AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1991

12475

CHEMISTRY — ORDINARY LEVEL

THURSDAY, 13 JUNE — AFTERNOON, 2 to 5

Question 1 and **five** other questions must be answered.
These questions *must* include question 2 or question 3 but may include *both* question 2 and question 3.

All questions carry the same number of marks.

Relative atomic masses: H = 1, C = 12, N = 14, O = 16, Na = 23, S = 32, Cl = 35·5, Ca = 40.

Molar volume S.T.P. = 22·4 dm^3

Avogadro constant = 6×10^{23} mol^{-1}

1. Answer *eleven* of the following items (*a*) (*b*), (*c*), etc. All items carry the same number of marks. *Keep your answers short.*

(*a*) Write down the electronic configuration (s, p etc.) of calcium (atomic number = 20).

(*b*) What is the oxidation number of nitrogen in HNO_3?

(*c*) What is the systematic (IUPAC) name for $CH_3CH(CH_3)CH_3$?

(*d*) A solution contains 0·2 g dm^{-3} of magnesium chloride. What is the concentration of the solution in parts per million (p.p.m.)?

(*e*) Name and sketch the shape i.e. linear, trigonal (planar), tetrahedral, of *one* of the following molecules:

BeH_2, BF_3, NH_3

(*f*) What is the functional group in methanoic acid (HCOOH)?

(*g*) State Le Chatelier's Principle.

(*h*) What are isotopes?

(*i*) How would you confirm the presence of chloride ions (Cl^-) in an aqueous solution of sodium chloride?

(*j*) What is meant by the electronegativity of an element?

(*k*) Given that $2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$ $\triangle H = -3080$ kJ, write down the heat of combustion of ethane.

(*l*) Define (i) an acid, (ii) a conjugate acid, in terms of the Brönsted-Lowry theory.

(*m*) Name and give the structural formula of an aromatic compound.

(*n*) State Avogadro's Law.

(*o*) Arrange the following metals in order of *decreasing* activity in the electrochemical series.

Cu Zn Fe

(11 × 6)

2. (*a*) (i) What is a primary standard? (6)

(ii) Anhydrous sodium carbonate (Na_2CO_3) is used as a primary standard but sodium hydroxide is not suitable. Why is this so? (6)

(iii) Describe how you make up accurately 250 cm^3 of a 0·1M sodium carbonate solution. (12)

(*b*) 25·0 cm^3 of a 0·1M sodium carbonate solution was titrated with a 0·125M solution of hydrochloric acid. The equation for the titration is:

$$Na_2CO_3 + 2HCl = 2NaCl + H_2O + CO_2$$

(i) Name a suitable indicator and state its colour before and after the endpoint of the titration. (9)

(ii) Mention *three* operations which should be carried out during the titration to ensure an accurate titre. (9)

(iii) Using the equation above calculate the volume of 0·125 M hydrochloric acid solution needed in the titration. (15)

(iv) A student carried out the titration three times. The first titre 41·5 cm^3 was inaccurate but the second and third titre values were identical. Complete the following table using the values obtained in (iii) above by inserting the correct values for A, B, C and D.

Titration	First	Second	Third
Initial Reading/cm^3	0·0	0·0	5·0
Final Reading/cm^3	41·5	A	C
Volume used/cm^3	41·5	B	D

(9)

3. The following are three statements taken from a student's practical notebook:

(i) "Flame tests were carrried out to identify the sodium and potassium compounds".

(ii) "The unknown compound was found to be a carbonate or a hydrogencarbonate".

(iii) "An oxidising agent was used to distinguish between ethanol and ethanoic acid".

(*a*) Describe how a flame test is carried out. (12)
State the colour changes observed in the case of the sodium compounds and the changes observed in the case of the potassium compounds. (6)

(*b*) Outline the procedures followed and the reagents used by the student in the experiment in (ii). (15)
What further test would be required to distinguish between carbonate ions and hydrogencarbonate ions in aqueous solution? (6)

(*c*) Outline how the student might have carried out the experiment in (iii) stating clearly the oxidising agent used. (18)
What was the colour of the oxidising agent both before and after its reaction, if any, with (i) ethanol, (ii) ethanoic acid. (9)

4. (*a*) State *two* differences between Mendeleef's Periodic Table and the modern form of the Periodic Table. (12)
Answer the following questions with reference to the eight elements labelled **(a)** to **(h)** in the part of the Periodic Table shown below. (Mathematics Tables p. 44).

3	4						1	2				5	6 (a)	7	8	9 (b)	10
11	12 (c)											13 (d)	14	15	16 (e)	17 (f)	18
19 (g)	20	21	22	23	24	25	26 (h)	27	28	29	30	31	32	33	34	35	36

(i) Which element is a transition element? (6)

(ii) Which element has three electrons in its outermost shell? (6)

(iii) Which *two* elements exist in allotropic forms? (12)

(iv) Write down the chemical formula of the compound formed by the most reactive metal shown in the table with the most reactive non-metal shown. (6)

(v) Which element forms a dipositive ion i.e. M^{2+}? (6)

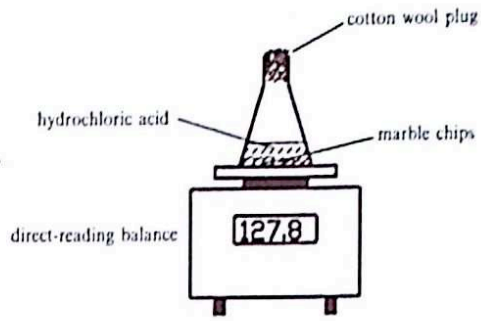
(vi) Why is the first ionisation energy value for element **(c)** lower than that for element **(e)**? (6)

(vii) Give the chemical formula of the compound formed by the combination of element **(a)** and element **(g)**. What type of bonding would be present in this compound? (Mathematics Tables p.46) (12)

5. State *two* factors that affect the rate of a chemical reaction. (12)

In an experiment 10·0 g of marble chips ($CaCO_3$) were reacted with excess hydrochloric acid using the apparatus shown.

The mass of the flask and contents were noted at half minute intervals and are shown in the following table.



Time/minutes	0·0	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5	5·0
Mass/g	131·9	130·7	129·7	129·0	128·5	128·1	127·8	127·6	127·5	127·5	127·5
Mass Loss	0·0	1·2	2·2	2·9	3·4	3·8	4·1	4·3	4·4	4·4	4·4

(i) For how long had the experiment been carried out when the balance reading shown in the diagram was taken? (6)

(ii) Why was a cotton wool plug used? (6)

(iii) Why did the mass of the flask and contents decrease during the experiment? (6)

(iv) Using graph paper, plot a graph of *loss in mass* against time. (12)

(v) (*a*) After how many minutes was the reaction half-complete?,
(*b*) During which minute interval was the reaction most vigorous? (12)

(vi) What mass of carbon dioxide was produced in this experiment and how many moles does this represent? (12)

6. (*a*) From the following list of hydrocarbons:

Methane (CH_4), Ethene (C_2H_4), Butane (C_4H_{10}), Pentane (C_5H_{12})

name the hydrocarbon which

(i) is the main constituent of natural gas,

(ii) is an unsaturated compound,

(iii) is most likely to be present in petrol,

(iv) undergoes mainly addition reactions,

(v) is commonly sold as 'bottled' (domestic) gas,

(vi) decolorises bromine solution,

(vii) contains 75% carbon and 25% hydrogen by mass. (7 × 6)

(*b*) Write down in your answer book the missing words or formulae 1 to 8 from the following passage on aldehydes and ketones.

The functional group in aldehydes is __(1)__ and the functional group in ketones is __(2)__. Ethanal is an aldehyde and its chemical formula is __(3)__. Propanone is a ketone and its chemical formula is __(4)__. When ethanal reacts with Fehling's solution, which has a __(5)__ colour, a red precipitate is formed. In this reaction ethanal is converted to ethanoic acid and has been __(6)__ whereas the Fehling's solution has been __(7)__. When this test is repeated using propanone the result is __(8)__. This reaction may be used to distinguish aldehydes from ketones. (8 × 3)

7. Define heat of reaction. (6)

In an experiment to determine the heat of neutralisation of hydrochloric acid, 100 cm^3 of 1M hydrochloric acid solution and 100 cm^3 of 1 M sodium hydroxide solution were mixed and 5·5 kJ of heat was produced.

(i) Is this reaction exothermic or endothermic? (6)

(ii) How many moles of (*a*) hydrochloric acid and (*b*) sodium hydroxide were used? (12)

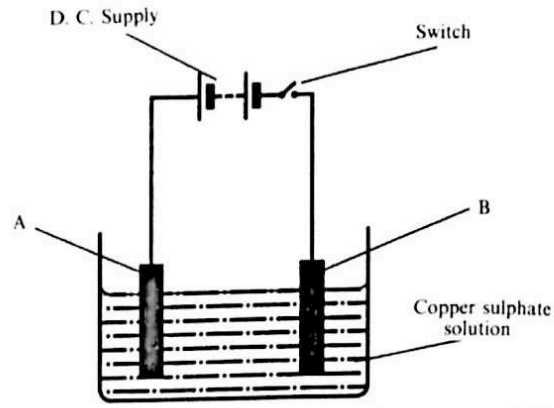
(iii) Calculate the heat change which would have occurred if solutions containing one mole of hydrochloric acid and one mole of sodium hydroxide had been mixed. (12)

(iv) If the same volume of 1M nitric acid had been used instead of 1M hydrochloric acid, the same heat change would have occurred. Explain why this is so and give an ionic equation in support of your answer. (12)

(v) Describe how you would carry out this experiment in the laboratory. (18)

8. (*a*) Describe briefly how *either* copper *or* iron is extracted from its ore. (18)

(*b*) The apparatus shown in the diagram is used to purify impure copper using copper electrodes A and B.



(i) Indicate which of the electrodes is the anode and which is the cathode in the above diagram. (12)

(ii) Which electrode increases in weight during the electrolysis and explain why this occurs? (12)

(iii) Give equations for the reactions that occur at each electrode and indicate where reduction occurs. (18)

(iv) Give *one* other use of electrolysis and mention *one* use of copper. (6)

9. (*a*) Flocculation, filtration, chlorination and fluoridation are carried out in the treatment of water. Sewage treatment involves three stages (i) primary, (ii) secondary, and (iii) tertiary. Explain the underlined terms. (6 × 6)

(*b*) A student was given three different samples of water labelled A, B and C and some soap solution. One was a sample of distilled water, another sample had temporary hardness in the water and the third sample had permanent hardness in the water. The student measured the volume of soap solution required to form a permanent lather with each sample (i) before boiling, (ii) after boiling and cooling. The results obtained are summarised below:

SAMPLE	VOLUME OF SOAP SOLUTION NEEDED/cm^3	
	BEFORE BOILING	AFTER BOILING
A	23·0	1·0
B	1·0	1·0
C	23·0	23·0

(i) Which was the sample of distilled water? Give a reason for your answer. (6)

(ii) Which sample had (a) temporary hardness in the water, (b) permanent hardness in the water? Give reasons for your answers. (12)

Suggest a compound in either case that could have been present in the water and caused the hardness. (12)

(iii) State *one* disadvantage of hard water. (6)

10. Answer any *two* of the following.

(*a*) State one way in which the natural fixation of nitrogen can occur. Explain why ammonium salts are effective fertilisers. (15)

Show, by calculation, in terms of nitrogen content, which of the two fertilisers ammonium sulphate, $(NH_4)_2SO_4$, or ammonium nitrate, NH_4NO_3, would be expected to be the more effective. (18)

(*b*) Define pH of a solution.

What is the pH of a 0·1M sodium hydroxide solution? (15)

What is the concentration in mol dm^{-3} of a solution of hydrochloric acid which has a pH equal to 1?

How does the pH change during the addition of a dilute solution of hydrochloric acid to a dilute solution of sodium hydroxide until neutralisation occurs? (18)

(*c*) Ammonia gas can be prepared in the laboratory according to the following equation.

$$NH_4Cl + NaOH = NaCl + H_2O + NH_3$$

If 10·7 g of ammonium chloride were used:

(i) How many moles of ammonium chloride does this represent? (6)

(ii) What mass of sodium chloride is formed? (9)

(iii) What volume of ammonia is liberated at S.T.P.? (9)

(iv) How many molecules of ammonia are formed? (9)

(*d*) In the case of *each* of the following oxides, state whether it is acidic, basic or neutral

Na_2O NO_2 CO

In the case of *each* of the oxides (i) state the type of bonding present and (ii) give the equation for its reaction (if any) with water. (33)