CHEMISTRY (CODE - 043)

SAMPLE QUESTION PAPER*

CLASS XII (2026-27)

Time: 3 hours **Max. Marks: 70**

GENERAL INSTRUCTIONS:

Read the following instructions carefully.

1. There are **33** questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. In addition to this, a separate question has been provided for visually impaired candidates in lieu of questions having visual inputs.
9. Use of log tables and calculators is not allowed.

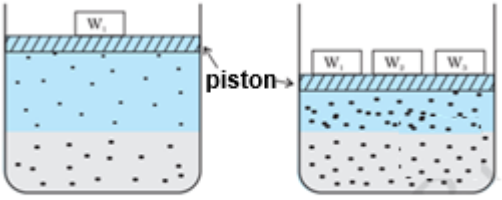
Section-A

Question 1 to 16 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.

1	The boiling points and K_b values of isomeric amines are given in table 1. **Table 1** Which one of the following statement is correct? A. Amine P is more volatile than amine R, but less basic B. Amine R will give white precipitate with Hinsberg reagent, which is soluble in NaOH C. Amine Q is more soluble in water as compared to R. D. Amine P and Q can be prepared by Gabriel Phthalimide process.	1
2	Which of the following complex is tetrahedral in shape? A. $[Ni(CN)_4]^{2-}$ B. $[Cu(NH_3)_4]^{2+}$ C. $[NiCl_4]^{2-}$ D. $[Co(en)_3]^{3+}$	1

Amine	Boiling point/K	pK_b (approx)
P	329.3	3.00
Q	310.5	9.83
R	350.8	3.22

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3	The quantity of charge required to obtain one mole of metal "M" from M_2O_3 is: A. 1F B. 6F C. 3F D. 2F	1
4	An organic compound "X" on reaction with chloroform and alcoholic KOH gives foul smelling product. In which of the following case compound X would be produced: A. Chloromethane is treated with AgCN. B. Nitrobenzene is reduced. C. Benzene diazonium chloride is treated with Cu/KCN D. Aniline reacts with Acetyl chloride.	1
5	Consider a system in a state of dynamic equilibrium, as shown in Fig. 1(a). The lower part is solution and the upper part is gaseous system at pressure p and temperature T. If the pressure is increased over the solution phase by compressing the gas to a smaller volume as shown in Fig 1(b).  Figure 1 Which of the following statements is true about figure 1(b) A. solubility of gas will increase until dynamic equilibrium is reached B. solubility of gas will decrease until dynamic equilibrium is reached C. solubility of gas will increase until static equilibrium is reached D. solubility of gas will decrease until static equilibrium is reached ***(For Visually Challenged Learners)*** According to Henry's law partial pressure P of a gas above the liquid at constant temperature is directly proportional to A. volume of the gas B. mole fraction of the gas in the solution C. atmospheric pressure D. vapour pressure of the solution	1
6	Aavya carries out hydrolysis of acetyl chloride. The reaction is represented by the following equation: $CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$ She carries out the reaction with (i) equimolar amounts of acetyl chloride and water (ii) excess of water. The rate law obeyed in the two cases will be: A. (i) First order (ii) Second Order B. (i) First order (ii) First order C. (i) Second order (ii) Second order D. (i) Second order (ii) First order	1

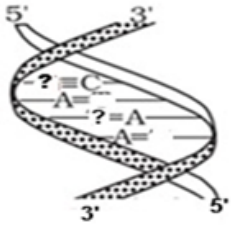
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7	The amino acid HOOC-CH_2-CH_2-CH (NH_2) COOH, can be synthesised within our body. Which of the following is true about this amino acid? HOOC-CH_2-CH_2-CH(NH_2) COOH is: A. an acidic and non-essential amino acid. B. a neutral and non- essential amino acid. C. an acidic and essential amino acid D. a neutral and essential amino acid	1
8	Identify the Grignard reagent and carbonyl compound which on reaction followed by hydrolysis will give 3-methyl pentan-3-ol. (i) $C_2H_5COC_2H_5 + CH_3MgCl$ (ii) $C_2H_5COCH_3 + C_2H_5MgCl$ (iii) $CH_3CHO + C_2H_5 - \underset{\displaystyle MgCl}{\overset{\displaystyle H}{\overset{|}{C}}} - C_2H_5$ (iv) $C_2H_5CHO + CH_3 - \underset{\displaystyle MgCl}{\overset{\displaystyle H}{\overset{|}{C}}} - C_2H_5$ A. (i) and (iii) B. (ii) and (iv) C. (iii) and (iv) D. (i) and (ii)	1
9	Which one of the following element will be strong oxidising agent in their +3 oxidation state? (Atomic no. Cr=24, Mn=25, Ti=22, Fe=26) A. Cr B. Mn C. Ti D. Fe	1
10	When (–)-2-bromohexane reacts with sodium hydroxide, (+)-hexan-2-ol is formed. Which one of the following observation would be correct? A. The reaction follows S_N2 mechanism and is accompanied by inversion of configuration. B. The reaction follows S_N1 mechanism and is accompanied by inversion of configuration. C. The reaction follows S_N2 mechanism and is accompanied by retention of configuration. D. The reaction follows S_N1 mechanism and is accompanied by retention of configuration.	1
11	If half-life of a first order reaction is 16 minutes, how much time does it take to complete 75% of the reaction? A. 16 min B. 32 min C. 48 min D. 64 min	1
12	Which solution has the highest conductivity? A. 0.1 M HCl B. 0.1 M CH_3COOH C. 0.1 M glucose D. 0.1 M NH_4OH	1

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13	**Assertion (A):** Nitration of aniline gives significant amount of meta derivative. **Reason (R):** -NH_2 is ortho and para directing and highly activating group. Select the most appropriate answer from the options given below: A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
14	**Assertion (A):** Permanganate and manganate ions have tetrahedral structure **Reason (R):** In permanganate and manganate ions, pi bonding takes place which is due to overlap of p orbitals of oxygen with p orbitals of manganese. Select the most appropriate answer from the options given below: A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
15	**Assertion (A)**: Miscibility of ethers with water resembles those of alcohols of the same molecular mass. **Reason (R)**: The oxygen of ether can also form hydrogen bonds with water. Select the most appropriate answer from the options given below: A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true	1
16	**Assertion (A):** $[Co(NH_3)_6]^{3+}$ is diamagnetic. **Reason (R):** NH_3 is a strong field ligand and causes pairing of electrons. Select the most appropriate answer from the options given below: A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true	1
	Section-B Question No. 17 to 21 are very short answer questions carrying 2 marks each.	
17(A)	**Attempt either A or B** (I) Complete and balance the following reaction $SO_3^{2-} + MnO_4^- + H^+ \rightarrow$ (II) Why does titanium melt at a lower temperature than chromium? **OR**	1 1

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17(B)	(I) Why do titanium and scandium forms complex compounds, whereas potassium and calcium do not, although they belong to same period? (II) Complete and balance the following reaction $Fe^{2+} + Cr_2O_7^{2-} + H^+ \rightarrow$	1 1
18	"The rate of reaction remains constant during the course of reaction." Is this statement always true or is true under certain conditions? Reflect on the statement.	2
19	(I) Complete the sequence of nitrogenous bases in the given DNA strand (Figure 2) (II) Milk contains a protein called casein. How does the structure of casein change on addition of a few drops of lemon juice to milk?  Figure 2 ***(For Visually Challenged Learners)*** (I) Name the nitrogenous bases in DNA (II) Milk contains a protein called casein. How does the structure of casein change on addition of a few drops of lemon juice to milk?	1 1 1 1
20	Chlorobenzene can be converted into phenol by heating in aqueous sodium hydroxide solution at a temperature of 623K and 300 atm, however presence of a substituent group effects its activity towards this nucleophilic substitution reaction. Which substituent (i) nitro or (ii) methoxy will increase the reactivity of chlorobenzene and why?	2
21	**Account for the following:** (I) Underground iron pipelines are often protected by connecting them to a more reactive metal like magnesium. (II) Write the reactions occurring at cathode and anode during the electrolysis of molten magnesium chloride.	2x1
	Section-C Question No. 22 to 28 are short answer questions, carrying 3 marks each.	
22	(I) Which of the following has the highest magnetic moment? Justify your answer. Ti^{2+} ,Co^{2+} , Fe^{2+} . [Atomic No. Ti = 22 Co = 27 , Fe = 26] (II) Which characteristic of iron make it suitable to: a) act as catalyst in Haber's process. b) form interstitial compound with oxygen.	1 2

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23	The values of log k and 1/T for a reaction are given-	3

S.No.	Log k	1/T (/K)
1.	-4.46	0.00333
2.	-3.91	0.00323
3.	-3.37	0.00313
4.	-2.82	0.00303
5.	-2.31	0.00294

The plot of log k vs 1/T obtained for the above data is as shown in Figure 3.

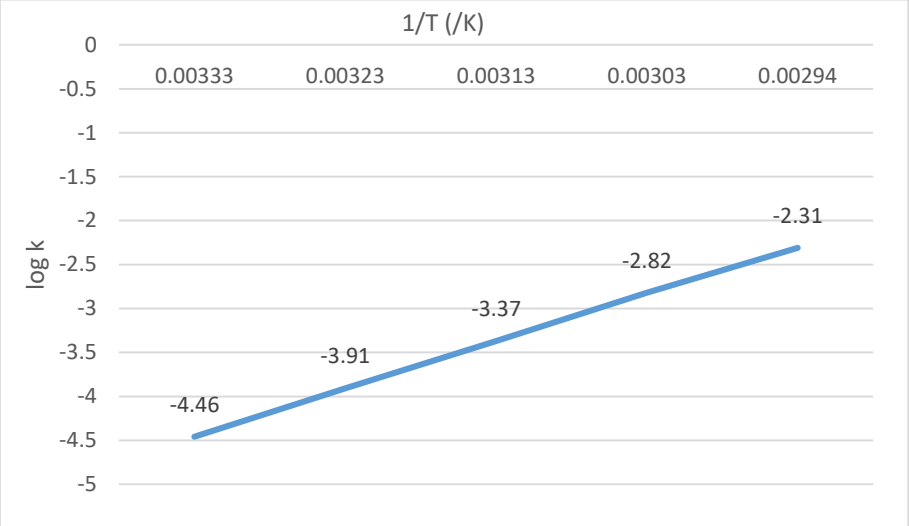


Figure 3

Here k is the rate constant and T is the absolute temperature.

Calculate E_a for the reaction. (Given R= 8.314 $JK^{-1}mol^{-1}$)

(For Visually Challenged Learners)

Rate constant k of a reaction varies with temperature 'T' according to the equation

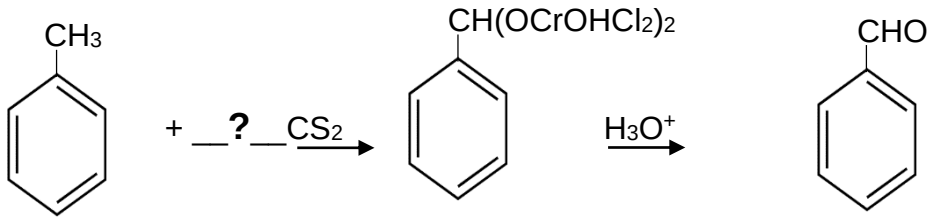
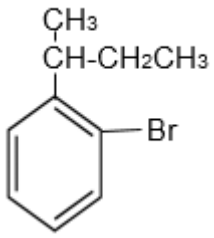
$$\log k = \log A - \frac{Ea}{2.303RT}$$

where E*a* is the activation energy. When a graph is plotted for log k vs 1/T, a straight line with a slope of − 4250 K is obtained. Calculate E*a* for the reaction. (Given R= 8.314 $JK^{-1}mol^{-1}$).

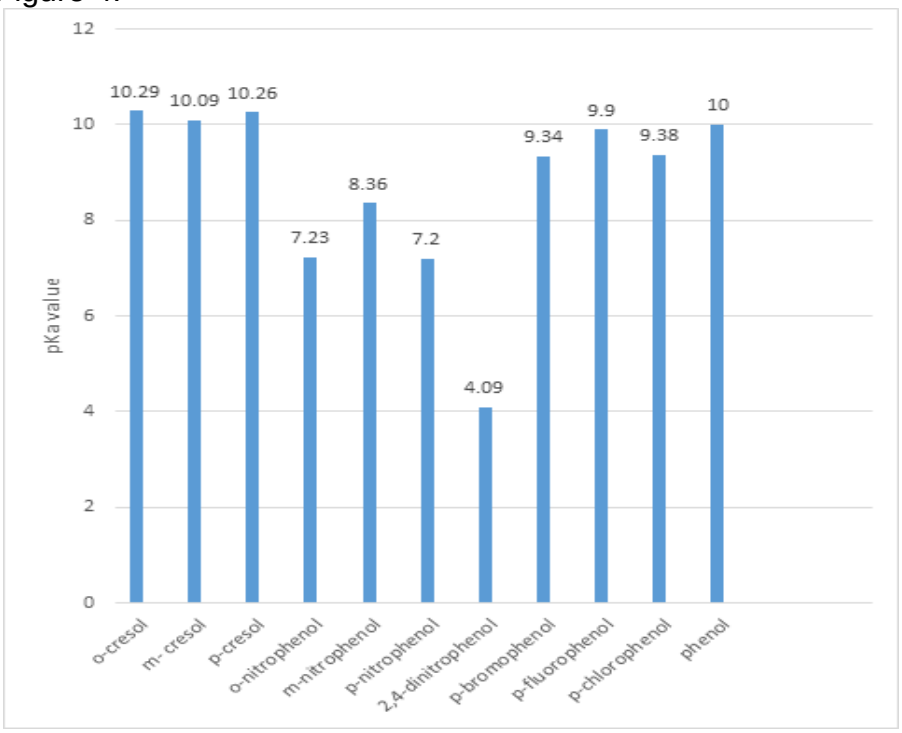
24	Identify each name reaction and complete the missing reactant/ product in the given reaction sequence.	3x1

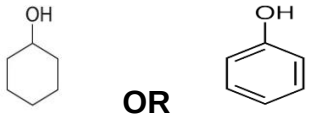
(I) $2CH_3CHO \xrightarrow{?} CH_3CH(OH)CH_2CHO$

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	(II)  (III) >C=O $\xrightarrow[-H_2O]{NH_2NH_2}$ __?_____ $\xrightarrow[\text{Heat}]{KOH/\text{ethylene glycol}}$ $>CH_2 + N_2$	
25	(I) Aman prepared a solution by dissolving 10 ml of Acetone and 10 ml of Carbon disulphide. The net volume of resulting solution was not found to be 20 mL. a) What would be the observation in this case? Comment. b) In case carbon disulphide is replaced by chloroform in the above case, what would be the expected changes in volume of the resulting solution? Support your answer with appropriate reason. (II) Calculate the concentration of oxygen (in ppm) present in 1 litre of sea water. Given that a litre of sea water weighs 1030 g and contains about 6×10^{-3} g of dissolved oxygen.	1+1 1
26	(I) Convert the following; a) Nitrobenzene to flourobenzene b) Benzoic acid to benzylamine (II) Aniline undergoes electrophilic substitution reactions readily. However, acetylation of aniline is required to obtain monosubstituted products. Give reason for your answer	2 1
	Attempt either A or B	
27(A)	(I) Write the IUPAC name of the following compound  (II) When $CH_3CH_2CH_2Cl$ reacts with AgCN and KCN, Compound "X" and "Y" respectively are formed. Identify "X" and "Y". Support your answer with appropriate reason.	1 2
	OR	
27(B)	(I) What is the IUPAC nomenclature of the compound: $(CH_3)_3C$-$C(CH_3)Br$-CH_2CH_3	1

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	(II) Which of the following will be hydrolysed more readily? $CH_2=CH-CH_2Cl$ or $(CH_3)_2CHCl$ Support your answer with reason.	2
28	(I) On adding 100 g of non-volatile solute A in 1000 g of water, the vapour gets reduced by 50 percent. Calculate the molar mass of solute A. (II) It has been observed that nitric acid solution containing 32% of water by mass, cannot be separated into its components through fractional distillation. Why?	2 1
	Section D Question No. 29 & 30 are case-based/data -based questions carrying 4 marks each.	
29	**Acidity of substituted phenols** Phenol and substituted phenols are relatively more acidic than aliphatic alcohols. The pKa value is a quantitative measure of the acidic strength. The effect of substituents on acidity of phenols (pKa values) is given in Figure 4.  **Figure 4** **Study the graph and answer the following questions** (I) The pKa value of 2,4,6- trinitrophenol will be: A. more than 8.36 B. between 7.2 and 8.3 C. between 4.09 and 2.3 D. less than 4.09 (II) The order of acidity of p-halophenols is : A. p-bromophenol > p-chlorophenol > p-flourophenol > phenol B. phenol > p-flourophenol > p-chlorophenol > p-bromophenol C. p-chlorophenol > p-bromophenol > p-flourophenol > phenol	 <

	D. phenol > p-flourophenol > p-bromophenol > p-chlorophenol **Attempt either (IIIA) or (IIIB).** (IIIA) Predict which one of the following two compounds will have lower value of pKa .	2
	 **OR** Give reason in support of your reason.	
	OR (IIIB) Predict whether 4 chloro-2, 6- dintirophenol is more or less acidic than 2,4,6-trinitrophenol? Use the values in the graph to support your answer.	2
	(For Visually Challenged Learners) **Read the passage and answer the questions that follow** The presence of electron withdrawing groups such as nitro group, enhances the acidic strength of phenol. It is due to the effective delocalisation of negative charge in phenoxide ion. On the other hand, electron releasing groups, such as alkyl groups, in general, do not favour the formation of phenoxide ion resulting in decrease in acid strength. Cresols, for example, are less acidic than phenol. The pKa value is a quantitative measure of the acidic strength. Higher the pKa value lower is the acidic strength. (I) Which of the following will form least stable phenoxide ion? A. phenol B. o-cresol C. o-nitrophenol D. o-chlorophenol	1
	(II) Which group causes the maximum increase in pKa value of phenol: A. – CH_3 B. – OCH_3 C. – NO_2 D. – Cl	1
	Attempt either (IIIA) or (IIIB) (IIIA). Which of the following will be more acidic? Nitrophenol or 2,4-Dinitrophenol. Support your answer with appropriate reason?	2
	OR (IIIB). Predict whether pka value of p-cresol or p-nitrophenol will be higher or lower than phenol. Give reason to support your answer.	2

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30	**Identification of carbohydrate** Students of class 12 are given a sample of carbohydrate obtained from a plant extract. They conducted the following tests to identify the carbohydrate. The students find that the given carbohydrate is soluble in water. They take about 1-2 mL of aqueous solution of the carbohydrate in a test tube and add 2 mL of Benedict's reagent. The test tube is heated in water bath for 3-5 minutes. A brick red precipitate is obtained. The sample of the given carbohydrate on hydrolysis with dilute acid, gives only one type of monosaccharide. Read the passage and answer the following questions: (I) The sample gives a positive Benedict's test. We can conclude that the given carbohydrate is a A. monosaccharide B. reducing sugar C. non-reducing sugar D. polysaccharide (II) Which of the following is plant based carbohydrate? (i) sucrose (ii)lactose (iii) starch (iv) glycogen A. (i) and (ii) B. (i) and (iii) C. (iii) and (iv) D. (i) and (iv) **Attempt either (IIIA) or (IIIB)** (IIIA) Considering all observations reported in the passage the sample is most likely (i) glucose (ii) fructose (iii) sucrose (iv) lactose (v) maltose. Justify your answer. **OR** (IIIB) Ravi reports that the given sample is starch. What could be his justification, based on the observations in the passage? Do you agree with Ravi? Why or why not?	1 1 2 2
Section-E Question No. 31 to 33 are long answer type questions carrying 5 marks each.		
31(A)	**Attempt either A or B** (I) Account for the following a. The pH should be around 3.5 during the addition of ammonia derivative compounds to aldehyde/ ketone. b. Alcohols are added to carbonyl compounds in the presence of dry HCl gas. c. The reaction of aldehydes with sodium hydrogen sulphite is commonly used for the separation and purification of aldehydes. (II) A student has three colourless samples: methanol, acetaldehyde, and acetic acid. They have only $NaHCO_3$, and 2,4-DNP reagent	3x1 2

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		Devise a flowchart to identify each compound using only these two reagents.	
		OR	
31(B)	(I)	Arrange the following according to the property indicated a) CH_3CHO, $HCHO$, C_6H_5CHO (decreasing order of the ease of oxidation) b) CH_3COCl, CH_3COOH, CH_3CONH_2, CH_3COOCH_3 (increasing order of nucleophilic acyl substitution) c) CH_3CHO, CH_3COCH_3, CF_3CHO (increasing order of electrophilicity of carbonyl carbon)	3x1
	(II)	Write any two possible isomers of the compound having molecular formula C_3H_6O. Identify which of these isomer/s will give a positive Tollen's test and explain the reason.	2
	Attempt either A or B		
32(A)	**Answer the following questions:**		5x1
	(I)	Two test tubes, X and Y, contain solutions of the complexes $[Cr(H_2O)_3Cl_3]$ and $[Cr(en)_3]^{3+}$ respectively. If plane-polarized light is passed through these solutions, which solution will rotate the plane of polarization and why?	
	(II)	$[Ni(CO)_4]$ and $[Ni(H_2O)_6]^{2+}$ are two complexes of Ni. Which complex will have higher crystal field splitting energy, and which factor determines this difference?	
	(III)	A solution of the coordination compound $PdCl_2 .4NH_3$ is treated with $AgNO_3$, and 2 mole of AgCl precipitate form. Determine the primary valency and secondary valency of Pd in the compound.	
	(IV)	The complex $[Fe(CN)_6]^{4-}$ exhibits d^2sp^3 hybridisation. Based on this, comment on the strength of the ligand CN^- and its effect on the geometry of the complex.	
	(V)	Why is anhydrous $CuSO_4$ white, but $CuSO_4 .5H_2O$ blue in colour?	
		OR	
32(B)	**Answer the following questions:**		5x1
	(I)	Three coordination compounds of cobalt(III) are given: Compound A: $[Co(NH_3)_6]Cl_3$ Compound B: $[Co(NH_3)_5Cl]Cl_2$ Compound C: $[Co(NH_3)_4Cl_2]Cl$ Which of the three compounds will show maximum electrolytic conductivity and why?	
	(II)	On the basis of crystal field theory, write the electronic configuration for d^5 ion if $\Delta_0 > P$.	
	(III)	Using IUPAC norms, write the formulae of Diaquadiammine (oxalato) chromium(III) chloride.	
	(IV)	Compare the optical activity of $[Co(NH_3)_2Cl_2(en)]Cl$ and $[Co(NH_3)_4Cl_2]Cl$. Which one is optically active and why?	
	(V)	Explain why $[Cu(NH_3)_4]^{2+}$ shows a blue colour while $[Cu(H_2O)_4]^{2+}$ shows a greenish colour. Which factor influences the colour difference?	

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Attempt either A or B

33(A) (I) A student investigates the effect of concentration on the cell potential of a Zn–Cu galvanic cell at 298 K. 1+2

The cell is: $Zn(s) \mid Zn^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

standard electrode potentials:

$E^0(Zn^{2+}/Zn) = -0.76$ V, $E^0Cu^{2+}/Cu = +0.34$ V, $E^o cell = 1.10$ V

The following experimental data were collected:

Experiment	$[Zn^{2+}]$ (M)	$[Cu^{2+}]$ (M)	Measured EMF (V)
1	1.00	1.00	1.10
2	0.1	1.00	1.16
3	1.00	0.10	1.04
4	0.01	1.00	1.22
5	1.00	0.01	0.98

a) Why does experiment 4 show the maximum EMF?

b) For experiment 3, calculate the theoretical EMF using the Nernst equation. Suggest one possible reason why the measured EMF differs slightly from the calculated value.

(II) If k is expressed in Sm^{-1} and the concentration, c in mol m^{-3} then the units of molar conductivity are in Sm^2mol^{-1}. However, if we use Scm^{-1} as the units for k and $molcm^{-3}$, the units of concentration, then the units of molar conductivity are in Scm^2mol^{-1}. Show how 1 Sm^2mol^{-1} is related to 1S cm^2mol^{-1} 1

(III) What happens to the specific gravity of electrolyte in lead storage battery during charging and discharging of battery? 1

OR

33(B) I. For aqueous NaCl at 25 °C the molar conductivities at two concentrations are measured as: 3

$\Lambda_m(0.010\ M) = 123.9\ S\ cm^2\ mol^{-1}$

$\Lambda_m(0.040\ M) = 120.7\ S\ cm^2\ mol^{-1}$

Molar conductivity for strong electrolytes can be represented as $\Lambda_m = \Lambda^\circ_m - A\sqrt{c}$. Determine Λ°(molar conductivity at infinite dilution) and the constant A for NaCl solution.

II. Write the electrode reactions that occur in a hydrogen–oxygen fuel cell. Also, state two advantages of fuel cells compared to conventional batteries. 2

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CHEMISTRY (CODE – 043)

MARKING SCHEME

CLASS XII (2026-27)

Time: 3 hours **Max. Marks: 70**

GENERAL INSTRUCTIONS:

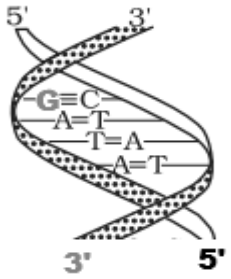
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Section-A		
1	B. Amine R will give white precipitate with Hinsberg reagent, which is soluble in NaOH. On the basis of information, P is secondary, Q is tertiary and R is primary amine. Primary amine gives white precipitate with Hinsberg reagent , which is soluble in NaOH.	1
2	C. $[NiCl_4]^{2-}$ $[NiCl_4]^{2-}$is tetrahedral because Cl^- is a weak field ligand, so it does not cause pairing of electrons. The other complexes are square planar or octahedral.	1
3	C. 3F M^{3+} + 3e- → M Quantity of charge = 3F	1
4	B. Nitrobenzene is reduced. In the above case, aniline is formed. The foul smell is given by the isocyanides produced, when aliphatic and aromatic primary amine compound undergoes carbylamine reaction. Out of the following, option B provides aromatic amine which will undergo carbylamine reaction. Hence (B) will give foul smell.	1

5	A. Solubility of gas will increase until dynamic equilibrium is reached Henry's law ***(for visually challenged learners)*** B. mole fraction of the gas in the solution	1
6	D. (i) second order (ii) first order The rate of reaction will depend on both the reactants in case (i) In case (ii), when water is in excess, the rate of reaction is independent of concentration of water. Such reactions are called pseudounimolecular reactions.	1
7	A. an acidic, non-essential amino acid. The amino acid can be synthesised in our bodies so it is non-essential. It has two –COOH groups and one -NH_2 group, therefore it is acidic.	1
8	D. (i) and (ii) (i) $C_2H_5COC_2H_5 + CH_3MgCl \rightarrow C_2H_5C(OMgCl)(CH_3)C_2H_5 \xrightarrow{\text{hydrolysis}} C_2H_5C(OH)(CH_3)C_2H_5$ (ii) $C_2H_5COCH_3 + C_2H_5MgCl \rightarrow C_2H_5C(OMgCl)(C_2H_5)CH_3 \xrightarrow{\text{hydrolysis}} C_2H_5C(OH)(C_2H_5)CH_3$ (iii) $C_2H_5CH(MgCl)C_2H_5 + CH_3CHO \rightarrow CH_3CH(OMgCl)C_2H_5C_2H_5 \xrightarrow{\text{hydrolysis}} CH_3CH(OH)C_2H_5CHC_2H_5$ (iv) $C_2H_5CH(MgCl)CH_3 + C_2H_5CHO \rightarrow C_2H_5CH(OMgCl)C_2H_5CHCH_3 \xrightarrow{\text{hydrolysis}} C_2H_5CH(OH)C_2H_5CHCH_3$	1
9	B: Mn Mn^{3+} act as strong oxidising agent.	1
10	A. The reaction follows S_N2 mechanism and is accompanied by inversion of configuration.	1
11	B. 32 min 50% reaction is completed in 16 min. For remaining 50% of the substance to reduce to its half (25%) time required will be 16 min. Therefore 50% +25% = 75% of the reaction will be completed in 32 min	1

12	A. HCl is a strong acid and fully dissociates into H^+ and Cl^- ions. More ions lead to higher conductivity. CH_3COOH and NH_3 are weak electrolytes and are partially ionized having lower conductivity. Glucose is a non-electrolyte, no ions and hence no conductivity.	1
13	B. A and R are true, and R is not the correct explanation of A	1
14	C. A is true but R is false. Reason is false, the correct statement - The pi bonding takes place by overlapping of p orbitals of oxygen with d orbitals of manganese.	1
15	A. A and R are true, and R is the correct explanation of A	1
16	A. A and R are true, and R is the correct explanation of A $[Co(NH_3)_6]^{3+}$ is diamagnetic because all electrons are paired. NH_3 is a strong field ligand, so it causes electron pairing in the d-orbitals. Hence, the reason correctly explains the assertion.	1
Section-B Question No. 17 to 21 are very short answer questions carrying 2 marks each		
17A 17B	I. $2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O,$ II. Chromium has more number of unpaired electrons than Titanium leading to stronger interatomic attractions holding its atoms together requiring more energy to break as compared to titanium. **OR** I. The transition metals form a large number of complex compounds. This is due to the comparatively smaller sizes of the metal ions, their high ionic charges and the availability of d orbitals for bond formation. Hence Titanium forms complex compounds, whereas Potassium and calcium do not. II. $Cr_2O_7^{2-} + 14\ H^+ + 6\ Fe^{2+} \rightarrow 2\ Cr^{3+} + 6\ Fe^{3+} + 7\ H_2O$	1 1 1 1
18	The statement is true for a zero order reaction as the rate is independent of concentration of reactants. For reactions of order other than zero, like order 1, 2 etc. the rate of reaction decreases with the decrease in concentration of reactants.	1 1

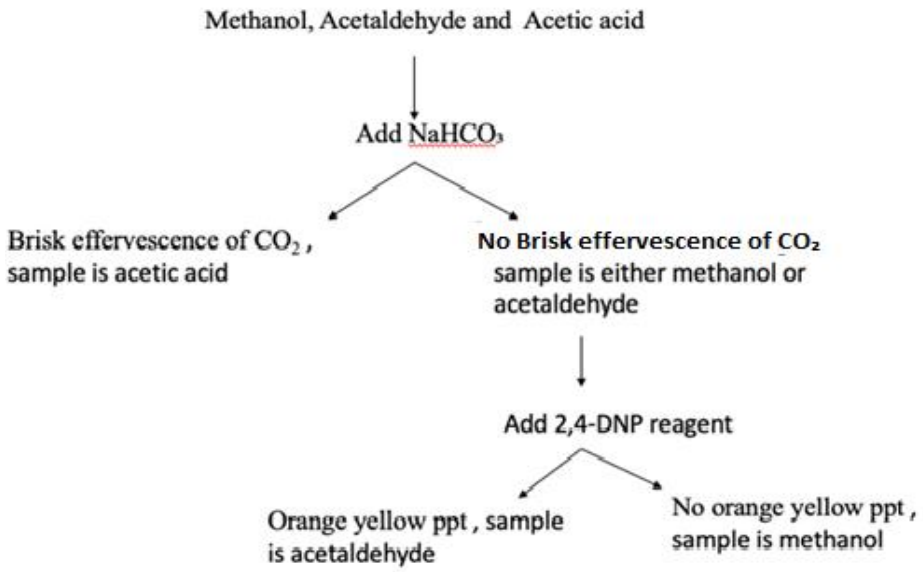
19	I.  II. Addition of lemon juice lowers the pH which breaks the hydrogen bonds, the globules of casein unfold and it gets denatured. **For Visually Challenged Learners** I. Adenine, Guanine, Cytosine and Thymine II. Addition of lemon juice lowers the pH which breaks the hydrogen bonds, the globules of casein unfold and it gets denatured.	1 1 1 1
20	Nitro group will increase the reactivity. The nitro group is a strong electron-withdrawing group (EWG) due to both its inductive (-I) and resonance (-M) effects whereas methoxy group is electron donating in nature. In chlorobenzene when nitro group is present at the *ortho* or *para* position, it withdraws electron density from the ring and stabilizes this negative charge through resonance. Hence increases its reactivity towards nucleophilic	1 ½ ½
21	I. Magnesium being more reactive than iron acts as a sacrificial anode and undergoes oxidation ($Mg \rightarrow Mg^{2+} + 2e^-$), supplying electrons to the iron pipe, which behaves like cathode, thus preventing corrosion. II. Cathode: $Mg^{2+} + 2e^- \rightarrow Mg$ (l) Anode: $2Cl^- \rightarrow Cl_2$ (g) + 2e-	1 ½ ½
	Section-C Question No. 22 to 28 are short answer questions, carrying 3 marks each.	
22	I. Fe^{2+} (4 unpaired electrons) has higher magnetic moment, as it contains more unpaired electrons as compared to other two. II. a) It provides large surface area and variable oxidation state. b) Iron has large crystal lattices containing interstitial sites large enough to accommodate small non-metal atoms like oxygen, carbon, nitrogen.	½, ½ 1 1
23	log K= log A - $\frac{Ea}{2.303RT}$ Slope = - $\frac{Ea}{2.303R}$	½ ½

	Slope = $\frac{y_2-y_1}{x_2-x_1}$ = $\frac{-4.46-(-3.91)}{.00333-.00323}$ = - 5500 J/K/mol (value of slope may vary slightly if different values of y_2,y_1, x_2 and x_1 are chosen) Equating the value of slope to the expression – $-\frac{Ea}{2.303R}$ = − 5500 where R= 8.314 $JK^{-1}mol^{-1}$ Ea = 5500 X 2.303 X 8.314 Ea = 105.31 $kJmol^{-1}$ **For Visually challenged learners** log k= log A - $\frac{Ea}{2.303RT}$ Slope = - $\frac{Ea}{2.303R}$ $-\frac{Ea}{2.303R}$ = − 4500 where R= 8.314 $JK^{-1}mol^{-1}$ Ea = 4500 X 2.303 X 8.314 Ea = 86.16 $kJmol^{-1}$	1 (Correct answer and correct unit) ½ , ½ 1 1 ½ , ½ (Correct answer and correct unit)
24	I. Aldol condensation, dil NaOH II. Etard Reaction, CrO_2Cl_2 III. Wolf -kishner reduction, >C=N.NH_2	½ + ½ ½ + ½ ½ + ½
25	I. a) The net volume of resulting solution was found to be slightly more than 20 mL. Carbon disulphide and acetone have weak intermolecular interactions which leads to increase in the volume of the solution. b) When solution is replaced with chloroform, net volume shows slight decrease from 20 mL, as chloroform and acetone have strong intermolecular interactions owing to hydrogen bonding.	½ ½ ½ ½

	II. Parts per million = $\frac{\text{Number of parts of the component} \times 10^6}{\text{Total number of parts of all components}}$ $= \frac{6 \times 10^{-3} \times 10^6}{1030 + 0.006}$ $= \frac{6 \times 10^{-3} \times 10^6}{1030}$ = 5.8 ppm	½ ½
26	I. a) Nitrobenzene to flurobenzene $C_6H_5NO_2 \xrightarrow{Sn/HCl} C_6H_5NH_2 \xrightarrow{NaNO2/HCl} C_6H_5N^{2+}Cl^- \xrightarrow{NaBF4} C_6H_5F$ b) Benzoic acid to benzylamine $C_6H_5COOH + NH_3 \xrightarrow{heat} C_6H_5CONH_2 \xrightarrow{LiAlH4} C_6H_5CH_2NH_2$ II. $-NH_2$ group in aniline is strongly activating in electrophilic substitutions, hence giving 2,4,6 trisubstituted products. Acetylation converts $-NH_2$ *to* $-NHCOCH_3$ which is less activating due to resonance with the carbonyl group, hence controlling and enabling the substitution at para position .	1 1 ½ ½
27(A)	I. 1-Bromo-2(1-methylpropyl) benzene II. When $CH_3CH_2CH_2Cl$ reacts with AgCN Compound X = $CH_3CH_2CH_2NC$ When $CH_3CH_2CH_2Cl$ reacts with KCN Compound Y = $CH_3CH_2CH_2CN$ KCN is predominantly an **ionic** compound, which it dissociates in solution to produce free cyanide ions which is an ambident nucleophile and attacks through C- side. AgCN is a covalent compound, in this case, the bond formation occurs through the nitrogen atom of the cyanide group, leading to the formation of the isocyanide.	1 ½ ½ ½ ½
	OR	
27(B)	I. **3-bromo-2,2,3-trimethylpentane** II. **CH_2=CH-CH_2Cl** (allyl chloride) will be hydrolysed more readily than **$(CH_3)_2CHCl$**	1 1

		allyl carbocation (CH_2=CH-CH_2^+) is more stabilised than secondary carbocation formed(**$(CH_3)_2CH^+$.** Due to resonance in allyl carbocation, where positive charge is delocalised on two carbons, makes it more stable.	1
28	I.	The relative lowering of vapour pressure is given by: $$\frac{P^\circ - P_S}{P^\circ} = \chi_B = \frac{n_B}{n_A + n_B}$$	½
		n_A= number of moles of water = 1000/18= 55.56 mol	
		n_B= number of moles of solute = W_B/M_B	
		$\frac{P^\circ - P_S}{P^\circ}$= 0.5 (as 50 % reduction is there)	½
		Substituting the value:	
		0.5= n_B/ (n_B +55.56)	
		0.5 n_B + 0.5 X 55.56 = n_B	
		Or	
		0.5 n_B= 0.5 X55.56	½
		n_B= **55.56 mol =** W_B/M_B	
		On calculation:	
		M_B =100/55.56 = 1.8 g/mol	½
	II.	Nitric acid solution containing 32% of water by mass forms an azeotropic solution. It has the *same composition* in both the liquid and vapor phases. Hence cannot be separated into its components through fractional distillation.	1
29	I.	D. less than 4.09	1
	II.	A. p-bromophenol > p-chlorophenol > p-flourophenol > phenol	1
	III.	A. Phenol is more stronger acid than the cyclohexanol so will have less pKa value than cyclohexanol.	1
		Phenol loses hydrogen ion to form its conjugate base - phenoxide ion, which is stabilised by resonance.	1
		Where as in the Cyclohexanol, conjugate base formed is less stable due to localisation of negative charge on oxygen atom.	
		OR	
	III.	B. pKa of p-nitrophenol is 7.2 while p-chlorophenol is 9.38. Following this trend, more the nitro groups, lower will be the pKa value. Therefore, pKa value of 4 chloro-2,6- dintirophenol is higher than	1

	2,4,6-trinitrophenol. More the pKa values, lower is the acidic strength, therefore 4 chloro-2,6- dintirophenol is less acidic than 2,4,6 trinitrophenol. **For visually challenged learners** **I.** B. o-cresol **II.** B. – OCH_3 **III.** A. 2,4 Dintirophenol is more acidic in nature. The nitro group is a strong electron withdrawing group. It exerts both –I effect and –M effect, hence withdraws electrondensity from the ring. Phenoxide ion formed is stabilised. Presence of two nitro groups make the phenoxide ion formed more stable as compared to the presence of one nitro group. **OR** **III.** B. pKa of cresol will be higher than phenol. The pKa values increases due to presence of electron donating groups. pKa of p-nitrophenol will be lower than phenol. The pKa values decreases due to presence of electron withdrawing groups	1 1 1 1+1 ½+½ ½+½
30	**I.** B. reducing sugars give a brick red ppt. with Benedict's solution **II.** B. sucrose and starch are plant based carbohydrates. lactose is milk sugar (animal milk) and glycogen is animal starch **III.** A. Sample is maltose. The sugar is reducing in nature as it gives positive Benedict's test – it is not sucrose. The sugar undergoes hydrolysis so it is not a monosaccharide –i.e not glucose or fructose. The sugar gives same monosaccharide on hydrolysis lactose gives glucose and galactose while maltose gives 2 glucose molecules. Therefore, it is maltose. **OR** **III.** B. The carbohydrate gives only one monosaccharide on hydrolysis. Starch on hydrolysis gives glucose. No, the carbohydrate is not starch. The carbohydrate is soluble in water while starch is insoluble. Moreover starch is not a reducing sugar.	1 1 1+1 1+1
31(A)	I. a) A highly acidic medium protonates the ammonia derivatives, reducing their nucleophilicity. In a basic medium, the carbonyl compound is not protonated. reducing its electrophilicity for nucleophilic attack. Hence, a mildly acidic pH of about 3.5 gives the best rate for derivative formation.	1

	b) Dry hydrogen chloride protonates the oxygen of the carbonyl compounds and therefore, increases the electrophilicity of the carbonyl carbon facilitating the nucleophilic attack of alcohol.	1
	c) The hydrogen sulphite addition compound is water soluble and can be converted back to the original carbonyl compound by treating it with dilute mineral acid or alkali. Therefore, these are useful for separation and purification of aldehydes.	1
	II. 	½ +½ ½ + ½
31(B)	**OR**	
	I. a) $HCHO > CH_3CHO > C_6H_5CHO$ b) $CH_3CONH_2 < CH_3COOH < CH_3COOCH_3 < CH_3COCl$ c) $CH_3COCH_3 < CH_3CHO < CF_3CHO$	1 1 1
	II. The possible isomers of compound with molecular formula C_3H_6O are: Propan-1-al: $CH_3–CH_2–CHO$ Propanone: $CH_3–CO–CH_3$ (a ketone)	½ ½
	Propanal (CH_3CH_2CHO) gives a positive Tollens' test (silver mirror). Tollens' reagent oxidises aldehydes to carboxylates, reducing Ag^+ to metallic Ag. Ketones and alcohols do not give this test.	½ + ½

32(A)	I.	$[Cr(en)_3]^{3+}$ contains three bidentate ethylenediamine ligands arranged in a chiral octahedral geometry, so it is optically active and will rotate the plane of polarization whereas $[Cr(H_2O)_3Cl_3]$ exists as a fac and mer isomers but is not optically active because it is symmetrical (has a plane of symmetry).	1
	II.	$[Ni(CO)_4]$ has higher crystal field splitting due to the strong field ligand CO as compared to $[Ni(H_2O)_6]^{2+}$ which has weak ligand H_2O. The ligand nature (strong vs weak field) determines the difference.	½+½
	III.	Primary valency is oxidation number of the metal which is 2 and secondary valency is coordination number which is 4 and is satisfied by all ligands coordinated to the metal.	½ +½
	IV.	CN^- is a strong field ligand, causing low-spin octahedral geometry with d^2sp^3 hybridisation.	½ +½
	V.	$[Cu(H_2O)_4]SO_4 \cdot H_2O$) is a complex, the blue colour is due to water that acts as ligand. In absence of ligand, crystal field splitting does not occur, hence on losing water of crystallisation copper sulphate becomes colourless.	1
		OR	
32(B)	I.	Compound A shows maximum conductivity. On dissociation A → $[Co(NH_3)_6]^{3+} + 3Cl^-$ (total 4 ions), B → $[Co(NH_3)_5Cl]^{2+} + 2Cl^-$ (3 ions), C → $[Co(NH_3)_4Cl_2]^+ + Cl^-$ (2 ions). The more the number of ions in solution, the higher is its conductivity.	1
	II.	$t_{2g}^5e_g^o$ Strong field causes pairing in t2g, only one unpaired electron remains.	1
	III.	$[Cr(NH_3)_2(H_2O)_2(C_2O_4)]Cl$	1
	IV.	$[Co(NH_3)_2Cl_2(en)]Cl$ is optically active; $[Co(NH_3)_4Cl_2]Cl$ is not. The bidentate ligand en can produce a chiral (non-superimposable) octahedral arrangement (no internal mirror plane), giving optical isomerism. Complexes with only monodentate ligands like MA_4B_2 are symmetric and achiral.	1
	V.	The different ligands (NH_3 vs H_2O) produce different crystal field splitting (Δ), so they absorb different wavelengths of light which gives different observed colours. Ligand nature ie strength of ligand determines crystal field splitting and thus the energy (wavelength) of d–d transitions, affecting colour.	½+½

33(A)	I. a) Cell potential from the Nernst equation increases when the reaction quotient Q=$[Zn^{2+}][Cu^{2+}]$ decreases. In experiment 4, $[Zn^{2+}]$=0.01 M (very low) and $[Cu^{2+}]$=1.00 M (high), so Qc is very small , log Qc is very negative , the −0.0591/2 log Q term is positive and large, giving the highest E. b) $E=E^{o}-0.059/2 \log Qc$ $E=E^{o}-0.059/2 \log [Zn^{2+}]/[Cu^{2+}]$ $= 1.1-0.059/2 \log [1/0.10]$ $=1.1-0.02955 \log 10$ $= 1.1 - 0.02955$ $= 1.07045$ V The measured EMF differs because when current flows through a cell, it faces some internal resistance (r) due to resistance of electrolyte, electrodes or salt bridge which lowers the observed cell voltage. II. $\Lambda_m(\text{S cm}^2\text{ mol}^{-1}) = \frac{\kappa\ (\text{S cm}^{-1}) \times 1000\ (\text{cm}^3/\text{L})}{\text{molarity (mol/L)}}$ Both type of units are used in literature and are related to each other by the equations: 1 S m^2mol^{-1} = 10^4 S cm^2mol^{-1} or 1 S cm^2mol^{-1} = 10^{-4} S m^2mol^{-1}. III. During charging, the specific gravity of electrolyte in a lead storage battery increases, while discharging it decreases. **OR**	1 ½ ½ ½ ½ 1 ½ + ½
33(B)	I. For c_1=0.010 $123.9=\Lambda^{\circ}_m - A\sqrt{0.0100}$ $123.9= \Lambda^{\circ}_m - A(0.100)$ ……(1) For c_2=0.040 M $120.7= \Lambda^{\circ}_m - A\sqrt{0.040}$ $120.7= \Lambda^{\circ}_m - A(0.2)$……..(2) Subtract (2) from (1): $123.9-120.7=[\Lambda^{\circ}_m-\Lambda^{\circ}_m]+[-0.100A-(-0.200A)]$ 3.2=0.100A A= 3.2/0.100 A = 32.0 $Scm^2\ mol^{-1}M^{-1/2}$ Now substitute A into (1) to get Λ°_m $123.9= \Lambda^{\circ}_m - 32\ (0.100)$ Λ°_m =123.9 + 3.2 Λ°_m = 127.1 Scm^2mol^{-1}	½ ½ ½ ½ ½ ½

	II. Electrode Reactions in a Hydrogen–Oxygen Fuel Cell: Anode: $2H_2 \rightarrow 4H^+ + 4e^-$ Cathode : $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ Overall Reaction: $2H_2 + O_2 \rightarrow 2H_2O$ The two advantages of fuel cells compared to conventional batteries are: • Higher efficiency: Fuel cells can convert chemical energy to electrical energy more efficiently than many conventional batteries. • Continuous operation: As long as fuel (hydrogen) and oxidant (oxygen) are supplied, fuel cells can operate indefinitely, unlike batteries which need recharging.	½ ½ ½ ½