Mapping grid

Core Questions

Question	Mark	Content	Outcome	Band
1	1	Recall character of alkenes	H9	2–3
2	1	Recall the processes in the formation of the polymers	H9	3–4
3	1	Identify the processes in a redox reaction	H7	4–5
4	1	Recall function of lead-acid battery	H7	2–3
5	1	Predict atomic basis of radioactivity	H6	4–5
6	1	Assess use of radioisotopes in medicine	H4	3–4
7	1	Relate hydronium ion concentration to acidity	H9	4–5
8	1	Recall definition of Bronsted-Lowry theory	H8	2–3
9	1	Identify basis of definition of weak acid	H8	3–4
10	1	Recall experimental steps in esterification reaction	H9	2–3
11	1	Interpret graphical information with respect to equilibrium reaction	H14	4–6
12	1	Recall the application of atomic absorption spectroscopy	H3	2–4
13	1	Recall test for anions in solution	H8	2–4
14	1	Recall differences between oxygen and ozone	H7	3–4
15	1	Identify structural feature of ozone destroying molecules	H4	3–4
16 a i	1	Write equation for reaction of ethylene and water	H9	3–4
16 a ii	1	Give experimental conditions for reaction of ethylene with water	H9	2–3
16 b i	3	Write structures of monomers and the name of their polymers	H9	2–4
16 b ii	2	Recall features of addition polymerisation reactions	H9	3–4
16 b iii	1	Name intermolecular forces in polymer	H9	3–4
16 c i	1	Define the term 'biopolymer'	H9	2–3
16 c ii	1	State major chemical component of biomass	H9	2–3
16 d	4	Assess ethanol as an alternative fuel	H3	3–4

Question	Mark	Content	Outcome	Band
17 a i	1	Interpret Table of Standard Potentials	H7	4–5
17 a ii	2	Write oxidation and reduction half reactions	H7	4–6
17 a iii	1	Write balanced cell reaction	H7	4–5
17 b i	5	Sketch and label silver oxide 'button' cell	H3	3–4
17 b ii	2	Write cell reaction for 'button' cell	H7	4–5
18 a	1	Write balanced equation	H10	3–4
18 b	1	Calculate moles present in solution	H10	2–4
18 c	2	Calculate moles remaining after reaction	H10	2–4
18 d	1	Calculate moles of acid reacted	H10	3–4
18 e	2	Calculate initial mass from neutralisation data	H10	4–5
18 f	1	Calculate percentage composition	H10	3–4
19 a	2	Predict reaction from data	H14	5–6
19 b	2	Interpret equilibrium data	H14	5–6
19 c	2	State effect of reaction conditions on equilibrium	H8	4–5
19 d	2	Suggest manipulation of equilibrium to increase product	H8	4–5
20 a i	2	Recall Bronsted-Lowry definition	H8	2–3
20 a ii	2	State behaviour of species in terms of Bronsted-Lowry definition	H8	3–4
20 b i	2	Compare concentrations of acids	H7	3–4
20 b ii	2	Compare strengths of acids	H7	3–4
20 b iii	2	Compare hydrogen concentrations in acid solutions	H7	3–5
21 a	2	Write formula and note bonding types	H6	3–4
21 b	2	Explain importance of ozone layer to human health	H4	3–4
22 a	2	Select suitable test for water pollution	H11	4–5
22 b i	1	Interpret data on cation testing	H11	5–6
22 b ii	2	Write chemical equations	H10	4–5
23 a i	1	Write equilibrium expression	H13	3–4
23 a ii	3	Calculate value of equilibrium constant	H10	3–4
23 b i	1	Recall detail of Contact Process	H8	2–3
23 b ii	1	Write equation for combustion of sulfur	H10	3–4

Question	Mark	Content	Outcome	Band
23 b iii	3	Recall conditions that maximise yield in Contact Process	H8	2–3
23 b iv	2	Write equation for sulfuric acid acting as an oxidising agent	H7	3–4
23 b v	3	Specify safety precautions in transport and storage of concentrated sulfuric acid	H4	2–3
23 c i	3	Calculate gas production in stage of Solvay Process	H10	5–6
23 c ii	2	Recall issues with waste from Solvay Process	H4	3–4
23 d i	3	Describe detail of saponification experiment	H9	2–3
23 d ii	2	Recall features of surfactants	H9	3–4
23 d iii	1	Recall environmental concern related to use of washing powders and detergents	H4	2–3
24 a i	2	Recall process associated with electrolytic cell	H7	3–4
24 a ii	3	Note factors affecting electrolytic reactions	H7	3–4
24 a iii	1	Describe contribution of a scientist to electrochemistry	H2	2–3
24 b i	3	Recall characteristics of solubility of gases	H8	3–4
24 b ii	3	Outline experiment on rate of corrosion	H11	4–5
24 c i	4	Detail mechanism of corrosion of iron	H8	5–6
24 c ii	1	Recall effect of pH on corrosion	H8	3–4
24 c iii	4	Explain how iron can be protected from corrosion by zinc coating	H3	4–5
24 c iv	1	Explain observation of corrosion in deep ocean	H3	3–4
24 d	3	Explain wooden ship restoration processes	H3	3–4
25 a i	3	Explain structural differences in carbohydrates	H9	4–5
25 a ii	2	Relate properties of polymers to structure	H9	3–4
25 b	2	Explain trends in fatty acid melting points	H8	3–4
25 c i	2	Write general formula and note functional groups in amino acids	H9	3–4
25 c ii	2	Explain meaning of protein denaturation	H9	3–4
25 d i	2	Describe function of ATP	H9	3–4
25 d ii	1	Locate cell respiration in cellular organelle	H8	2–3

Chemistry HSC 2006

Question	Mark	Content	Outcome	Band
25 e i	3	Name major muscle proteins	H8	2–3
25 e ii	1	Recall structural difference between muscle types	H8	3–4
25 e iii	3	Discuss fuels used in muscle	H7	5–6
25 e iv	3	Relate lactic acid accumulation to muscle function	H7	4–5
25 e v	1	Give IUPAC name of lactic acid	H9	3–4
26 a	2	Recall method of preparation of canvas for painting	H1	2–3
26 b i	3	Explain flame tests for metals	H6	4–5
26 b ii	3	Relate atomic spectra to art conservation	H3	4–5
26 c	3	Discuss Bohr's model of the atom	H6	5–6
26 d	3	Relate X-rays to art conservation	H3	4–5
26 e i	4	Describe electronegativity of elements to position in Periodic Table	H6	3–5
26 e ii	2	Discuss factors that influence ionisation energy of atoms	H6	5–6
26 f i	2	Compare electron configuration of transition elements with main element Groups	H6	3–4
26 f ii	3	Relate properties of transition elements to electron structure	H6	4–5
27 a i	4	Describe use of electrophoretic techniques in identification of amino acids	H3	3–4
27 a ii	2	Describe forensic use of DNA in identifying relationships between individuals	H3	3–4
27 a iii	2	Examine ethical issues related to maintenance of DNA banks	H4	3–4
27 b	5	Describe structure of DNA	H9	2–4
27 c i	3	Describe meaning of term 'monosaccharide'	H9	2–3
27 c ii	1	Recall structure of sucrose	H9	2–3
27 d	5	Describe function of parts of mass spectrometer	H4	3–4
27 e	3	Describe use of spectroscopy in forensic science	H3	3–5

Marking guidelines

Section I – Part A

1	B	**2**	A	**3**	A	**4**	C
5	D	**6**	B	**7**	D	**8**	A
9	B	**10**	B	**11**	C	**12**	D
13	C	**14**	A	**15**	B		

Section I – Part B

Question 16a(i)
Suggested answer

$$C_2H_4 + H_2O \longrightarrow CH_3CH_2OH$$

Marking guidelines

Criteria	Marks
• correct balanced equation	1

Question 16a(ii)
Suggested answer
Phosphoric acid catalyst, temperature 300°C

Marking guidelines

Criteria	Marks
• correct conditions for reaction (accept catalyst and heat)	1

Question 16b(i)
Suggested answer

Monomer	Structure of Monomer	Name of Polymer
ethylene	CH_2CH_2	polyethylene
chloroethylene	CH_2CHCl	polyvinylchloride (or PVC)
phenylethylene	$CH_2C(C_6H_6)H$	polystyrene

Marking guidelines

Criteria	Marks
• correct structure of monomer and name of polymer (1 mark each)	3 total

Question 16b(ii)
Suggested answer
The polymer forms by monomers bonding together without the loss of any atoms.

Marking guidelines

Criteria	Marks
• monomers bond	1
• no loss of any atoms when bonds are formed	1

Question 16b(iii)
Suggested answer
Dispersion forces

Marking guidelines

Criteria	Marks
• dispersion (or Van der Waal forces)	1

Question 16c(i)
Suggested answer
Biopolymers are polymers that are totally, or in large part, made by living organisms.

Marking guidelines

Criteria	Marks
• polymers totally or largely made by living organisms	1

Question 16c(ii)
Suggested answer
Cellulose

Marking guidelines

Criteria	Marks
• cellulose	1

Question 16d
Suggested answer
Advantages – a renewable resource; potential to reduce greenhouse gas emissions
Disadvantages – large areas of agricultural land required to grow suitable crops; disposal of waste products from fermentation processes

Marking guidelines

Criteria	Marks
• Advantage – renewable resource	1
• Advantage – potential reduction of greenhouse gases	1
• Disadvantage – crops for production require large area of agricultural land	1
• Disadvantage – disposal of fermentation waste products	1

Question 17a(i)
Suggested answer
Any TWO of Mg, Al, Zn, Fe, Ni, Sn or Pb

Marking guidelines

Criteria	Marks
• any TWO of Mg, Al, Zn, Fe, Ni, Sn or Pb	1

Question 17a(ii)
Suggested answer
e.g. Oxidation half reaction $Mg \longrightarrow Mg^{2+} + 2e$
Reduction half reaction $2H^+ + 2e \longrightarrow H_2$

Marking guidelines

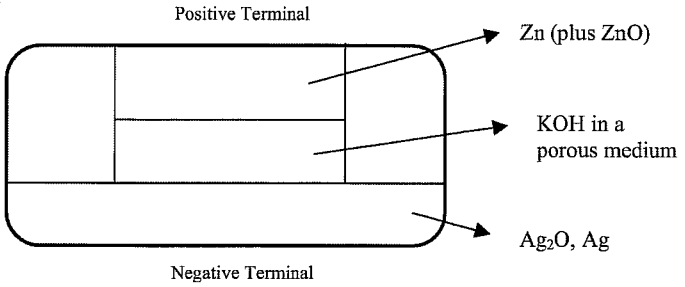
Criteria	Marks
• oxidation half reaction appropriate to metal chosen	1
• reduction half reaction $2H^+ + 2e \longrightarrow H_2$	1

Question 17a(iii)
Suggested answer
e.g. Redox cell reaction $Mg + 2H^+ \longrightarrow Mg^{2+} + H_2$

Marking guidelines

Criteria	Marks
• correct combination of half cell reactions to overall redox cell reaction (depending on metal chosen)	1

Question 17b(i)
Suggested answer



Marking guidelines

Criteria	Marks
• correct schematic sketch of cell	1
• correct labelling of electrodes and electrolyte (1 mark each)	3 total
• correct labelling of terminals	1

Question 17b(ii)
Suggested answer
$Zn(s) + Ag_2O(s) \longrightarrow ZnO(s) + 2Ag(s)$

Marking guidelines

Criteria	Marks
• correct formula of reactants and products	1
• balanced equation	1

Question 18a
Suggested answer
$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

Marking guidelines

Criteria	Marks
• correct balanced equation	1

Question 18b
Suggested answer
1000 mL has 1 mole NaOH, thus 11.2 mL has ((11.2/1000) × 1) moles = **1.12×10^{-2} moles**

Marking guidelines

Criteria	Marks
• correct working and result	1

Question 18c
Suggested answer
Since the mole ratio for reaction NaOH with HCl is 1:1, the amount of HCl reacted is 1.12×10^{-2} moles.
Thus, amount of HCl in beaker after reaction with shell, and before dilution to 25 mL, is $(25/10) \times 1.12 \times 10^{-2} =$ **2.8×10^{-2} moles**.

Marking guidelines

Criteria	Marks
• correct calculation of amount of HCl reacted	1
• correct result for undiluted acid	1

Question 18d
Suggested answer
Original amount HCl reacted, 10 mL of 5 $molL^{-1}$, is (10/1000) × 50 = 0.05 moles
Thus amount reacted with shell = 0.05 – 0.028 = 0.022 or **2.2×10^{-2} moles**

Marking guidelines

Criteria	Marks
• correct calculation of moles reacted with shell	1

Question 18e
Suggested answer
From equation in (a), 1 mole $CaCO_3$ reacts with 2 moles of HCl, thus number of moles of $CaCO_3$ reacting with HCl is 0.022/2 or 0.011 moles.
1 mole of $CaCO_3$ has mass of 100 g, thus 0.011 moles has a mass of $0.011 \times 100 =$ **1.10 g**.

Marking guidelines

Criteria	Marks
• correct calculation of number of moles $CaCO_3$ reacting	1
• correct conversion of moles to mass	1

Question 18f
Suggested answer
(mass of $CaCO_3$/mass of shell) × 100% = (1.10/1.306) × 100% = **84.2%**

Marking guidelines

Criteria	Marks
• correct calculation of percentage mass	1

Question 19a
Suggested answer
From information given, at constant pressure, an increase in temperature causes the equilibrium yield of product to decrease, i.e. the equilibrium system is changing in favour of the reactants. According to Le Chatelier's Principle, if reaction is exothermic, equilibrium will change to reduce the temperature, i.e. in backward direction reducing the yield of product.

Marking guidelines

Criteria	Marks
• reaction is exothermic	1
• increase in temperature causes the equilibrium yield of product to decrease	1

Question 19b
Suggested answer
From information given, at constant temperature, the percentage of product in the equilibrium vessel increases, i.e. the equilibrium system is changing in the favour of the product. According to Le Chatelier's Principle, the equilibrium system reacts to the change by decreasing its volume, i.e. in forward direction in favour of the product. Since 2 moles of gaseous reactants produces 1 mole of gaseous product, volume is reduced by the reaction going in the forward direction.

Marking guidelines

Criteria	Marks
• volume decreases	1
• at constant temperature, the percentage of product in the equilibrium vessel increases – since 2 moles of gaseous reactants produces 1 mole of gaseous product, the system is reacting to the change by decreasing its volume	1

Question 19c
Suggested answer
Low temperature; High pressure

Marking guidelines

Criteria	Marks
• low temperature	1
• high pressure	1

Question 19d
Suggested answer
According to Le Chatelier's Principle if an equilibrium is disturbed it will change to minimise the disturbance. To move the reaction to the right, i.e. to increase product, EITHER the concentration of reactants could be increased OR the concentration of product decreased by removing it from the equilibrium system.

Marking guidelines

Criteria	Marks
• statement of Le Chatelier's Principle	1
• EITHER increase concentration of reactants OR decrease concentration of product	1

Question 20a(i)
Suggested answer
An acid is a substance, that in solution, tends to donate protons, and a base is a substance that tends to accept protons.

Marking guidelines

Criteria	Marks
• acid is a proton donor	1
• base is a proton acceptor	1

Question 20a(ii)
Suggested answer
In the first reaction, HCO_3^- is acting as a base as it accepts H^+ to form H_2CO_3; in the second reaction, HCO_3^- is acting as an acid as it donated a proton to form CO_3^{2-}.

Marking guidelines

Criteria	Marks
• HCO_3^- is acting as a base as it accepts H^+ to form H_2CO_3	1
• HCO_3^- is acting as an acid as it donated a proton to form CO_3^{2-}	1

Question 20b(i)
Suggested answer
The concentration of an acid refers to the amount of solute in a volume of solution, thus hydrochloric acid is less concentrated.

Marking guidelines

Criteria	Marks
• hydrochloric acid is less concentrated	1
• concentration of an acid refers to the amount of solute in a volume of solution	1

Question 20b(ii)
Suggested answer
The strength of an acid refers to the degree of ionisation on dissociation in solution. Ethanoic is less ionised in solution and thus is the weaker acid.

Marking guidelines

Criteria	Marks
• ethanoic acid is the weaker acid	1
• strength of an acid refers to the degree of ionisation on dissociation in solution	1

Question 20b(iii)
Suggested answer
Since the pH, which is a measure of hydrogen ion concentration, of each acid is the same, the hydrogen ion concentration in solution must be the same.

Criteria	Marks
• the hydrogen ion concentration of each acid in solution is the same	1
• the pH, which is a measure of hydrogen ion concentration, is the same	1

Question 21a
Suggested answer
O_3; covalent and co-ordinate covalent bonds

Marking guidelines

Criteria	Marks
• O_3	1
• covalent and co-ordinate covalent bonds	1

Question 21b
Suggested answer
Ozone in the stratosphere absorbs much of the harmful UV rays from the sun. The UV rays absorbed can cause problems such as skin cancer and eye cataracts.

Marking guidelines

Criteria	Marks
• ozone absorbs much of the harmful UV rays from the sun	1
• UV rays absorbed can cause problems such as skin cancer and eye cataracts	1

Question 22a
Suggested answer
The main problems expected from sewage discharge would be disease-causing microorganisms and oxygen-demanding wastes. Thus water suspected to be contaminated by sewage would be tested for coliform bacteria counts and for biochemical oxygen demand (BOD). Both these indicators would have increased values compared to clean water.

Marking guidelines

Criteria	Marks
• water suspected to be contaminated by sewage would be tested for coliform bacteria counts and for biochemical oxygen demand	1
• increased values compared to clean water	1

Question 22b(i)
Suggested answer
Pb^{2+} (white precipitate with HCl) and Cu^{2+} (blue precipitate with OH^- which dissolves in NH_3)

Marking guidelines

Criteria	Marks
• Pb^{2+} and Cu^{2+}	1

Question 22b(i)
Suggested answer

$Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4$ $\quad$ $Cu^{2+} + 2OH^- \longrightarrow Cu(OH)_2$

Marking guidelines

Criteria	Marks
• $Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4$	1
• $Cu^{2+} + 2OH^- \longrightarrow Cu(OH)_2$	1

Section II
Question 23 – Industrial Chemistry
Question 23a(i)
Suggested answer
$Kp = p(N_2O_4)/p^2(NO_2)$

Marking guidelines

Criteria	Marks
• correct answer	1

Question 23a(ii)
Suggested answer
Change in pressure of N_2O_4 = 0.54 atm – 0.51 atm = 0.03 atm
Change in pressure of NO_2 = -(0.03 atm N_2O_4)(2 mol NO_2/1 mol N_2O_4) = -0.06 atm
Thus, equilibrium pressure of NO_2 = 0.56 atm + (-0.06 atm) = 0.50 atm
Now, $Kp = p(N_2O_4)/p^2(NO_2) = 0.54/(0.50)^2 =$ **2.2**

Marking guidelines

Criteria	Marks
• correct calculation of change in pressure that occurs at equilibrium	1
• correct calculation of equilibrium pressure of NO_2	1
• correct calculation of Kp	1

Question 23b(i)
Suggested answer
The process is called the Contact process because SO_2 and O_2 gases must come in contact with a catalyst.

Marking guidelines

Criteria	Marks
• correct answer	1

Question 23b(ii)
Suggested answer

$$S(s) + O_2(g) \longrightarrow SO_2(g)$$

Marking guidelines

Criteria	Marks
• correct equation	1

Question 23b(iii)
Suggested answer
Moderate temperatures (400–500°C)
Catalyst – vanadium(v) oxide
Pressures of 1–2 atm

Marking guidelines

Criteria	Marks
• moderate temperatures (400–500°C)	1
• catalyst – vanadium(v) oxide	1
• pressures of 1–2 atm	1

Question 23b(iv)
Suggested answer
Sulfuric acid can be used to oxidise copper to copper ions.

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$$

Marking guidelines

Criteria	Marks
• correct equation	1
• correct balancing of equation	1

Question 23b(v)
Suggested answer
Concentrated (98%) sulfuric acid can be safely stored or transported in steel containers. Care must be taken to avoid contamination of the acid with water, because water could set off a vigorous reaction between acid and a steel container.

Marking guidelines

Criteria	Marks
• can be safely stored or transported in steel containers	1
• avoid contamination of the acid with water	1
• water could set off a vigorous reaction between acid and a steel container	1

Question 23c(i)
Suggested answer
The equation for the reaction of carbon dioxide in the production of sodium hydrogen carbonate is:

$$NaCl + CO_2 + NH_3 + H_2O \longrightarrow NaHCO_3 + NH_4Cl$$

From equation, 1 mole CO_2 produces 1 mole $NaHCO_3$
or 24.5 L of CO_2 produces 84 g of $NaHCO_3$
thus amount required to produce 10^6 g (1 tonne) is $(24.5/84) \times 10^6 = \mathbf{2.9 \times 10^5}$ **L**

Marking guidelines

Criteria	Marks
• correct equation	1
• 24.5 L of CO_2 produces 84 g of $NaHCO_3$	1
• correct calculation of amount of CO_2 required	1

Question 23c(ii)
Suggested answer
The major issue is the disposal of the calcium chloride waste. Evaporation to dryness and disposal in a suitable burial site is an acceptable method of disposal.

Marking guidelines

Criteria	Marks
• calcium chloride waste	1
• evaporation to dryness and disposal in a suitable burial site	1

Question 23d(i)
Suggested answer
There are three main steps in a saponification reaction:
- Place the oil and alkali solution in a large beaker and heat for 30–60 minutes
- Add salt to precipitate the soap
- Filter and wash the soap

Marking guidelines

Criteria	Marks
• one mark for each correct step	3

Question 23d(ii)
Suggested answer
Surfactants are 'surface active' because they are able to alter the surface properties of water. Surfactants lower the surface tension of water so the water is more readily able to 'solubilise' oil or dirt particles and so move them off skin or fabric.

Marking guidelines

Criteria	Marks
• alter surface properties/ lower surface tension of water	1
• 'solubilise' oil or dirt particles so they can be removed from surfaces	1

Question 23d(iii)
Suggested answer
Phosphate pollution from 'builders' normally present in washing powders and detergents.

Marking guidelines

Criteria	Marks
• phosphate pollution.	1

Question 24 – Shipwrecks, Corrosion and Conservation
Question 24a(i)
Suggested answer
Oxidation occurs at the anode (the positive electrode in an electrolytic cell), and reduction occurs at the cathode (the negative electrode in an electrolytic cell).

Marking guidelines

Criteria	Marks
• oxidation occurs at the anode (the positive electrode in an electrolytic cell)	1
• reduction occurs at the cathode (the negative electrode in an electrolytic cell)	1

Question 24a(ii)
Suggested answer
The nature of the electrolyte.
The nature of the electrodes.
The concentration of ions present.

Marking guidelines

Criteria	Marks
• the nature of the electrolyte	1
• the nature of the electrodes	1
• the concentration of ions present	1

Question 24a(iii)
Suggested answer
Michael Faraday's work related to determining the amount of substance produced relative to the quantity of electricity passed through an electrolytic cell.

Marking guidelines

Criteria	Marks
• amount of substance produced relative to the quantity of electricity passed through an electrolytic.cell	1

Question 24b(i)
Suggested answer
The solubility of a gas changes as follows:
- decreased temperature increases solubility
- increased pressure increases solubility
- increased salinity decreases solubility

Marking guidelines

Criteria	Marks
• decreased temperature increases solubility	1
• increased pressure increases solubility	1
• increased salinity decreases solubility	1

Question 24b(ii)
Suggested answer
Make up solutions of various salinities, e.g. fresh water, sea water and dilutions of sea water with fresh water.
Place steel nails in each of the test solutions.
Qualitatively/visually observe the amount of rust forming over extended periods of time and record and report results appropriately.

Marking guidelines

Criteria	Marks
• make up solutions of various salinities	1
• place steel nails in each of the test solutions	1
• qualitatively/visually observe the amount of rust forming over extended periods of time	1

Question 24c(i)
Suggested answer
Iron and steel rust in the presence of oxygen and moisture. It is a galvanic process where iron(II) ions are formed by oxidation of iron, and hydroxide ions are formed by the reduction of oxygen in the presence of water. The products of the redox process result in the formation of iron(II) hydroxide; the iron(III) oxide (rust) is then formed from the oxidation of the hydroxide.

Marking guidelines

Criteria	Marks
• iron and steel rust in the presence of oxygen and moisture	1
• a galvanic process where iron(II) ions are formed by oxidation of iron, and hydroxide ions are formed by the reduction of oxygen in the presence of water	1
• the products of the redox process result in the formation of iron(II) hydroxide	1
• the iron(III) oxide (rust) is then formed from the oxidation of the hydroxide	1

Question 24c(ii)
Suggested answer
Galvanic corrosion occurs more rapidly in slightly acidic solutions.

Marking guidelines

Criteria	Marks
• occurs more rapidly in slightly acidic solutions	1

Question 24c(iii)
Suggested answer
Galvanising means the covering of the iron surface with a thin layer of a more reactive metal such as zinc. Instead of the iron(II) ions combining with hydroxide ions to start the formation of rust, zinc ions (formed by a galvanic reaction with iron(II) ions) preferentially react with the hydroxide ions to form zinc hydroxide (some of which is converted to zinc carbonate). These zinc compounds form an impervious layer over any exposed iron.

$$Zn + Fe^{2+} \longrightarrow Zn^{2+} + Fe$$

Marking guidelines

Criteria	Marks
• instead of the iron(II) ions combining with hydroxide ions to start the formation of rust, zinc ions preferentially react	1
• the zinc ions react with hydroxide ions to form zinc hydroxide	1
• the zinc compounds form an impervious layer over any exposed iron	1
• $Zn + Fe^{2+} \longrightarrow Zn^{2+} + Fe$	1

Question 24c(iv)
Suggested answer
Certain anaerobic bacteria can create conditions that cause corrosion in deep ocean water.

Marking guidelines

Criteria	Marks
• anaerobic bacteria can create conditions that cause corrosion in deep ocean water	1

Question 24d
Suggested answer
The extensive washing with fresh water removes salt from the wood. If salts were not washed out, crystals of salt would form as the wood dries out. These growing crystals would crack the wood.

Marking guidelines

Criteria	Marks
• extensive washing with fresh water removes salt from the wood	1
• if not washed crystals of salt would form as the wood dries out	1
• growing crystals would crack the wood	1

Question 25 – The Biochemistry of Movement
Question 25a(i)
Suggested answer
Glucose and galactose are six carbon sugars while fructose is a five carbon sugar. The difference between glucose and galactose is the orientation of the hydroxyl group on one of the carbon atoms.

Marking guidelines

Criteria	Marks
• glucose and galactose are six carbon sugars	1
• fructose is a five carbon sugar	1
• difference between glucose and galactose is the orientation of the hydroxyl group on one of the carbon atoms	1

Question 25a(ii)
Suggested answer
The glucose linkages are different in the two polymers resulting in a different orientation of those glucose molecules.

Marking guidelines

Criteria	Marks
• glucose linkages are different	1
• different orientation of the glucose molecules	1

Question 25b
Suggested answer
These three fats have an increasing number of carbon atoms and thus increased molar mass and increased intermolecular attraction. Increased intermolecular attraction is the prime reason for increasing melting point.

Marking guidelines

Criteria	Marks
• increasing number of carbon atoms and thus increased molar mass and increased intermolecular attraction	1
• increased intermolecular attraction results in increased melting points	1

Question 25c(i)
Suggested answer
General formula of amino acids is $H_2NCH(R)COOH$, where R is a carbon-containing side chain. The functional groups are the amine group (H_2N) and the carboxyl group (COOH).

Marking guidelines

Criteria	Marks
• general formula of amino acids is $H_2NCH(R)COOH$	1
• functional groups are the amine group (H_2N) and the carboxyl group (COOH)	1

Question 25c(ii)
Suggested answer
Functional proteins have a complex three dimensional shape. If this three dimensional shape is destroyed (by heating) the protein no longer will function as it should and is described as having been denatured.

Marking guidelines

Criteria	Marks
• functional proteins have a complex three dimensional shape	1
• if the three dimensional shape is destroyed (by heating) the protein no longer will be functional and is described as having been denatured	1

Question 25d(i)
Suggested answer
In cellular respiration the energy produced by the oxidation of carbon compounds is stored as ATP. The energy stored in ATP can then be released to provide energy for various aspects of cellular function.

Marking guidelines

Criteria	Marks
• in cellular respiration the energy produced by the oxidation of carbon compounds is stored as ATP	1
• energy stored in ATP can then be released to provide energy for various aspects of cellular function	1

Question 25d(ii)
Suggested answer
Mitochondrion.

Marking guidelines

Criteria	Marks
• mitochondrion	1

Question 25e(i)
Suggested answer
Myosin, actin, tropomysin and troponin. These proteins contribute to the structure of the thick and thin filaments in skeletal muscle.

Marking guidelines

Criteria	Marks
• myosin, actin, tropomysin and troponin	2
• the structure of the thick and thin filaments in skeletal muscle	1

Question 25e(ii)
Suggested answer
The Type 1 muscle cells contain fewer contractile filaments than do Type 2 cells.

Marking guidelines

Criteria	Marks
• fewer contractile filaments in Type 1 cells	1

Question 25e(iii)
Suggested answer
In long distance endurance running most of the energy required comes from the aerobic metabolism of carbohydrates, fats and protein. During an endurance run, as the demand for oxygen for aerobic respiration rises, anaerobic respiration is required to support the extra requirement for energy. The muscles of athletes that compete in short sprint events use anaerobic respiration because it provides high levels of energy at a rapid rate.

Marking guidelines

Criteria	Marks
• in long distance running most of the energy required is from the aerobic metabolism of carbohydrates, fats and protein	1
• in an endurance run, as the demand for oxygen for aerobic respiration rises, anaerobic respiration is required to supply energy	1
• in short sprint events use anaerobic respiration because it provides high levels of energy at a rapid rate	1

Question 25e(iv)
Suggested answer
In muscle cells, during bursts of extra hard work, amount of oxygen available to the muscle is insufficient and lactic acid is produced as the product of anaerobic respiration. The muscles accumulate what is known as oxygen debt by producing lactic acid from glucose. The accumulated lactic acid causes the sensation of muscle fatigue.

Marking guidelines

Criteria	Marks
• amount of oxygen available to the muscle is insufficient and lactic acid is produced as the product of anaerobic respiration	1
• muscles accumulate what is known as oxygen debt by producing lactic acid	1
• accumulated lactic acid causes the sensation of muscle fatigue	1

Question 25e(v)
Suggested answer
2-hydroxypropanoic acid.

Marking guidelines

Criteria	Marks
• 2-hydroxypropanoic acid	1

Question 26 – The Chemistry of Art
Question 26a
Suggested answer
Canvas is generally unsuitable for painting on directly since it is too rough and adsorbent. It is prepared for painting with layers of ground or priming.

Marking guidelines

Criteria	Marks
• canvas is rough and adsorbent	1
• prepared for painting with layers of ground or priming	1

Question 26b(i)
Suggested answer
The distinctive colours of some metal ions can be used to identify their presence in compounds using a flame test. When excited in a flame an electron jumps to a higher energy level. It then falls back to a lower energy state emitting a photon of radiation that is exactly equal to the difference in energy between the two levels in the atom. For some of these emissions the energy released is in the visible spectrum and so can be seen as visible light.

Marking guidelines

Criteria	Marks
• when excited an electron can jump to a higher energy level	1
• electron falls back to lower energy state emitting a photon of radiation	1
• if energy released is in the visible spectrum it can be seen as visible light	1

Question 26b(ii)
Suggested answer
A line absorption spectrum results when light is passed through a substance in the vapour phase with the resulting spectrum observed as a pattern of dark lines across a continuous spectrum. These spectra are used to identify different components of pigments, media and varnishes. Knowledge of the pigments, media and varnishes in a painting allow conservators to decide which products and techniques will be used in the restoration or conservation of a painting.

Marking guidelines

Criteria	Marks
• line absorption spectrum results when light is passed through a substance in the vapour phase and the resulting spectrum is observed as a pattern of dark lines across a continuous spectrum	1
• spectra are used to identify different components of pigments, media and varnishes	1
• allow conservators decide which products and techniques will be used in the restoration or conservation of a painting	1

Question 26c
Suggested answer
Bohr proposed, when studying the line spectrum of hydrogen, that in a hydrogen atom the electron moves around the nucleus in orbits without radiating energy. Only orbits of certain energy are allowed. Electrons can jump from one orbital to another by absorbing or emitting energy of a particular quantum amount. Bohr's model was limited in that it could not successfully explain the atomic spectra of elements other than hydrogen.

Marking guidelines

Criteria	Marks
• Bohr proposed that in a hydrogen atom the electron moves around the nucleus in orbits without radiating energy	1
• only orbits of certain energy are allowed and electrons can jump from one orbital to another by absorbing or emitting energy of a particular quantum amount	1
• Bohr's model was limited in that it could not successfully explain the atomic spectra of elements other than hydrogen	1

Question 26d
Suggested answer
X-ray diffraction is used in the chemistry of art. The diffraction pattern of X-rays seen from a painting is analysed for identification by comparison with patterns of known pigments. The information gained about pigments in a painting can be used for conservation or restoration of the artwork being studied.

Marking guidelines

Criteria	Marks
• the diffraction pattern of X-rays seen from a painting is analysed	1
• X-rays patterns seen from a painting is used for identification by comparison with patterns of known pigments	1
• information gained about pigments in a painting can be used for conservation or restoration	1

Question 26e(i)
Suggested answer
Electronegativity of an atom is a measure of its ability to attract electrons to itself. As you move from left to right across a Period, the trend in electronegativity is to increase; down a Group the electronegativity tends to decrease.

Marking guidelines

Criteria	Marks
• electronegativity of an atom is a measure of its ability to attract electrons to itself	1
• electronegativity increases from left to right across a Period	1
• down a Group the electronegativity tends to decrease	1

Question 26e(ii)
Suggested answer
Ionisation energy is influenced by the increasing number of protons (positive charge) in the nucleus as you go from left to right across a Period in the Periodic Table. As you go down a Group the ionisation energy is influenced by the distance of the outer electrons from the nucleus and the number of electron shells shielding outer electrons.

Marking guidelines

Criteria	Marks
• influenced by the increasing number of protons (positive charge) in the nucleus as you go from left to right across a Period	1
• down a Group the ionisation energy is influenced by the distance of the outer electrons from the nucleus	1
• down a Group the ionisation energy is influenced by the number of electron shells shielding outer electrons	1

Question 26f(i)
Suggested answer
The transition elements have electron configurations that include the filling of d-block orbitals. The other elements in the main groups of the Periodic Table have either empty or filled d-block orbitals.

Marking guidelines

Criteria	Marks
• transition elements have electron configurations that include the filling of d-block orbitals	1
• elements in the main groups of the Periodic Table have either empty or filled d-block orbitals	1

Question 26f(ii)
Suggested answer
The presence of partially filled d-orbitals in transition elements accounts for:
- often more than one stable oxidation state
- magnetic properties
- compound colours of metal ions

Marking guidelines

Criteria	Marks
• any two properties correct	2
• any one property correct	1

Question 27 – Forensic Chemistry
Question 27a(i)
Suggested answer
Electrophoresis involves separating the amino acids by exposing them to an electrical field. Negatively charged amino acids will move toward the positive electrode and those with a positive charge toward the negative electrode. Once the amino acids are localised in the electrophoresis gel, with a reagent such as ninhydrin, the distance moved is characteristic and can be used to identify the amino acid.

Marking guidelines

Criteria	Marks
• electrophoresis involves separating the amino acids by exposing them to an electrical field	1
• negatively charged amino acids will move toward the positive electrode and those with a positive charge toward the negative electrode	1
• amino acids are localised in the electrophoresis gel with a reagent such as ninhydrin	1
• the distance moved is characteristic of and can be used to identify the amino acid	1

Question 27a(ii)
Suggested answer
Because of the similarity of the human species, much of the genetic material (DNA) is similar. The uniqueness of a person's DNA comes from the so called non-coding bits of their DNA. If people are related then these non-coding bits of DNA show some similarity. People who are not related have very little of their non-coding DNA in common.

Marking guidelines

Criteria	Marks
• much of the genetic material (DNA) is similar – the uniqueness of a person's DNA comes from the so called non-coding bits of their DNA	1
• if people are related then these non-coding bits of DNA show some similarity	1

Question 27a(iii)
Suggested answer
If data banks of DNA samples exist, analysis of the DNA could give information about a person that would be an invasion of their privacy. Routine screening of such DNA, for example, could give access to information about genetic disorders.

Marking guidelines

Criteria	Marks
• analysis of the DNA could give information about a person that would be an invasion of their privacy	1
• routine screening of such DNA, for example, could give access to information about genetic disorders	1

Question 27b
Suggested answer
The DNA (deoxyribonucleic acid) molecule is a polymeric chain of nucleotides. Nucleotides consist of three components – a phosphate group, a pentose sugar group and a nitrogenous base. In DNA there are four possible nitrogenous bases that may be part of a nucleotide, split into two groups, the purines and the pyrimidines. Purines are double ringed structures and consist of the bases adenine and guanine, the pyrimidines have a single ringed structure and consist of cytosine and thymine. The sugar part of the nucleotide in DNA is deoxyribose. The DNA polymeric chain of nucleotides is formed by condensation reactions.
DNA in genetic material consists of two strands of nucleic acid that interact through hydrogen bonds between opposing bases to form a double helical structure. In the structure, adenine and thymine are present in the helix opposite each other, as are cytosine and guanine.

Marking guidelines

Criteria	Marks
• DNA molecule is a polymeric chain of nucleotides	1
• nucleotides consist of three components: a phosphate group, a pentose sugar group and a nitrogenous base	1
• purine bases are double ringed structures and consist of the bases adenine and guanine, the pyrimidine bases have a single ringed structure and consist of cytosine and thymine	1
• sugar part of the nucleotide in DNA is deoxyribose	1
• DNA genetic material consists of two strands of nucleic acid that interact through hydrogen bonds between opposing bases to form a double helical structure	1

Question 27c(i)
Suggested answer
Monosaccharides are carbohydrates that cannot be hydrolysed into two or more simpler sugars. The features of a monsaccharide are one carbonyl group and at least two hydroxyl groups. They have the empirical fromula CH_2O.

Marking guidelines

Criteria	Marks
• they cannot be hydrolysed into two or more simpler sugars	1
• they have one carbonyl group and at least two hydroxyl groups	1
• empirical fromula CH_2O	1

Question 27c(ii)
Suggested answer
Fructose.

Marking guidelines

Criteria	Marks
• fructose	1

Question 27d
Suggested answer
1. Atoms/molecules vaporised and ionised
2. Ions collimated into a fine beam
3. Ions accelerated in vacuum
4. Ions deflected by electromagnet
5. Ions detected

Marking guidelines

Criteria	Marks
• atoms/molecules vaporised and ionised	1
• ions collimated into a fine beam	1
• ions accelerated in vacuum	1
• ions deflected by electromagnet	1
• ions detected	1

Question 27e
Suggested answer
Spectroscopic methods permit routine and relatively simple ways of identifying inorganic and organic substances. They have been particularly useful in that the analyses can be performed on very small samples, much less than required by classical chemical analysis. An example of their use is in the monitoring of the environment and policing environmental legislation.

Marking guidelines

Criteria	Marks
• permit routine and relatively simple ways of identifying inorganic and organic substances	1
• analyses can be performed on very small samples	1
• monitoring of the environment (OR other suitable example)	1