

[0500/170] 1986

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

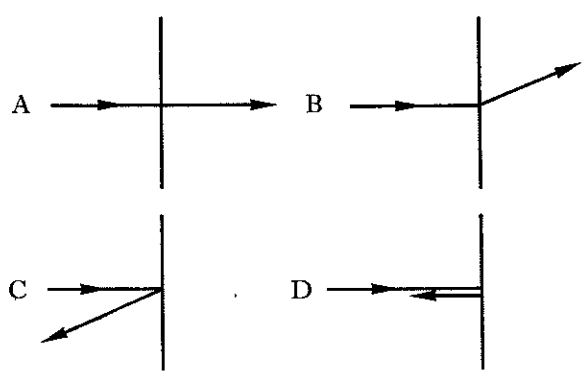
Friday, 16th May—1.30 p.m. to 4.00 p.m.

Candidates are reminded that 4 marks in this paper are allocated for communication skills.

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).

- A mixture of powdered quartz and magnesium powder was heated. There was a vigorous reaction, after which the element silicon and magnesium oxide were found to be present. This shows that quartz
 - contains only silicon and oxygen
 - contains silicon and oxygen
 - contains silicon, oxygen and other elements
 - is the compound silicon dioxide.
- When a mixture of nitrogen and hydrogen is burned in oxygen, which of the following compounds is formed?
 - ammonia
 - water
 - nitric acid
 - ammonium nitrate

- Which diagram shows the commonest path taken by alpha-particles directed at thin gold foil?
 

- 18 g of an oxide of copper was strongly heated and hydrogen gas passed over it. When the oxide was completely reduced, 16 g of copper remained. The relative atomic masses of copper and oxygen are 64 and 16 respectively. A possible formula for the oxide is
 - Cu_2O
 - CuO
 - Cu_2O_3
 - CuO_2

- What mass of anhydrous sodium sulphate is required to make 1 litre of molar solution?
 - 71 g
 - 119 g
 - 126 g
 - 142 g
- It is desired to coat a piece of iron with zinc. Which of the following methods would be successful?
 - Dip the iron in a concentrated solution of zinc sulphate for several hours.
 - Make the iron the positive electrode during the electrolysis of a 1 M solution of zinc chloride.
 - Lower the iron into molten zinc, remove and allow to cool.
 - None of these.
- A pupil found that, on neutralising 50 cm³ of lithium hydroxide solution with 2 M hydrochloric acid, the final volume of the mixture was 110 cm³. Which of the following statements is true?
 - 10 cm³ of water was formed during the reaction.
 - The final solution had a pH greater than 7.
 - The lithium hydroxide solution was more concentrated than the acid.
 - The final volume was about 100 cm³ after the salt formed had been filtered off.
- An element conducts electricity. When it is burned in oxygen and the product added to water, the resulting solution has a pH greater than 7. The element could be
 - carbon
 - sodium
 - sulphur
 - aluminium.

9. A solution of copper(II) sulphate is electrolysed between platinum electrodes until all the blue colour has disappeared. What will be the pH of the resulting solution?
- A The same as for water
 B The same as that of the original copper(II) sulphate solution
 C Much greater than that of the original copper(II) sulphate solution
 D Much less than that of the original copper(II) sulphate solution

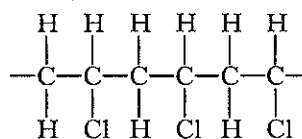
Questions 10 and 11 refer to the following properties of sulphuric acid.

- A a typical acid
 B an oxidising agent
 C an involatile acid
 D a dehydrating agent

Which property is shown in the following reactions?

10. The production of sulphur dioxide from sulphur.
11. The production of carbon dioxide from copper carbonate.
12. Dilute sulphuric acid (2 M) is dropped onto a mixture of zinc and zinc carbonate. Which of the following is the most likely composition of the gas evolved?
- A Carbon dioxide only
 B Hydrogen only
 C Hydrogen and carbon dioxide
 D Carbon dioxide and sulphur dioxide
13. Which of the following gases burns easily, forming only one product that is gaseous at s.t.p.?
- A Hydrogen
 B Ammonia
 C Carbon monoxide
 D Sulphur dioxide

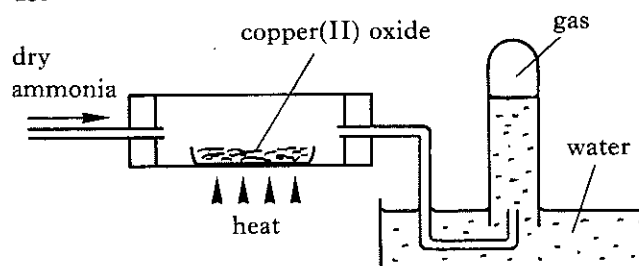
14. The polymer



is classed as a

- A natural addition polymer
 B natural condensation polymer
 C synthetic addition polymer
 D synthetic condensation polymer.

- 15.



Copper (II) oxide was heated in the above apparatus and dry ammonia was passed over it. After a few seconds, the test tube was placed in position and a gas collected.

The gas collected was

- A nitrogen
 B nitrogen monoxide (nitrogen oxide)
 C nitrogen dioxide
 D hydrogen.

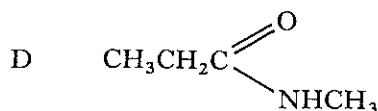
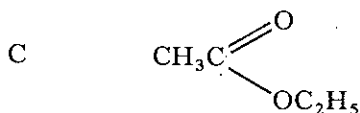
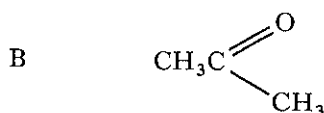
16. In the reaction represented by the equation $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, the forward reaction is exothermic. Which set of conditions would give the best yield of ammonia at equilibrium?
- A 800 atmospheres and 2000 °C
 B 1 atmosphere and 500 °C
 C 1 atmosphere and 2000 °C
 D 800 atmospheres and 500 °C

[Turn over

17. Some copper was dropped into moderately concentrated nitric acid and it was observed that a colourless gas was produced.

The gas was

- A nitrogen
 B nitrogen monoxide (nitrogen oxide)
 C nitrogen dioxide
 D hydrogen.
18. When a substance is heated with soda-lime, ammonia is released. **From this information alone**, what is the most precise description you may make of the substance? It is
- A a nitrogen compound
 B an organic nitrogen compound
 C a compound built up of amino acids
 D a protein.
19. Which of the following substances is classed as an ester?



20. The action of digestive enzymes on carbohydrates in food is an example of

- A hydrolysis
 B hydrogenation
 C dehydration
 D dehydrogenation.

21. Which of the following is a polymer?

- A Cellulose
 B Sucrose
 C Stearic acid
 D Propene

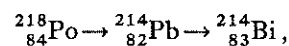
22. The chloride of a trivalent element is examined in a mass spectrometer. The element has one isotope and chlorine has two, ^{35}Cl and ^{37}Cl . Lines appear at mass numbers 180, 182, 184 and 186. What is the mass number of the element?

- A 75
 B 77
 C 79
 D 81

23. The half-life of the isotope ^{14}C is 5.5×10^3 years. What fraction of the original ^{14}C atoms will be present after 2.2×10^4 years?

- A 0.5
 B 0.25
 C 0.125
 D 0.0625

24. In the sequence of changes



which of the following particles are emitted?

- A An α -particle followed by a neutron
 B An α -particle followed by a β -particle
 C A β -particle followed by an α -particle
 D A β -particle followed by a proton

25. How many Faradays are required to liberate one mole of nickel at the negative electrode, from a solution of Ni^{2+} ions?

- A $\frac{1}{2}$
 B 2
 C $\frac{\text{Avogadro's constant}}{2}$
 D $\frac{2}{\text{Avogadro's constant}}$

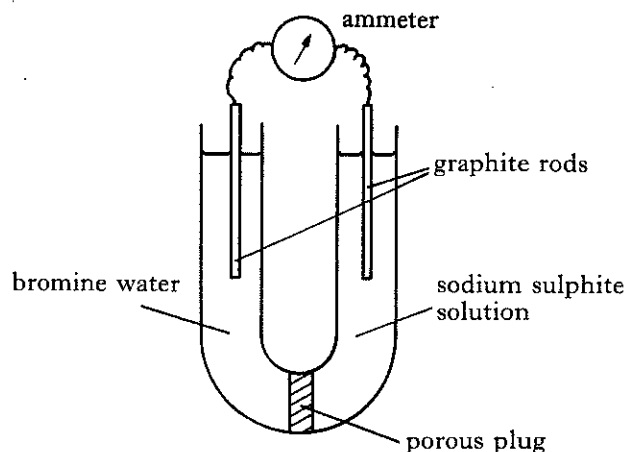
26. Which of the following occupies a volume of 22.4 litres at s.t.p.?

- A 1 g of hydrogen
- B 4 g of helium
- C 18 g of ammonia
- D 18 g of water

27. In which of the following reactions will the total volume of products be greater than the total volume of reactants, all volumes being measured at s.t.p.?

- A Sulphur reacting with oxygen
- B Methane reacting with oxygen
- C Carbon reacting with carbon dioxide
- D Magnesium reacting with carbon dioxide

Questions 28 and 29 refer to the cell shown below.



28. Which of the following ions is oxidised?

- A $\text{OH}^-(\text{aq})$
- B $\text{SO}_3^{2-}(\text{aq})$
- C $\text{Na}^+(\text{aq})$
- D $\text{Br}^-(\text{aq})$

29. Apart from the ammeter reading, what visual evidence would there be that a reaction was taking place?

- A Sulphur dioxide would be evolved.
- B A white precipitate would be formed in the sulphite solution.
- C The bromine water would gradually be decolourised.
- D The sodium sulphite solution would turn brown.

30. 20 cm³ of 0.3 M sodium hydroxide solution can be exactly neutralised by

- A 20 cm³ of 0.3 M sulphuric acid
- B 20 cm³ of 0.6 M sulphuric acid
- C 10 cm³ of 0.6 M sulphuric acid
- D 10 cm³ of 0.3 M sulphuric acid.

31. The bond dissociation energy (enthalpy) of the C-H bond is equal to $\frac{1}{4}$ of the value of ΔH for one of the following reactions. Which one is it?

- A $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$
- B $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{s}) + 4\text{H}(\text{g})$
- C $\text{C}(\text{s}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g})$
- D $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$

32. Three metals X, Y and Z have standard reduction potentials (E^0 values) of -2.9 V , -0.98 V , and $+0.06\text{ V}$ respectively. Which of the following statements is true?

- A X is the best oxidising agent.
- B Z is the poorest reducing agent.
- C Y is a better reducing agent than X.
- D Y is the most difficult to oxidise.

33. When an atom X of an element in Group VII (halogens) reacts to become an ion, X^- ,

- A the diameter of the particle decreases
- B the nucleus acquires a negative charge
- C the atomic number increases
- D the number of electron shells is unchanged.

34. Which of the following compounds, when molten, would give hydrogen at the positive electrode during electrolysis?

- A Sodium hydride
- B Sodium hydroxide
- C Hydrogen fluoride
- D Hydrogen oxide

[Turn over

Questions 35 and 36 refer to the following types of bonds.

- A Covalent (non-polar)
- B Ionic
- C Hydrogen
- D Covalent (polar)

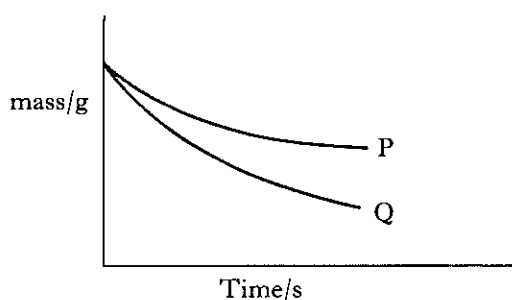
35. Which type of bond is broken when silicon is melted?

36. Which type of bond is broken when solid hydrogen fluoride is melted?

37. Which of the following reagents will **not** give a reaction when added to a solution containing iodide ions?

- A Chlorine water
- B Potassium chloride
- C Bromine water
- D Silver nitrate solution

38. The course of the reaction between marble chips and dilute hydrochloric acid was followed by determining the mass of the reaction vessel and contents as carbon dioxide was evolved. The rate curves (P and Q) obtained under two different conditions are shown in the graph below.



The change in the form of the rate curve from P to Q would be obtained by

- A increasing the concentration of the acid
- B decreasing the temperature of the reactants
- C increasing the particle size of the marble
- D decreasing the volume of the acid.

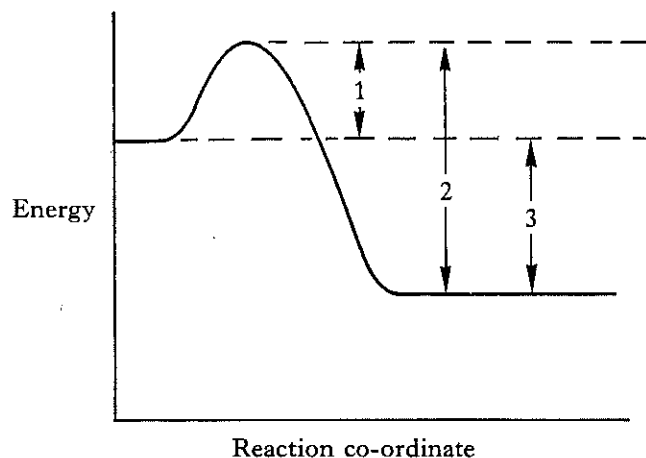
39. Some starch solution was added to a solution of potassium iodate, followed by some potassium sulphite solution. The colourless mixture became dark blue after 30 seconds. Which of the following statements explains why the blue colour did not appear immediately?

- A The rate-controlling step was slow.
- B Too little starch was used.
- C The solutions were too concentrated.
- D The reaction between iodine and starch is slow.

40. When a mixture of hexane and bromine vapour is exposed to light for some time, the colour slowly fades and some hydrogen bromide is produced. Which of the following agrees with these observations?

- A Hexane is an unsaturated hydrocarbon.
- B Light is activating a substitution reaction.
- C A slow addition reaction is taking place.
- D None of these.

41.



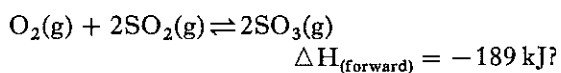
Which of the following correctly represents the activation energy (E_A) and the enthalpy change (ΔH) in the above diagram?

	E_A	ΔH
A	2	3
B	1	2
C	1	3
D	2	1

42. Which statement describes the effect of a catalyst?

	<i>Activation energy</i>	<i>Enthalpy of reaction</i>
A	decreases	decreases
B	decreases	increases
C	remains unchanged	decreases
D	decreases	remains unchanged

43. Which of the following procedures would **not** affect the position of equilibrium in the system



- A Decreasing the pressure
 B Decreasing the temperature
 C Adding a catalyst
 D Adding more oxygen
44. Some solid ammonium chloride is added to a dilute solution of ammonia. Which of the following ions will decrease in concentration?
- A Ammonium
 B Hydrogen
 C Hydroxide
 D Chloride
45. Which compound gives an alkaline solution in water?
- A Ammonium sulphate
 B Potassium nitrate
 C Sodium propanoate
 D Aluminium chloride

46. The number of structural isomers having the molecular formula C_5H_{12} is

- A 2
 B 3
 C 4
 D 5.

47. Which of the following has the formula C_6H_{12} and does not decolourise bromine water?

- A Cyclohexane
 B Benzene
 C Hexene
 D Cyclohexene

48. Which of the following aqueous solutions has a pH less than 7?

- A Butan-1-ol
 B Propanone
 C Propanal
 D Phenol

49. The compound $\text{CH}_3\text{CH}_2\text{CH}_2\text{O}^-\text{Na}^+$ is formed by reaction between

- A sodium and propanoic acid
 B sodium and propan-1-ol
 C sodium hydroxide and propene
 D sodium hydroxide and propanal.

50. Wool can be dyed easily with picric acid (a yellow dye) and also with rhodamine B (a red basic dye).

This suggests that wool

- A is a natural polymer
 B readily forms hydrogen bonds
 C contains nitrogen atoms
 D contains acidic and basic groups.

[END OF QUESTION PAPER]

PART A (48 marks)

All questions should be attempted. It should be noted, however, that questions 1 and 5 contain a choice.

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

Marks

1. Answer EITHER A OR B.

A. An organic compound has the formula HCOOCH_3 .

(a) Name this compound.

1

(b) Write its empirical formula.

1

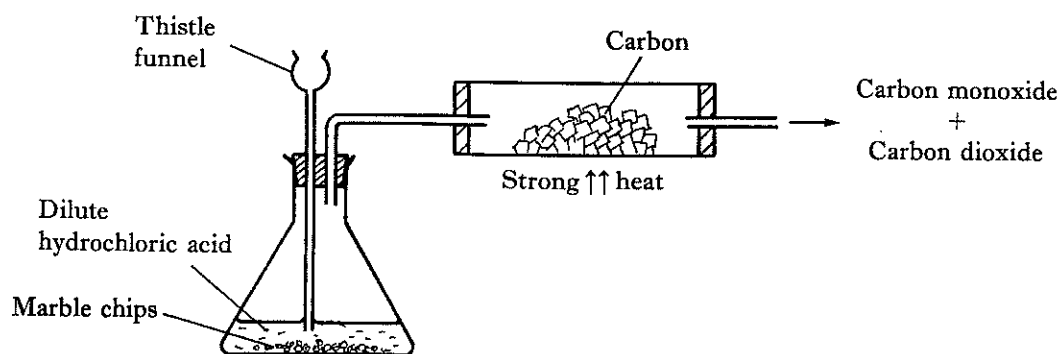
(2)

OR

B. Draw the full structural formula of 2,2,4-trimethylpentane. (All bonds must be shown.)

(2)

2. A sample of carbon monoxide, contaminated with carbon dioxide, may be obtained as shown below.



Sketch and label **ADDITIONAL** apparatus (and reagents) required to remove the carbon dioxide and collect the carbon monoxide over water.

(2)

3. Calculate the volume (at s.t.p.) of oxygen required for the complete combustion of 1 g of ethene.

(3)

4. Calculate the number of electrons in 6 g of magnesium (II) ions.

(3)

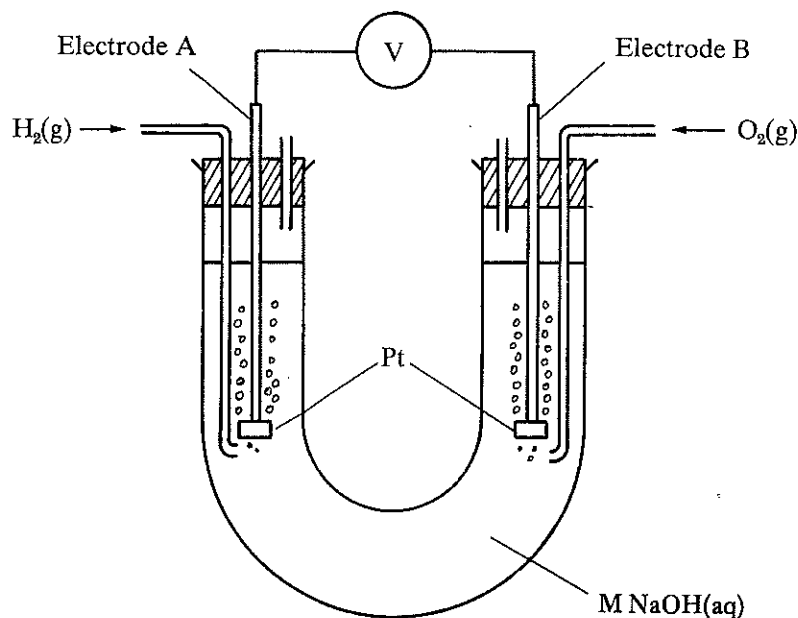
5. Answer **EITHER A OR B.**

- A. (a) Which type of bonding exists in (i) sulphur;
 (ii) aluminium? 1
- (b) Use the Data Booklet (page 2) to find the melting points of these elements. 1
- (c) Explain why the melting point of aluminium is high. 1
- (3)**

OR

- B. (a) Which type of bonding exists in (i) sulphur dioxide;
 (ii) silicon dioxide? 1
- (b) Use the Data Booklet (page 9) to find the boiling points of these compounds. 1
- (c) Explain why the boiling point of sulphur dioxide is low. 1
- (3)**

6. Some fuel cells are based on the fact that electricity can be produced by supplying oxygen and hydrogen to platinum electrodes immersed in sodium hydroxide solution.

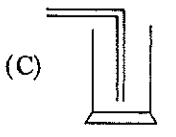
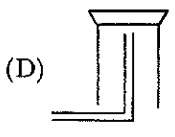
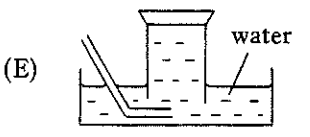


- (a) Using the Data Booklet (page 7), write an ion-electron equation for the reaction taking place at (i) electrode A,
 (ii) electrode B. 2
- (b) Calculate the voltage that would be expected from this fuel cell. (Assume standard conditions.) 1
- (3)**

[Turn over

7.

Drying agent	(A) CaO	(B) H ₂ SO ₄
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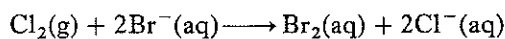
Method of collection	(C) 	(D) 	(E) 
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For the preparation of a sample of dry ammonia,

- (a) select a suitable drying agent and **explain** your choice;
 (b) select a suitable method of collection and **explain** your choice.

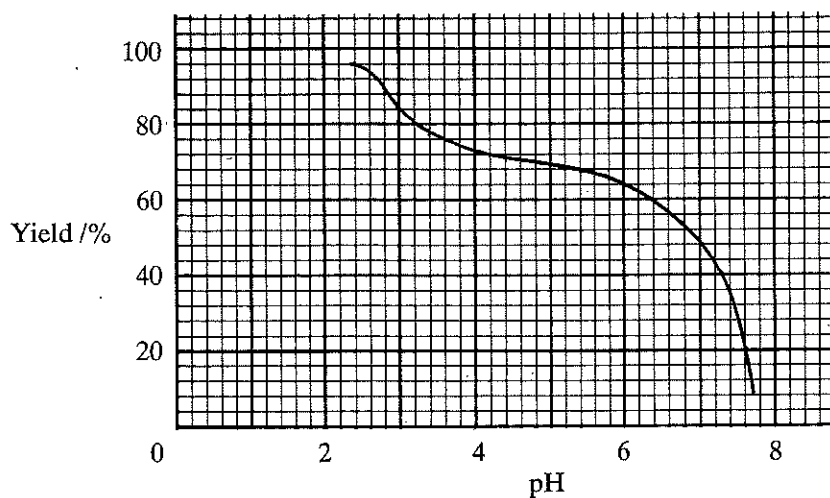
2
2
(4)

8. The following equation shows how bromine can be extracted from sea water.



- (a) Which type of chemical reaction is represented by this equation?
 (b) The graph shows the effect of pH on the yield of bromine obtained.

1



- What happens to the yield of bromine as the sea water becomes more acidic?
 (c) Would chlorine be a suitable reagent for obtaining fluorine from fluoride ions?
Explain your answer.

1
2
(4)

9. The following terms are used in thermochemistry:

Ionisation energy (enthalpy)	Sublimation enthalpy	Electron affinity
Enthalpy of formation	Lattice enthalpy	Dissociation enthalpy

- (a) Which term is associated with each of the following?
- (i) $\text{Cl(g)} + \text{e}^- \longrightarrow \text{Cl}^-\text{(g)}$
- (ii) $\text{Na}^+\text{Cl}^-\text{(s)} \longrightarrow \text{Na}^+\text{(g)} + \text{Cl}^-\text{(g)}$
- (iii) $\text{C(s)} + 2\text{Cl}_2\text{(g)} \longrightarrow \text{CCl}_4\text{(l)}$ 3
- (b) Which of the above equations represents an endothermic process? 1
- (4)
10. A copper compound was known to contain either copper (I) or copper (II) ions. The compound was dissolved in water and electrolysed. It was found that 0.32 g of copper was formed after the electrolysis cell had been operating for 16 minutes with a steady current of 1.0 A.
- (a) At which electrode would copper have been formed? 1
- (b) Using the above information, determine which copper ion was present. **Working must be shown.** 3
- (4)
11. (a) (i) What shape are the crystals of both sodium chloride and caesium chloride? 1
- (ii) In these crystals, each sodium ion is surrounded by six chloride ions whereas each caesium ion is surrounded by eight chloride ions. Describe the lattice arrangement in each of these compounds and explain why they are different. 2
- (b) $\text{NaOH(s)} \longrightarrow \text{NaOH(aq)} \quad \Delta H = a$
- $\text{NaOH(s)} + \text{HCl(aq)} \longrightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)} \quad \Delta H = b$
- $\text{NaOH(aq)} + \text{HCl(aq)} \longrightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)} \quad \Delta H = c$
- From the above data, write an equation to show the relationship between a, b, and c. 2
- (5)
12. Two isomeric straight-chain alkanols, having four carbon atoms, are known.
- (a) Draw a structural formula for each of these alkanols. 2
- (b) Name a reagent which could be used to oxidise each of these alkanols to a carbonyl compound. 1
- (c) How could the carbonyl compounds be distinguished by a chemical test? State the results of the test. 2
- (5)

[Turn over

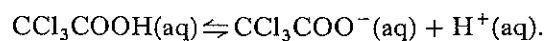
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<i>Acid</i>	<i>pH of 2M aqueous solution</i>
A CCl ₃ COOH	0.50
B CHCl ₂ COOH	0.90

(a) Which is the stronger acid? **Explain** your choice.

2

(b) Acid A dissociates in water as follows:



How would the equilibrium be affected by the addition of

- (i) solid NaOH;
- (ii) solid NaCl;
- (iii) solid CH₃COONa?

3

(c) Explain your answer in the case of solid CH₃COONa.

1

(6)

PART B (48 marks)

All four questions should be attempted. It should be noted however that question 17 contains a choice.

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

Marks

14. The following are variables which can affect the progress of a chemical reaction.

temperature	light	catalyst	concentration
particle size	stirring	pressure	inhibitor

- (a) (i) In the chain reaction between hydrogen and chlorine, which of the above is commonly used to initiate (start) the reaction? **1**
- (ii) Explain how this causes the reaction to begin. **1**
- (iii) Name the two other stages in a chain reaction. **1**
- (b) Which of the above variables will alter the position of equilibrium in the following reaction? **2**
- $$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) \quad \Delta H = +90\text{kJ mol}^{-1}$$
- (c) Explain why reactions involving solids tend to go faster when the solids are finely divided. **2**
- (d) A mixture of hydrogen and oxygen does not react at room temperature. When a piece of clean platinum is placed in the mixture, the hydrogen and oxygen react explosively.
- (i) Explain why hydrogen and oxygen do not react at room temperature. **1**
- (ii) What is the purpose of the platinum? **1**
- (iii) Discuss and explain how the platinum functions. **3**
- (12)**

[Turn over

15. The names or formulae of some compounds are shown in the table below.
The questions which follow are based on the table.

propane	$C_2H_5NH_2$	ethyl propanoate	hex-1-ene
C_2H_5CHO	phenol	C_3H_6	propyne
phenylamine (aniline)	CH_3COCH_3	propan-1-ol	C_6H_6

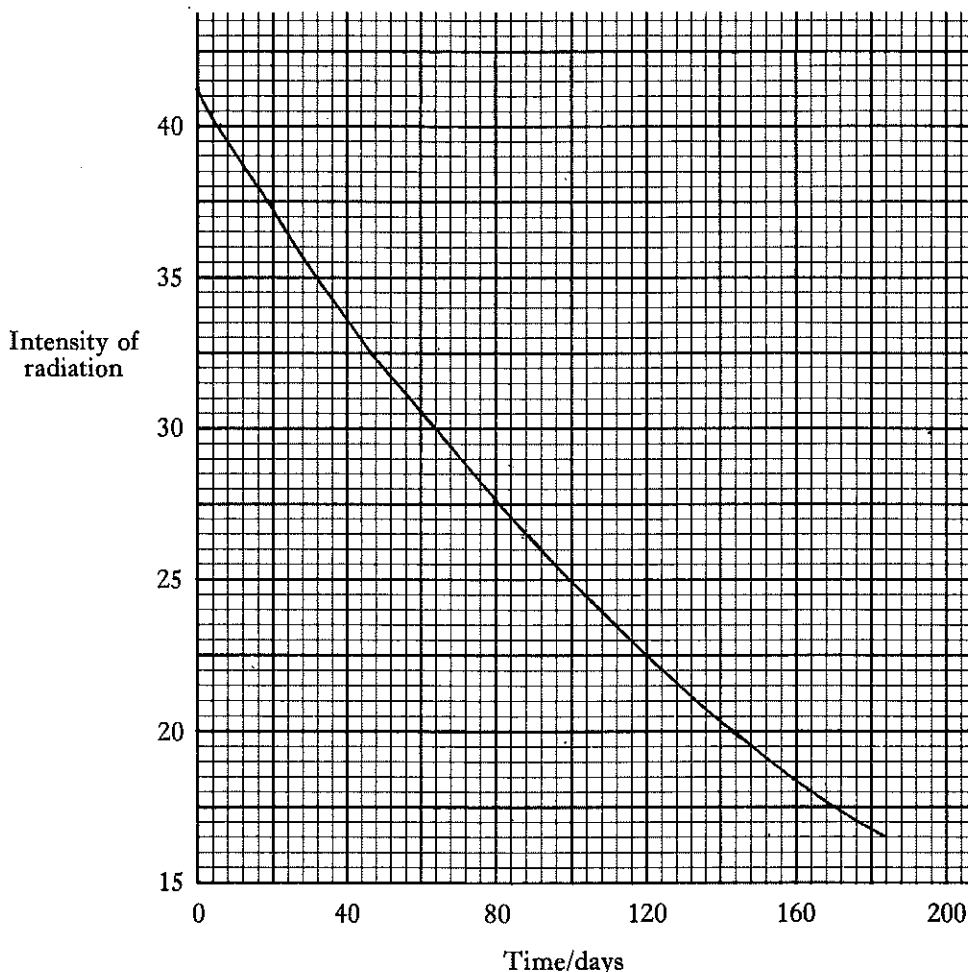
- (a) Name the compound with formula C_3H_4 . 1
- (b) Which compound is an ester? 1
- (c) Which substances are basic in character? 2
- (d) Select **two** compounds which can be prepared directly (in one step) from propan-1-ol. 2
- (e) Which two compounds are isomers? 1
- (f) (i) Which chemical (**not** in the table) would be suitable for removing phenol from a sample of benzene contaminated with phenol? 1
- (ii) Describe briefly how this would be done in the laboratory. 1
- (g) Discuss any differences in structure or chemical behaviour between benzene (C_6H_6) and hex-1-ene (C_6H_{12}).
Mention three differences apart from the number of hydrogen atoms. 3
- (12)**

16. (a) The extraction of phosphorus is similar to that of iron. Calcium phosphate is heated with sand and coke in an electric furnace at about 1500°C . The sand (SiO_2) combines with the calcium phosphate forming slag and phosphorus(V) oxide. The phosphorus(V) oxide is reduced by the coke to phosphorus which is removed from the furnace and stored under water.
- (i) What is the chemical name for the molten slag which forms during the reaction? 1
 - (ii) Why is it relatively easy to remove the phosphorus from the furnace? (You may wish to consult the Data Booklet.) 1
 - (iii) Why is the phosphorus stored under water? 1
- (b) Phosphoric acid, (H_3PO_4), is triprotic (tribasic).
- (i) Write correct formulae for **two** of the three calcium salts of this acid. 2
 - (ii) For **one** of the salts you have chosen, calculate the percentage by mass of phosphorus present. 2
- (c) Phosphorus forms two hydrides PH_3 and P_2H_4 .
- (i) 0.152 g of a hydride of phosphorus has a volume of 100 cm^3 at s.t.p.
Calculate the mass of one mole of the hydride **and** identify it. 3
 - (ii) Liquid ammonia boils at -33°C but liquid phosphine (PH_3) boils at -87.5°C .
Explain this difference in terms of bonding. 1
 - (iii) Both ammonia and phosphine molecules have the same shape. Draw this shape. 1
- (12)

[Turn over

17. Answer EITHER A OR B.

A. (a) A radioisotope X decays to a stable product as shown in the following graph.



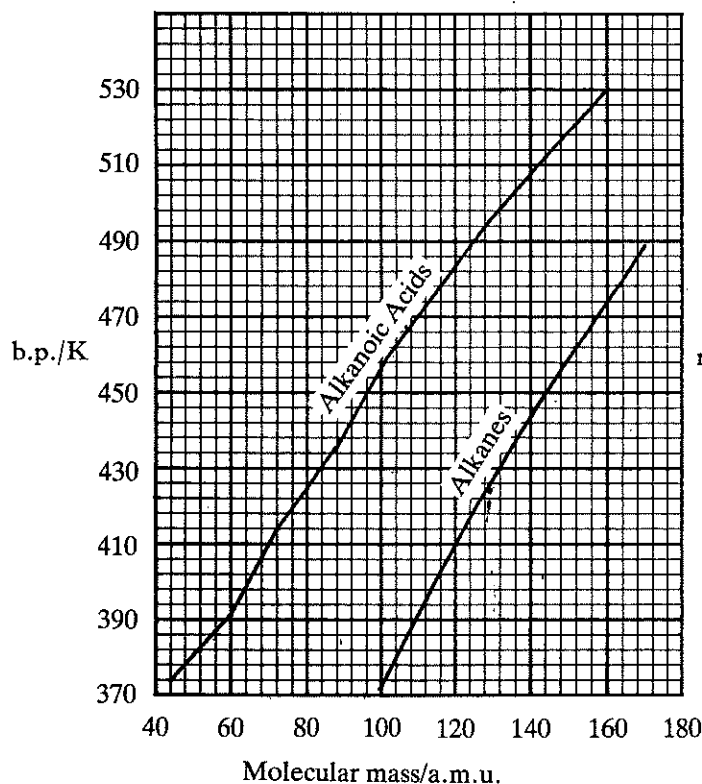
- (i) Determine the half-life of X. 1
 - (ii) Identify X. (Use the Data Booklet, page 3.) 1
 - (iii) Write a nuclear equation for the decay of X. 1
 - (b) The mass spectrometer is used to determine mass numbers.
 - (i) Which type of particle moves through a mass spectrometer? 1
 - (ii) Explain the significance of the word relative in the term "relative atomic mass". 1
 - (iii) Neon has two isotopes ^{20}Ne and ^xNe .
 If the relative atomic mass of neon is 20.2 and the abundance of ^{20}Ne is 90%, calculate the mass number, x, of the second isotope. (**Working must be shown.**) 2
 - (c) Many radioisotopes are made by bombarding stable atoms with alpha particles, neutrons or protons.
 - (i) Explain why neutrons are widely used for producing radioisotopes. 1
 - (ii) Why are beta particles not used to produce radioisotopes? 1
 - (iii) Explain how radioactivity can be used to estimate the age of organic remains. 3
- (12)**

OR

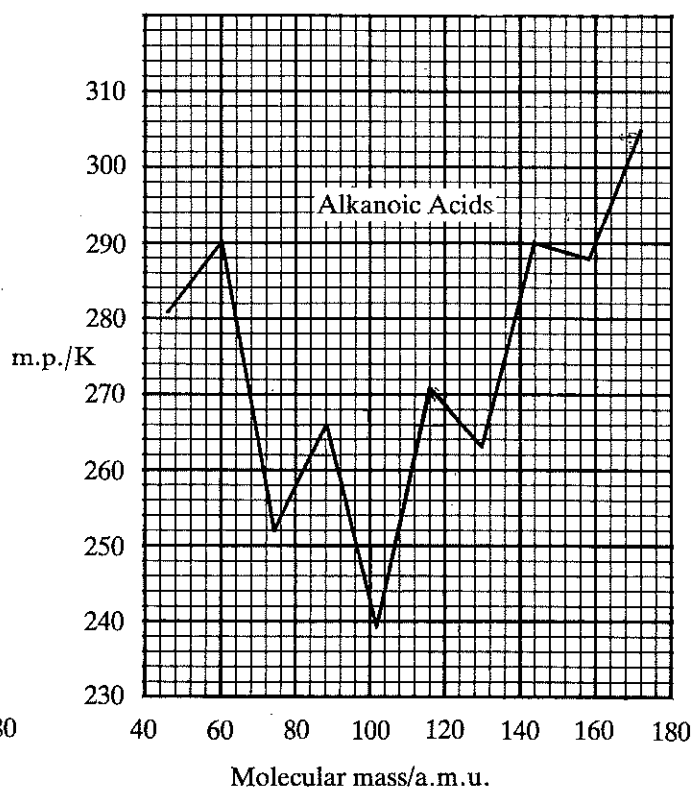
B. Graph 1 shows how the boiling points of the straight-chain alkanolic acids and the straight-chain alkanes vary with molecular mass.

Graph 2 shows how the melting points of the straight-chain alkanolic acids vary with molecular mass.

GRAPH 1 — BOILING POINTS



GRAPH 2 — MELTING POINTS



The following questions relate to Graph 1.

- (a) What are the boiling points of the **alkanes** of molecular mass
 - (i) 100 a.m.u.;
 - (ii) 128 a.m.u.?

2
- (b) Why do the boiling points of the alkanes increase with increasing molecular mass? 1
- (c) An alkanolic acid contains 6 carbon atoms.
 - (i) Give its formula and molecular mass. 2
 - (ii) Name the alkane of comparable mass. 1
 - (iii) What accounts for the higher boiling point of the alkanolic acid? 1

The following questions relate to Graph 2.

- (d) The melting points of the alkanolic acids are anomalous. Explain what is meant by the word "anomalous". 1
- (e) How many carbon atoms are there in the alkanolic acid which is a solid at room temperature (assume 293K)? 2
- (f) Explain why propanoic acid is found in the laboratory as a liquid but ethanoic acid is found sometimes as a liquid and sometimes as a solid. 2

(12)

[END OF QUESTION PAPER]

Page eleven