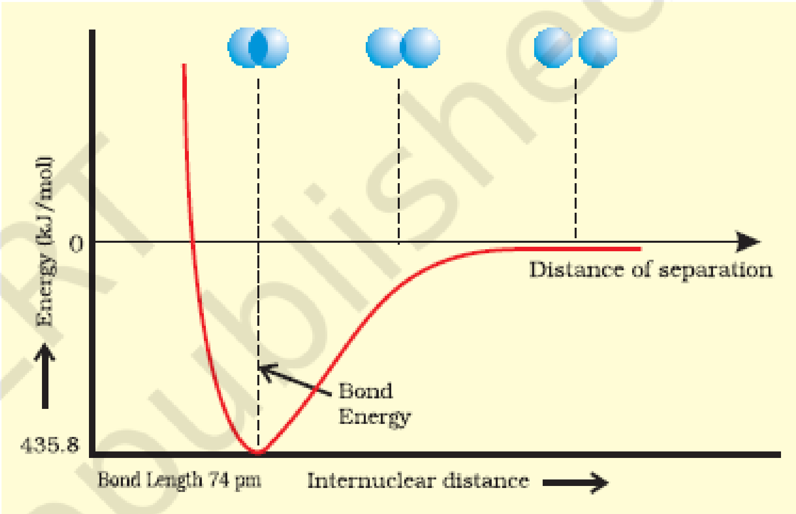
FY CHEMISTRY IMPROVEMENT EXAMINATION 2022

SL.O	SOLUTION	SCORE
1.	**(ANY TWO POINTS)** 1.The electrons are ejected from the metal surface as soon as the beam of light strikes the surface. i.e., there is no time lag between the striking of light beam and the ejection of electrons from the metal surface. 2. The number of electrons ejected is proportional to the intensity or brightness of light. 3. For each metal, there is a minimum frequency (known as threshold frequency [v0]) below which photoelectric effect is not observed. 4. The kinetic energy of the ejected electrons is directly proportional to the frequency of the incident light	2
2.	(i) 2p (ii) 5s	1 1
3.		2
4.	$$\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT$$ Where P is the pressure of the gas, V is the volume, R is the universal gas constant, T is the absolute temperature, n is the no. of moles, 'a' and 'b' are called van der Wall's constants. 'a' is a measure of magnitude of inter molecular attractive forces within the gas and 'b' is related to the volume of the particles.	1 1

<table>
<tr><td>5.</td><td>The law states that the total enthalpy change for a physical or chemical process is the same whether the reaction taking place in a single step or in several steps. Or, the total enthalpy change for a process is independent of the path followed.</td><td>2</td></tr>
<tr><td>6.</td><td>Solution which resists the change in pH on dilution or with the addition of small amount of acid or alkali is called Buffer solution.

E.g. a mixture of acetic acid and sodium acetate acts as an acidic buffer around pH 4.75.

E.g. a mixture of NH_4OH and NH_4Cl acts as a basic buffer around pH 9.25.

(anyone example)</td><td>1

1</td></tr>
<tr><td>7.</td><td>(i) The acid base pair that differs by only one proton is called a conjugate acid – base pair.

Or
Acid – H+ → Conjugate base
Base + H+ → Conjugate acid
(ii) H_3O^+→ Conjugate acid
OH^- → Conjugate base
(aq)</td><td>1

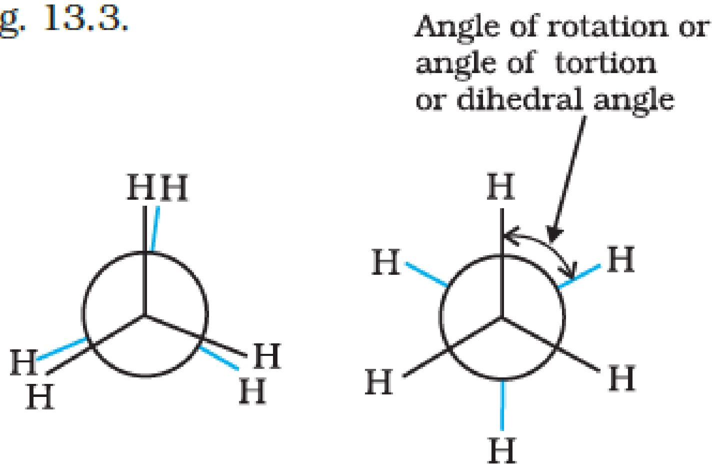
1</td></tr>
<tr><td>8.</td><td><table>
<tr><th>Compound</th><th>Use</th></tr>
<tr><td>(i) Calcium sulphate</td><td>(d) Dentistry</td></tr>
<tr><td>(ii) Sodium bicarbonate</td><td>(c) Antiseptic</td></tr>
<tr><td>(iii) Calcium oxide</td><td>(b) Purification of sugar</td></tr>
<tr><td>(iv) Sodium carbonate</td><td>(a) Water softening</td></tr>
</table></td><td>½
½
½
½</td></tr>
<tr><td>9.</td><td>(i) 3-ethyl-5-methyl hexane
(ii) 5-Oxohexanoic acid.</td><td>1
1</td></tr>
</table>

10.

Homolytic Cleavage	Heterolytic Cleavage
1. Each of the bonded atoms gets one electron	The shared pair of electrons remains with one fragment
2. Movement of a single occurs	Movement of a pair of electrons occurs
3. Free radicals are formed 	Carbo cataion or carbo anion are formed 

2

11. Fig. 13.3.



(i) Eclipsed (ii) Staggered

***Fig. 13.3** Newman's projections of ethane*

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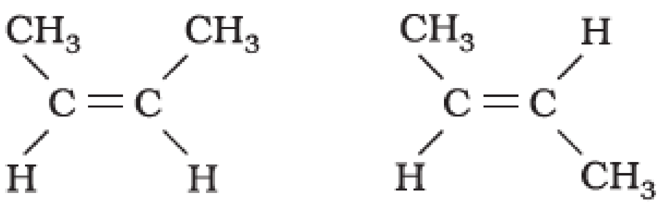
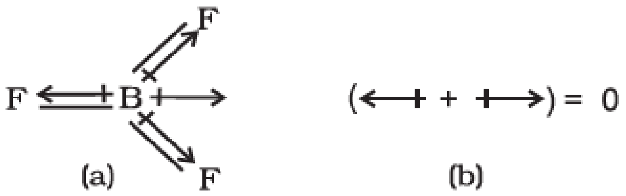
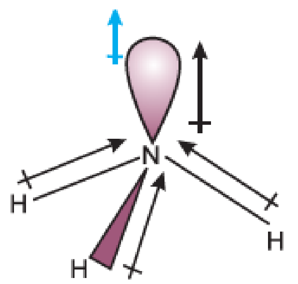
12.



cis-But-2-ene (b.p. 277 K) *trans*-But-2-ene (b.p. 274 K)

2

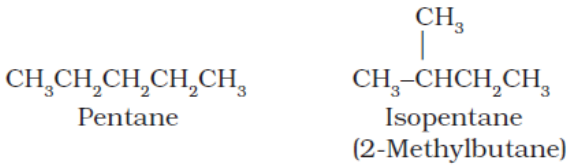
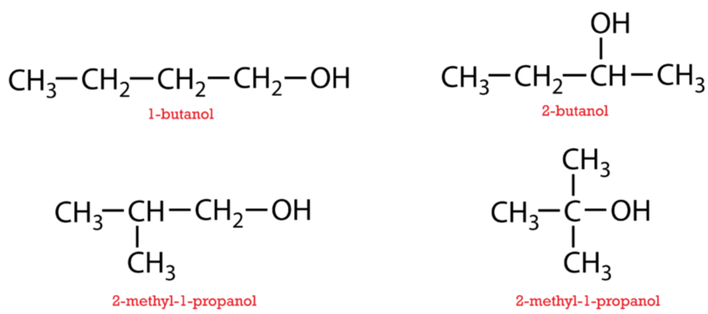
13.	**<u>Law of Multiple Proportions</u>:** **This law was proposed by John Dalton. It states that *if two elements can combine to form more than one compound, the different masses of one of the elements that combine with a fixed mass of the other element, are in small whole number ratio.*** ***(For any other correct example give full mark)*** **Illustration: Hydrogen combines with oxygen to form two compounds – water and hydrogen peroxide.** **Hydrogen + Oxygen → Water** **2g 16g 18g** **Hydrogen + Oxygen → Hydrogen Peroxide** **2g 32g 34g** **Here, the masses of oxygen (i.e. 16 g and 32 g) which combine with a fixed mass of hydrogen (2g) bear a simple ratio, i.e. 16:32 or 1: 2.**	**1** **2**
14.	**(i)** $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$ **1 mol 2 mol 1 mol 2 mol** **17g 32g 44g 36g** **Here 3 mol of CH_4 react with 2 mol of O_2. But 2 mol of O_2 need 1 mol CH_4 i.e, CH_4 is in excess and O_2 is completely consumed.** **Amount of CO_2 produced = 44g** **(ii) O_2 is the limiting reagent**	**2** **1**
15.	**(i)** **"*the physical and chemical properties of elements are the periodic functions of their atomic numbers*". This is known as Modern Periodic law.** **(ii)** • **form coloured compounds** • **show variable oxidation states** • **they have catalytic properties** • **shows magnetic properties** **(any two)**	**1** **2**

16.	i.	It is the heat change (enthalpy change) when an electron is added to the outer most shell of an isolated gaseous atom. It can be represented as $X_{(g)} + e^- \rightarrow X^-_{(g)}$	1
	ii.	when an electron is added to F, it enters into the smaller 2^{nd} shell. Due to the smaller size, the electron suffers more repulsion from the other electrons. But for Cl, the incoming electron goes to the larger 3rd shell. So the electronic repulsion is low and hence Cl adds electron more easily than F	2
17.	i.	The polarity of a molecule is expressed in terms of *dipole moment* (μ). It is defined as *the product of the magnitude of charge at one end (Q) and the distance between the charges (r)*. Mathematically, μ = Q x r.	1
	ii.	In BF_3, the net dipole moment is zero. Here the resultant of any 2 bond dipoles is equal and opposite to the third.  This is because in the case of NH_3, the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the three N – H bond  Resultant dipole moment in $NH_3 = 4.90 \times 10^{-30}$ C m	2

18.	i. It states that at constant temperature, the volume of a fixed mass of gas is inversely proportional to its pressure. Mathematically, $P \alpha 1/V$ ii. *From Boyle's law,* $P_1V_1 = P_2V_2$ *Here* $P_1 = 1.2$ *bar,* $V_1 = 120$ *mL,* $V_2 = 180$ *mL,* $P_2 = ?$ $P_2 = \frac{P_1V_1}{V_2} = \frac{1.2 \times 120}{180} = \frac{4}{5} = 0.8\ bar$	1 2
19.	i. The two wrong assumptions are: 1. The actual volume of the molecules is negligible compared to the volume of the gas. 2. There is no force of attraction between the gas particles. ii. It is the ratio of product PV and nRT. Mathematically, $Z = \frac{PV}{nRT}$	2 1
20.	i. *Extensive properties*: These are properties which depend on the amount of matter present in the system. Or, these are the properties which change when a system is divided. *Intensive properties*: These are properties which are independent of the amount of matter present in the system. Or, these are the properties which do not change when a system is divided. ii. *Extensive properties: enthalpy, internal energy, heat capacity* *Intensive properties: molar volume*	2 1
21.	$Gibb's\ Energy, \Delta G = \Delta H - T\Delta S$ $=490\times10^3-(198\times300)$ $= 4.3\times10^5 J$ Since ΔG is positive the reaction is non spontaneous	2 ½ ½

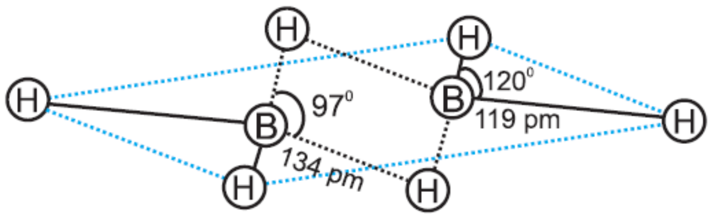
22.	**Step-1: Assign the oxidation number of each element and find out the substance oxidised and reduced.** $Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) \rightarrow Fe^{3+}(aq) + Cr^{3+}(aq)$ **Step-2: Separate the equation into 2 half reactions - oxidation half reaction and reduction half reaction.** **Oxidation half:** $\overset{+2}{Fe^{2+}}(aq) \rightarrow \overset{+3}{Fe^{3+}}(aq)$ **Reduction half:** $\overset{+6\ -2}{Cr_2O_7^{2-}}(aq) \rightarrow \overset{+3}{Cr^{3+}}(aq)$ **Step-3: Balance the atoms other than O and H in each half reaction individually.** **Oxidation half:** $\overset{+2}{Fe^{2+}}(aq) \rightarrow \overset{+3}{Fe^{3+}}(aq)$ **Reduction half:** $Cr_2O_7^{2-}(aq) \rightarrow 2\,Cr^{3+}(aq)$ **Step-4: Now balance O and H atoms. Add H_2O to balance O atoms and H^+ to balance H atoms since the reaction occurs in acidic medium.** $Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 2\,Cr^{3+}(aq) + 7H_2O\,(l)$ **Step -5: Now balance the ionic charges. For this add electrons to one side of the half reaction.** **Oxidation half:** $6Fe^{2+}(aq) \rightarrow 6Fe^{3+}(aq) + 6e^-$ **Reduction half:** $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O\,(l)$ (8. **Step-6: Now add the two half reactions after equating the electrons.** **Overall reaction is:** $6Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 6\,Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$ (8.58) **Now the equation is balanced.**	**3**

23.	i. In a disproportionation reaction, an element in one oxidation state is simultaneously oxidised and reduced. One of the reacting substances always contains an element that can exist in at least three oxidation states. ii. $\overset{+1\ -1}{2H_2O_2}(aq) \rightarrow \overset{+1\ -2}{2H_2O}(l) + \overset{0}{O_2}(g)$ Here the oxygen of peroxide is in –1 state and it is converted to zero oxidation state in O_2 and –2 oxidation state in H_2O. so, it is a disproportionation reaction	1 2
24.	i. (c) CO and H_2 ii. The production of dihydrogen can be increased by reacting carbon monoxide of syngas mixtures with steam in the presence of iron chromate as catalyst. This is called *water-gas shift reaction*. $CO(g) + H_2O(g) \xrightarrow{673K,catalyst} CO_2(g) + H_2(g)$	1 2
25.	i. • does not easily form lather with soap • cause corrosion in boiler ii. In the presence of metal surfaces or traces of alkali (present in glass containers), the above reaction is catalysed. It is, therefore, *stored in wax-lined glass or plastic vessels in dark*. $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$	1 2
26.	*Solvay Process (Ammonia-Soda Process)* In this process, CO_2 is passed through a concentrated solution of NaCl saturated with ammonia. Ammonium carbonate first formed then converted to ammonium bicarbonate and finally reacts with NaCl to form $NaHCO_3$. $2NH_3 + H_2O + CO_2 \rightarrow (NH_4)_2CO_3$ $(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3$ $NH_4HCO_3 + NaCl \rightarrow NH_4Cl + NaHCO_3$ Sodium bicarbonate crystals are separated and heated to get sodium carbonate. $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$ In this process, NH_3 is recovered when the solution containing NH_4Cl is treated with $Ca(OH)_2$. $2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + 2H_2O$	3

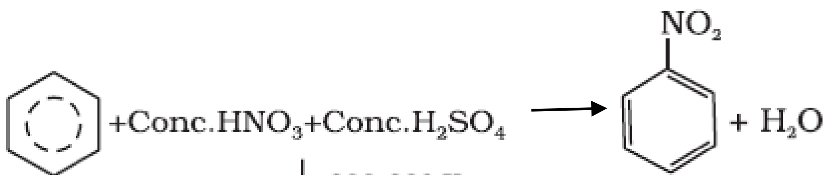
27.	**i.** • **Due to its small size** • **high polarizing power**	**1**
	ii. (any two) **1. Li is much harder and has high melting point and boiling point.** **2. Li is the least reactive but the strongest reducing agent among all the alkali metals.** **3. It forms only monoxide with oxygen.** **4. LiCl is deliquescent and crystallizes as a hydrate ($LiCl.2H_2O$). But the other alkali metal chlorides do not form hydrates.** **5. Lithium bicarbonate ($LiHCO_3$) is stable only in solution.**	**2**
28.	**i.** ***Chain Isomerism*: Isomers differ in carbon chain or skeleton are called chain isomers and the phenomenon is called chain isomerism.**  **b) *Position isomerism*: Isomers which differ in the position of the substituent or side chain are called position isomers and the phenomenon is called position isomerism.** **E.g. : Alcohol with molecular formula C4H10O may be 1-butanol or 2-butanol** **CH3-CH2-CH2-CH2-OH CH3-CHOH-CH2-CH3** **1-Butanol 2-Butanol**	**2**
	ii. 	**1**

29.	i. The important observations made by Rutherford are: 1. Most of the α– particles passed through the gold foil without any deviation. 2. A small fraction of the α–particles was deflected by small angles. 3. A very few α– particles (~1 in 20,000) bounced back, that is, were deflected by nearly 180°. ii. *the nuclear model (Planetary model) of atom* 1. All the positive charge and most of the mass of the atom are concentrated in an extremely small region called nucleus. 2. Electrons are revolving round the nucleus with a very high speed in circular paths called orbits. 3. Electrons and the nucleus are held together by electrostatic forces of attraction.	2 2
30.	i. Heisenberg's Uncertainty Principle "*it is impossible to determine simultaneously, the exact position and exact momentum (or velocity) of a moving microscopic particle like electron*". Mathematically, it can be given as in equation $\Delta x.\ \Delta p \geq \frac{h}{4\pi}$ Or, $\Delta x. m\Delta v \geq \frac{h}{4\pi}$ Or, $\Delta x.\Delta v \geq \frac{h}{4\pi m}$ ii. Wavelength, $\lambda = \frac{h}{mv} = \frac{6.626\times10^{-34}}{0.1\times10} = 6.626 \times 10^{-34}$m	2 2

31.	**i. (B) Bent shape** **ii. The important postulates of this theory are:** **1) The shape of the molecule depends on the number of valence shell electron pairs (VSEPRs) around the central atom.** **2) The valence shell electron pairs repel each other.** **3) In order to reduce the repulsion, the electron pairs stay at maximum distance.** **4) Presence of lone pairs of electron causes distortion in the expected geometry of the molecule.** **5) The repulsion between two lone pairs of electrons is different from those between two bond pairs or between a lone pair and bond pair. The repulsion decreases in the order lone pair - lone pair > lone pair - bond pair > bond pair - bond pair.** **6) As the angle between the electron pairs increases, the repulsion decreases.**	**1** **3**
32.	**i.** ***O_2 molecule contains 16 electrons.*** ***Its M.O configuration is:*** $\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2pz^2\ \pi 2px^2\ \pi 2py^2\ \pi^* 2px^1\ \pi^* 2py^1$ ***due to one lone pair of electron it is paramagnetic in nature*** ***ii. Bond order B.O= ½ (N_B-N_A)*** ***= ½ (10-6)=2***	**2** **2**
33.	**i.** **<u>Le Chatlier's Principle</u>.** **It states that *whenever there is a change in concentration, pressure or temperature of a system at equilibrium, the system will try to readjust in such a way so as to cancel the effect of that change.*** **ii.** ***N*** **(a) Forward reaction / production of ammonia increases** **(b) -ve enthalpy indicate exothermic reaction so backward reaction/ production of ammonia decreases** **(c) Forward reaction / production of ammonia increases**	**1** **3**

34.	i. pH is defined as the negative logarithm of the hydrogen ion or hydronium ion concentration in moles per litre (i.e. molarity). i.e. pH = - log[H^+] or pH = - log[H_3O^+] ii. Here [H^+] = 3 x 10^{-12} We know that pH = -log[H+]=-log[3 x 10^{-12}] =-11.52 So it is basic in nature	1 3
35.	i. (c) Fullerenes ii. In diamond, each carbon atom is in sp^3 hybridisation and linked to four other carbon atoms in a tetrahedral manner. So it has a a rigid three dimensional network of carbon atoms. It is very difficult to break covalent bonds. So there are no free electrons. Graphite has a layered structure. Different layers are held by weak van der Waals forces of attraction. Each layer contains planar hexagonal rings of carbon atoms. Here each carbon atom is in sp^2 hybridisation and makes three C-C sigma bonds with three neighbouring carbon atoms. Fourth electron forms a π bond. These electrons are delocalised and are mobile. Therefore graphite conducts electricity	1 3
36.	i. Diborane is prepared industrially by the reaction of BF_3. $2BF_3 + 6NaH \xrightarrow{450K} 2B_2H_6 + 6NaF$ ii. *Borazine($B_3N_3H_6$) / inorganic benzene* iii. Structure of Diborane  The four terminal hydrogen atoms and the two boron atoms lie in one plane. Above and below this plane, there	1 1 2

	are two bridging hydrogen atoms. The four terminal B-H bonds are regular two centre-two electron bonds while the two bridge (B-H-B) bonds are different and can be described in terms of three centre–two electron bonds	
37.	***"Lassaigne's test"*** **Here theorganic compound is fused with metallic sodium in a fusion tube. It is then plunged into distilled water taken in a china dish. The solution is boiled and filtered. The filtrate is known as sodium fusion extract.** **Principle: In an organic compound, nitrogen, sulphur and halogen atoms are present in covalent form. By heating with metallic sodium, these elements are converted to ionic form as follows:** $Na + C + N \xrightarrow{\Delta} NaCN$ **To one part of sodium fusion extract add freshly prepared ferrous sulphate ($FeSO_4$) solution. Heated to boiling, cooled and acidified with dil. H_2SO_4. Blue or green coloration or precipitate (ppt) Presence of nitrogen**	**3**
38.	**i.** ***Wurtz reaction*:** **Alkyl halides react with metallic sodium in dry ether to form alkanes. This reaction is known as Wurtz reaction.** $CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} CH_3-CH_3 + 2NaBr$ Bromomethane Ethane **ii.** **In the presence of peroxide, addition of HBr to unsymmetrical alkenes takes place against Markovnikov rule. This is known as *peroxide or Kharash effect*** **e.g.** $CH_3\text{-}CH{=}CH_2 + HBr \xrightarrow{\text{Org.peroxide}} CH_3\text{-}CH_2CH_2Br$ **Propene 1-bromopropane**	**2** **2**

39.	i. Acetylene or ethyne ii. Electrophilic Substitution Reactions These are reactions in which a weak electrophile is replaced by a strong electrophile. The important electrophilic substitution reactions are Nitration, Sulphonation, Halogenation and Friedel-Crafts alkylation and acylation. Eg: Nitration 	1 3
40.	i. (b) CO ii. The amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water, is called Biochemical Oxygen Demand (BOD). The amount of BOD in the water is a measure of the amount of organic material in the water. Clean water would have BOD value of less than 5 ppm whereas highly polluted water could have a BOD value of 17 ppm or more. iii. (Any one) (i) Dry Cleaning of Clothes: Liquefied carbondioxide, with a suitable detergent is used for dry cleaning clothes. (ii) Bleaching of Paper: Hydrogen peroxide (H_2O_2) with suitable catalyst is used for bleaching paper. (iii) Synthesis of Chemicals: Ethanal (CH_3CHO) is now commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium. $CH_2 = CH_2 + O_2 \xrightarrow[\text{Pd(II)/Cu(II)(in water)}]{\text{Catalyst}} CH_3CHO$	1 2 1