Lisachem Materials

Chemistry Physics Biology
Psychology

VCE CHEMISTRY 2007
TRIAL EXAM YEAR 12
UNIT 4

Time allowed: 90 minutes
Total marks: 80

SECTION A
Contains 20 multiple choice questions
22 minutes, 20 marks

SECTION B
5 Extended response questions
68 minutes, 60 marks

A data sheet and multiple choice answer sheet are provided. Answer extended response questions in the space provided. Use the marks and time allowed as a guide to how much time you should spend answering each question.

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relative atomic number
symbol
name
relative atomic mass

							1 H Hydrogen 1.0										2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulfur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 44.9	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.6	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yittrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium 98.1	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (266)	107 Ns Neilsbohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (272)	111 Rg Roentgenium (272)	112 Uub Ununbium (277)		114 Uuq Ununquadium (289)				

Lanthanide series	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.3	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinide series	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.1	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (255)	103 Lr Lawrencium (256)

Data Sheet VCE Chemistry 2007 Trial Exam Year 12 Unit 4

Physical Constants

F	= 96 500 C mol^{-1}
R	= 8.31 JK^{-1} mol^{-1}
V_m (STP)	= 22.4 L mol^{-1}
V_m (SLC)	= 24.5 L mol^{-1}

Specific heat of water = 4.18 J g^{-1} $^oC^{-1}$

Ideal gas equation

$pV = nRT$

The Electrochemical Series

		$E°$ in volt
$F_2(g) + 2e^-$	$\rightarrow 2F^-(aq)$	+ 2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^-$	$\rightarrow 2H_2O(l)$	+ 1.77
$Au^+(aq) + e^-$	$\rightarrow Au(s)$	+ 1.68
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$	$\rightarrow Mn^{2+}(aq) + 4H_2O(l)$	+ 1.50
$Cl_2(g) + 2e^-$	$\rightarrow 2Cl^-(aq)$	+ 1.36
$O_2(g) + 4H^+(aq) + 4e^-$	$\rightarrow 2H_2O(l)$	+ 1.23
$Br_2(l) + 2e^-$	$\rightarrow 2Br^-(aq)$	+ 1.09
$Ag^+(aq) + e^-$	$\rightarrow Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^-$	$\rightarrow Fe^{2+}(aq)$	+ 0.77
$I_2(s) + 2e^-$	$\rightarrow 2I^-(aq)$	+ 0.54
$O_2(g) + 2H_2O(l) + 4e^-$	$\rightarrow 4OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2e^-$	$\rightarrow Cu(s)$	+ 0.34
$CO_2(g) + 8H^+(aq) + 8e^-$	$\rightarrow CH_4(g) + 2H_2O(l)$	+ 0.17
$S(s) + 2H^+(aq) + 2e^-$	$\rightarrow H_2S(g)$	+ 0.14
$2H^+(aq) + 2e^-$	$\rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^-$	$\rightarrow Pb(s)$	- 0.13
$Sn^{2+}(aq) + 2e^-$	$\rightarrow Sn(s)$	- 0.14
$Ni^{2+}(aq) + 2e^-$	$\rightarrow Ni(s)$	- 0.23
$Co^{2+}(aq) + 2e^-$	$\rightarrow Co(s)$	- 0.28
$Fe^{2+}(aq) + 2e^-$	$\rightarrow Fe(s)$	- 0.44
$Zn^{2+}(aq) + 2e^-$	$\rightarrow Zn(s)$	- 0.76
$2H_2O(l) + 2e^-$	$\rightarrow H_2(g) + 2OH^-(aq)$	- 0.83
$Mn^{2+}(aq) + 2e^-$	$\rightarrow Mn(s)$	- 1.03
$Al^{3+}(aq) + 3e^-$	$\rightarrow Al(s)$	- 1.67
$Mg^{2+}(aq) + 2e^-$	$\rightarrow Mg(s)$	- 2.34
$Na^+(aq) + e^-$	$\rightarrow Na(s)$	- 2.71
$Ca^{2+}(aq) + 2e^-$	$\rightarrow Ca(s)$	- 2.87
$K^+(aq) + e^-$	$\rightarrow K(s)$	- 2.93
$Li^+(aq) + e$	$\rightarrow Li(s)$	- 3.02

VCE Chemistry 2007 Year 12 Trial Exam Unit 4

Section A

Section A consists of 20 multiple-choice questions.
Section A is worth approximately 25 per cent of the marks available.
*You should spend approximately **22 minutes** on this section.*
*Choose the response that is **correct** or **best answers** the question.*
Indicate your choice on the answer sheet provided.

Question 1.

Copper (II) hydroxide is relatively insoluble in water but will can dissolve in 2 M ammonia solution according to the equilibrium

$$Cu(OH)_2(s) + 4NH_3(aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq) + 2OH^-(aq)$$

The chemical formula of an hydroxide which would be most likely to react in a similar way in 2 M ammonia solution is

A. NaOH
B. $Ni(OH)_2$
C. $Mg(OH)_2$
D. LiOH

Question 2.

The operation of a nuclear device depends on the availability of a particular isotope, Y. At sufficiently high temperatures the following self-sustaining set of reactions can be initiated

$$Y + {}^1n \rightarrow {}^4He + X \qquad \textbf{1.}$$

$$X + X \rightarrow {}^4He + 2\,{}^1n \qquad \textbf{2.}$$

Y is an isotope of

A. hydrogen
B. beryllium
C. lithium
D. carbon

Question 3.

The fact that there must be a limit on the number of electrons which may be present in an atomic orbital was first recognised by

A. Pauli
B. Bohr
C. Rutherford
D. Dalton

Question 4.

When light from a sodium lamp is viewed through a spectroscope a series of coloured lines appears on a black background. This effect is due to the fact that

A. when sodium atoms are excited they absorb particular wavelengths of light as electrons drop back from a higher energy level to a lower energy level.
B. when sodium atoms are excited they emit energy as electrons move from energy levels close to the nucleus to energy levels further from the nucleus
C. when sodium atoms are excited electrons are promoted to higher energy levels each of these energy levels is represented by one of the coloured lines.
D. when sodium atoms are excited they absorb energy, which is then emitted as particular wavelengths of light as electrons return to lower energy levels.

Question 5.
An element which has high electronegativity could also be expected to
A. exist as a cation in many of its compounds
B. form a basic oxide
C. have a high first ionisation energy
D. be a strong reductant.

Question 6.
Which of the following statements about Mendeleev's periodic table is not correct?
A. There were gaps in his table
B. Each element had an atomic weight greater than the one before it
C. The table was used to predict the existence of some then unknown elements
D. The elements were arranged into vertical groups of elements with similar chemical properties.

Question 7.
Elements other than hydrogen are believed to have been manufactured by nuclear reactions occurring inside stars. As these reactions proceed within a star, the number of nuclei in the star
A. increases, and the mass of the star decreases
B. decreases, and the mass of the star increases
C. increases, and the mass of the star increases
D. decreases, and the mass of the star decreases

Question 8.
Electrolysis of 1 L of a 1.0 M $Cu(NO_3)_2(aq)$ solution using platinum electrodes results in copper being plated onto the negative electrode. The concentration of $Cu^{2+}(aq)$ in the solution after the passage of 20000 C of electrical charge is closest to
A. 0.1 M
B. 0.2 M
C. 0.8 M
D. 0.9 M

Question 9.
1 L of an aqueous solution contains 0.02 mol of each of the dissolved salts $FeCl_2$, $ZnCl_2$ and $CuCl_2$. Two graphite rods are placed in the solution and electrolysis is started. At the end of the electrolysis, all of the metal ions have been reduced at one of the graphite rods.

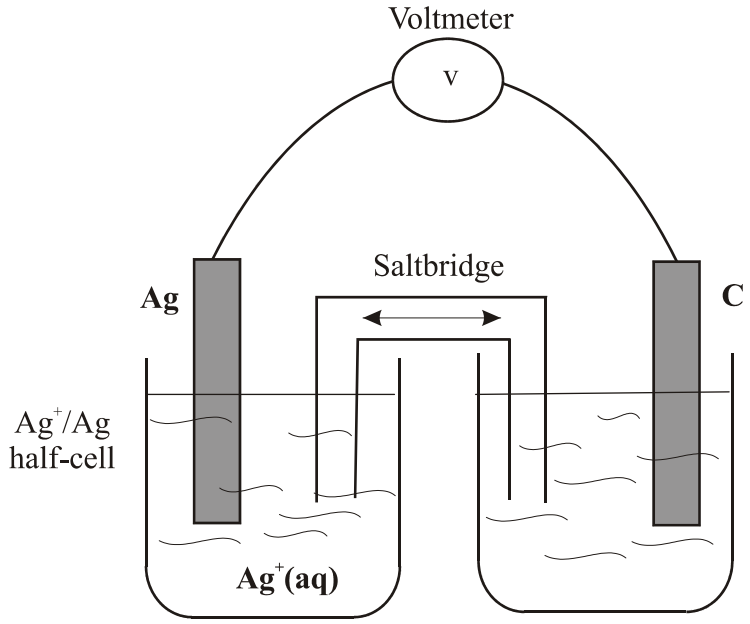
The three coatings on this graphite rod would be expected to be in the following order, from the inside to the outside
A. Zn Fe Cu
B. Fe Cu Zn
C. Cu Zn Fe
D. Cu Fe Zn

Question 10.
When a lead acid-accumulator, used as a common car battery, is being recharged, i.e. converting electrical energy into chemical energy, the following redox reaction occurs

$$2PbSO_4(s) + 2H_2O(l) \rightarrow Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq)$$

When a lead acid accumulator is discharging, i.e. delivering electrical energy
A. PbO_2 is reduced at the positive electrode
B. the pH decreases
C. the oxidation numbers of lead changes from +4 to +2 at the negative electrode.
D. H^+ is oxidised to water

Question 11.
The following galvanic cell was set up in a secondary college laboratory. All solutions were 1 M and at 25°C



Saltbridge

According to the electrochemical series, under standard conditions the cell should have a potential difference of 0.26 V. The reaction occurring at the right hand electrode would be

A. $Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$
B. $I_2(s) + 2e^- \rightarrow 2I^-(aq)$
C. $2I^-(aq) \rightarrow I_2(s) + 2e^-$
D. $2Br^-(aq) \rightarrow Br_2(l) + 2e^-$

Question 12.
The Australian Government's commonwealth cars now run on E10 ethanol blended fuel where ever possible. E10 fuel is a mixture of 10 per cent ethanol and 90 per cent petrol (octane).
The thermochemical equations for the combustion of octane and ethanol are shown below.

$2C_8H_{18}(g) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$, $\Delta H = -10090$ kJ mol^{-1}
$C_2H_5OH(l) + 9O_2(g) \rightarrow 2CO_2(g) + 6H_2O(g)$, $\Delta H = -1367$ kJ mol^{-1}

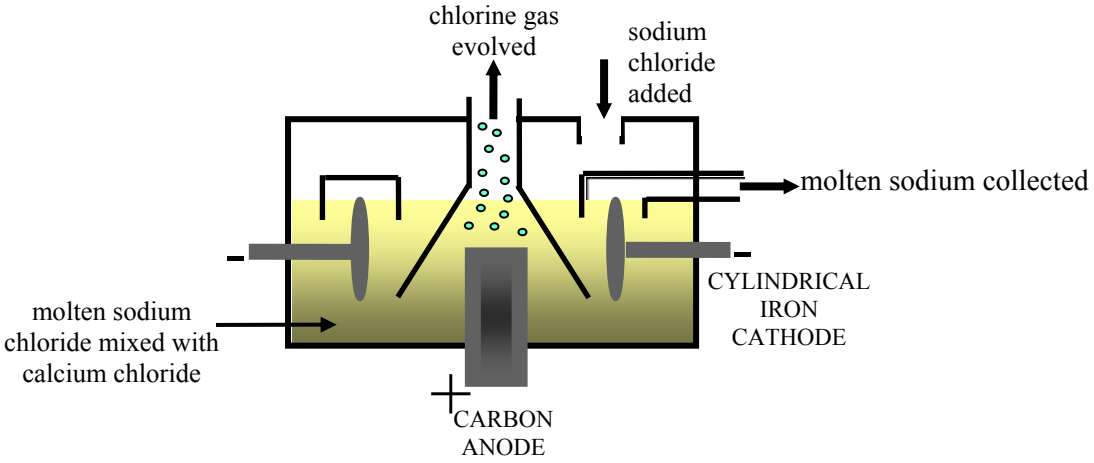
Compared to the combustion of octane, the combustion of ethanol

A. releases more energy for each gram combusted.
B. produces more CO_2 for each kJ of energy released.
C. uses less O_2 for each kJ of energy produced.
D. produces less CO_2 for each gram combusted.

Question 13.
An aqueous solution calorimeter containing 150 g of water was calibrated electrically. If the calorimeter was well insulated, the calibration factor (calorimeter constant) would be expected to be closest to?

A. 450 J K^{-1}
B. 700 J K^{-1}
C. 1.50 kJ K^{-1}
D. 630 kJ K^{-1}

Questions 14 and 15 refer to the electrolytic cell diagram shown below

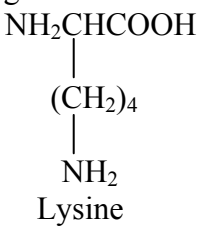


Question 14.
The electrolytic cell shown in the diagram is commonly known as the
A. Down's cell
B. Hall Cell
C. Diaphragm cell
D. Membrane cell

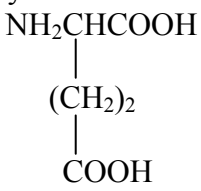
Question 15.
A possible explanation for the use of an iron cathode but a carbon anode is
A. sodium is a stronger reductant than iron and so is preferentially reduced.
B. iron is a stronger reductant than chloride ions and would be preferentially oxidised.
C. calcium ions would be reduced in preference to sodium ions at a carbon cathode
D. an iron anode would dissolve in the molten electrolyte.

Question 16.
During an electrolysis experiment, oxygen gas was produced at the (+) electrode. The electrolyte in the experiment could **not** have been
A. 1 M NaOH(aq)
B. 1 M $MgCl_2$(aq)
C. 1 M LiBr(aq)
D. 1 M KF(aq)

Question 17.
The amino acids lysine and glutamic acid are represented by the semi-structural formulae shown below

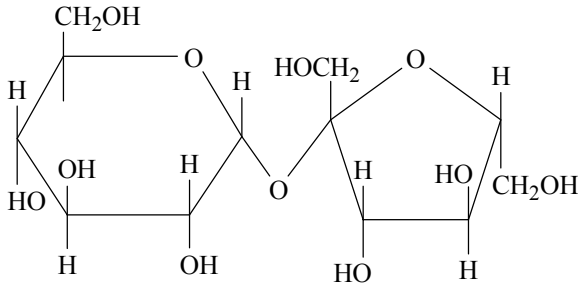


Lysine



In an aqueous solution of pH 12,
A. lysine molecules will be converted to ions each carrying a +1 charge
B. lysine molecules will be converted to ions each carrying a -1 charge
C. glutamic acid molecules will be converted to ions each carrying a +1 charge
D. glutamic acid molecules will be converted to ions each carrying a -1 charge

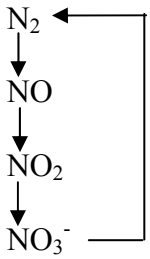
Question 18.
The structure of a common carbohydrate is shown below



The digestion of this carbohydrate produces
A. a pair of structural isomers
B. glucose and maltose
C. carbon dioxide and water
D. glycogen

Question 19.
Olive oil usually contains two polyunsaturated fatty acids; both of which have the same number of C atoms in their molecules.
Linoleic acid which is approximately 9% by mass of the oil and has the molecular formula $C_{18}H_{32}O_2$
Linolenic acid which is approximately 1% by mass of the oil and has a relative molecular mass of 278.
Linolenic acid molecules have
A. one C=C double bond
B. two C=C double bonds
C. three C=C double bonds
D. four C=C double bonds

Question 20.
Part of the nitrogen cycle may be represented as shown below



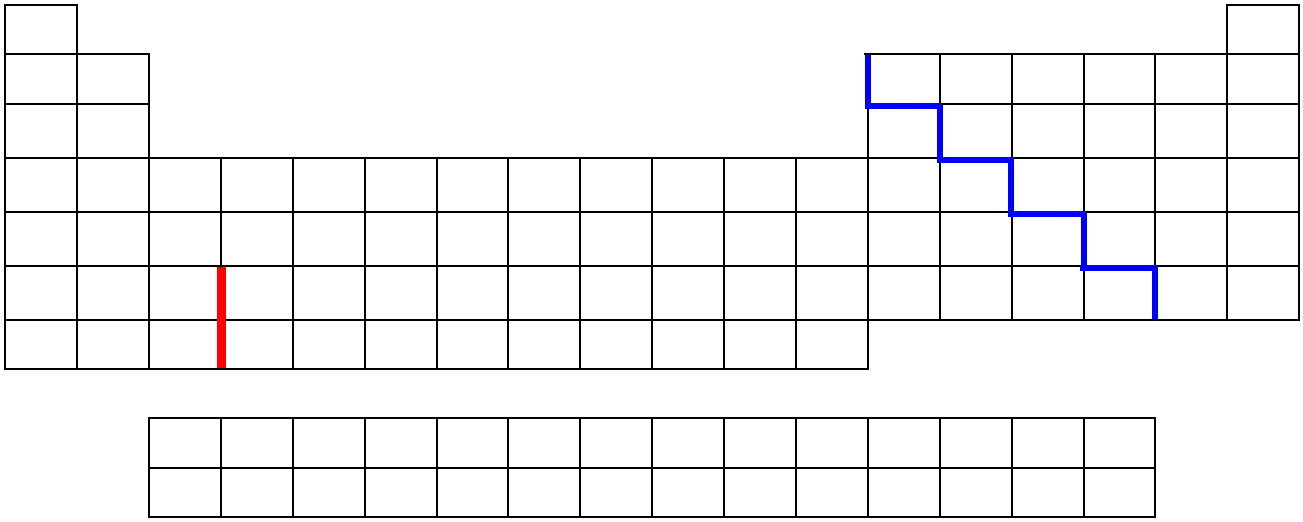
Which one of the following could **not** be involved in this part of the nitrogen cycle?
A. nitrogen fixing bacteria
B. high temperature combustion
C. lightning
D. denitrifying bacteria.

Section B

Section B consists of 5 short answer questions.
You should answer all of these questions.
This section is worth approximately 75% per cent of the total marks available.
You should spend approximately 68 minutes on this section of the examination.
The marks allotted are shown at the end of each part of each question.
Questions should be answered in the spaces provided.

Question 1.

For each part of this question, write, in its correct location on the blank periodic table below, the chemical symbol of the element which best matches the description given.



a) The most abundant element in the universe

b) The anode product of the electrolysis of molten potassium bromide

c) The cathode in a galvanic cell made from a $Ni^{2+}(aq)/Ni(s)$ half-cell and a $Pb^{2+}(aq)/Pb(s)$ half-cell.

d) The nucleus produced when a ^{192}Os nucleus emits a β-particle, i.e. $^{0}_{-1}e$

e) The gaseous product of photosynthesis.

f) The most electronegative element.

g) The element with atoms that have seven fully occupied subshells in the ground state.

h) The anodes used in the industrial production of aluminium by electrolysis.

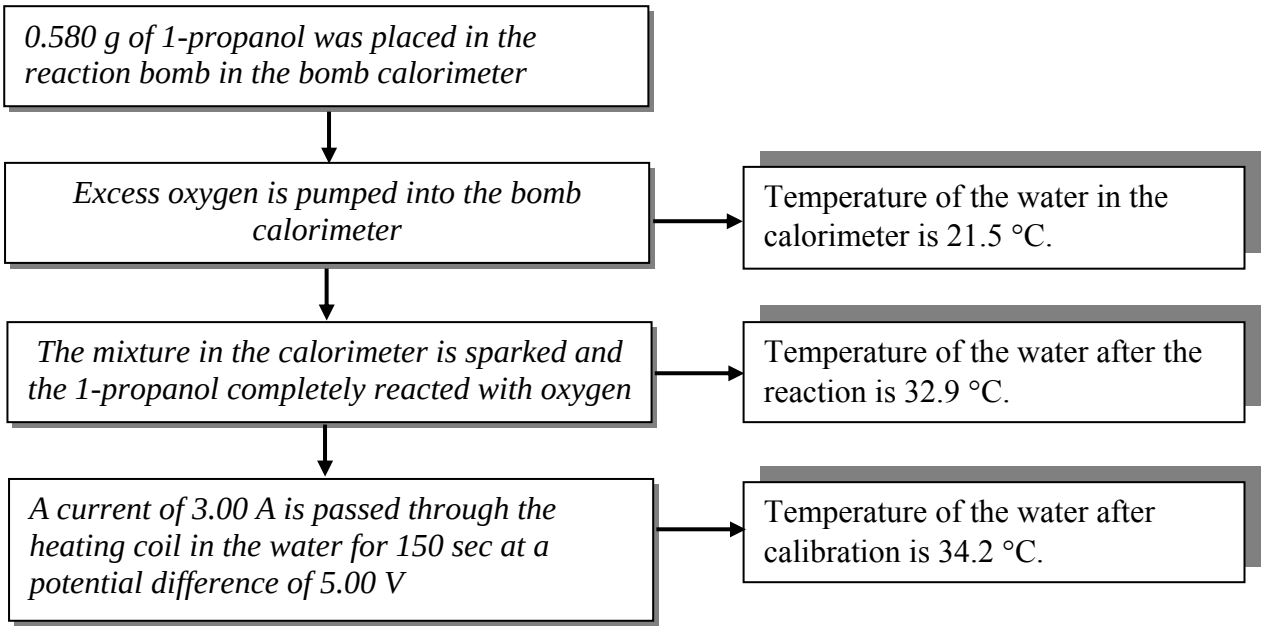
i) In the third period and forms an oxide which, whilst insoluble in water, reacts with aqueous solutions of both hydrochloric acid and sodium hydroxide.

j) The first transuranium element

10 marks

Question 2.

The heat of combustion of 1-propanol, C_3H_8O was determined by bomb calorimetry. The procedure followed is described in the flowchart below.



(a) Calculate the calibration factor of the calorimeter in kJ $°C^{-1}$

2 marks

(b) Calculate the energy released, in kJ, by the combustion of the 1-propanol in the calorimeter

2 marks

(c) Calculate the heat of combustion of 1-propanol, in

(i) kJ g^{-1}

(ii) kJ mol^{-1}

1+1 = 2 marks

(d) Write a balanced equation describing the combustion of 1-propanol.

2 marks

(e) Calculate the ΔH for the equation in (d)

2 marks

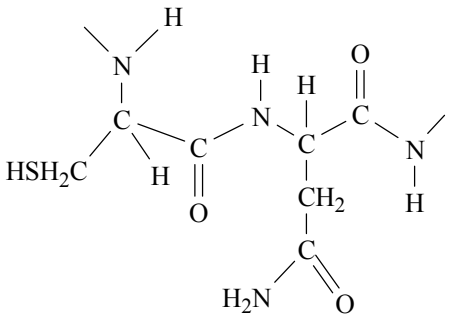
(f) Explain why the heat of combustion of petrol cannot be expressed in kJ mol^{-1}

1 mark

Total 11 marks

Question 3.

The diagram below shows a segment of a large molecule found in biological systems



(a) To what group of biological compounds does this molecule belong?

1 mark

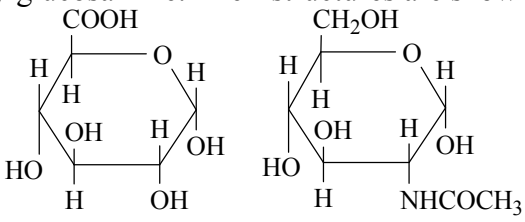
(b) Name the type of reaction involved in the formation of this molecule.

1 mark

(c) Molecules of this type assume particular structures based on bonding between different sections of the same molecule. Explain how hydrogen bonds influence the structure of these molecules.

2 marks

(d) Hyaluronic acid, a lubricant in bone joints, is a polysaccharide formed from the monosaccharides glucuronic acid and acetylglucosamine. Their structures are shown below



(i) On each of the structures above circle one functional group on each molecule which could be involved in the reaction to produce hyaluronic acid.

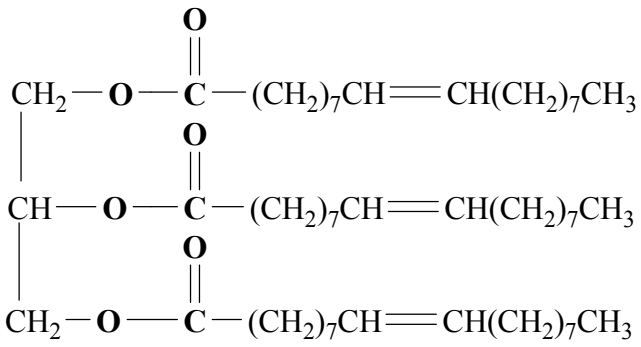
(ii) Write the name of the functional group formed when glucuronic acid and acetylglucosamine react together to produce hyaluronic acid.

(iii) Write the name and chemical formula of the monosaccharide from which the polysaccharides associated with the human diet are made?

(iv) Briefly describe the function of each of the three polysaccharides associated with the human diet.

1+1+1+3 = 6 marks

(e) Write semistructural formulae for the products of digestion of the substance shown below.



2 marks

(f) Write the names and chemical formula of the three compounds considered to be the 'end products of the body's use of food'.

3 marks
Total 15 marks

Question 4.
Hydrogen has recently charged into public awareness because of its potential benefits as an alternative to fossil fuels as an energy source.

(a) Write a balanced equation describing the combustion of hydrogen.

1 mark

(b) What would be the main environmental benefit of replacing fossils fuels with hydrogen as an energy source?

1 mark

(c) Hydrogen can be produced by the electrolysis of a dilute aqueous solution of potassium chloride. Write balanced half-equations for the reactions occurring at the (-) and (+) electrodes during this electrolysis.

(-) electrode

(+) electrode

2 marks

(d) Explain why hydrogen is not initially produced during the electrolysis of a 1M aqueous solution of copper(II) chloride.

2 marks

(e) Solar (photovoltaic) cells are considered to be a more environmentally desirable way of producing the electrical energy needed to produce hydrogen by electrolysis.

(i) Briefly describe the environmental advantage of solar cells and also identify one current problem with this technology.

(ii) What is the main energy transformation occurring in a photovoltaic cell?

2+1 = 3 marks

(f) Explain, using a balanced equation, how hydrogen is the 'source' of solar energy.

2marks

(g) Hydrogen-oxygen fuel cells provide a clean, efficient way to convert chemical energy directly into electrical energy.

(i) Write a balanced half-equation for the anode reaction in a hydrogen-oxygen fuel cell using an alkaline electrolyte.

(ii) State three essential properties of the electrodes in a hydrogen-oxygen fuel cell.

1+2 = 3 marks
Total 14 marks

Question 5.

(a) Ammonium nitrate, NH_4NO_3, a common fertiliser plays a significant role in food production. Why are nitrogenous fertilisers an essential part of the nitrogen cycle?

2 marks

(b) Lecithin, which has molecules with distinct polar and non-polar regions, is present in many foods! How does lecithin improve the quality of these foods?

2 marks

(c) Potassium atoms are larger than sodium atoms but have a lower first ionisation energy. Explain!

2marks

(d) Calcium atoms and manganese atoms both have two electrons in their fourth shells. Why does calcium exhibit only the +2 oxidation state in its compounds whereas manganese can exhibit oxidation states as high as +7?

2 marks

(e) When a freshly cut banana is exposed to air it quickly starts to brown. However if the lemon juice is squirted over the freshly cut banana the onset of browning is significantly delayed. What is the chemical basis of these observations?

2 marks

Total 10 marks

End of Exam