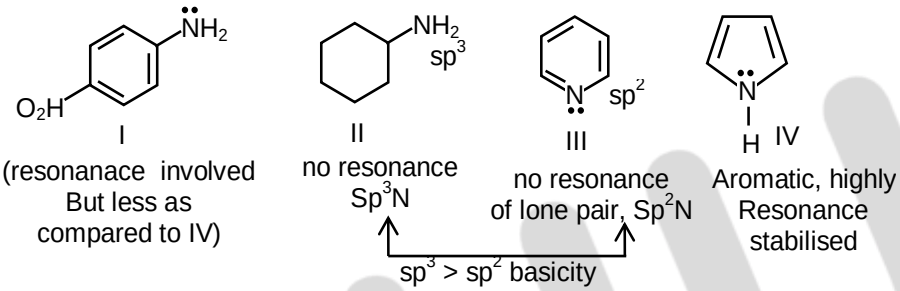
4. (D)



5. (C)

More the tendency of donating lone pair, more will be the basicity
More the lone pair involved in resonance, less will be the basicity
More electronegativity, less basicity

$Sp < sp^2 < sp^3$ (order of basicity)



Hence over all order of basicity
II > III > I > IV

6. (B)

Na $\rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1 \rightarrow$ will attain noble gas configuration after removing one $e^- \rightarrow$ least I.E.
B $\rightarrow 1s^2\ 2s^2\ 2p^1$
N $\rightarrow 1s^2\ 2s^2\ 2p^3 \rightarrow$ half- filled stabilized $\rightarrow$ highest I.E.
O $\rightarrow 1s^2\ 2s^2\ 2p^4$
In between B and O
Along the period size $\downarrow$ I.E. $\uparrow$
Na < B < O < N

7. (A)

$P_2^{+5}O_5$

$As_2^{+3}O_3$

$Sb_2^{+3}O_3$

$Bi_2^{+3}O_3$

More the oxidation number more will be the tendency to accept lone pair of $e^- \rightarrow$ more will be the acidic character.
OR
Down the group, metallic character increase, hence basic character of oxides increases.
Hence P_2O_5 is the most acidic oxide.

8. (D)

$2CuFeS_2 + 2SiO_2 + 4O_2 \rightarrow Cu_2S + 2FeSiO_3 + 3SO_2$

$Cu_2S + O_2 \rightarrow 2Cu + SO_2$

9. (B)

Given:- $S^{2-} \rightarrow 18\ e^-$

From the options,

$Na^+ \rightarrow 10e^-$

$Ca^{2+} \rightarrow 18e^-$

$Mg^{2+} \rightarrow 10e^-$

$Sr^{2+} \rightarrow 36\ e^-$

Ca^{2+} and S^{2-} have same number of electrons.

10. (C)

$1Ca(s)$	+	$2HCl$	$\rightarrow$	$1CaCl_2$	+	$1H_2(g)$
xg		conc.				5.04L at STP
Moles:- $\frac{x}{40}$mol						$\frac{5.04L}{22.4L} = 0.225$moles

Apply mole – mole analysis:-

1 mole of Ca produce $\rightarrow$ 1 mole of $H_2(g)$

$\frac{x}{40}$ moles of Ca will produce $\rightarrow$ $\frac{x}{40}$ moles of $H_2(g)$

Given: $\frac{x}{40} = 0.225$

$= 9.0$

11. (A)

Given, $m = 20g$, $v = 100\ ms^{-1}$

De Broglie wavelength $\rightarrow \lambda = \frac{h}{mv} = \frac{6.626\times10^{-34}Js.}{20\times10^{-3}kg\times100ms^{-1}}$

$$\left[\begin{array}{l}\text{Units}: m \rightarrow kg \\ \qquad\quad v \rightarrow m/s \\ \qquad\quad h \rightarrow Js \\ \text{then} \quad \lambda \rightarrow (m)\end{array}\right] \qquad \lambda = 3.313 \times 10^{-34}\,m$$

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12. (B)

$$1CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

At STP 50L 150L

$$\left[\begin{array}{l}\text{Air} \rightarrow 750\text{L} \\ 20\%\ O_2 \rightarrow \dfrac{20\times 750}{100} = 150\text{L}\end{array}\right]$$

Divide by S.C $\dfrac{50}{1}$ $\dfrac{150}{2}$

= 50 = 75

(Minimum no.)

Hence, CH_4 is the limiting reagent (consumed completely)

$1\ CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

50L 150L

After the reaction

0 150 – 100 = 50L 50L 100L

Volume of O_2 remained = 50L

Moles of O_2 remained = $\dfrac{50\text{L}}{22.4\text{L}} = 2.2\text{moles}$

13. (D)

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

(turn milky) → because of the formation of $CaCO_3$ ppt

$CaCO_3 + H_2O \xrightarrow{CO_2} Ca(HCO_3)_2$

Clear solution because of the formation of soluble $Ca(HCO_3)_2$

14. (A)

n = 3

Then possible subshell = 3s, 3p, 3d

Maximum electrons occupied → 2 + 6 + 10 = 18 electrons

15. (D)

Li F Na Si

Li–F: 2^{nd} period elements

Na–Si: 3^{rd} period elements

→ Size of 3^{rd} period element > size of 2^{nd} element period

→ along the period → size ↓

Overall order

∴ Na > Li > Si > F

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PART-II

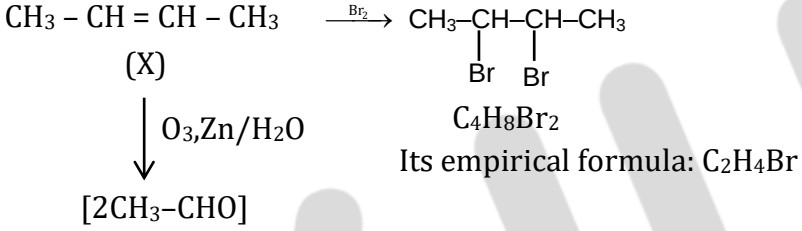
16. (C)

	%	Atomic man	Relative no of atoms	(Whole no) ratio of atoms
C	22.22	12	22.22/12= 1.85	$\frac{1.85}{0.925}=2$
H	3.71	1	3.71 /1 = 3.71	$\frac{3.71}{0.925}=4$
Br	74.07	SO	74.07/80 = 0.925	$\frac{0.925}{0.925}=1$

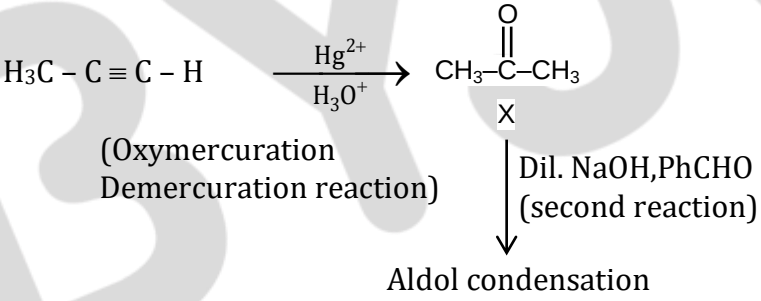
Hence empirical formula of Y = C_2H_4Br

On Ozonolysis of X → it gives only one product

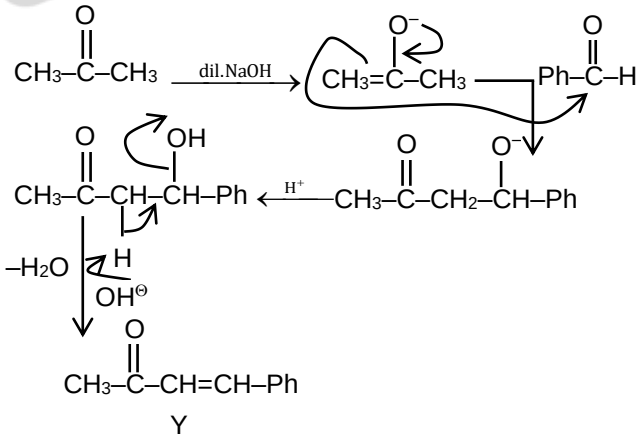
Hence correct option is C (2 – butene)



17. (B)



2nd reaction aldol condensation is given as:-



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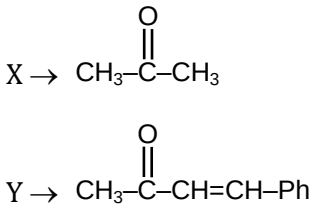
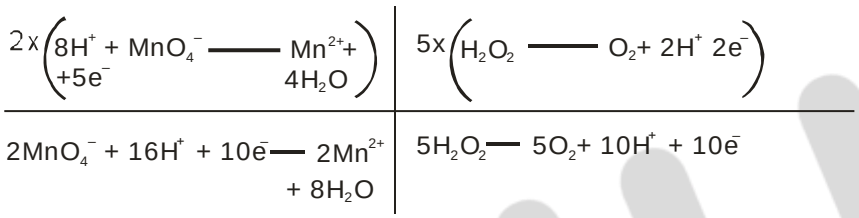
Hence



18. (A)

$2KMnO_4 + 5H_2O_2 + 3H_2SO_4 \longrightarrow 2MnSO_4 + 5O_2 + K_2SO_4 + 8H_2O$



Add both reactions

$2MnO_4^- + 5H_2O_2 + 8H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$

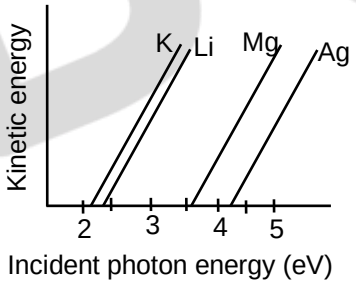
From the reaction

2 mole of $KMnO_4$ produce $\rightarrow$ 5 moles of O_2

1mole of $KMnO_4$ produce $\rightarrow$ 2.5 moles of O_2

Hence mole of O_2 produced / mole of $KMnO_4$ = 2.5

19. (B)



Incident light λ = 400nm.

Energy of incident light = $\frac{12400}{4000A^\circ}$eV = 3.1 eV

If energy of incident light $\geq$ work function then photo electron will be ejected.

From the graph,

In case of K, Li $\rightarrow$ work function < 3.1 eV: hence photoelectrons will be emitted.

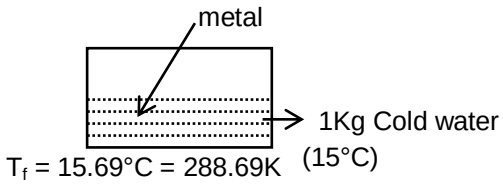
But in case of Mg, Ag $\rightarrow$ work function > 3.1 eV: hence no photoelectrons will be emitted.

20. (C)

For metal,

M = 100 g

$T_1 = 80°C$



Heat loss by metal = Heat gain by cold water

$-m_1S_1(T_f - T_1) = m_2S_2(T_f - T_2)$

$-100S_1(288.69 - 353) = 1000 \times 4.2(288.69 - 288)$

$S_1 = 0.45$ J/g°C

(Specific heat of metal)