PERIODIC TABLE OF THE ELEMENTS

KEY: 79 (Atomic Number) · Au (Symbol of element) · 197.0 (Atomic Weight) · Gold (Name of element)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [98.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [210.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun — Ununnilium	111 Uuu — Unununium	112 Uub — Ununbium	113	114 Uuq — Ununquadium	115	116 Uuh — Ununhexium	117	118 Uuo — Ununoctium

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [146.9] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [239.1] Plutonium	95 Am [241.1] Americium	96 Cm [244.1] Curium	97 Bk [249.1] Berkelium	98 Cf [252.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.

2001
Higher School Certificate
Trial Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your student number and/or name at the top of every page

Section I - Pages 3 – 16
Total marks (75)
This section has two parts, Part A and Part B

Part A
Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Part B
Total marks (60)
Attempt questions 16 – 28
Allow about 1 hour 45 minutes for this part

Section II - Pages 16 – 29
Total marks (25)
Attempt ONE question from Questions 29-33
Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: ....

STUDENT NUMBER/NAME: .....

Section I

Total marks (75)

Part A

Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
1				
2				
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12				
13				
14				
15				

STUDENT NUMBER/NAME: .....

1. Microscopic membrane filters are used to:

   (A) electrolyse water
   (B) purify contaminated water
   (C) deionise water
   (D) remove heavy metals

2. What is the product formed from the dehydration of ethanol?

   (A) ethane
   (B) ethene
   (C) methane
   (D) ethanoic acid

3. The pH of washing soda and an oven cleaner were measured with a pH meter. The washing soda had a pH of 11.0 and the oven cleaner had a pH of 13.0. Compared with washing soda the concentration of hydroxide ions in the oven cleaner is:

   (A) 3 times greater
   (B) 3 times less
   (C) 100 times greater
   (D) 100 times less

4. The conjugate acid of HS^- is:

   (A) H_2SO_4
   (B) H_2S
   (C) S
   (D) S^{2-}

5. **Biological Oxygen Demand is:**

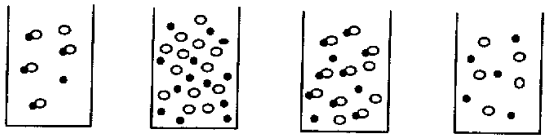
   (A) a measure of the number of aerobic organisms in a sample of water
   (B) a measure of organic wastes that can be broken down by organisms in a body of water
   (C) a measure of inorganic wastes that can be broken down by anaerobic organisms
   (D) the quantity of oxygen needed to respire organic wastes in a body of water

STUDENT NUMBER/NAME: .....

6. The following diagrams represent samples of 4 acids dissolved in water

   Which diagram represents a concentrated solution of a weak acid?

   (A) (B) (C) (D)



7. The process used industrially to convert some fractions from the refining of petroleum into useful products such as ethene is:

   (A) catalytic cracking
   (B) fractional distillation
   (C) polymerisation
   (D) dehydration

8. Some steps in the radioactive decay series for uranium-238 are shown in the following flow chart.

   $$^{238}_{92}U \rightarrow {}^{234}_{90}Th \rightarrow X \rightarrow {}^{234}_{92}U$$

   The type of radioactive decay to produce X and the name of element X are

   (A) alpha decay, protactinium
   (B) gamma decay, actinium
   (C) beta decay, neptunium
   (D) beta decay, protactinium

9. One of the more important effects of high turbidity (>25 NTU) in a freshwater system is:

   (A) all commercial species of fish die
   (B) photosynthetic activity is suppressed
   (C) marine mammals cannot see their food
   (D) heavy metals are removed

10. Which one of the following solutions, each 0.1 mol L^{-1}, has the highest pH?

(A) nitric acid
(B) sulfuric acid
(C) acetic acid (ethanoic acid)
(D) hydrochloric acid

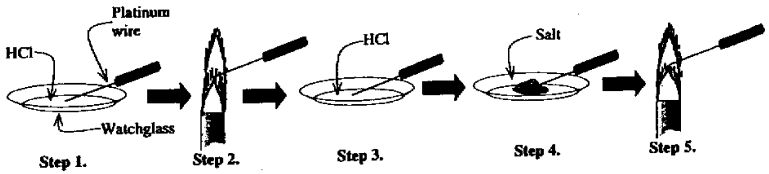
11. The table lists the boiling temperatures, in kelvins, of some alkanols and the corresponding alkanoic acids

Alkanols		Alkanoic Acids	
Substance	BP (K)	Substance	BP (K)
1-propanol	370	propanoic acid	414
1-butanol	390	butanoic acid	434
1-pentanol	411	pentanoic acid	459

The principal reason for the higher boiling temperatures of the alkanoic acids, compared with alkanols is:

(A) the greater dispersion forces between the molecules of the alkanoic acids
(B) ionic bonding that occurs in the alkanoic acids when they become ionised
(C) the stronger acidic properties of the alkanoic acids
(D) stronger hydrogen bonding between the alkanoic acid molecules

12. The diagram below shows the steps that a student could take to identify metal ions using a luminous flame.



What flame colour would Ca^{2+} ions produce, using this technique?

(A) red
(B) bright yellow
(C) green
(D) blue

13. A student constructed a galvanic cell using two different metals in electrolytes of the nitrate of the metals (1 mol L^{-1} solution). The combination of metals which would give the greatest potential difference is:

(A) magnesium and zinc
(B) zinc and nickel
(C) manganese and silver
(D) nickel and silver

14. The heat of combustion for four alkanols, in kJ mol^{-1}, is:

methanol : 715
ethanol : 1371
1-propanol : 2010
2-butanol : 2673

The alkanol (above) which produces the greatest amount of heat in kJ/g is:

(A) methanol
(B) ethanol
(C) 1-propanol
(D) 2-butanol

15. What is the pH of a solution with a hydroxide ion concentration of 7.2×10^{-9} mol L^{-1}?

(A) 4.86
(B) 5.86
(C) 8.14
(D) 9.14

STUDENT NUMBER/NAME: .....

Section I

Part B

Total marks (60)
Attempt questions 16 – 28
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Question 16 (5 marks) **Marks**

Vinyl chloride is a significant monomer used in the production of polymers.

(a) Give the common AND systemic name for the polymer made from vinyl chloride. **2**

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(b) Draw the structure of this polymer. **1**

(c) State ONE use of this polymer and a property which makes it useful for this purpose. **2**

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STUDENT NUMBER/NAME: .....

Question 17 (5 marks) **Marks**

Consider the following ions: CH_3COO^-, NH_4^+ and HPO_4^{2-}

(a) Which of the ions above can act as an amphiprotic species? **1**

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(b) Write equations showing its behaviour in the acidic and basic environment. **2**

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(c) Name a second chemical species which, together with this ion, can form a buffer solution in water. Briefly explain the buffering action in this example. **2**

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Question 18 (3 marks)

During your chemistry course you compared and evaluated the use of a mercury cell to a dry cell or lead/acid battery.
Evaluate the use of a mercury cell in comparison to EITHER a dry cell OR a lead/acid battery. **3**

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STUDENT NUMBER/NAME: .....

Question 19 (2 marks) **Marks**

Ethanol is an organic chemical with the potential to be used as an alternative fuel to fossil fuels. Discuss ONE advantage and ONE disadvantage of ethanol as an alternative to fossil fuels. **2**

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Question 20 (3 marks) **Marks**

Carbon dioxide, as a by-product of fermentation, is cooled and compressed to form 'dry ice' for use as a refrigerant and as a cleaning agent.

$$CO_{2(g)} \rightarrow CO_{2(s)}$$

(a) Calculate the volume of carbon dioxide gas at 25°C and 101.3 kPa pressure which could be obtained by the fermentation of 1.0 kg of glucose ($C_6H_{12}O_6$). **2**

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(b) What mass of solid carbon dioxide (dry ice) could be obtained? **1**

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STUDENT NUMBER/NAME: .....

Question 21 (4 marks)

In February the Richmond River in northern NSW experienced its most extensive fish kill recorded to date. NSW fisheries sampling data are shown in the table below.

Table 1: Water quality parameters recorded during the survey conducted along the lower Richmond River on 9 February (records taken at approx. 0.3 m depth)

Site	Dissolved O_2 (mg/L)	pH	Conductivity (ms/cm)	Turbidity (NTU)	Temp. (°C)
Dungarubba	0.07	6.4	0.010	24	26.3
Broadwater	0.06	6.4	0.090	25	25.9
Laws Pt	0.01	6.4	0.090	29	25.9
Goat Is.	0.40	6.2	0.114	25	25.4
Wardell	0.08	6.3	0.114	32	25.2
Pimlico	0.03	6.4	0.125	32	26.4

A Fisheries spokesperson suggested that the fish kill was caused by low oxygen levels in the water.

(a) Identify an additional item of information you need to assess the correctness of this statement. **1**

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(b) Suggest a reason for the water being sampled at a depth of 0.3 m. **1**

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(c) Explain why a low level of dissolved oxygen might be linked to: (i) water turbidity (ii) water temperature. **2**

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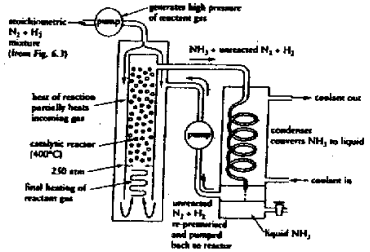
STUDENT NUMBER/NAME: .....

Question 22 (6 marks)

Marks

The Haber process for the production of ammonia could be shown diagrammatically as follows.



In this process nitrogen and hydrogen are fused using a catalyst. The equilibrium reaction can be expressed by the equation.

$$N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)} \qquad \Delta H = -92.4 \text{ kJ}$$

(a) Identify a catalyst used in the Haber Process and explain its role in the reaction. **2**

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(b) According the Le Chatelier's Principle a lower temperature favours a higher yield of ammonia at equilibrium. Explain why the reacting gases are heated to 400°C to optimise ammonia production. **2**

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(c) Give TWO reasons for the use of high pressure to optimise the production of ammonia. **2**

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STUDENT NUMBER/NAME: .....

Question 23 (7 marks)

Marks

As part of a practical investigation into esters, a student read in a practical manual that the ester methyl ethanoate can be prepared by heating methanol and ethanoic acid together, under reflux, in a flask to which a few millilitres of concentrated sulfuric acid has been added.

(a) Describe the apparatus you would use to heat the reactants safely, under reflux, in a school laboratory. **2**

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(b) State the purpose of heating under reflux. **1**

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(c) State TWO purposes for adding the concentrated sulfuric acid to the reaction mixture. **2**

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(d) Using structural formulae, write a balanced equation for the reaction between methanol and ethanoic acid. **2**

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STUDENT NUMBER/NAME: .....

Question 24 (4 marks)

Marks

To identify unlabelled samples of cyclohexane and cyclohexene, both colourless liquids, a group of students added a few drops of each to bromine water, under normal room lighting and under ultraviolet light.
The table summarises their observations.

Substance	Room Light	UV light
Liquid A	decolourises	decolourises
Liquid B	no change	decolourises

(a) Identify TWO risk factors you would consider in performing risk analysis for this experiment. **2**

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(b) Identify the liquid which is cyclohexane and, using a chemical equation, explain its reaction with bromine water. **2**

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Question 25 (2 marks)

When ammonia solution is added to a blue solution of copper(II) sulfate, a deep blue solution of $Cu(NH_3)_4^{2+}$ ions is formed.

(a) In this reaction, the copper(II) ions are acting as a Lewis acid. Explain why. **1**

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(b) Are the copper(II) ions also behaving as a Bronsted-Lowry acid, in this reaction? Explain your answer. **1**

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STUDENT NUMBER/NAME: .....

Question 26 (7 marks)

Marks

A strip of zinc metal is placed in a 1.0 mol L^{-1} solution of copper sulfate.

(a) State TWO changes you would observe. **2**

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(b) Write the oxidation and reduction half-equations for the reaction, identifying each. **2**

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(c) Draw a labelled diagram of a cell which uses this reaction to generate an electric current. **2**

(d) State the maximum voltage obtained from this cell. **1**

1.1V

STUDENT NUMBER/NAME: .....

Question 27 (6 marks) **Marks**

A student determined the concentration of acetic acid (ethanoic acid) in some white vinegar by titrating a sample of the vinegar that had been diluted, accurately, by a factor of 5. A standardised 0.0950 mol L^{-1} sodium hydroxide solution was used for the titration. The student's results are shown below.

Volume of diluted vinegar = 25.0 mL	
Volume of standardised sodium hydroxide solution (mL) :	
1st titration	34.2
2nd titration	33.5
3rd titration	33.7
4th titration	33.6

(a) Name the vessel in which the vinegar solution could be diluted accurately. **1**

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(b) The following indicators were available for the student to use.

Indicator	Colour Change	pH range
methyl orange	red-yellow	3.1 – 4.4
bromocresol green	yellow-blue	3.8 – 5.4
bromothymol blue	yellow-blue	6.2 – 7.6
phenolphthalein	colourless-red	8.3 – 10.0

Which of these indicators would be best for this titration? Explain why. **2**

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Excpt basic ans from basic salt

$CH_3COOH + NaOH \rightarrow H_2O + CH_3COO^- Na^+$

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$

(c) Calculate the concentration (in mol L^{-1}) of acetic acid (ethanoic acid) in the undiluted vinegar. **3**

$CH_3COOH + NaOH \rightarrow H_2O + CH_3COO^- Na^+$

3.192 3.192

0.12768 0.095

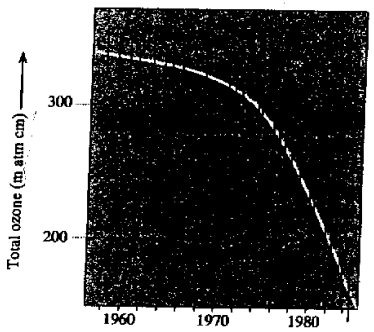
25 mL 33.6 mL

$\therefore$ factor by $5 = \times 5 = C \times 5 = 0.6384$ M.

STUDENT NUMBER/NAME: .....

Question 28 (6 marks) **Marks**

The graph below plots the ozone levels measured in Antarctica from 1957 to 1985.



(a) Draw an electron dot structure for ozone. **1**

O=O→O

(b) Identify the origins of CFC's in the atmosphere. **1**

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(c) Analyse the graph above and describe the changes observed. **1**

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rapid decrease from 1976

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(d) Discuss, using relevant chemical equations, the problems associated with the use of CFC's. **3**

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u.v. light

$CCl_2F_2 \rightarrow Cl$

Cl

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STUDENT NUMBER/NAME: .....

Question 29 – Industrial Chemistry (continued) **Marks**

(c) The formula below shows the structure of the soap, sodium stearate.

$CH_3(CH_2)_{16}COO^-Na^+$

(i) Name the TWO reactants required to be mixed and heated for this soap to form. **2**

(ii) In relation to the structure of the soap molecule, account for the cleaning action of soap. **4**

(iii) Sodium stearate is considered an anionic detergent. Describe how cationic detergents are chemically different and state ONE use for them. **3**

End of Question 29

STUDENT NUMBER/NAME: .....

Question 30 – Shipwrecks and Salvage (25 marks) **Marks**

(a) The ship RMS Titanic sank on its first voyage across the Atlantic Ocean in 1912. In 1985, deep-sea researcher, Bob Ballard was able to use deep-sea submersibles to locate, explore and photograph the wreck lying on the ocean floor in 3810 metres of water.

(i) The environmental conditions at the wreck of the RMS Titanic have been described as "extremely cold, totally dark with tremendous pressures due to the depth of the water".
Predict how these conditions would affect the rate of corrosion of this shipwreck's steel hull. **2**

(ii) Explain the different rate of corrosion for a submerged ship such as the Titanic with that of a ship such as the Cherry Venture (located on the coast of Fraser Island, Queensland) which is fully exposed at low tide. **2**

(iii) Explain how bacterial activity contributes to corrosion at great depth. **2**

(iv) A piece of leather clothing was removed from a 600-year-old wreck in the Mediterranean Sea by divers. It was in "reasonable condition" at the time of removal from the wreck but as the water evaporated from it at the surface, it underwent progressive deterioration. Using your knowledge of artefact preservation, account for this deterioration as evaporation occurred. **2**

(b) Often when describing a galvanic cell a useful shorthand notation is used. This question refers to the galvanic cell:

$Ni_{(s)} \mid Ni^{2+} \parallel Ag^+ \mid Ag_{(s)}$

(i) Identify the anode and cathode, and write the equation for the reaction. **2**

(ii) An external voltage can be used to reverse the cell reaction, making an electrolytic cell. State Faraday's First Law as it applies to this cell. **1**

(iii) Calculate the minimum voltage which must be applied to electrolyse this cell, under standard conditions. **1**

(iv) Describe THREE factors that affect the rate of this electrolysis reaction. **3**

Question 30 – Shipwrecks and Salvage continued on the next page

STUDENT NUMBER/NAME: .....

Question 30 – Shipwrecks and Salvage (continued) **Marks**

(c) In 1622, a galleon called Atocha was destroyed on a reef following a hurricane. Part of the cargo was silver and gold in wooden chests. In 1985 part of the valuable cargo was salvaged. The silver coins recovered were encrusted with limestone ($CaCO_3$). After removing the limestone, the silver coins were black on the surface.

(i) Explain how the silver coins became corroded and encrusted. **2**

(ii) Discuss TWO procedures that could be used to restore the silver to almost the condition it was in when the Atocha sailed in 1622. **2**

(d) Steel is the main structural material for bridges, cars and buildings. The controlling of its corrosion is extremely important. Describe the conditions under which rusting occurs and explain the process of rusting, using diagrams and chemical equations. **4**

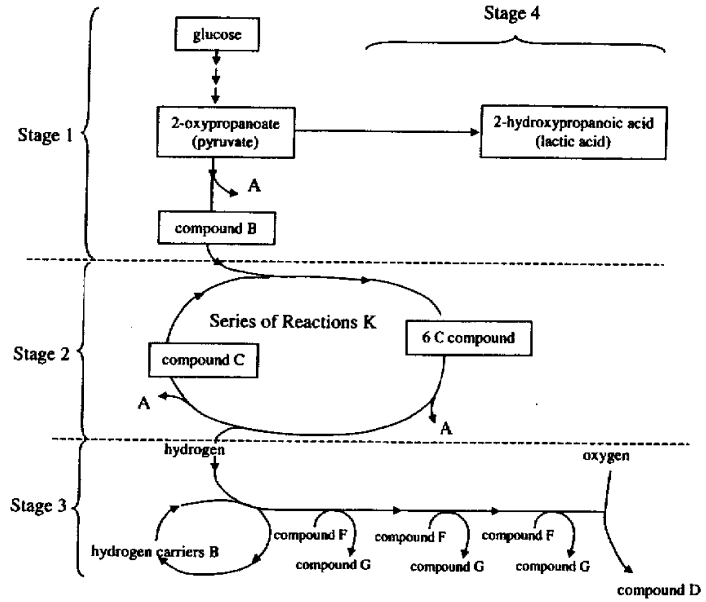
(e) Underground iron pipes are often protected from corrosion through cathodic protection. Describe how the process of cathodic production works for the iron pipe. **2**

End of Question 30

STUDENT NUMBER/NAME: .....

Question 31 – The Biochemistry of Movement (25 marks) **Marks**

(a) The diagram below represents an outline of the four stages in respiration in muscle cells.



(i) Identify which Stages occur during aerobic respiration. **1**

(ii) State the name for Stage I **1**

(iii) State the name of compound B **1**

(iv) What is the name given to the series of reactions K in Stage 2? **1**

(v) State the exact location within the cell where the series of reactions K occurs. **1**

(vi) Stage 2 is regarded as oxidative decarboxylation. What is the meaning of decarboxylation? **1**

Question 31 – Biochemistry of Movement continued on next page

21. (a) Need to know the normal (saturation) value of dissolved oxygen OR the minimum value of DO for fish to survive. **1**

(b) To obtain a representative value of the DO available, away from surface layer where value is higher due to contact with air. **1**

(c) (i) turbidity blocks light and inhibits photosynthesis
OR turbidity may be due to suspended organic material raising BOD **1**

(ii) oxygen's solubility in water decreases as the temperature increases **1**

22. (a) Iron provides a surface on which the molecules of N_2 and H_2 can be dissociated and condensed into NH_3 molecules, ie. accelerates the reaction. **2**

(b) Temp of 400°C to speed up the reaction and reach equilibrium faster. However this temp will favour a decrease in NH3 yield. If temp is too low then a higher yield but at a slower rate, so a compromise needed in conditions. **2**

(c) Increasing the pressure shifts the equilibrium to the right, and produces more ammonia. **1**
Higher pressure also accelerates the reaction by increasing the concentrations of the reactants (increased frequency of molecular collisions with the catalyst) **1**

23. (a) using a hotplate, heating mantle or water bath for heating **1**
using a condenser arranged vertically above the reaction flask **1**

(b) refluxing keeps the volatile reactants and products in the reaction vessel, while maintaining them at boiling temperature to speed the reaction. **1**

(c) sulfuric acid provides hydrogen ions that catalyse the reaction **1**
concentrated sulfuric acid absorbs water which is a product of the reaction, thus shifting the equilibrium towards the product. **1**

(d) $CH_3OH + CH_3COOH \rightarrow CH_3COOCH_3 + H_2O$ **2**

24. (a) flammability of liquids A and B)
toxicity of vapours of A, B, bromine) any 2 **2**
exposure of body to UV light)

(b) B = cyclohexane **1**
the reaction with bromine is <u>substitution</u> $C_6H_{12} + Br_2 \rightarrow C_6H_{11}Br + HBr$ **1**
UV light is needed to provide required activation energy

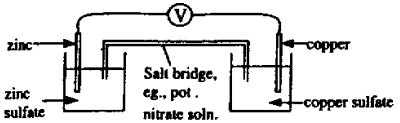
25. (a) the copper ion accepts the lone electron pair from the ammonia molecule. **1**

(b) no because copper ions have no hydrogen atoms to donate as protons. **1**

26. (a) A copper deposit forms on the zinc.)
The blue colour of the solution fades)
The temperature increases) any 2 **2**
Some of the zinc dissolves)

(b) oxidation $Zn_{(s)} \rightarrow Zn^{2+} + 2e^-$ **1**
reduction $Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$ **1**

(c)



2

(d) 1.10 V **1**