

CHEMISTRY**Higher Grade—PAPER I**

Friday, 12th May—9.30 a.m. to 11.00 a.m.

READ CAREFULLY

1. Check that the answer sheet provided is for Chemistry Higher I.
2. Fill in the details required on the answer sheet.
3. In this paper a question is answered by indicating the choice A, B, C or D by a stroke made in INK in the appropriate place in the answer sheet—see the sample question below.
4. For each question there is only ONE correct answer.
5. Reference may be made to the booklets of Science Data and Mathematical Tables provided (1982 editions).
6. Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—NOT on the answer sheet.

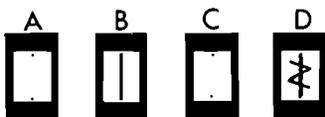
SAMPLE QUESTION

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

- A fractional distillation
- B chromatography
- C fractional crystallisation
- D filtration.

The correct answer is B—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown in the example on the answer sheet.

If after you have recorded your answer you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:



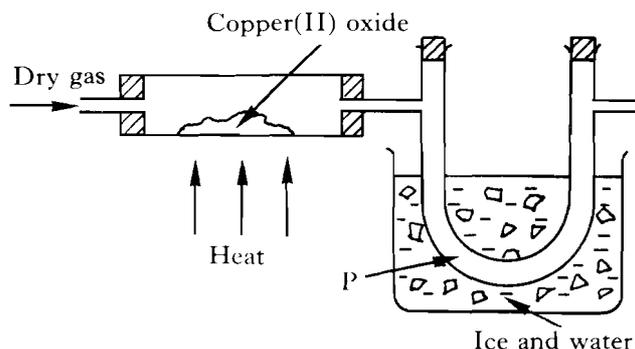
If you want to change back to an answer which has already been scored out, you should enter a tick (✓) to the **RIGHT** of the box of your choice, thus:



- Which of the following is sufficient to show that a sample of hydrogen is impure?
 - Its density at room temperature is 0.090 kg m^{-3} .
 - It burns with a blue flame to produce water.
 - It is insoluble in water.
 - It turns moist pH indicator paper red.
- Which of the following statements is **not** true about isotopes of an element?
 - Their electron arrangements are the same.
 - The masses of their nuclei are different.
 - Their numbers of protons are different.
 - Their nuclear charges are the same.
- A positively charged particle with electron arrangement 2,8 could be
 - a fluoride ion
 - a sodium atom
 - a neon atom
 - an aluminium ion.
- 139 g of an oxide of lead was strongly heated and hydrogen gas passed over it. When the oxide was completely reduced, 120 g of lead remained. The relative atomic masses of lead and oxygen are approximately 207 and 16. A possible formula for the oxide is
 - Pb_2O_3
 - PbO_2
 - Pb_2O
 - PbO
- 16 g of copper is allowed to react completely with 1 litre of molar silver nitrate solution. Which of the following statements represents one of the results of this reaction?
 - The resulting solution is colourless.
 - All the copper dissolves.
 - 16 g of silver is displaced.
 - 1 mole of silver is displaced.

- In which of the following does oxidation of iron take place?
 - The addition of silver to iron(II) sulphate solution
 - The addition of iron to dilute sulphuric acid
 - The addition of zinc to iron(II) sulphate solution
 - The addition of iron to freshly boiled, distilled water

Questions 7 and 8 refer to the experiment illustrated below, in which a dry gas is passed through the apparatus as shown.



- Which gas would leave the copper(II) oxide unchanged?
 - Carbon monoxide
 - Ammonia
 - Ethanol vapour
 - Carbon dioxide
- Which gas could **not** produce a liquid at P?
 - Hydrogen
 - Ammonia
 - Carbon monoxide
 - Ethanol vapour

9. In which of the following changes is hydrogen being reduced?
- A $\text{H}_2(\text{g}) \rightarrow \text{H}_2(\text{l})$
 B $\text{Na}(\text{s}) + \frac{1}{2}\text{H}_2(\text{g}) \rightarrow \text{NaH}(\text{s})$
 C $\text{H}(\text{g}) + \text{H}(\text{g}) \rightarrow \text{H}_2(\text{g})$
 D $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
10. The following oxides are shaken with water. Which oxide forms a solution of pH greater than 7?
- A Barium oxide
 B Carbon dioxide
 C Sulphur dioxide
 D Copper(II) oxide
11. The pH of a given solution is 8. Which of the following, when added to the given solution, would decrease its pH?
- A Saturated calcium hydroxide solution
 B Solid potassium nitrate
 C Potassium hydroxide solution
 D Water
12. For the reaction

$$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}),$$

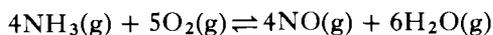
$$\Delta H = -57.5 \text{ kJ mol}^{-1}$$
 The enthalpy change when a solution containing 4.00 g of NaOH is neutralised by dilute HCl is
- A -5.75 kJ
 B -28.7 kJ
 C -57.5 kJ
 D -115 kJ .
13. The preparation of a sample of calcium chloride by the addition of excess calcium to dilute hydrochloric acid is not satisfactory because
- A calcium chloride is insoluble in water
 B calcium is too difficult to oxidise
 C calcium will react with the water and not with the acid
 D a mixture of calcium chloride and calcium hydroxide is formed.
14. Which of the following gives off a gas when treated with cold dilute sulphuric acid?
- A Ethanol
 B Sodium carbonate
 C Sodium sulphate
 D Sodium nitrate
15. If one mole of sodium hydroxide is added to one mole of sulphurous acid, the salt formed is
- A sodium sulphide
 B sodium sulphite
 C sodium hydrogensulphate
 D sodium hydrogensulphite.
16. The addition of barium nitrate solution to a solution Y gave a white precipitate which dissolved on addition of dilute hydrochloric acid. Which of the following ions has been shown by this experiment to be absent from Y?
- A Carbonate
 B Sulphate
 C Chloride
 D Sulphite
17. Which of the following statements about carbon monoxide is **false**?
- A It is the main constituent of natural gas.
 B It is a reducing agent.
 C It reacts with haemoglobin in red blood cells.
 D It can be formed by the reduction of carbon dioxide.
18. The gas C_3H_6 is used on an industrial scale to manufacture
- A an addition polymer
 B a condensation polymer
 C bottled gas
 D diesel fuel.

[Turn over

19. Which of the following statements is true about an aqueous solution of ammonia?

- A It has a pH less than 7.
- B It is completely ionised.
- C It contains more hydroxide ions than hydrogen ions.
- D It reacts with acids producing ammonia gas.

20. Which catalyst is normally used for the reaction shown?



- A Iron
- B Vanadium pentoxide
- C Aluminium oxide
- D Platinum

21. The conversion of starch to glucose is an example of

- A esterification
- B hydrolysis
- C oxidation
- D polymerisation.

22. When green plants convert carbohydrate to carbon dioxide and water,

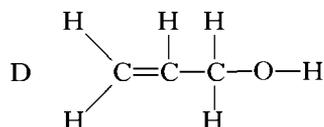
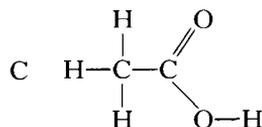
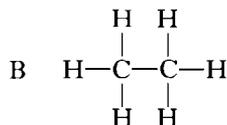
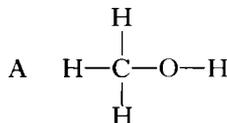
- A energy is released
- B oxygen is released
- C chlorophyll acts as a catalyst
- D the process is called photosynthesis.

23. Which of the following substances has the same formula mass as 2,2-dimethylbutan-1-ol?

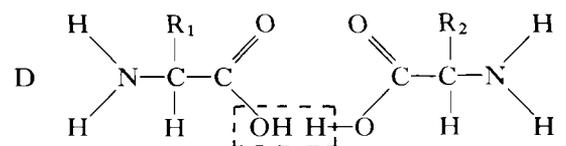
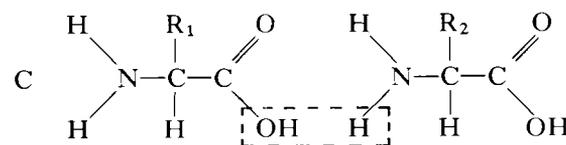
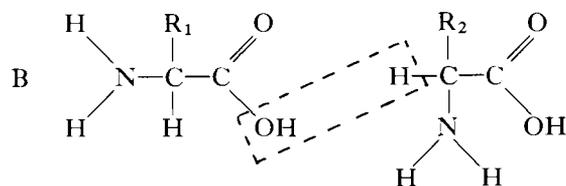
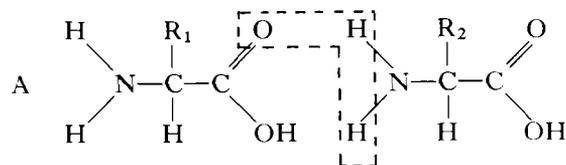
- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{CH}_3$
- B $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}(\text{CH}_3)_2$
- C $(\text{CH}_3)_3\text{CCH}_2\text{OH}$
- D $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$

24. Which of the compounds below would you expect to have all the following properties?

- (i) Soluble in water
- (ii) No reaction with alkali
- (iii) No reaction with bromine water



25. When two amino acids condense together they eliminate water, forming a peptide link. Which of the following represents this process?



26. Hydrogen has two main isotopes

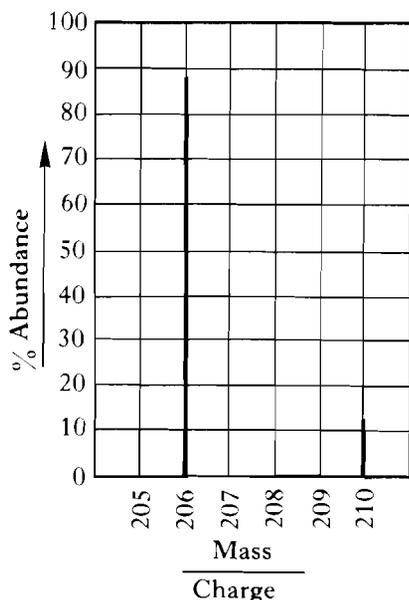
Isotope	Symbol	Mass number	Atomic number
Hydrogen	H	1	1
Deuterium	D	2	1

In a mass spectrometer, hydrogen gas containing the isotope deuterium produced five gaseous ions: H^+ , D^+ , HD^+ , H_2^+ , and D_2^+ .

Which pair of ions give overlapping lines in the spectrum?

- A H^+ and D^+
- B H_2^+ and D_2^+
- C H_2^+ and D^+
- D H_2^+ and HD^+

27. $^{210}_{84}\text{Po}$ is an α -emitter with a half-life of 140 days. A sample of the isotope was placed in a mass spectrometer and the chart shown below was obtained.



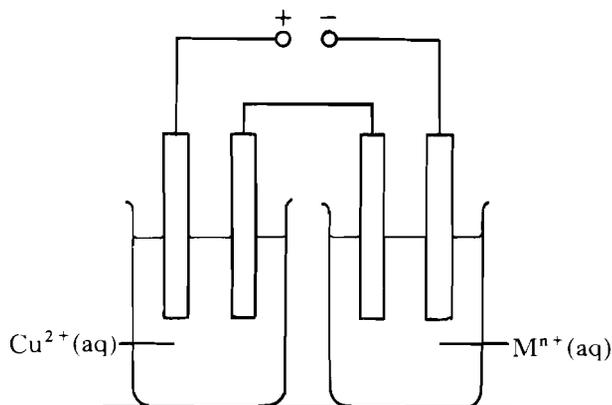
What is the age of the isotope?

- A 140 days
- B 280 days
- C 420 days
- D 840 days

28. Which of the following have an electrical charge?

- A α -particles
- B X-rays
- C Neutrons
- D γ -rays

Questions 29 and 30 refer to the experiment illustrated below.



29. It took X hours to deposit 1 mole of Cu. How long would it take to deposit 1 mole of the metal M? (Assume that only M^{n+} ions are discharged at the negative electrode.)

- A X hours
- B nX hours
- C $\frac{X}{n}$ hours
- D $\frac{nX}{2}$ hours

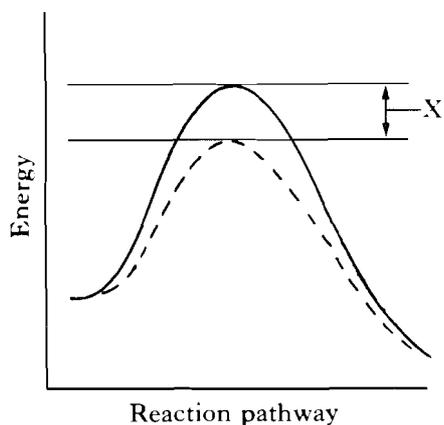
30. It took t minutes to deposit 1 g of Cu. How long would it take to deposit 1 g of the metal M?

- A t minutes
- B nt minutes
- C $\frac{t}{n}$ minutes
- D You cannot say without knowing the relative atomic masses of Cu and the metal M.

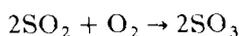
[Turn over

31. How much hydrogen would be released by placing 6.5 g of zinc in 205 cm³ of 1.0 M hydrochloric acid? (Take the relative atomic mass of zinc to be 65.)
- A 0.2 mole
 B Just over 0.2 mole
 C 0.1 mole
 D Just over 0.1 mole
32. Which of the following gases (at the same temperature and pressure) contains the **greatest** number of molecules?
- A 100 g oxygen
 B 100 g ammonia
 C 100 g fluorine
 D 100 g sulphur dioxide
33. A gaseous hydrocarbon has a density of 1.25 g l⁻¹ at s.t.p. Its molecular formula is
- A C₂H₄
 B C₃H₆
 C C₄H₈
 D C₅H₁₀.
34. Which of the following is the most powerful oxidising agent?
- A Zn²⁺(aq)
 B H⁺(aq)
 C Cu²⁺(aq)
 D Ag⁺(aq)
35. $\text{NO}_3^-(\text{aq}) + 4\text{H}^+(\text{aq}) + 3\text{e}^- \rightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}(\ell)$
 $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$
- These equations represent a reaction between nitric acid and copper. How many moles of NO₃⁻(aq) are reduced by 1 mole of copper?
- A $\frac{2}{3}$
 B 1
 C $\frac{3}{2}$
 D 2
36. The element radium occurs in Group II of the Periodic Table. Which of the following statements is likely to be true?
 Of all the elements in Group II, radium will have the
- A highest first ionisation energy
 B highest electronegativity
 C smallest covalent radius
 D most negative standard reduction potential.
37. Which of the following statements is correct?
- A Lithium hydride is ionic.
 B Rubidium hydride is covalent.
 C Alkali metal hydrides are made by reducing the metal with hydrogen.
 D Alkali metal hydrides are made by reducing the metal oxide with hydrogen.
38. An element (m.p. 3500°C) forms a gaseous oxide. Which type of bonding is likely to be present in the element?
- A Metallic
 B Polar covalent
 C Non-polar covalent
 D Ionic
39. Which of the following comparisons is correct?
- A Fluorine atoms are larger than chlorine atoms.
 B Chlorine is more reactive than fluorine.
 C The H-F bond is stronger than the H-Cl bond.
 D The ionisation energy of fluorine is lower than that of chlorine.
40. The continuous use of large extractor fans greatly reduces the possibility of an explosion in a flour mill. This is mainly because
- A a build up in the concentration of oxygen is prevented
 B local temperature rises are prevented by the movement of the air
 C particles of flour suspended in the air are removed
 D the slow accumulation of carbon monoxide is prevented.

41.



The diagram refers to the reaction



What does X represent?

- A Energy of activation for reaction without a catalyst
- B Enthalpy of reaction for reaction without a catalyst
- C Bond dissociation energy
- D None of these
42. In a reversible reaction, equilibrium is reached when
- A molecules of reactants cease to change into molecules of products
- B the concentrations of reactants and products are equal
- C the concentrations of reactants and products are constant
- D the activation energy of the forward reaction is equal to that of the reverse reaction.
43. For which of the following reactions will the proportion of product present at equilibrium be increased as the pressure is lowered?
- A $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- B $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
- C $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$
- D $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$

44. Which of the following, when dissolved in distilled water, gives rise to a solution with pH greater than 7?

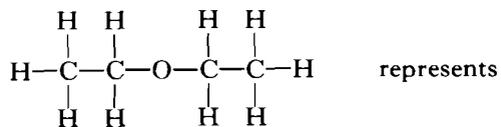
- A Hydrogen chloride
- B Ammonium nitrate
- C Sodium sulphate
- D Sodium ethanoate
45. Which statement about the compound $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ is correct?
- A It can be oxidised to an alkanone.
- B It can be oxidised to an alkanal.
- C Its systematic name is pentan-2-ol.
- D It will rapidly decolourise bromine water.
46. The action of hot aluminium oxide on ethanol is an example of
- A hydrogenation
- B dehydrogenation
- C hydrolysis
- D dehydration.
47. Which one of the following statements is true?
- A Benzene has the same empirical formula as ethyne.
- B Benzene contains more elements than ethyne.
- C Benzene is more volatile than ethyne.
- D Benzene undergoes addition reactions more readily than ethyne.
48. Which statement is correct?
- A $\text{C}_6\text{H}_5\text{OH}$ is a stronger acid than CH_3COOH .
- B CH_3OH is a stronger acid than $\text{C}_6\text{H}_5\text{OH}$.
- C $\text{C}_6\text{H}_5\text{OH}$ is a stronger base than $\text{C}_6\text{H}_5\text{NH}_2$.
- D CH_3NH_2 is a stronger base than $\text{C}_6\text{H}_5\text{NH}_2$.

[Turn over

49. Which of the following are produced by hydrolysis of simple proteins?

- A Simple sugars
- B Glycerol
- C Amino-acids
- D None of these

50. The formula



- A an alcohol
- B an ester
- C a ketone
- D none of the above types of compound.

[END OF QUESTION PAPER]

[0500/203]

1989

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Friday, 12th May—1.30 p.m. to 4.00 p.m.

Candidates are reminded that 4 marks are allocated for communication skills, assessed in Part B of this paper.

Working should be shown in all answers involving calculations.

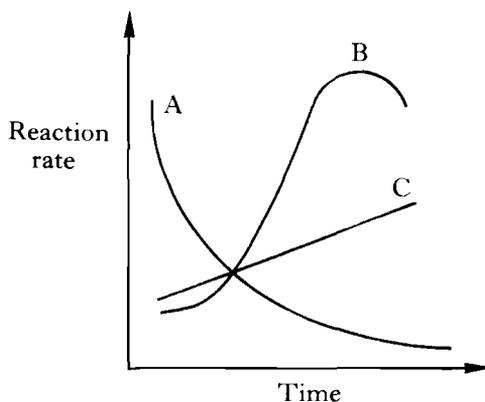
Necessary tables and data will be found in the booklets of Mathematical Tables and Science Data (1982 editions).

PART A (48 marks)

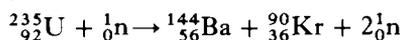
All questions should be attempted. It should be noted, however, that questions 4 and 7 contain a choice.

It is suggested that about 1½ hours be spent on this part of the paper.

- | | <i>Marks</i> |
|--|-----------------|
| 1. (a) Draw the full structural formula of 2-methylbut-2-ene. | 1 |
| (b) Calculate the volume of oxygen required to burn 1000 cm ³ of this hydrocarbon vapour, both volumes being measured under the same conditions of temperature and pressure. | 2
(3) |
| 2. (a) The radioactive isotope ${}^{221}_{87}\text{Fr}$ decays to form a stable isotope ${}^b_a\text{X}$ by the following sequence of emissions:
$\alpha, \alpha, \beta, \alpha, \beta$
Identify element X and write values for a and b. | 2 |
| (b) | |



During the fission of uranium, one of the reactions which occurs is:



- (i) Which of the above curves could represent this reaction?
 (ii) Explain your choice.

2
(4)

3. A mass spectrometer produced the following information for the element silicon.

<i>Isotope</i>	$^{28}_{14}\text{Si}$	$^{29}_{14}\text{Si}$	$^{30}_{14}\text{Si}$
<i>Percentage abundance</i>	92.2	4.7	3.1

- (a) Calculate the relative atomic mass of silicon. 2
- (b) When the gas disilane, Si_2H_6 , was passed through the mass spectrometer, a series of peaks was obtained on the graph corresponding to mass/charge ratios of 62, 63, 64, 65 and 66 respectively.
- (i) Which of these peaks is likely to be the highest (most intense)? 1
- (ii) The graph also produced a peak at a value of 31.
Write the formulae for two different ions which could be responsible for this peak. 2
- (5)**

4. Answer **EITHER A OR B**.

A. When potassium chlorate (KClO_3) is heated strongly, it decomposes to give potassium chloride and oxygen.

Calculate the mass of potassium chlorate which would produce 1.8×10^{23} molecules of oxygen. (3)

OR

B. Calculate the mass of calcium phosphate which contains 3.6×10^{22} phosphate ions. (3)

5. Some chlorides **dissolve** in water without further reaction; some **react** with water, giving off a gas.

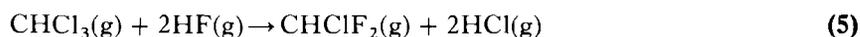
- (a) (i) Which gas is given off? 1
- (ii) Name the type of chemical reaction involved. 1

(b) Copy and complete the following table:

<i>Formula</i>	<i>mp/K</i>	<i>Action with water</i>	<i>Type of bonding</i>
KCl	1043		
SiCl_4	203		

2
(4)

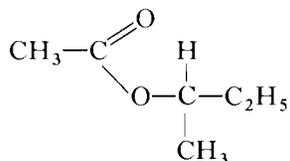
6. Using information on Page 7 of the Data Booklet, calculate the enthalpy change for the reaction:



[Turn over

7. Answer **EITHER A OR B**.

A.



Give the systematic names of the two compounds which, when warmed with concentrated sulphuric acid, react to form the above compound. (2)

OR

B. Give the name and draw the structural formula of the organic product formed by heating pentan-3-ol with concentrated sulphuric acid. (2)

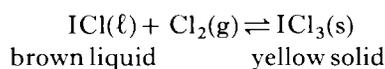
8. (a) Name the gas produced in each case when concentrated sulphuric acid is heated with
- (i) potassium chloride crystals; 1
 - (ii) zinc metal. 1
- (b) In each reaction above, state which property of sulphuric acid is being illustrated. 2
- (4)**

9. The table gives the ionisation energies of some of the alkali metals and some of the halogens.

<i>Element</i>	<i>Ionisation Energies/kJ mol⁻¹</i>		
	<i>First</i>	<i>Second</i>	<i>Third</i>
lithium	526	7310	11800
fluorine	1690	3380	6060
sodium	502	4560	6920
chlorine	1260	2310	3840
potassium	425	3060	4440
bromine	1150	2100	3480

- (a) Why is the first ionisation energy of each alkali metal much less than that of the halogen **in the same period**? 1
- (b) Why is the second ionisation energy of each alkali metal much greater than that of the halogen **in the same period**? 1
- (c) Calculate the energy per mole required to bring about the change
- $$\text{K}^+(\text{g}) \rightarrow \text{K}^{3+}(\text{g})$$
- 2**
- (4)**

10. Consider the following equilibrium:



What would be **seen** if the following were added to the mixture at equilibrium:

- (a) a catalyst; 1
- (b) more chlorine? 1
- (2)**

11. The table gives information about four different substances:

<i>Formula</i>	CH ₄	NH ₃	SiO ₂	SO ₂
<i>Formula mass</i>	16	17	60	64
<i>Melting point/°C</i>	−183	−78	1610	−73

Consider the types of bonding involved in **each** of the substances listed, and explain why

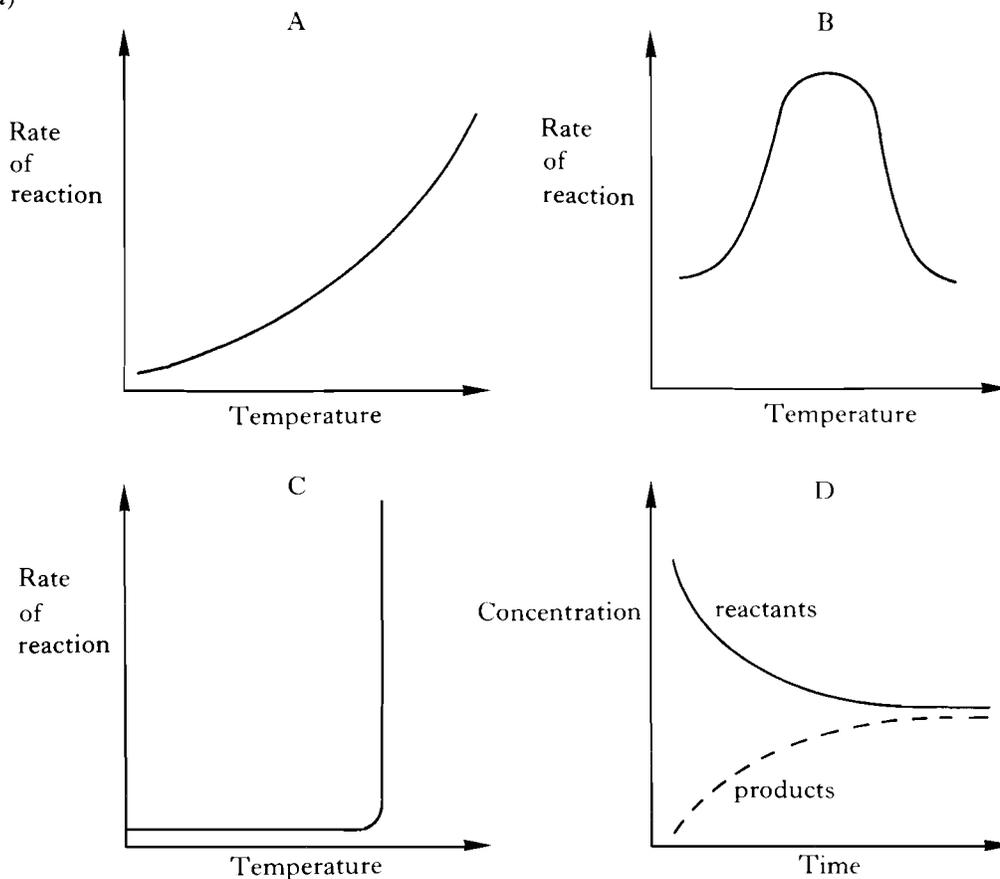
- (a) ammonia has a much higher melting point than methane; 2
- (b) silica has a much higher melting point than sulphur dioxide. 2
- (4)**

12. An aqueous solution of sodium carbonate is alkaline.

- (a) What is the formula of the acid from which sodium carbonate is derived? 1
- (b) Explain fully why sodium carbonate solution is alkaline. 2
- (3)**

[Turn over

13. (a)

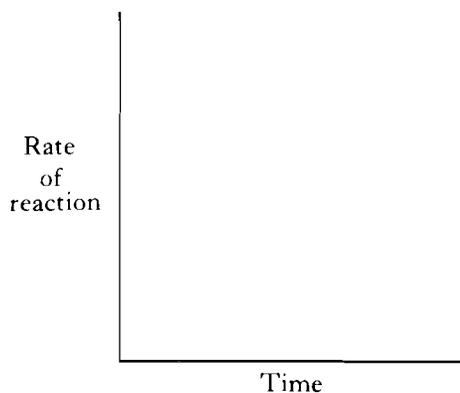


Which of the diagrams could apply to each of the following reactions?

- (i) $\text{C}_4\text{H}_{10}(\text{g}) + 6\frac{1}{2}\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{g})$
 (ii) $\text{CH}_3\text{COOH}(\ell) + \text{CH}_3\text{OH}(\ell) \rightleftharpoons \text{CH}_3\text{COOCH}_3(\ell) + \text{H}_2\text{O}(\ell)$
 (iii) $\text{S}_2\text{O}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell) + \text{SO}_2(\text{g}) + \text{S}(\text{s})$
 (iv) $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) \xrightarrow{\text{zymase}} 2\text{C}_2\text{H}_5\text{OH}(\ell) + 2\text{CO}_2(\text{g})$

4

(b)



Copy the set of axes and draw a rough graph (no graph paper required) to show how the reaction rate varies with time for the reaction:

1
(5)

PART B (48 marks)

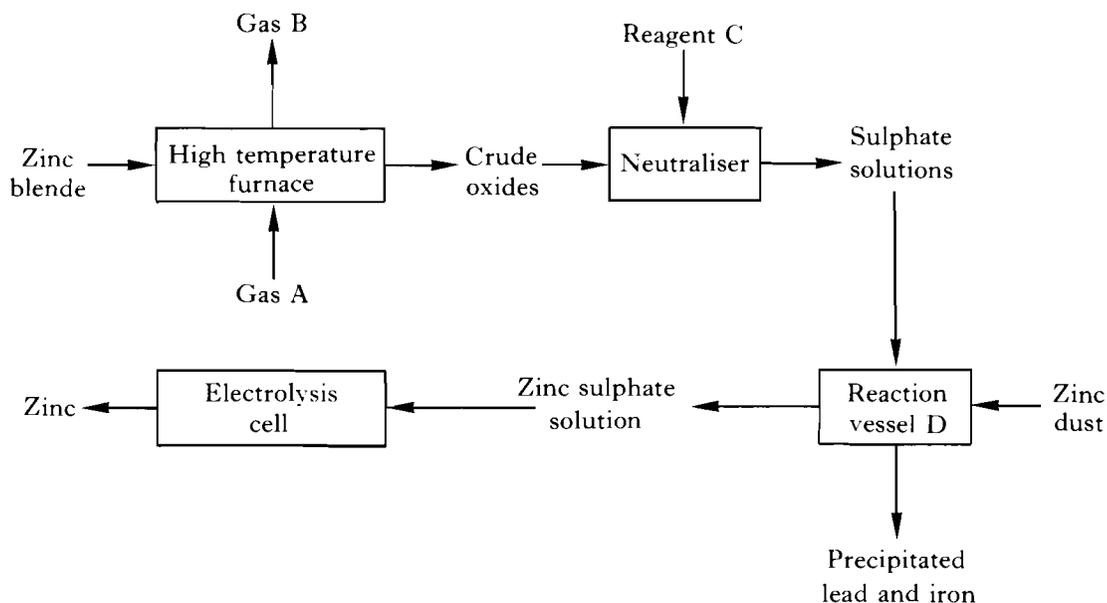
All four questions should be attempted. It should be noted however that question 14 contains a choice.

Candidates are advised to spend about 1½ hours on this part.

Marks

14. Answer EITHER A OR B.

A. Zinc is obtained from sulphide ores such as zinc blende which also contain other metal ion impurities.

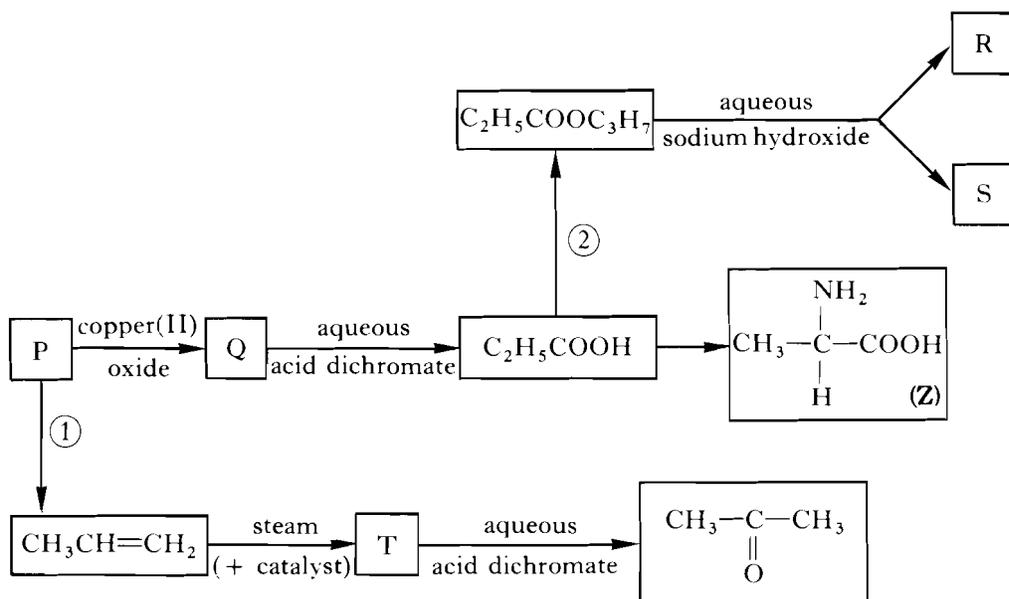


- (a) Name gases A and B. 2
- (b) Name reagent C. 1
- (c) It is not economical to waste gas B. Suggest the most likely industrial use for this gas. 1
- (d) **Explain** the purpose of adding zinc dust to reaction vessel D. 1
- (e) Write the ion-electron equations for the reactions occurring during the electrolysis at
- (i) the positive electrode;
- (ii) the negative electrode. 2
- (f) Assuming that all of the charge flowing produces zinc, calculate the mass of zinc deposited when a current of 10 000 A flows for 6 minutes 26 seconds. 3
- (g) What happens to the pH of the electrolyte during the electrolysis? 1
- (h) Zinc may also be obtained by reducing its oxide with carbon monoxide. Write a balanced chemical equation for this reaction. 1
- (12)**

[Turn over

OR

B.



The reaction scheme shows a number of common reactions.

- (a) Name compounds P, Q, R and S. 2
- (b) State the types of chemical reaction occurring at ① and ②. 2
- (c) Write a structural formula for compound T. 1
- (d) Describe a chemical test you could use to distinguish between compound Q and propanone. 2
- (e) (i) Name the class of compounds to which Z belongs. 1
(ii) Write the systematic name for compound Z. 1
- (f) Assuming 80% efficiency, what mass of propanone would be formed from 84 kg of propene? 3

(12)

15. In a “clock reaction” to study reaction rates, iodate ions in acid solution can be reduced to iodine by a solution of sulphite ions. Starch turns blue-black when iodine is formed and can be used as an indicator.

Two experiments were performed at room temperature. In each case, a solution of iodate ions was added to a solution containing sulphite ions and starch. The mixture was stirred and the time measured for the blue-black colour to appear.

Experiment 1

Volume of iodate solution/cm ³	Volume of water/cm ³	Volume of sulphite solution/cm ³	Time/s
25	40	15	13.8
20	45	15	17.0
15	50	15	24.8
10	55	15	35.5
5	60	15	68.7

Experiment 2

Volume of iodate solution/cm ³	Volume of water/cm ³	Volume of sulphite solution/cm ³	Time/s
25	25	30	5.8
20	30	30	8.0
15	35	30	10.0
10	40	30	13.5
5	45	30	24.3

- (a) In Experiment 1, which factor affects the reaction rate? 1
- (b) (i) **Compared with Experiment 1**, which condition is altered in Experiment 2? 1
 (ii) What effect does this have on the reaction rate? 1
- (c) This reaction between iodate ions and sulphite ions can also be carried out in a cell.
 (i) Draw a labelled diagram for such a cell, indicating the direction of electron flow in the external circuit. 2
 (ii) Write an ion-electron equation for the reduction, in acid solution, of iodate ions (IO₃⁻) to iodine. 2
 (iii) The Standard Reduction Potential for the reduction of iodate ions to iodine is +1.19V. Assuming standard conditions, calculate the voltage of the cell (Data Booklet, Page 6). 1
 (iv) Write a balanced ionic equation for the overall reaction. 1
 (v) From consideration of your equation, explain why the reaction is unlikely to proceed in one step. 1
- (d) The rates of many reactions are roughly doubled for a 10K rise in temperature. Explain with the aid of an energy diagram why a small temperature rise has such a great effect on reaction rate. 2

(12)

16. The tables below show some of the elements arranged as in the Periodic Table.

Table 1 gives covalent (atomic) radii in nm; Table 2 gives ionic radii.

Table 1 — **covalent (atomic) radii**

				N 0.074	O 0.074	F 0.072
Na 0.157	Mg 0.136	Al 0.125	Si 0.117	P 0.110	S 0.104	Cl 0.099

Table 2 — **ionic radii**

				N^{3-} 0.171	O^{2-} 0.132	F^- 0.133
Na^+ 0.097	Mg^{2+} 0.066	Al^{3+} 0.051	Si^{4+} 0.042	P^{3-} 0.212	S^{2-} 0.184	Cl^- 0.181

- (a) (i) Explain why the ions of sodium, magnesium, aluminium and silicon are much smaller than the corresponding atoms. 1
- (ii) Explain why there is a large increase in ionic radius from silicon to phosphorus. 1
- (iii) What do all the **ions** from nitrogen to silicon have in common? 1
- (iv) Explain why the ionic radii tend to decrease along the sequence from nitrogen to silicon. 1
- (b) (i) Which two elements given above will form the compound with most ionic character? 1
- (ii) Give a reason for your choice. 1
- (c) (i) Name the oxide of a metal given above which reacts with acids and also with alkalis. 1
- (ii) What name is given to an oxide of this type? 1
- (iii) Name **or** give the formula of the compound formed in solution when this oxide reacts with sodium hydroxide. 1
- (iv) Write a balanced chemical equation for the reaction between the oxide and hydrochloric acid. 1
- (d) The following table shows five different types of structure considered to exist among the elements.

Molecular gas	Closely packed molecules	Atomic gas	Covalent network	Ionic lattice with delocalised electrons
A	B	C	D	E

Answer the following by giving the box letter in each case.

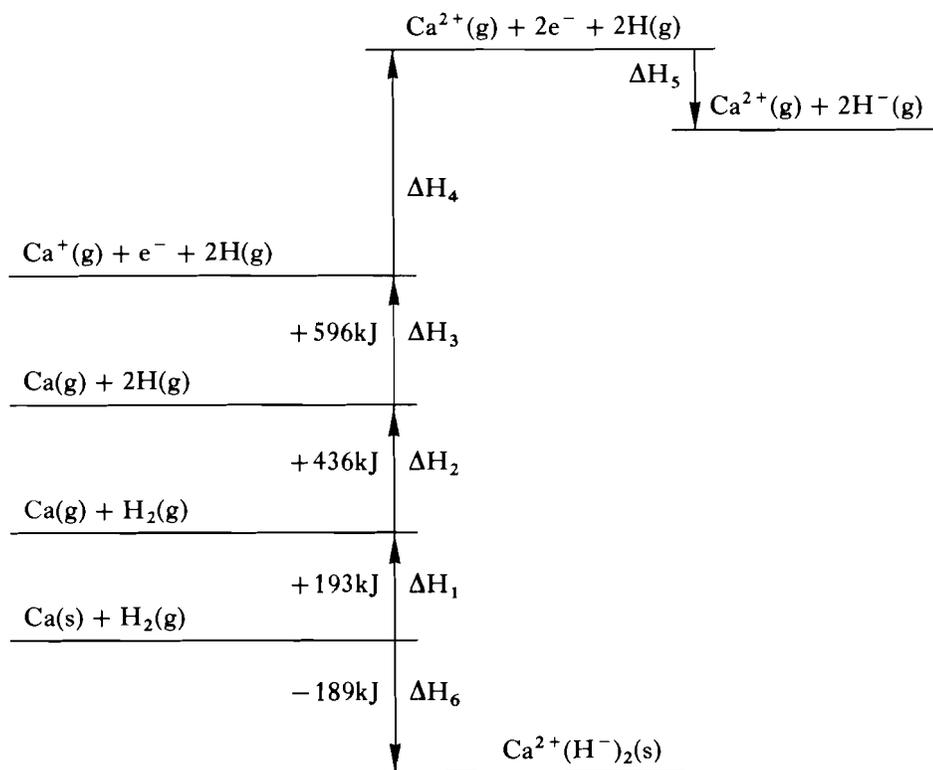
Which structure best describes the normal state of

- (i) fluorine;
- (ii) sodium;
- (iii) phosphorus;
- (iv) silicon?

2

(12)

17. Consider the following enthalpy diagram which is **not** drawn to scale.



- (a) What names are given to
- the enthalpy change ΔH_2 ;
 - the enthalpy change ΔH_6 ?
- (b) Use the Data Booklet to find the value of ΔH_4 .
- (c) Explain why the value of ΔH_4 is much greater than that of ΔH_3 .
- (d) Given that the electron affinity of hydrogen is -72 kJ mol^{-1} , calculate the value of ΔH_5 .
- (e) Calculate the enthalpy change for
- $$\text{Ca}^{2+}(\text{g}) + 2\text{H}^{-}(\text{g}) \rightarrow \text{Ca}^{2+}(\text{H}^{-})_2(\text{s}).$$
- (f) When excess calcium hydride is added to water, a saturated solution of calcium hydroxide is formed.
- In an experiment to determine the solubility of calcium hydroxide, a saturated solution was filtered and on titration it was found that 25.0 cm^3 of the filtrate required 10.5 cm^3 of 0.1 M hydrochloric acid for neutralisation.
- Write a balanced equation for the neutralisation reaction.
 - Calculate the number of moles of acid required to react completely with 25 cm^3 of the filtrate.
 - Calculate the solubility of calcium hydroxide in g l^{-1} .

(12)

[END OF QUESTION PAPER]