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TRIALS EXAMINATION 2016

GRADE 12

Physical Science – Paper 2

Examiner: K Mari

Time: 3 Hours

Moderator: H Nund

Marks: 200

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- 16 pages.
- 13 page question paper.
- 3 Pages data sheet.

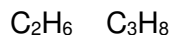
Please make sure your question paper is complete.

2. Read the questions carefully.
3. Do question 1 (multiple choice) on the inside of the cover sheet of your answer booklet.
4. Start each question on a new page.
5. Show all working were necessary.
6. It is in your own interest to write legibly and to set your work out neatly.
7. You may use a non – programmable calculator.
8. Answer all questions.

Question 1

There are four alternatives given for each question. Choose the most correct alternative and cross the appropriate letter on the answer sheet provided on the inside of the cover page.

1.1 Consider the organic compounds below:

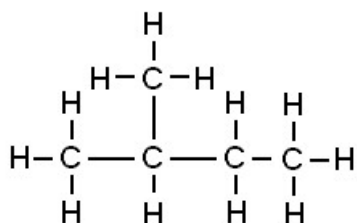


Which of the following statements does **NOT** apply to these compounds? They...

- A) both burn in oxygen.
- B) are both unsaturated.
- C) are both alkanes.
- D) are both hydrocarbons.

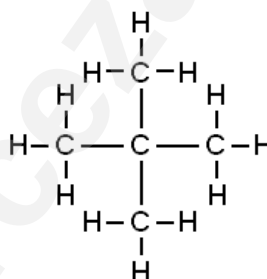
1.2 Two isomers of C_5H_{12} and their respective boiling points are shown below.

Compound P



Boiling Point: 27.8 °C

Compound Q



Boiling Point: 9.5 °C

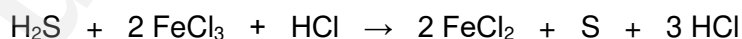
Which one of the following statements is correct about the structural formula of compound Q?

- A) It has less side chains and weaker intermolecular forces.
- B) It has more side chains and weaker intermolecular forces.
- C) It has less side chains and stronger intermolecular forces.
- D) It has more side chains and stronger intermolecular forces.

1.3 The reaction of propane with bromine can be classified as ...

- A) an elimination reaction
- B) an addition reaction
- C) a redox reaction
- D) a substitution reaction

- 1.4 The increase in the rate of a chemical reaction with a rise in temperature is most likely due to:
- A) the reaction being exothermic
 - B) the increase in activation energy
 - C) the increase in the heat of the reaction
 - D) the larger number of reacting particles with enough energy to react
- 1.5 When a catalyst is added to a system at equilibrium, there is a decrease in the activation energy of
- A) the forward reaction
 - B) the reverse reaction
 - C) both the forward and reverse reactions
 - D) neither reaction
- 1.6 Consider the following reaction: $\text{C(s)} + 2\text{H}_2\text{(g)} \rightleftharpoons \text{CH}_4\text{(g)}$ $\Delta\text{H} = -74.8 \text{ kJ}$
Which of the following will cause an increase in the value of the K_c ?
- A) increasing $[\text{H}_2]$
 - B) decreasing the volume
 - C) finely powdering the C(s)
 - D) decreasing the temperature
- 1.7 In the reaction $\text{X} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HSO}_4^-$, X represents:
- A) an acid having the formula SO_4^{2-} .
 - B) a base having the formula SO_4^{2-} .
 - C) an acid having the formula H_2SO_4 .
 - D) a base having the formula H_2SO_4 .
- 1.8 The reaction between hydrogen sulphide and an acidified solution of iron(III)chloride can be represented by the following equation:



The reduction half reaction is represented by

- A) $\text{H}_2\text{S} \rightarrow \text{S} + 2 \text{H}^+ + 2\text{e}^-$
- B) $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+} + \text{e}^-$
- C) $\text{Fe}^{3+} + \text{e}^- \rightarrow \text{Fe}^{2+}$
- D) $\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}$

A) Zn and Cu

B) Pb and Hg

C) Zn and Ag

D) Fe and Pb

A) CH_3CH_3

B) $\text{CH}_3\text{CH}_2\text{CH}_3$

C) $\text{CH}_3\text{CH}_2\text{OH}$

D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

[20]

Question 2

The letters A – F in the table below represent six organic compounds.

A <u>Hexanoic Acid</u>	B $\begin{array}{c} \text{CH}_3\text{-CH}_2\text{-CH}_2 \\ \\ \text{OH} \end{array}$
C $\begin{array}{ccccccc} & \text{H} & & \text{CH}_3 & & \text{H} & & \text{H} \\ & & & & & & & \\ \text{H} & \text{-C-} & \text{C=} & \text{C-} & \text{C-} & \text{C-} & \text{H} \\ & & & & & & & \\ & \text{H} & & \text{CH}_3 & & \text{H} & & \text{H} \end{array}$	D $\begin{array}{ccccccc} & & & \text{Br} & & & & \\ & & & & & & & \\ \text{CH}_3 & \text{-CH-} & \text{CH-} & \text{CH}_2 & \text{-CH}_3 \\ & & & & \\ & & & \text{CH}_3 & \end{array}$
E $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$	F CH_2CHCH_3

Use the information in the table (where applicable) to answer the questions that follow:

2.1 Write down only the LETTER that represents a compound that:

2.1.1 is an unsaturated compound. (1)

2.1.2 has a hydroxyl group as a functional group. (1)

2.1.3 belongs to the same homologous series as compound B. (1)

2.2 Write down the

2.2.1 IUPAC name of compound C. (2)

2.2.2 IUPAC name of compound D. (2)

2.2.3 structural formula of compound F. (1)

2.3 Consider ISOMERS:

2.3.1 Define the term isomers. (2)

2.3.2 Which compound in the table is a functional isomer of ethyl butanoate? (1)

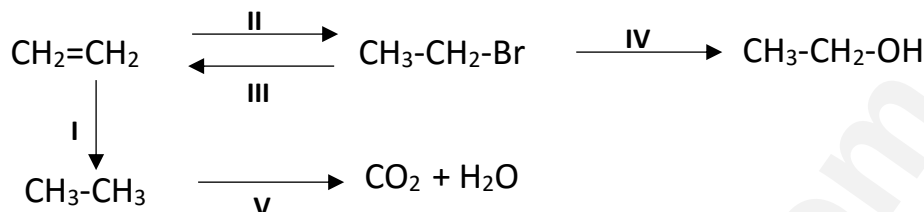
2.3.3 Draw the structural formula of a chain isomer of compound E. (2)

2.4 Draw the structural formula for the organic compound formed when Compounds A and B react in the presence of concentrated sulphuric acid. (3)

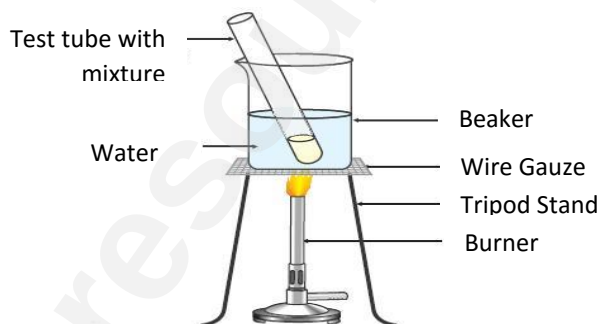
[16]

Question 3

- 3.1 Organic reactions are often represented by reaction pathways as represented below. The reactions are labelled from I to V.



- 3.1.1 Identify the type of organic reactions I to V. (5)
- 3.1.2 Write down the formula of the other reactant that has to be used in reactions I and IV. (2)
- 3.1.3 Name the catalyst used in reaction I. (1)
- 3.1.4 If the other reactant for reaction V is oxygen gas, using molecular formula write a balanced chemical equation. (2)
- 3.1.5 If 300g of CH_3CH_3 is used in reaction V, calculate the volume of carbon dioxide gas that is formed at STP. (5)
- 3.2 Propyl propanoate is an example of an ester that has a pineapple scent. The apparatus below represents the apparatus used in the laboratory to produce this ester.



http://www.ekshiksha.org.in/images_carbon_its_compound_X/figure_11.JPG

- 3.2.1 Write down the name of the type of reaction that takes place in the above experiment. (1)
- 3.2.2 Explain why it is so important to add sulphuric acid to the reaction mixture. (2)
- 3.2.3 State and explain the safety precautions built into the design of the experiment when using the above set-up. (2)
- 3.2.4 Use structural formulae, to write down a balanced chemical equation for the reaction taking place in the test tube. (5)

[25]

Question 4

Abigail carried out an investigation to determine the relationship between the mass of a haloalkane and the boiling point, and obtained the results as shown in the table below.

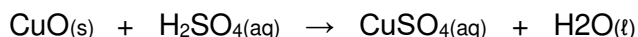
Haloalkane	Molar Mass ($\text{g}\cdot\text{mol}^{-1}$)	Boiling Point (K)
Fluoromethane	34	194.7
Chloromethane	50.5	248.9
Bromomethane	95	276.7
Iodomethane	142	315.5

- 4.1 Write the investigative question for this investigation. (2)
- 4.2 What was the dependent variable in this investigation? (2)
- 4.3 What was the variable that was kept constant in this investigation? (1)
- 4.4 Why must the variable, in 4.3 above, be kept constant? (2)
- 4.5 What trend in boiling points can be observed from the table? (2)
- 4.6 Give an explanation for the observed trend. (3)

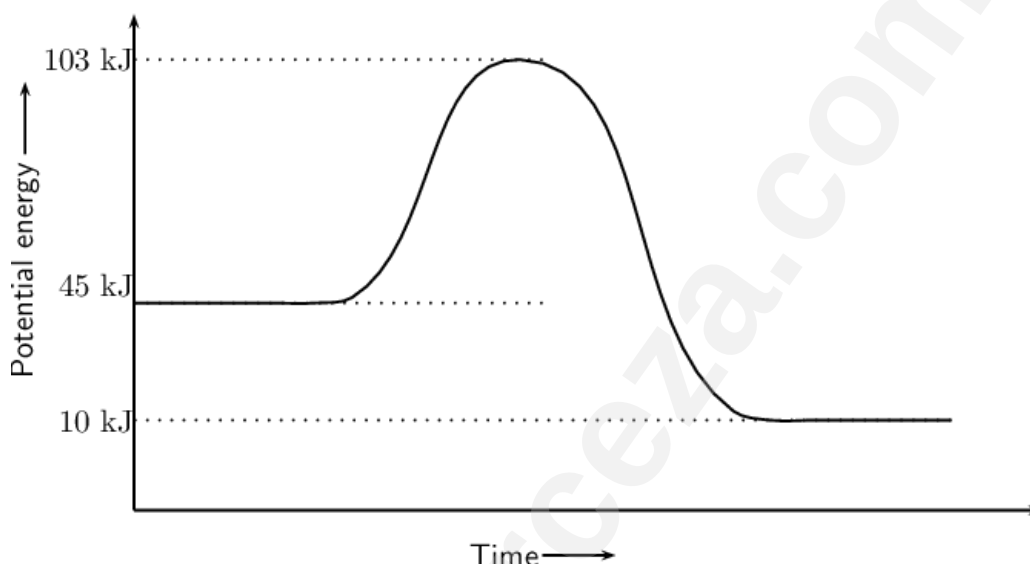
[12]

Question 5

Students conduct the following experiment between copper (II) oxide and sulphuric acid.

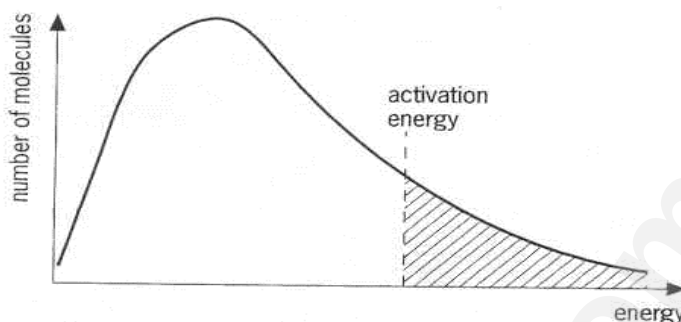


100 cm³ of H₂SO₄ of concentration 0,8 mol.dm⁻³ is allowed to react completely with an unknown mass of copper(II)oxide at a temperature of 50 °C. The potential energy profile for this reaction is illustrated below.



- 5.1 Define the term activated complex. (2)
- 5.2 Is this reaction an endothermic or exothermic reaction? (1)
- 5.3 Calculate the activation energy for this reaction. (2)
- 5.4 Calculate the enthalpy/ ΔH /Heat of reaction for this reaction. (2)
- 5.5 The concentration of H₂SO₄ is decreased to 0,4 mol.dm⁻³.
 - 5.5.1 How would this affect the rate of the reaction? (2)
 - 5.5.2 Use the collision theory to explain your answer to question 5.5.1. (3)
- 5.6 Calculate the following:
 - 5.6.1 The INITIAL number of moles of H₂SO₄ used in the reaction. (3)
 - 5.6.2 The mass of CuO used in the reaction. (4)

- 5.7 The Maxwell-Boltzmann energy distribution curve for the above reaction is illustrated below.



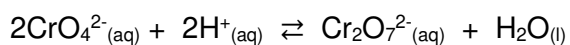
- 5.7.1 The temperature is increased to 60°C . Copy the above graph in your ANSWER BOOK and label it T_1 . On the same set of axes draw a graph that will be obtained when the temperature is increased to 60°C and label it T_2 . (2)

- 5.7.2 Explain why the shape of graph T_2 differs from the shape of graph T_1 . (2)

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Question 6

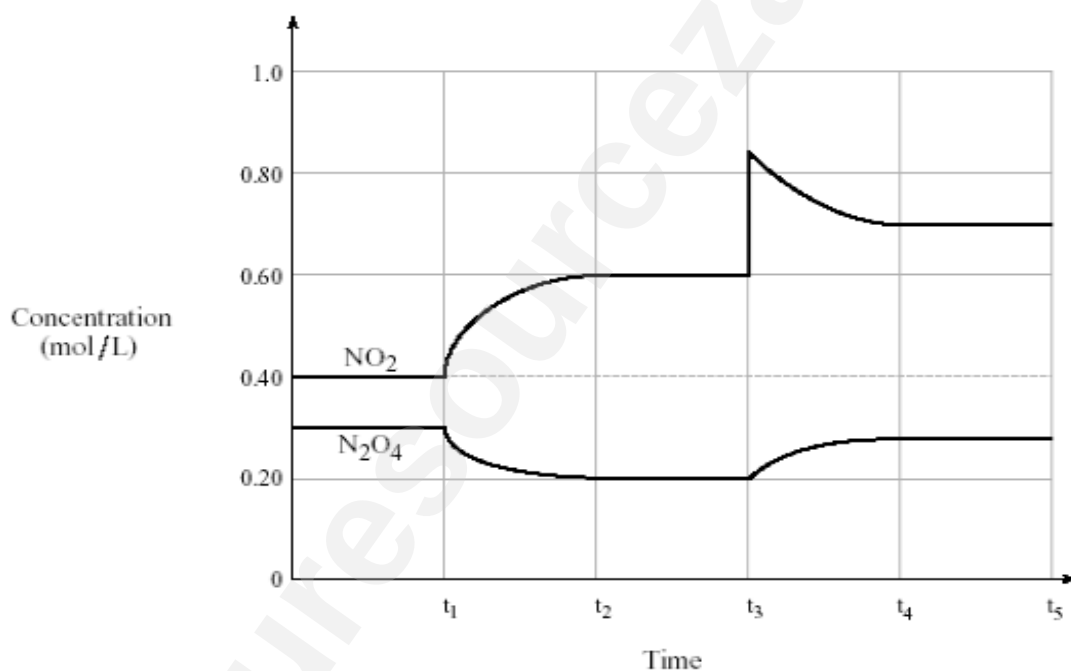
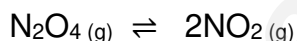
- 6.1 The following equilibrium between chromate ion (CrO_4^{2-}) and dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$) was studied by grade 12 students.



yellow

orange

- 6.1.1 What colour will be observed when HCl is added to the solution? (1)
- 6.1.2 Explain why this colour change occurs. (4)
- 6.1.3 What would you observe if you add a few drops of NaOH to the equilibrium mixture. Explain your answer. (4)
- 6.2 N_2O_4 gas is introduced into a container at a certain temperature, which is then sealed and the reaction taking place reaches dynamic chemical equilibrium, according to the following balanced chemical equation:

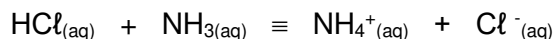


- 6.2.1 At time t_1 the temperature in the container is increased. Is the forward reaction exothermic or endothermic? (1)
- 6.2.2 Consider the changes in concentration shown in the graph between time t_1 and t_2 and apply Le Chatelier's principle to explain your answer to Question 5.2.1 (3)
- 6.2.3 Identify the change (stress) which was introduced to the reaction at time t_3 and explain the subsequent changes in the concentrations of all substances immediately after time t_3 . (4)
- 6.2.4 Calculate the K_c for the equilibrium between t_2 and t_3 (3)

[20]

Question 7

7.1 Consider the following acid-base equilibrium:



7.1.1 Define 'a base' in terms of the Lowry- Brønsted model. (2)

7.1.2 Identify the two bases in the above equation. (4)

7.1.3 Which one is the stronger base? Explain your answer. (2)

7.2 With the aid of an example, explain what is meant by the term 'diprotic acid' (3)

7.3 30 ml of an NaOH solution exactly neutralises 45 ml of a 0,1 mol.dm⁻³ HCl solution.

7.3.1 Explain what is meant by the term 'neutralisation'. (2)

7.3.2 Write a balanced chemical equation for the reaction between NaOH and HCl. (2)

7.3.3 What mass of NaOH was used to make 150 ml of the NaOH solution? (8)

7.3.4 Consider the following possible indicators to use in this titration:

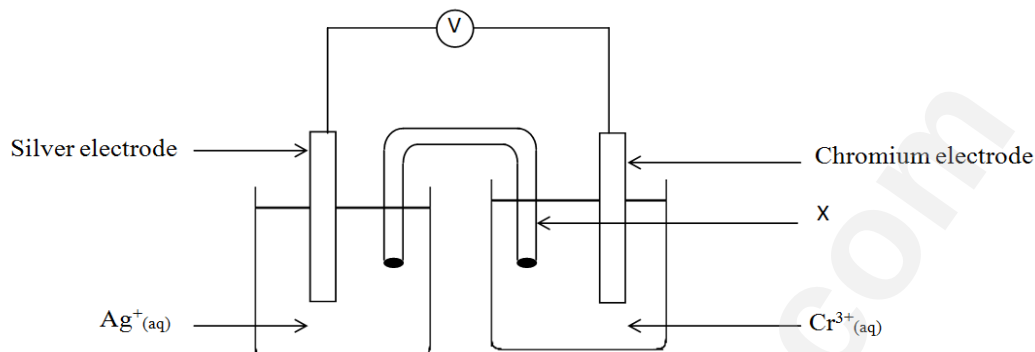
Typical pH at end point of titration	A suitable indicator for the titration	pH range in which indicator changes colour
7,0	bromothymol blue	6,0 – 7,7
4,0	methyl orange	3,2 – 4,4
9,0	phenolphthalein	8,3 – 10,0

Explain, using hydrolysis, which one of the above indicators would be the most suitable to use in this titration. (7)

[30]

Question 8

The $\text{Ag}|\text{Ag}^+$ half-cell is now connected to the $\text{Cr}|\text{Cr}^{3+}$ as in diagram below to construct a galvanic cell under standard conditions. A voltmeter is connected in the external circuit and a salt bridge connects the two solutions.

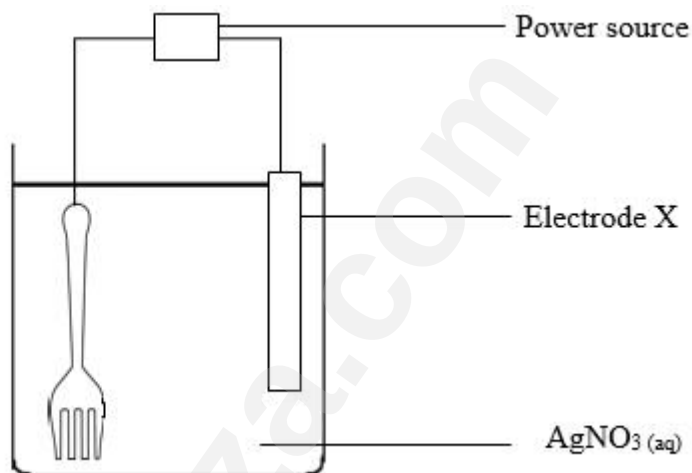


- 8.1 What energy conversion takes place in a galvanic cell? (1)
- 8.2 Define the term oxidation. (1)
- 8.3 For this galvanic cell, predict the half-cell in which oxidation will take place. (2)
- 8.4 Define the term oxidising agent. (1)
- 8.5 Identify the oxidising agent in this galvanic cell. (2)
- 8.6 Define the term cathode. (1)
- 8.7 Identify the cathode in this galvanic cell. (2)
- 8.8 For this galvanic cell, write down the:
 - 8.8.1 oxidation half reaction. (2)
 - 8.8.2 reduction half reaction (2)
 - 8.8.3 net cell reaction. (3)
- 8.9 How will the reading on the voltmeter be affected if the concentration of the Cr^{3+} solution is increased? Explain your answer fully using Le Chatelier's principle. (3)
- 8.10 Write down the cell notation for this galvanic cell, including any standard conditions used in its setup. (4)
- 8.11 Calculate the initial emf of this galvanic cell that the voltmeter will register. (3)
- 8.12 What essential piece of apparatus is labelled X? (1)
- 8.13 Sodium nitrate is a very popular electrolyte for use in X. In terms of the sodium nitrate electrolyte used, fully explain the function of X in this galvanic cell. (4)

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Question 9

My silver-plated cutlery set is not worth that much since it is only a cheap metal alloy that has been plated with silver. A technician uses the electrolytic cell setup below to electroplate silver onto a cheap metal alloy fork.



- 9.1 Give two reasons why a cheap metal alloy fork should be plated with silver. (2)
- 9.2 What energy conversion takes place in an electrolytic cell? (1)
- 9.3 The technician uses a power box that has a DC and an AC setting on it. Recommend the correct setting for the power source and justify your answer. (3)
- 9.4 A battery is connected into the circuit to electroplate the iron fork with silver. Redraw the diagram into your answer book, draw in the battery symbol in the circuit, paying particular attention to the polarity of the electrodes required for the electroplating to occur. (2)
- 9.5 The technician has a platinum electrode or a silver electrode that she can use in the electrolytic cell for electrode X. Recommend which of the two electrodes is preferable in the setup above to electroplate silver onto the fork most efficiently. Justify your recommendation and make sure to refer to the expected reaction that will occur at the chosen electrode. (4)
- 9.6 Is electrode X or the fork the cathode? (2)
- 9.7 Write down the reduction half reaction. (2)
- 9.8 Calculate the mass of silver that is plated onto the fork if a current of 900 mA runs for 10 minutes. (6)

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**EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES
(CHEMISTRY)**

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Magnitude of charge on electron	e	$1,6 \times 10^{-19} \text{ C}$
Mass of an electron	m_e	$9,1 \times 10^{-31} \text{ kg}$
Standard pressure	p^θ	$1,01 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Faraday's constant	F	$96\,500 \text{ C} \cdot \text{mol}^{-1}$

TABLE 2 CHEMISTRY FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$	$n = \frac{V}{V_m}$
$c = \frac{n}{V} \quad \text{OR} \quad c = \frac{m}{MV}$		$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$
$Q = It$	$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$	

TABLE 3 PERIODIC TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Atomic number (Z)																	
	Electronegativity																	
1	1 2.1 H 1																	2 He 4
2	3 1.0 Li 7	4 1.5 Be 9	Relative atomic mass										5 2.0 B 10.8	6 2.5 C 12	7 3.0 N 14	8 3.5 O 16	9 4.0 F 19	10 Ne 20
3	11 0.9 Na 23	12 1.2 Mg 24.3											13 1.5 Al 27	14 1.8 Si 28	15 2.1 P 31	16 2.5 S 32	17 3.0 Cl 35.5	18 Ar 40
4	19 0.8 K 39	20 1.0 Ca 40	21 1.3 Sc 45	22 1.5 Ti 48	23 1.6 V 51	24 1.6 Cr 52	25 1.5 Mn 55	26 1.8 Fe 56	27 1.8 Co 59	28 1.8 Ni 59	29 1.9 Cu 63.5	30 1.6 Zn 65.4	31 1.6 Ga 70	32 1.8 Ge 72.6	33 2.0 As 75	34 2.4 Se 79	35 2.8 Br 80	36 Kr 84
5	37 0.8 Rb 85.5	38 1.0 Sr 88	39 1.2 Y 89	40 1.4 Zr 91	41 1.6 Nb 93	42 1.8 Mo 96	43 1.9 Tc 99	44 2.2 Ru 101	45 2.2 Rh 103	46 2.2 Pd 106	47 1.9 Ag 108	48 1.7 Cd 112	49 1.7 In 115	50 1.8 Sn 119	51 1.9 Sb 121	52 2.1 Te 128	53 2.5 I 127	54 Xe 131
6	55 Cs 133	56 Ba 137.3		72 Hf 178.5	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 200.6	81 Tl 204.4	82 Pb 207	83 Bi 209	84 Po -	85 At -	86 Rn -
7	87 Fr	88 Ra																

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lw

TABLE 4 STANDARD ELECTRODE POTENTIALS

	Half-reaction	E°/volt
	$\text{Li}^+ + \text{e}^- = \text{Li}$	-3.05
	$\text{K}^+ + \text{e}^- = \text{K}$	-2.93
	$\text{Cs}^+ + \text{e}^- = \text{Cs}$	-2.92
	$\text{Ba}^{2+} + 2\text{e}^- = \text{Ba}$	-2.90
	$\text{Sr}^{2+} + 2\text{e}^- = \text{Sr}$	-2.89
	$\text{Ca}^{2+} + 2\text{e}^- = \text{Ca}$	-2.87
	$\text{Na}^+ + \text{e}^- = \text{Na}$	-2.71
	$\text{Mg}^{2+} + 2\text{e}^- = \text{Mg}$	-2.37
	$\text{Al}^{3+} + 3\text{e}^- = \text{Al}$	-1.66
	$\text{Mn}^{2+} + 2\text{e}^- = \text{Mn}$	-1.18
	$2\text{H}_2\text{O} + 2\text{e}^- = \text{H}_2(\text{g}) + 2\text{OH}^-$	-0.83
	$\text{Zn}^{2+} + 2\text{e}^- = \text{Zn}$	-0.76
	$\text{Cr}^{3+} + 3\text{e}^- = \text{Cr}$	-0.74
	$\text{Fe}^{2+} + 2\text{e}^- = \text{Fe}$	-0.44
	$\text{Cd}^{2+} + 2\text{e}^- = \text{Cd}$	-0.40
	$\text{Co}^{2+} + 2\text{e}^- = \text{Co}$	-0.28
	$\text{Ni}^{2+} + 2\text{e}^- = \text{Ni}$	-0.25
	$\text{Sn}^{2+} + 2\text{e}^- = \text{Sn}$	-0.14
	$\text{Pb}^{2+} + 2\text{e}^- = \text{Pb}$	-0.13
	$\text{Fe}^{3+} + 3\text{e}^- = \text{Fe}$	-0.04
	$2\text{H}^+ + 2\text{e}^- = \text{H}_2(\text{g})$	0.00
	$\text{S} + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{S}(\text{g})$	+0.14
	$\text{Sn}^{4+} + 2\text{e}^- = \text{Sn}^{2+}$	+0.15
	$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- = \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0.17
	$\text{Cu}^{2+} + 2\text{e}^- = \text{Cu}$	+0.34
	$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- = 4\text{OH}^-$	+0.40
	$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- = \text{S} + 2\text{H}_2\text{O}$	+0.45
	$\text{I}_2 + 2\text{e}^- = 2\text{I}^-$	+0.54
	$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{O}_2$	+0.68
	$\text{Fe}^{3+} + \text{e}^- = \text{Fe}^{2+}$	+0.77
	$\text{Hg}^{2+} + 2\text{e}^- = \text{Hg}$	+0.79
	$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- = \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0.80
	$\text{Ag}^+ + \text{e}^- = \text{Ag}$	+0.80
	$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- = \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0.96
	$\text{Br}_2 + 2\text{e}^- = 2\text{Br}^-$	+1.09
	$\text{Pt}^{2+} + 2\text{e}^- = \text{Pt}$	+1.20
	$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- = \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1.21
	$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- = 2\text{H}_2\text{O}$	+1.23
	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- = 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
	$\text{Cl}_2(\text{g}) + 2\text{e}^- = 2\text{Cl}^-$	+1.36
	$\text{Au}^{3+} + 3\text{e}^- = \text{Au}$	+1.42
	$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- = \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51
	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- = 2\text{H}_2\text{O}$	+1.77
	$\text{F}_2(\text{g}) + 2\text{e}^- = 2\text{F}^-$	+2.87

Increasing oxidising ability

Increasing reducing ability