Neap

Trial Examination 2023

HSC Year 12 Chemistry

Solutions and Marking Guidelines

SECTION I

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 1 B **B** is correct. The diagram shows the non-polar and polar components found in a soap molecule. An example of a soap molecule is sodium stearate. **A** is incorrect. A detergent molecule has a non-polar component similar to that shown in the diagram, but the polar end is different. An example of a detergent molecule is sodium lauryl sulfate. **C** is incorrect. A hydrocarbon contains carbon and hydrogen atoms only. **D** is incorrect. A polymer comprises many monomers joined together, but soap has separate molecules.	Mod 7 Organic Chemistry CH12–14 Bands 1–2
Question 2 A **A** is correct. Lowering the activation energy, E_a, enables a reaction to reach equilibrium faster. This is because a lower E_a means that more reactant molecules will have sufficient energy to overcome the E_a and react. **B** is incorrect. E_a has no effect on equilibrium position. **C** is incorrect. E_a affects both exothermic and endothermic reactions. **D** is incorrect. E_a applies to both equilibrium and non-equilibrium reactions.	Mod 5 Equilibrium and Acid Reactions CH12–12 Bands 2–3
Question 3 D **D** is correct. Dynamic equilibrium occurs in only closed systems where energy but not matter can be exchanged with the surroundings. Static equilibrium can occur in both open systems (where matter and energy can be exchanged with the surroundings) and closed systems. **A** and **B** are incorrect. Dynamic equilibrium is reversible in nature because the reactants and products are still participating in chemical reactions. On the other hand, static equilibrium is irreversible as no chemical reactions are occurring. **C** is incorrect. In dynamic equilibrium, the forward and backward reaction rates are equal. In static equilibrium, the reaction rates are zero because no reactions are occurring.	Mod 5 Equilibrium and Acid Reactions CH12–12 Bands 2–3
Question 4 A **A** is correct. This option is the only balanced equation with the correct states. **B** and **D** are incorrect. These options do not show the correct states. **C** is incorrect. This option is unbalanced.	Mod 6 Acid/Base Reactions CH12–6 Bands 2–3

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 5 D A buffer should contain a mixture of a weak acid and its salt or a weak base and its salt. Only option **D** meets these criteria.	Mod 6 Acid/Base Reactions CH12–13 Bands 2–3
Question 6 B The equation for this reaction is as follows. $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$ Solution X is $KNO_3(aq)$ and precipitate Y is $PbI_2(s)$.	Mod 5 Equilibrium and Acid Reactions CH12–6 Bands 4–5
Question 7 C A reaction proceeds spontaneously when $\Delta G^\circ < 0$ and non-spontaneously when $\Delta G^\circ > 0$. Letting $\Delta G^\circ = 0$ and solving $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ for T gives: $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ $0 = -30\,000 - (T \times -90)$ $30\,000 = 90T$ $T = 333$ K	Mod 5 Equilibrium and Acid Reactions CH12–6 Bands 5–6
Question 8 B The initial pH is 11, which implies that the initial solution was a weak base. The final pH is 1, which implies that a strong acid was added.	Mod 6 Acid/Base Reactions CH12–6, 12–13 Bands 3–4
Question 9 A $pOH + pH = 14$ $pOH = 14 - pH$ $14 - 3.5 = 10.5$ Hence, $[OH^-] = 1 \times 10^{-10.5}$ mol L^{-1}.	Mod 6 Acid/Base Reactions CH12–5, 12–13 Bands 4–5
Question 10 D **D** is correct. A Brønsted–Lowry base is defined as a substance that can accept a donated proton. **A** is incorrect. This option defines an Arrhenius acid. **B** is incorrect. This option defines an Arrhenius base. **C** is incorrect. This option defines a Brønsted–Lowry acid.	Mod 6 Acid/Base Reactions CH12–13 Bands 3–4
Question 11 C **C** is correct. This equation represents the addition reaction of an unsaturated hydrocarbon and is balanced. **A**, **B** and **D** are incorrect. In these equations, the hydrocarbons are saturated and will not undergo addition reactions. Option **D** is also an unbalanced equation.	Mod 7 Organic Chemistry CH12–14 Bands 3–4
Question 12 C An open system allows the flow of matter and energy in and out of a system. A closed system allows the flow of only energy.	Mod 5 Equilibrium and Acid Reactions CH12–2, 12–6 Bands 3–4

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 13 A Molecule *P* has a carboxyl group (COOH) and so is a carboxylic acid. Molecule *Q* has an amino group (NH_2) and so is an amine. Molecule *R* has an amide group (carbonyl group (C=O) attached to an N) and so is an amide.	Mod 7 Organic Chemistry CH12–14 Bands 4–5
Question 14 B The mass loss occurs due to the evolution of carbon dioxide (CO_2). It starts at zero, initially increases quickly and then settles to a steady value.	Mod 7 Organic Chemistry CH12–6, 12–14 Bands 3–4
Question 15 C **C** is correct. The reaction occurs according to the following equation. $C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2C_2H_5OH(aq) + 2CO_2(g)$ Stoichiometry shows that 2 mol of CO_2 was produced per mole of $C_6H_{12}O_6$. **A** is incorrect. The initial concentration was $\frac{5}{50} \times 100 = 10$ m/v%. **B** is incorrect. More yeast would have been formed during fermentation. **D** is incorrect. C_2H_5OH is also used as a solvent and a biofuel.	Mod 7 Organic Chemistry CH12–4, 12–14 Bands 4–5
Question 16 D **D** is correct. In mass spectra, the species have positive charges. **A** is incorrect. The species with the greatest mass-to-charge ratio is at m/z = 75. **B** is incorrect. This option shows a negative charge. **C** is incorrect. This option shows no charge.	Mod 8 Applying Chemical Ideas CH12–6, 12–14 Bands 3–4
Question 17 D The correct order is as follows. 1. Obtain a pure sample of the substance being investigated. (IV) 2. Prepare a solution containing a known mass of the substance being investigated. (III) 3. Separate the desired constituent. (II) 4. Determine the mass of the isolated constituent. (V) 5. Calculate the amount of the isolated constituent using its mass. (I)	Mod 8 Applying Chemical Ideas CH12–6, 12–15 Bands 3–4

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 18 **A** **A** is correct. A flame test is used to identify metallic ions (positive cations); the different cations produce different colours in the flames. **B** is incorrect. Anions can be identified using, for example, a precipitation reaction. **C** is incorrect. Organic compounds can be identified using, for example, chromatography, mass spectrometry and infrared spectroscopy. **D** is incorrect. Mineral acids can be identified using, for example, mass spectrometry.	Mod 8 Applying Chemical Ideas CH12–3, 12–15 Bands 3–4
Question 19 **C** Reading from the curve, an absorbance of 0.53 corresponds to a concentration of 0.350 mg per 100 mL. Therefore, 1.0 L of solution (and hence 10 g of ore) contains 3.5 mg of lead. $\%(\text{Pb}) = \frac{m(\text{Pb})}{m(\text{sample})} \times 100$ $= \frac{3.5 \times 10^{-3}}{10} \times 100$ $= 0.035\%$	Mod 8 Applying Chemical Ideas CH12–6, 12–15 Bands 5–6
Question 20 **C** The monomer has the formula C_2H_3Cl and a molar mass of 62.494 g mol^{-1}. n is the number of monomers in the chain. value of $n = \frac{MM(\text{sample})}{MM(\text{monomer})}$ $= \frac{623\,800}{62.494}$ $= 9982$	Mod 7 Organic Chemistry CH12–6, 12–14 Bands 4–5

SECTION II

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 21	
(a) They are the same.	Mod 5 Equilibrium and Acid Reactions CH12– 6, 12–12 Bands 1–2 • States that the reaction rates are the same 1
(b) The equation is $Fe^{3+} + SCN^- \rightleftharpoons FeSCN^{2+}$. The equilibrium expression is: $K_{eq} = \frac{[\text{products}]}{[\text{reactants}]} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]}$	Mod 5 Equilibrium and Acid Reactions CH12–6, 12–12 Bands 3–4 • Provides the correct equilibrium expression 1
(c) The equilibrium constant, K_{eq}, is a relatively large number, which suggests that at equilibrium there are significantly more products than reactants. This indicates that the equilibrium position lies to the right.	Mod 5 Equilibrium and Acid Reactions CH12–6, 12–12 Bands 2–3 • Provides a detailed explanation . . . . 2 • Provides some relevant information 1
Question 22	
(a) $NH_3(g) + 2CO(g) \rightleftharpoons HCN(g) + CO_2(g) + H_2(g)$ $\Delta H > 0$ *Note: The enthalpy change is not required to obtain the mark.*	Mod 5 Equilibrium and Acid Reactions CH12–12 Bands 1–2 • Provides the correct balanced equation 1
(b) *Change* / *Effect* adding a catalyst — no effect *(A catalyst enables the reaction to reach the equilibrium position faster but does not affect the position.)* increasing the pressure — no effect *(Volumes are equal on both the left-hand side and right-hand side.)* increasing the temperature — shifts the equilibrium to the right *(The reaction is endothermic.)* adding a quantity of an inert gas — no effect *(Volumes are equal on both the left-hand side and right-hand side.)*	Mod 5 Equilibrium and Acid Reactions CH12–12 Bands 2–3 • States all FOUR effects . . . . . 4 • States THREE effects . . . . . 3 • States TWO effects . . . . . 2 • States ONE effect OR • Provides some relevant information 1
(c) $HCN(aq) + H_2O(l) \rightleftharpoons CN^-(aq) + H_3O^+(aq)$ HCN: acid; H_2O: base; CN^-: conjugate base; H_3O^+: conjugate acid	Mod 6 Acid/Base Reactions CH12–13 Bands 3–4 • Labels BOTH pairs . . . . . 2 • Labels ONE pair 1

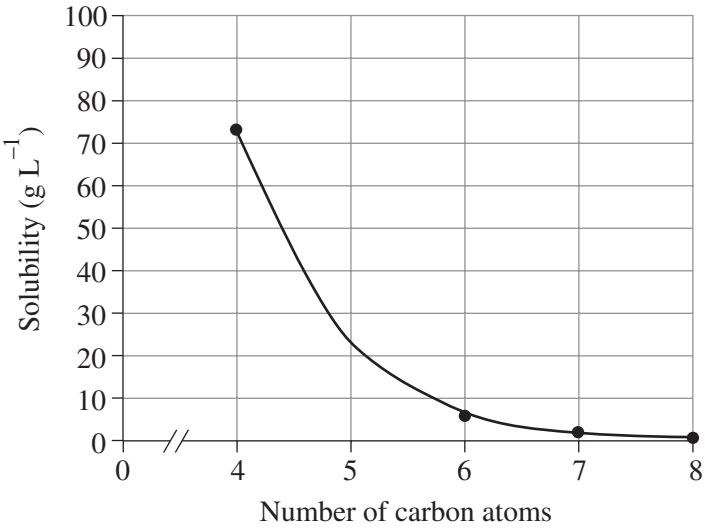
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 23	
The student explained some aspects of collision theory and reaction rate more successfully than others. Although the basic principles of the student's report are sound, the student incorrectly stated that activation energy is the maximum amount of energy required for a reaction to occur; however, it is the minimum amount. They used some appropriate language and terms, such as kinetic energy and activation energy, which are part of collision theory. However, they used poor terminology to address orientation. The student included accurate diagrams and an example to illustrate the theory. However, they did not accurately cross-reference the graph and the example reaction is not an equilibrium reaction. Overall, the student's report did not provide an in-depth analysis and described the relationship between collision theory and reaction rate with errors.	Mod 5 Equilibrium and Acid Reactions CH12–7, 12–12 Bands 4–6 • Provides a detailed evaluation. AND • Explains the strengths of the report. AND • Explains the weaknesses of the report. AND • Provides a judgement of the report . . . . . .5 • Explains the strengths of the report. AND • Explains the weaknesses of the report . . . . . .4 • Identifies the strengths of the report. AND • Identifies the weaknesses of the report . . . . . .3 • Identifies the strengths of the report. OR • Identifies the weaknesses of the report . . . . . .2 • Provides some relevant information 1

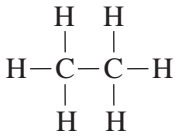
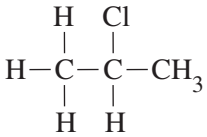
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 24	
(a) silver chloride, AgCl	Mod 5 Equilibrium and Acid Reactions CH12–6, 12–15 Bands 2–3 • Provides the correct name and molecular formula. 1
(b) the level of the substance's solubility in water *Note: The lower the K_{sp} value, the lower the solubility; the higher the K_{sp} value, the higher the solubility.*	Mod 5 Equilibrium and Acid Reactions CH12–5, 12–12 Bands 1–2 • Identifies the information provided by K_{sp} 1
(c) $K_{sp} = [Ag^+][Cl^-]$ $= 1.77 \times 10^{-10}$ $[Ag^+] = [Cl^-]$, hence $[Ag^+]^2 = 1.77 \times 10^{-10}$ mol L^{-1}. $[Ag^+] = \sqrt{1.77 \times 10^{-10}}$ $= 1.3304 \times 10^{-5}$ mol L^{-1} $MM(AgCl) = 143.35$ g mol^{-1} $m(AgCl)$ in 1 L $= MM \times c$ $= 143.35 \times 1.3304 \times 10^{-5}$ $= 1.91 \times 10^{-3}$ g L^{-1}	Mod 5 Equilibrium and Acid Reactions CH12–6, 12–12 Bands 5–6 • Determines the correct equilibrium expression. AND • Calculates the concentration of Ag^+. AND • Calculates the solubility. . . . . 4 --- • Determines the correct equilibrium expression. AND • Calculates the concentration of Ag^+ with some minor errors. AND • Calculates the solubility. . . . . 3 --- • Determines the correct equilibrium expression. AND • Calculates the solubility. OR • Determines the correct equilibrium expression. AND • Shows some relevant working. . . . . 2 --- • Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 25	
(a) when the addition of dilute hydrochloric acid (HCl) did not cause more evolution of the carbon dioxide (CO_2) gas	Mod 6 Acid/Base Reactions CH12–13, 12–15 Bands 2–3 • Provides an appropriate reason 1
(b) Reaction of egg shell: $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l)$ Stoichiometry shows that 1 mol of Ca^{2+} is produced per mole of calcium carbonate ($CaCO_3$). Precipitation: $Ca^{2+}(aq) + C_2O_4{}^{2-}(aq) + H_2O(l) \rightarrow CaC_2O_4.H_2O(s)$ Stoichiometry shows that 1 mol of Ca^{2+} is present in 1 mol of calcium oxalate monohydrate ($CaC_2O_4.H_2O(s)$). $n(CaC_2O_4.H_2O) = \frac{m}{MM}$ $= \frac{0.497}{146.116}$ $= 3.4014 \times 10^{-3}$ mol Hence, the number of moles of Ca^{2+} present in the initial mass of $CaCO_3$ is 3.4014×10^{-3} mol. $m(CaCO_3) = n \times MM$ $= 3.4014 \times 10^{-3} \times 100.09$ $= 0.3404$ g $\%(CaCO_3) = \frac{m(CaCO_3)}{m(\text{egg shell})} \times 100$ $= \frac{0.3404}{0.391} \times 100$ $= 87.1\%$	Mod 6 Acid/Base Reactions CH12–6, 12–13 Bands 5–6 • Shows all relevant chemical equations. AND • Calculates the amount of $CaC_2O_4.H_2O$. AND • Calculates the mass of $CaCO_3$. AND • Determines the percentage by mass . . . . 4 • Shows some relevant chemical equations. AND • Shows some relevant working. AND • Determines the percentage by mass . . . . 3 • Determines the percentage by mass. AND • Shows some relevant working. OR • Shows some relevant chemical equations . . . . 2 • Provides some relevant information 1
(c) *For example, any one of:* • No undissolved solid remained after the initial reaction between eggshell and HCl. • All of the $CaC_2O_4.H_2O$ was precipitated out; that is, it was totally insoluble. • No mass was lost when the $CaC_2O_4.H_2O$ was allowed to dry to a constant mass.	Mod 6 Acid/Base Reactions CH12–5, 12–13 Bands 5–6 • Identifies ONE assumption 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 26	
For example: The strength of an acid or base is a measure of how completely ionised the molecules become when dissolved in water. Strong acids and bases are completely (or nearly completely) ionised in aqueous solutions. Weak acids and bases are only partially ionised. This means that when comparing a strong acid with a weak acid of the same concentration, the strong acid will have more hydrogen ions (H^+) in the solution and thus a lower pH. Similarly, when comparing a strong base with a weak base of the same concentration, the strong base will have more hydroxide ions (OH^-) in solution and thus a higher pH. To investigate this in the laboratory, a range of aqueous solutions of various acids and bases were made. These were made to various concentrations; for example, 1 mol L^{-1}, 0.1 mol L^{-1} and 0.01 mol L^{-1}. A pH meter was calibrated using a buffer of known pH and was used to record the pH of each acidic solution. The meter's electrode was rinsed with distilled water between each test. The meter was re-calibrated for use with the basic solutions and the pH of each of these solutions were recorded in the same manner as the acidic solutions. It was found that acids with a low pH could be classified as strong (for example, hydrochloric, nitric and sulfuric) and acids with a higher pH could be classified as weak (for example, citric, ethanoic and phosphoric). Similarly, bases with a high pH could be classified as strong (for example, sodium hydroxide and potassium hydroxide) and bases with a lower pH could be classified as weak (for example, aqueous ammonia and magnesium hydroxide). Safety precautions taken included wearing safety glasses, ensuring all glassware was free from cracks and sharp edges, ensuring all electrical items had a current safety tag and working on a bench free from clutter.	Mod 6 Acid/Base Reactions CH12–7, 12–13 Bands 5–6 • Explains the investigation in detail. AND • Refers to how pH relates to acid and base strength. AND • Refers to the conclusions reached. AND • Refers to any safety precautions taken . . . . . 6–7 --- • Explains the investigation. AND • Refers to how pH relates to acid and base strength. AND • Refers to the conclusions reached. AND • Refers to any safety precautions taken . . . . . 4–5 --- • Describes the investigation with limited detail. AND • Refers to at least ONE conclusion reached. AND • Refers to at least ONE safety precaution taken . . . . . 2–3 --- • Provides some relevant information 1

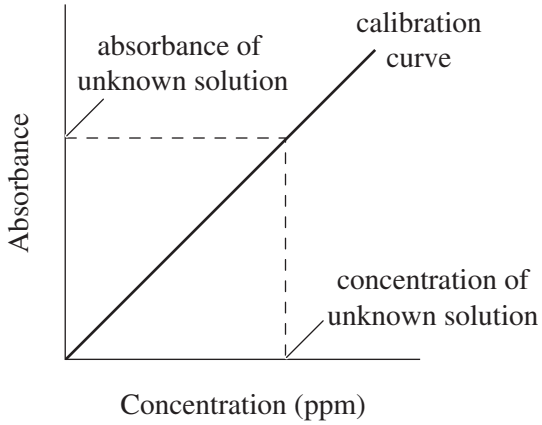
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 27	
(a) Reaction: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$ stoichiometry = 1 : 1 Hence: $V(HCl) \times c(HCl) = V(NaOH) \times c(NaOH)$ $23.45 \times 1.07 = 20.00 \times c(NaOH)$ $c(NaOH) = \frac{23.45 \times 1.07}{20.00}$ $= 1.25 \text{ mol L}^{-1}$	Module 6 Acid/Base Reactions CH12–6, 12–13 Bands 4–5 • Determines a 1 : 1 ratio. AND • Shows relevant working. AND • Calculates the concentration . . . . . 3 • Shows some relevant working. AND • Calculates the concentration . . . . . 2 • Shows some relevant working. OR • Calculates the concentration 1
(b) As the pipette was rinsed with water instead of the NaOH solution, residual traces of water would have caused there to be less NaOH in the 20.00 mL aliquot. Hence, less HCl would have been required to neutralise the NaOH, meaning that the titre obtained is lower than would be expected.	Mod 6 Acid/Base Reactions CH12–6, 12–13 Bands 4–5 • Explains the effect . . . . . 2 • Identifies the effect 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 28	
(a) refluxing	Mod 7 Organic Chemistry CH12–7, 12–14 Bands 1–2 • Identifies the technique 1
(b) *Any one of:* • The reactants and products are flammable/ noxious and could be dangerous if they were to escape from the reaction vessel; the technique ensures that these reactants and products are kept in the reaction vessel and not lost. • The reaction is an equilibrium reaction that takes some time to reach equilibrium; the technique increases the percentage yield of products by ensuring that they are kept in the reaction vessel and not lost.	Mod 7 Organic Chemistry CH12–12, 12–14 Bands 3–4 • Provides ONE appropriate reason. 1
(c) ester	Mod 7 Organic Chemistry CH12–14 Bands 1–2 • Provides the general name. 1
(d) 	Mod 7 Organic Chemistry CH12–4 Bands 2–3 • Plots the correct data points. AND • Uses appropriate scales. AND • Draws a line of best fit. AND • Labels axes . . . . . 3 • Any THREE of the above points. . . 2 • Any TWO of the above points. 1
(e) 22 g L^{-1} *Note: Accept responses consistent with the line of best fit. Consequential on answer to* ***Question 28(d)****.*	Mod 7 Organic Chemistry CH12–6 Bands 2–3 • Estimates the solubility 1

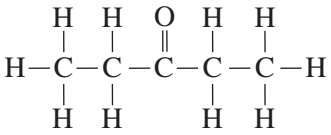
	Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(f)	The solubility of the alcohols decreases with increasing hydrocarbon chain length. For an alcohol to be soluble in water, the energy released when new intermolecular bonds form between the alcohol molecules and water molecules must be greater than the energy required to break the bonds between the alcohol molecules and the bonds between the water molecules. The alcohols have a covalent component (the hydrocarbon chain) and a polar component (the hydroxyl (OH) group). The hydroxyl group is hydrophilic and forms hydrogen bonds with water molecules but, as a result, the hydrocarbon chain becomes longer as the number of carbons increases. Consequently, the effect of the hydrogen bonding becomes proportionately less and solubility decreases.	Mod 7 Organic Chemistry CH12–7,12–14 Bands 5–6 • Identifies the trend. AND • Explains the energy changes involved. AND • Explains the bonding involved . . . . 3 --- • Identifies the trend. AND • Identifies the energy changes involved. OR • Identifies the bonding involved . . . . 2 --- • Identifies the trend. OR • Identifies the energy changes involved. OR • Identifies the bonding involved 1
Question 29		
	<table><tr><th>Structural formula of product</th><th>Name of product</th></tr><tr><td>  </td><td>ethane</td></tr><tr><td>  </td><td>2-chloropropane</td></tr></table>	Mod 7 Organic Chemistry CH12–14 Bands 2–4 • Identifies ethane. AND • Draws the structural formula of ethane. AND • Identifies 2-chloropropane. AND • Draws the structural formula of 2-chloropropane . . . . . 4 --- • Any THREE of the above points . . . 3 --- • Any TWO of the above points . . . . . 2 --- • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 30	
Hydrocarbons, which are often referred to as petrochemicals, are compounds that contain only hydrogen and carbon. They can be gases (for example, methane) or liquids (for example, crude oil) and have many uses. They tend to be used as fossil fuels and the raw materials for the production of more complex compounds (for example, as monomers for the production of polymers). The use of hydrocarbons has many environmental implications. They are extracted from the ground and this physical removal can damage sensitive environments as well as release toxic chemicals and greenhouse gases. Some companies that extract hydrocarbons claim that they have become more aware of their environmental impact and are putting practices into place that reduce damage to the environment. Additionally, burning hydrocarbons releases vast quantities of carbon dioxide, a greenhouse gas, into the atmosphere. Some vehicles that use hydrocarbon fuels such as diesel and petrol have become more fuel efficient and thus have less of a negative effect on the environment. Hydrocarbons are very useful chemicals, and the technology to extract and use them is well proven. Their use has implications for many economies. It has been estimated that in 2023 the petrochemical industry will be worth around a trillion Australian dollars annually. Many countries are financially dependent on exporting hydrocarbons and many people are employed in hydrocarbon-related industries. A large number of countries are reliant on hydrocarbons for heating and power stations. From a sociocultural perspective, the use of hydrocarbons has provided benefits such as the invention of durable polymers, including PVC and polystyrene. However, in recent years, many people have become concerned about the negative impacts of hydrocarbons on the environment and their contribution to global warming. Despite the many negative aspects of using hydrocarbons, they will most likely continue to play an important industrial role for many years. This is due to the benefits of using them, familiarity, the quantity of existing infrastructure and the absence of alternative materials. *Note: Responses may refer to environmental, economic and sociocultural implications. Students can obtain full marks by referring to only one of these areas provided that sufficient detail is given.*	Mod 7 Organic Chemistry CH12–7, 12–14 Bands 5–6 • Refers to a wide range of implications. AND • Discusses the implications in detail . . . . . .6–7 • Refers to a range of implications. AND • Discusses the implications adequately . . . . . .4–5 • Refers to at least TWO implications. AND • Outlines the implications . . . . . .3 • Refers to at least TWO implications . . . . . .2 • Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 31	
For example: A qualitative test is designed to identify the type of species present. Both compounds have a hydroxyl (OH) group, but they have different functional groups. Compound *A* is an alcohol and compound *B* is a carboxylic acid. An organic acid could be added to compound *A* and gently heated; this would produce the sweet smell of an ester. Alternatively, ceric ammonium nitrate solution, which has an orange-yellow colour, could be added; this would cause the mixture to turn red. Sodium hydrogen carbonate ($NaHCO_3$) could be added to compound *B*; this would effervesce, evolving bubbles of CO_2. Alternatively, an alcohol could added to compound *B* and gently heated; this would produce the sweet smell of an ester.	Mod 8 Applying Chemical Ideas CH12–14 Bands 4–5 • Outlines qualitative tests. AND • Identifies compound *A*. AND • Identifies compound *B*. AND • Explains at least TWO tests that could be used to differentiate the compounds . . . .5–6 --- • Identifies compound *A*. AND • Identifies compound *B*. AND • Outlines at least TWO tests that could be used to differentiate the compounds . . . . . .4 --- • Identifies compound *A*. AND • Identifies compound *B*. OR • Outlines at least TWO tests that could be used to differentiate the compounds . . . . . .3 --- • Identifies at least ONE test that could be used to differentiate the compounds . . . . . .2 --- • Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 32	
Colourimetry is a technique used to measure the concentration of a particular compound in a coloured solution. A colourimeter is a device that measures how much light of a particular frequency is absorbed by a liquid. The technique is based on the principle that the concentration of a coloured solute is proportional to the light absorbance of that solute, according to the Beer–Lambert law. Simply, this means that, if a light is shone through a coloured solution, a more concentrated solution will allow less light to pass through it. In the colourimeter shown, polychromatic light is passed through a slit, which controls the amount of light that passes into a condenser lens. The condenser lens focuses this light onto a filter. The filter passes monochromatic light of a frequency that will be absorbed by the sample solution being tested. The cuvette contains the sample; some light is absorbed by the sample as the light passes through the sample. The light that is not absorbed is then collected by the photocell and electricity is generated. The lower the concentration, the greater the amount of light that passes through the sample, and the greater the amount of electricity that is generated. Conversely, the higher the concentration, the lesser the amount of light and the lesser the amount of electricity. The electrical signal is translated into a number or reading on a digital scale. Before a colourimeter can be used for testing a particular solution, it needs to be calibrated. This involves making up standard solutions of known concentration of the substance under investigation. These should be in the approximate range of the concentration of the sample. The absorbances of these solutions are determined and the values plotted as a calibration curve, as shown in the diagram. The absorbance of the sample is compared to the calibration curve and its concentration calculated.  *Note: Responses are not required to include a diagram to obtain full marks.*	Mod 8 Applying Chemical Ideas CH12–7, 12–15 Bands 5–6 • Explains the purpose of colourimetry. AND • Explains the principle behind colourimetry. AND • Explains how a colourimeter works with reference to ALL the components in the diagram. AND • Explains colourimetry calibration . . . . . .5–6 • Outlines the purpose of colourimetry. AND • Outlines the principle behind colourimetry. AND • Explains how a colourimeter works with reference to some of the components in the diagram . . . . . .3–4 • Outlines the purpose of colourimetry. OR • Outlines the principle behind colourimetry. AND • Outlines how a colourimeter works with reference to some of the components in the diagram . . . . . .2–3 • Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 33	
(a) The molecular formula is $C_5H_{10}O$. The empirical formula is $C_5H_{10}O$, so the molecular formula is determined using $n \times (C_5H_{10}O)$. The molar mass of the compound is 86.13 g mol^{-1}. $12.01 \times 5 + 1.008 \times 10 + 16.00 = 86.13$ g mol^{-1}; therefore, $n = 1$, so the molecular formula is the same as the empirical formula.	Mod 7 Organic Chemistry CH12–6, 12–14 Bands 2–3 • Determines the correct molecular formula. AND • Justifies the answer . . . . . 2 • Determines the correct molecular formula 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(b) **Structure:**  **Name:** pentan-3-one The molecular formula is $C_5H_{10}O$, which means that oxygen is present. This cannot be present in a hydroxyl group (OH) because OH does not fit the formula, and the infrared spectrum does not show absorption at the corresponding frequency (3230–3550 cm^{-1}). There is strong absorption at 1700 cm^{-1}; this corresponds to a carbonyl group (C=O), which indicates an aldehyde or ketone. The carbon-13 NMR spectrum shows peaks at 10 ppm and 33 ppm, which indicate carbon–carbon single bonds. The peak at 215 ppm corresponds to C=O, again indicating an aldehyde or ketone. The proton NMR shows two groups/environments. The triplet at 1 ppm and the quartet at 2.5 ppm show that there are CH_2 and CH_3 groups next to each other. As there are only two major groups, this indicates a symmetry where there are two groups of CH_3–CH_2–. This information points to a molecule with the C=O group in a central position, thus the compound is a ketone and not an aldehyde as C=O is chain-ending in an aldehyde. Therefore, the chemical formula of the compound is $CH_3CH_2COCH_2CH_3$ and the name is pentan-3-one.	Mod 8 Applying Chemical Ideas CH12–6, 12–14 Bands 5–6 • Draws the structure of the compound. AND • Names the compound. AND • Provides detailed justification. AND • Refers to ALL spectra . . . . . 5 --- • Draws the structure of the compound. AND • Names the compound. AND • Provides justification. AND • Refers to at least TWO spectra . . . . 4 --- • Draws the structure of the compound. AND • Names the compound. AND • Provides adequate justification. AND • Refers to at least ONE spectra . . . . . 3 --- • Draws the structure of the compound. AND • Names the compound. AND • Provides some justification . . . . . 2 --- • Provides some relevant information 1

