2021 HSC Chemistry
Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	A
2	B
3	A
4	C
5	B
6	C
7	A
8	D
9	D
10	B
11	C
12	A
13	C
14	D
15	B
16	B
17	D
18	D
19	C
20	C

Section II

Question 21 (a)

Criteria	Marks
• Identifies a safety concern associated with organic liquids • States how the safety concern could be addressed	2
• Provides some relevant information	1

Sample answer:

Organic solvents are generally flammable so no sources of ignition should be present.

Question 21 (b)

Criteria	Marks
• Correctly identifies all four liquids	2
• Correctly identifies one liquid	1

Sample answer:

Flask	*Liquid*
1	propanoic acid
2	hex-1-ene
3	propan-1-ol
4	hexane

Question 21 (c)

Criteria	Marks
• Provides a relevant test for the liquid • States the expected observation	2
• Provides some relevant information	1

Sample answer:

Liquid: propanoic acid

Add a small amount of solid sodium hydrogen carbonate to the organic liquid. Bubbles of gas are produced indicating propanoic acid.

Answers could include:

Liquid: propanoic acid

Add drops of universal indicator to the organic liquid. If it is propanoic acid, the indicator will change colour from green to yellow/orange/red.

Use of other indicators such at litmus paper or a pH probe.

Liquid: hex-1-ene

Add drops of bromine water to the organic liquid. If it is hex-1-ene, the bromine water will decolourise.

Liquid: propan-1-ol

Sodium metal or Lucas test.

Question 22

Criteria	Marks
• Justifies TWO relevant ways	3
• Justifies ONE relevant way OR • Identifies TWO relevant ways	2
• Provides some relevant information	1

Sample answer:

The concentration of hydrogen ions could be reduced. This would increase the concentration of chromate ions, which will make the solution more yellow.

Heating the solution will drive the reaction to the left, as the forward reaction is exothermic. Thus the concentration of yellow chromate ions would increase.

Question 23 (a)

Criteria	Marks
• Provides a substantially correct balanced equation	2
• Provides some relevant information	1

Sample answer:

$HCOOH(aq) + KOH(aq) \rightarrow KHCOO(aq) + H_2O(\ell)$.

Answers could include:

$HCOOH(aq) + KOH(aq) \rightarrow KHCOO(s) + H_2O(\ell)$.

Question 23 (b)

Criteria	Marks
• Correctly identifies salt as basic • Provides suitable justification	2
• Provides some relevant information	1

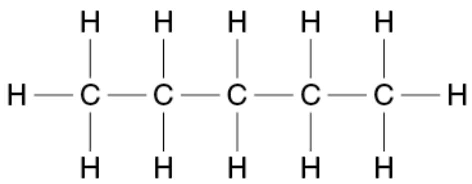
Sample answer:

Potassium methanoate is a basic salt as $HCOO^-$ is the conjugate base of a weak acid.

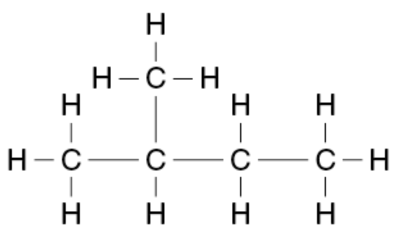
Question 24

Criteria	Marks
• Names pentane as the straight-chained alkane • Provides the structural formula • Correctly provides the structural formulae and names the other two isomers	4
• Provides THREE correct structural formulae and ONE correct name OR • Provides TWO correct structural formulae and TWO correct names	3
• Provides TWO correct structural formulae without names OR • Provides TWO correct names without structural formulae OR • Provides ONE correct structural formula and ONE correct name	2
• Provides some relevant information	1

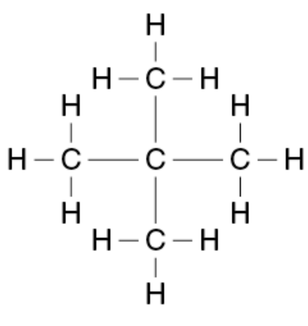
Sample answer:



Pentane – the straight-chained alkane



2-methylbutane



2,2-dimethylpropane

Question 25

Criteria	Marks
• Performs correct calculations • Includes a relevant chemical equation	4
• Provides the main steps • Includes a chemical equation	3
• Provides some relevant steps	2
• Provides some relevant information	1

Sample answer:

$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$

1006 mL = 1.006 L CO_2

1.006 L / 24.79 L mol^{-1} = 0.04058087939 moles of CO_2

$n_{CO_2} = n_{C_2H_5OH}$ = 0.04058087939 moles

$m_{C_2H_5OH} = n_{C_2H_5OH} \times MM_{C_2H_5OH}$ = 0.04058087939 mol $\times$ 46.068 g mol^{-1} = 1.869479952 g

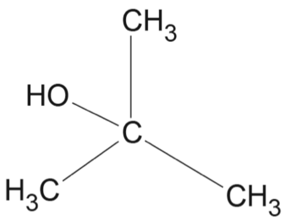
$m_{C_2H_5OH}$ = 1.869 g

Question 26 (a)

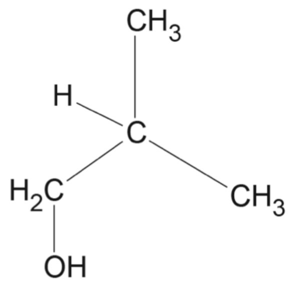
Criteria	Marks
• Draws correct structural formulae for compounds A–D	4
• Draws correct structural formulae for three compounds	3
• Draws structural formulae demonstrating an understanding of some different reactions	2
• Provides some relevant information	1

Sample answer:

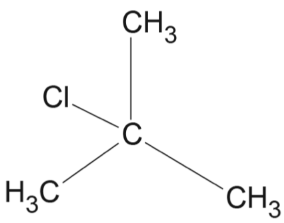
A



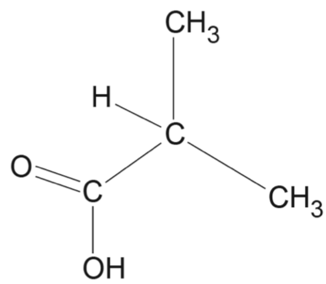
B



C



D



Question 26 (b)

Criteria	Marks
• Gives TWO reasons for refluxing reaction mixture	2
• Provides some relevant information	1

Sample answer:

Reflux uses heat to speed up the reaction.

The condenser retains the volatile reactants and products.

Question 27 (a)

Criteria	Marks
• Correctly calculates the range with the correct significant figures	4
• Provides some relevant steps	2–3
• Provides some relevant information	1

Sample answer:

$$K_{sp} = \left[Li^{+}\right]^{3}\left[PO_4^{\ 3-}\right]$$

Sample 3

$$K_{sp} = \left[Li^{+}\right]^{3}\left[PO_4^{\ 3-}\right]$$

$$= (0.15)^{3} \times (0.010) = 0.00003375$$

$$= 0.000034 \quad \text{to 2 significant figures}$$

Sample 4

$$K_{sp} = \left[Li^{+}\right]^{3}\left[PO_4^{\ 3-}\right]$$

$$= (0.15)^{3} \times (0.10) = 0.0003375$$

$$= 0.00034 \quad \text{to 2 significant figures}$$

Precipitation will occur somewhere between sample 3 and sample 4. The K_{sp} value is between 3.4×10^{-5} and 3.4×10^{-4}.

Question 27 (b)

Criteria	Marks
• States one way to improve the investigation and relates that to the accuracy of the calculated result	2
• Provides some relevant information	1

Sample answer:

Increase the number of solutions of $PO_4^{\ 3-}$ ions in the concentration range of 0.010 mol L^{-1} to 0.10 mol L^{-1}. This will narrow the range of values and bring the estimated value closer to the SI value of lithium phosphate.

Answers could include:

Titrate the Li^{+} ions against a $PO_4^{\ 3-}$ ion solution until a permanent precipitate is formed. This will give an experimental value that is correct or close to correct to the SI value for lithium phosphate.

Question 28

Criteria	Marks
• Correctly identifies the alkali hydroxide • Provides correct calculations and a balanced equation	4
• Provides the main steps of the calculation	3
• Provides some relevant steps	2
• Provides some relevant information	1

Sample answer:

Alkali metals = group 1

$$Cu(NO_3)_2(aq) + 2XOH(aq) \rightarrow Cu(OH)_2(s) + 2XNO_3(aq)$$

Net Ionic equation: $Cu^{2+}(aq) + 2OH^{-}(aq) \rightarrow Cu(OH)_2(s)$

Mass $Cu(OH)_2(s) = 4.61 \text{ g}$

$$\begin{aligned} \text{Moles } Cu(OH)_2(s) &= 4.61 \text{ g} \div MM\left(Cu(OH)_2\right) \\ &= 4.61 \text{ g} \div 97.566 \text{ g mol}^{-1} \\ &= 0.04725 \text{ mol} \end{aligned}$$

$n_{Cu(OH)_2} = 2n_{OH^-} = 0.09450 \text{ mol } OH^-$

$2n_{OH^-} = n_{XOH^-} = 0.09450 \text{ mol}$

amount = mass ÷ molar mass

∴ molar mass = mass ÷ amount

$MM = 5.30 \text{ g} \div 0.09450 \text{ mol} = 56.085 \text{ g mol}^{-1}$

Mass of OH = (16 + 1.008) = 17.008 g mol^{-1}

Mass of Alkali Metal = 56.085 g mol^{-1} – 17.008 g mol^{-1} = 39.077 g mol^{-1}

39.077 g mol^{-1} ≅ 39.10 g mol^{-1} (Molar Mass of *K* from Periodic table)

Therefore, the unknown alkali hydroxide = Potassium Hydroxide.

Question 29

Criteria	Marks
• Demonstrates a comprehensive understanding of the relationship between the highlighted features of the spectra and the structure of pentane-1,5-diamine • Refers to the relevant spectroscopic data in each of the four spectra	7
• Demonstrates a thorough understanding of the relationship between the highlighted features of the spectra and the structure of pentane-1,5-diamine • Refers to relevant spectroscopic data in at least three of the spectra	6
• Demonstrates a sound understanding of the relationship between the highlighted features of the spectra and the structure of pentane-1,5-diamine • Refers to relevant spectroscopic data in at least two of the spectra	4–5
• Demonstrates some understanding of the interpretation of spectroscopic data	2–3
• Provides some relevant information	1

Answers could include:

Infrared spectrum

- Peak at wave number range 3300–3400 cm^{-1} is due to N-H group (amino group)
  The spectrum confirms the presence of amino group.

Mass spectrum

- The highlighted feature is the fragment $CH_2NH_2^+$ ($12 \times 1 + 1.0 \times 4 + 14 \times 1 = 30$)

Carbon-13 NMR spectrum

- There are 5 carbon atoms in the molecule, however, there are only three peaks (three signals) shown in the spectrum.
- Due to symmetry, carbon atoms 1 and 5 are in identical environments. The same is true for carbon atoms 2 and 4. Carbon atom 3 is in a unique environment.
- The signals at 24 and 33 ppm are consistent with $–CH_2–CH_2–$ carbon atoms (5−40 ppm)
- The signal at 42 ppm is due to the C-N-H groups (25−60 ppm)

Proton NMR

- Quintets arise from H atoms with four H atoms on neighbouring C atoms, e.g. the H atoms on C-3 have four neighbouring H atoms on C-2 and C-4.
- The highlighted signal results from similar chemical shifts of protons in two different environments.
- The highlighted signal results from overlap of a 2H signal and a 4H signal, giving 6 H.

Question 30

Criteria	Marks
• Shows a comprehensive understanding of the procedure • Outlines positive and negative aspects of the procedure • Makes an informed judgement	5
• Outlines some positive and negative aspects of the procedure • Makes a judgement	4
• Outlines some positive and/or negative aspects of the procedure	3
• Identifies positive and/or negative aspects of the procedure OR • Outlines a positive OR negative aspect of the procedure	2
• Provides some relevant information	1

Sample answer:

The first test is not necessary to identify either the anion or cation. Sodium won't precipitate with either of the anions and chloride will not precipitate with any of the possible cations.

Adding silver ions to the solution in the second test is appropriate to identify the anion. Silver acetate is a soluble salt, but silver hydroxide is an insoluble, brown salt which dissolves when HCl is added. Therefore the anion must be hydroxide.

The second test also eliminates magnesium as the cation, as magnesium hydroxide is insoluble.

A third test is needed to distinguish between barium and calcium. However, both barium and calcium will produce a precipitate with concentrated sulfate ions as seen in the observations, so this test can't accurately distinguish between barium and calcium ions.

This procedure is insufficient to completely identify both ions in the compound and so is not an appropriate method to identify the unknown compound. A flame test is needed to identify the cation.

Question 31

Criteria	Marks
• Correctly calculates the moles of nitrogen	4
• Provides the main steps of the calculation	3
• Provides some relevant steps of the calculation	2
• Provides some relevant information	1

Sample answer:

N_2	+	$3H_2$	$\rightleftharpoons$	$2NH_3$
4.5 moles + x moles		1.0 moles		5.8 moles
− 0.025 moles		− 0.075 moles		+ 0.05 moles
$4.475 + x$ moles		0.925 moles		5.85 moles
$\dfrac{4.475+x}{10}$ mol L^{-1}		0.0925 mol L^{-1}		0.585 mol L^{-1}

$$K_{eq} = \frac{\left[NH_3\right]^2}{\left[N_2\right]\left[H_2\right]^3}$$

$$748 = \frac{0.585^2}{\dfrac{4.475+x}{10} \times 0.0925^3}$$

$$748 \times \left(\frac{4.475+x}{10} \times 0.0925^3\right) = 0.585^2$$

$$\frac{4.475+x}{10} \times 0.0925^3 = \frac{0.585^2}{748}$$

$$\frac{4.475+x}{10} = \frac{0.585^2}{748 \times 0.0925^3}$$

$$4.475 + x = \frac{10 \times 0.585^2}{748 \times 0.0925^3}$$

$$x = \frac{10 \times 0.585^2}{748 \times 0.0925^3} - 4.475$$

$$x = 1.3 \text{ moles}$$

1.3 moles of nitrogen must be added to the equilibrium mixture.

Question 32

Criteria	Marks
• Shows a thorough understanding of why the first two values are the same and why the last value is different	4
• Shows a sound understanding of why the first two values are the same and why the last value is different	3
• Shows some understanding of the reactions	2
• Provides some relevant information	1

Sample answer:

The net ionic equation for all three reactions is $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$.

HCl and HNO_3 are strong acids and completely ionised. When they react with aqueous KOH they both have the same exothermic enthalpy value due to the same net ionic equation.

When weak acid HCN reacts with aqueous KOH, HCN starts off only partially ionised in an equilibrium reaction with water $HCN(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + CN^-(aq)$. As the reaction proceeds, the HCN will further ionise as the equilibrium shifts to the right. This is endothermic so it removes some heat from the system and the overall reaction is less exothermic than the first two reactions. The reaction has a smaller but still exothermic $\Delta H^{\ominus}$ value.

Question 33 (a)

Criteria	Marks
• Correctly calculates ΔG	2
• Provides some relevant information	1

Sample answer:

From graph, $T\Delta S$ = –78 kJ/mol, ΔH = –93 kJ/mol

$\Delta G = \Delta H - T\Delta S$ = –93 kJ/mol – –78 kJ/mol = –15 kJ/mol

Answers could include:

Acceptable range of ΔH and $T\Delta S$ to be determined at Marking Centre.

Question 33 (b)

Criteria	Marks
• Makes correct deductions about the system at temperatures T_1, T_2 and T_3 • Supports answer with reference to the graph	4
• Makes correct deductions about the system at two of the temperatures • Refers to the graph	3
• Makes a relevant deduction about the system at temperature(s) T_1 and/or T_2 and/or T_3	2
• Provides some relevant information	1

Sample answer:

At all three temperatures the reaction is exothermic, as ΔH is negative. The entropy of reaction, ΔS is also negative as $T\Delta S$ is negative, and T is always positive. From the relationship $\Delta G = \Delta H - T\Delta S$ we can see that at T_1, ΔG is negative and therefore the reaction is spontaneous. At T_2 $\Delta G = 0$ and therefore the system is in equilibrium. At T_3, ΔG is positive and therefore the reaction is non-spontaneous.

Question 34

Criteria	Marks
• Explains the pH of water, solution *X* and solution *Y* • Includes a relevant balanced equation	5
• Shows a sound understanding of the pH of the water, solution *X* and solution *Y* • Includes a balanced equation	4
• Shows some understanding of the pH of the water and/or solution *X* and/or solution *Y* AND/OR • Includes a balanced equation	2–3
• Provides some relevant information	1

Sample answer:

At t_0 the pH of water is 7. *X* and *Y* have pH 4.9 so are acidic.

At t_1, the pH of water is dropping rapidly due to production of H_3O^+. The pH of *X* and *Y* have only dropped slightly, therefore they are buffers. When HCl is added it donates a proton to the base, producing HA instead of H_3O^+ minimising the change in pH:

$HCl(g) + A^-(aq) \rightleftharpoons HA(aq) + Cl^-(aq)$

At t_2, the pH of *X* and *Y* have begun to decrease, but the pH of *X* is lower. A^- has been used up so $[H_3O^+]$ increases lowering the pH. The pH is lower for *X* because it was a less concentrated buffer initially and the A^- was used up more rapidly.

Question 35

Criteria	Marks
• Correctly calculates the concentration of ethanol in the undiluted sample in % v/v • Removes the outlier from the calculation of thiosulfate volume • Provides a judgement about the ethanol concentration consistent with the calculations	7
• Provides substantially correct steps for calculating the concentration of ethanol • Provides a judgement about the ethanol concentration consistent with the calculations	6
• Provides the main steps for calculating the concentration of ethanol	4–5
• Provides some steps for calculating the concentration of ethanol	2–3
• Provides some relevant information	1

Sample answer:

Titration 1 is an outlier and excluded from the average.

$$\text{Average } V\left(S_2O_3{}^{2-}\right) = \frac{28.7 + 28.4 + 28.6}{3} = 28.5667 \text{ mL} = 0.0285667 \text{ L}$$

$$n\left(S_2O_3{}^{2-}\right) = cV = 0.900 \text{ mol L}^{-1} \times 0.0285667 \text{ L} = 0.02571 \text{ mol}$$

$$n\left(S_2O_3{}^{2-}\right) = n\left(I_2\right) = 2:1 \qquad \therefore\ n\left(I_2\right) = \frac{1}{2} \times 0.02571 = 0.012853 \text{ mol}$$

$$n\left(I_2\right) : n\left(\text{excess } Cr_2O_7{}^{2-}\right) = 3:1$$

$$\therefore\ n\left(\text{excess } Cr_2O_7{}^{2-}\right) = \frac{1}{3} \times 0.012853 = 0.004285 \text{ mol}$$

$$n\left(\text{initial } Cr_2O_7{}^{2-}\right) = cV = 0.500 \text{ mol L}^{-1} \times 0.0200 \text{ L} = 0.0100 \text{ mol}$$

$$n\left(Cr_2O_7{}^{2-} \text{ reacted with ethanol}\right) = n\left(\text{initial } Cr_2O_7{}^{2-}\right) - n\left(\text{excess } Cr_2O_7{}^{2-}\right)$$

$$= 0.0100 - 0.004285 = 0.005715 \text{ mol}$$

$$n\left(Cr_2O_7{}^{2-} \text{ reacted with ethanol}\right) : n\left(\text{ethanol}\right) = 2:3$$

$$\therefore\ n\left(\text{ethanol}\right) = \frac{3}{2} \times 0.005715 = 0.0085725 \text{ mol}$$

$$m\left(C_2H_5OH\right) = n \times MM = 0.0085725 \text{ mol} \times (2 \times 12.01 + 6 \times 1.008 + 16.00) \text{ g mol}^{-1}$$

$$= 0.00857 \text{ mol} \times 46.068 \text{ g mol L}^{-1} = 0.394918 \text{ g in 25.0 mL diluted solution}$$

$$m\left(C_2H_5OH\right) = \frac{1000.0}{25.0} \times 0.394918\ldots = 15.797\ldots \text{ g in 25.0 mL undiluted sample}$$

$$V\left(C_2H_5OH\right) = 15.797\ldots \text{ g} \div 0.789 \text{ g mL}^{-1} = 20.02\ldots \text{ mL}$$

$$\%\left(C_2H_5OH\right) = (20.02 \text{ mL} \div 25.0 \text{ mL}) \times 100 = 80.08\%\ldots = 80\% \text{ v/v}$$

As the concentration found is under 85%, the product does not meet the manufacturer's requirement.

Question 36

Criteria	Marks
• Calculates K_{eq}	5
• Provides the main steps of the calculation	4
• Provides some relevant steps of the calculation	2–3
• Provides some relevant information	1

Sample answer:

The pK_a of sulfurous acid in the following reaction is 1.82.

$$H_2SO_3(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_3^-(aq)$$

K_a for sulfurous acid is:

$$K_a = 10^{-pK}$$

$$K_a = 10^{-1.82} = 0.01513561248 = 1.51 \times 10^{-2}$$

K_a for hydrogen sulfite is:

$$K_a = 10^{-pK_a}$$

$$K_a = 10^{-7.17} = 0.0000000676 = 6.76 \times 10^{-8}$$

(1) $\quad H_2SO_3(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_3^-(aq) \quad K_a(1) = 1.51 \times 10^{-2}$

(2) $\quad HSO_3^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_3^{2-}(\ell) \quad K_a(2) = 6.76 \times 10^{-8}$

$$K_a(1) = \frac{\left[H_3O^+\right]\left[HSO_3^-\right]}{\left[H_2SO_3\right]}$$

$$K_a(2) = \frac{\left[H_3O^+\right]\left[SO_3^{2-}\right]}{\left[HSO_3^-\right]}$$

For $H_2SO_3(aq) + 2H_2O(\ell) \rightleftharpoons 2H_3O^+(aq) + SO_3^{2-}(aq)$

$$K_{eq} = \frac{\left[H_3O^+\right]^2\left[SO_3^{2-}\right]}{\left[H_2SO_3\right]}$$

$$K_a(1) \times K_a(2) = \frac{\left[H_3O^+\right]^2\left[HSO_3^-\right]\left[SO_3^{2-}\right]}{\left[HSO_3^-\right]\left[H_2SO_3\right]}$$

$$= \frac{\left[H_3O^+\right]^2\cancel{\left[HSO_3^-\right]}\left[SO_3^{2-}\right]}{\cancel{\left[HSO_3^-\right]}\left[H_2SO_3\right]}$$

$$= \frac{\left[H_3O^+\right]^2\left[SO_3^{2-}\right]}{\left[H_2SO_3\right]}$$

$$= K_{eq}$$

$$K_{eq} = 1.51 \times 10^{-2} \times 6.76 \times 10^{-8}$$

$$= 1.0 \times 10^{-9}$$

2021 HSC Chemistry Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 5 Static and dynamic equilibrium	12-6, 12-12
2	1	Mod 8 Analysis of inorganic substances	12-2, 12-15
3	1	Mod 7 Nomenclature	12-7, 12-14
4	1	Mod 7 Reactions of organic acids and bases	12-6,12-14
5	1	Mod 6 Quantitative Analysis	12-5, 12-13
6	1	Mod 6 Using Brønsted–Lowry/quantitative analysis	12-5, 12-13
7	1	Mod 7 Products of reactions involving hydrocarbons Mod 7 Alcohols	12-6, 12-14
8	1	Mod 7 Reactions of organic acids and bases	12-5, 12-14
9	1	Mod 8 Analysis of organic compounds	12-5, 12-15
10	1	Mod 7 Polymers	12-6, 12-14
11	1	Mod 5 Factors that affect equilibrium	12-6, 12-12
12	1	Mod 8 Analysis of organic compounds	12-6, 12-15
13	1	Mod 7 Products of reactions involving hydrocarbons Mod 7 Alcohols	12-6, 12-14
14	1	Mod 8 Analysis of inorganic substances	12-4, 12-15
15	1	Mod 6 Using Brønsteda–Lowry	12-4, 12-13
16	1	Mod 6 Quantitative analysis	12-5, 12-13
17	1	Mod 8 Analysis of inorganic substances	12-6, 12-15
18	1	Mod 8 Analysis of organic compounds	12-6, 12-15
19	1	Mod 5 Calculating the equilibrium constant	12-4, 12-12
20	1	Mod 6 Quantitative analysis	12-6, 12-13

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	2	Mod 7 Hydrocarbons	12-2, 12-14
21 (b)	2	Mod 8 Analysis of organic substances	12-5, 12-15
21 (c)	2	Mod 8 Analysis of organic substances	12-3, 12-15
22	3	Mod 5 Factors affecting equilibrium	12-6, 12-12
23 (a)	2	Mod 6 Using Brønsted–Lowry, reactions of organic acids and bases	12-6, 12-13
23 (b)	2	Mod 6 Using Brønsted–Lowry, reactions of organic acids and bases	12-6, 12-13
24	4	Mod 7 Nomenclature	12-6, 12-7, 12-14
25	4	Mod 7 Alcohols	12-5, 12-6, 12-14

Question	Marks	Content	Syllabus outcomes
26 (a)	4	Mod 7 Alcohols Mod 7 Reactions of organic acids and bases	12-6,12-7,12-14
26 (b)	2	Mod 7 Reactions of organic acids and bases	12-2, 12-14
27 (a)	4	Mod 5 Solution equilibria	12-5, 12-6, 12-12
27 (b)	2	Mod 5 Solution equilibria	12-2, 12-12
28	4	Mod 8 Analysis of inorganic substances	12-6, 12-15
29	7	Mod 8 Analysis of organic substances	12-4,12-5, 12-6,12-15
30	5	Mod 8 Analysis of inorganic substances	12-2, 12-4, 12-15
31	4	Mod 5 Calculating the equilibrium constant	12-5, 12-6, 12-12
32	4	Mod 6 Properties of acids and bases Mod 6 Quantitative analysis	12-4, 12-5, 12-6, 12-13
33 (a)	2	Mod 5 Static and dynamic equilibrium	12-4, 12-5, 12-12
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34	5	Mod 6 Quantitative analysis	12-4, 12-5, 12-6, 12-13
35	7	Mod 6 Quantitative analysis Mod 7 Alcohols	12-4, 12-6, 12-13, 12-14
36	5	Mod 6 Quantitative analysis	12-4, 12-6, 12-13