Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2019

Chemistry

Standard level

Paper 3

33 pages

Subject Details: Chemistry SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[15 marks]** and all questions from **ONE** option in Section B **[20 marks]**.
Maximum total = **[35 marks]**.

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative word is indicated in the "Answers" column by a slash (/). Either word can be accepted.

6. An alternative answer is indicated in the "Answers" column by "**OR**". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading **ALTERNATIVE 1** *etc*. Either alternative can be accepted.

8. Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

11. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect) in the "Notes" column.

12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.

14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the “Notes” column.

15. If a question specifically asks for the name of a substance, do not award a mark for a correct formula unless directed otherwise in the “Notes” column. Similarly, if the formula is specifically asked for, do not award a mark for a correct name unless directed otherwise in the “Notes” column.

16. If a question asks for an equation for a reaction, a balanced symbol equation is usually expected. Do not award a mark for a word equation or an unbalanced equation unless directed otherwise in the “Notes” column.

17. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the “Notes” column.

Section A

Question			Answers	Notes	Total
1.	a		best-fit smooth curve ✓	*Do **not** accept a series of connected lines that pass through all points **OR** any straight line representation.*	1
1.	b	i	tangent drawn at time zero ✓ g day^{-1} ✓ 0.16 ✓	*Accept other reasonable units for initial rate eg, mol dm^{-3} s^{-1}, mol dm^{-3} min^{-1}, g s^{-1} **OR** g min^{-1}.* *M3 can only be awarded if the value corresponds to the correct unit given in M2.* *Accept values for the initial rate for M3 in the range:* *0.13 – 0.20 g day^{-1} **OR*** *1.5×10^{-6} g s^{-1} – 2.3×10^{-6} g s^{-1} **OR*** *7.5×10^{-8} – 1.2×10^{-7} mol dm^{-3} s^{-1} **OR*** *4.5×10^{-6} – 6.9×10^{-6} mol dm^{-3} min^{-1} **OR** 9.0×10^{-5} – 1.4×10^{-4} g min^{-1} **OR** a range based on any other reasonable unit for rate.* *Ignore any negative rate value.* *Award **[2 max]** for answers such as 0.12/0.11 g day^{-1}, incorrectly obtained by using the first two points on the graph (the average rate between t = 0 and 1 day).* *Award **[1 max]** for correctly calculating any other average rate.*	3

(continued…)

(Question 1b continued)

Question			Answers	Notes	Total
1.	**b**	**ii**	acid used up ***OR*** acid is the limiting reactant ✓ concentration of acid decreases ***OR*** less frequent collisions ✓	*Award **[1 max]** for "surface area decreases" if the idea that "$CaCO_3$ is used up/acts as the limiting agent" is conveyed for M1.* *Do **not** accept "reaction reaches equilibrium" for M2.*	**2**

(continued…)

(Question 1b continued)

Question			Answers	Notes	Total
1.	**b**	**iii**	surface area not uniform ***OR*** limestone pieces do not have same composition/source ***OR*** limestone absorbed water **«**which increased mass**»** ***OR*** acid removed from solution when limestone removed ***OR*** **«**some**»** calcium sulfate deposited on limestone lost ***OR*** pieces of paper towel may have stuck to limestone ***OR*** beakers not covered/evaporation ***OR*** temperature not controlled ✓	*Accept "acids impure".* *Accept "**«**limestone**»** contains impurities".* *Accept "loss of limestone when dried" **OR** "loss of limestone due to crumbling when removed from beaker".*	**1**
1.	**c**	**i**	sulfuric acid is diprotic/contains two H^+ **«**while nitric acid contains one H^+**»**/releases more H^+ **«**so reacts with more limestone**»** ***OR*** higher concentration of protons/H^+ ✓	*Ignore any reference to the relative strengths of sulfuric acid and nitric acid.* *Accept "sulfuric acid has two hydrogens **«**whereas nitric has one**»".*** *Accept "dibasic" for "diprotic".*	**1**
1.	**c**	**ii**	calcium sulfate remained/deposited on limestone **«**in sulfuric acid**»** ***OR*** reaction prevented/stopped by slightly soluble/deposited layer of calcium sulfate ✓	*Answer must refer to calcium sulfate.*	**1**

Question			Answers	Notes	Total
2.	**a**	**i**	*Ethanal using Pt/C:* decreases ✓ *Carbon dioxide using PtRu/C:* **«**generally**»** increases ***AND*** then decreases ✓	*Accept "no clear trend/pattern" **OR** "increases and decreases" **OR** "increases, reaches a plateau and **«**then**»** decreases" for M2.*	**2**
2.	**a**	**ii**	*From ethanol to ethanal:* −2 to −1 ***OR*** +1/increases by 1 ✓ *From ethanol to carbon dioxide:* −2 to +4 ***OR*** +6/increases by 6 ✓	*Do **not** accept 2− to 1−.* *Do **not** accept 2− to 4+.* *Do **not** penalize incorrect notation twice.* *Penalize incorrect oxidation state value of carbon in ethanol once only.*	**2**
2.	**a**	**iii**	ethanal < ethanoic acid < carbon dioxide ✓	*Accept formulas.* *No ECF from 2aii calculations.*	**1**
2.	**b**		Pt/platinum/PtC ***AND*** highest yield of CO_2 **«**at all voltages**»** ✓	*ECF from 2aiii.*	**1**

Section B

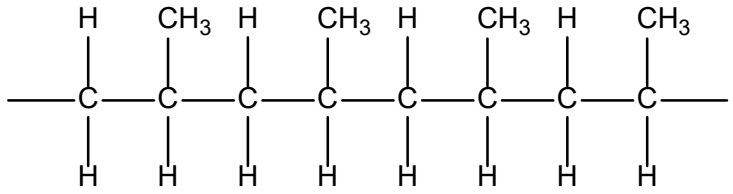
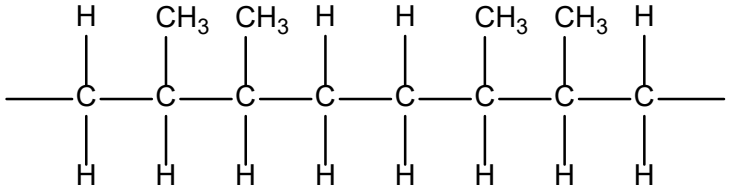
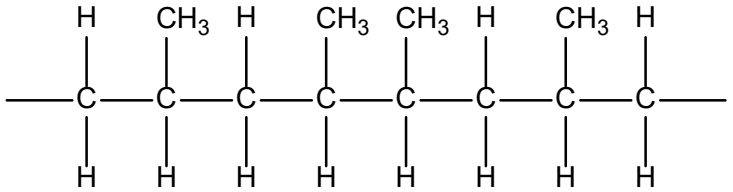
Option A — Materials

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>3.</td><td>a</td><td></td><td>reactant(s) adsorb onto active sites/surface ✓

«reactant» bonds weakens «and products are desorbed» ✓</td><td>Do not accept “absorb” for “adsorbs” for M1.
Accept “bonds to” for “adsorb” for M1.

Accept “bonds break/stretch «and products are desorbed»” for M2

Award [1 max] for “lowers activation energy”.</td><td>2</td></tr>
<tr><td>3.</td><td>b</td><td></td><td>Any one of the following:
<table>
<tr><th>Heterogeneous catalysts</th><th></th><th>Homogeneous catalysts</th></tr>
<tr><td>«solution of» different phase/state to reactants</td><td>AND</td><td>same phase/state as reactants ✓</td></tr>
<tr><td>do not change</td><td>AND</td><td>react and are regenerated ✓</td></tr>
<tr><td>do not form intermediate/activated complex</td><td>AND</td><td>form intermediate/activated complex ✓</td></tr>
<tr><td>reactions at higher temperatures</td><td>AND</td><td>reactions at lower temperatures ✓</td></tr>
<tr><td>less selective</td><td>AND</td><td>more selective ✓</td></tr>
<tr><td>recovery easier/cheaper</td><td>AND</td><td>recovery more difficult/expensive ✓</td></tr>
</table></td><td>Accept “heterogeneous adsorb reactants and homogeneous” but do not accept “absorb” for “adsorb”.
Accept “heterogeneous have active sites and homogeneous do not”.</td><td>1 max</td></tr>
<tr><td>3.</td><td>c</td><td></td><td>high temperature used ✓
oxygen/O_2 reacts with carbon/C
OR
carbon dioxide/CO_2 can form ✓</td><td></td><td>2</td></tr>
</table>

Question			Answers	Notes	Total
4.	a		 ✓	*Continuation bonds must be shown.* *Ignore square brackets and "n".* *Do **not** accept one repeating unit in square brackets with a subscript of 4.* *Accept condensed structure provided all C to C bonds are shown and CH_3 groups on same side.* *Accept*  ***OR***  *Do **not** accept syndiotactic (alternating orientation of the CH_3 groups).*	**1**
4.	b		isotactic «has higher melting point» ***AND*** ordered chains pack more closely ***OR*** isotactic «has higher melting point» ***AND*** stronger intermolecular/London/dispersion forces ✓	*Accept "van der Waals' forces"/"vdW".*	**1**
4.	c		softens when heated «and hardens when cooled» ✓		**1**

Question			Answers	Notes	Total
4.	d		*Any two of:* collection/transportation of plastic waste ✓ separation of different types «of plastic» ***OR*** separation of plastic from other materials ✓ melting plastic ✓ processing/washing/cleaning/drying/manufacture of recycled plastic ✓		**2 max**

Question			Answers	Notes	Total
5.	**a**		ions of more reactive metals are harder to reduce ***OR*** more reactive metals have more negative electrode potentials ✓ electrolysis is needed/used for the most reactive metals ***OR*** carbon is used to reduce metal oxides of intermediate reactivity/less reactive than carbon ***OR*** heating ore is sufficient for less reactive metals ✓	*Award **[1 max]** for "**«**ease of reduction/extraction**»** depends on reactivity".*	**2**
5.	**b**	**i**	electronegativity difference = 1.8 **«**and average electronegativity = 2.5**»** ✓ 57 **«**%**»** ✓	*Accept any value in the range 52–65 %.* *Award **[2]** for correct final answer.*	**2**

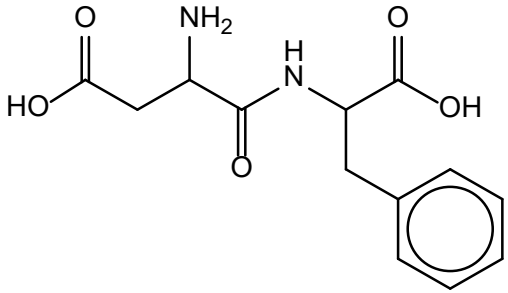
(continued…)

(Question 5b continued)

Question			Answers	Notes	Total
5.	**b**	**ii**	*Anode (positive electrode):* $2O^{2-} \rightarrow 4e^- + O_2(g)$ ***OR*** $2O^{2-} + C \rightarrow 4e^- + CO_2(g)$ ✓ *Cathode (negative electrode):* $Al^{3+} + 3e^- \rightarrow Al(l)$ ✓ O_2 gas ***AND*** Al liquid ✓	*Award **[1 max]** for M1 and M2 if correct half-equations are given at the wrong electrodes **OR** if incorrect reversed half-equations are given at the correct electrodes.* *Only state symbols of **products** required, which might be written as (g) and (l) in half-equations. Ignore any incorrect or missing state symbols for reactants.*	**3**

Question			Answers	Notes	Total
6.	**a**		molecules point/align in same direction/orientation ***OR*** molecules have directional order ✓ molecules are randomly distributed ***OR*** molecules are not in a layered arrangement ***OR*** molecules do not have positional order ✓	*Accept suitable diagram for M1 and M2.*	**2**
6.	**b**		molecules align with field ✓		**1**

Option B — Biochemistry

Question			Answers	Notes	Total
7.	**a**		 amide link (*eg,* CONH) ✓ correct order and structure of amino acids ✓	*Accept a skeletal formula or a full or condensed structural formula.* *Accept zwitterion form of dipeptide.* *Accept CO–NH but **not** CO–HN for amide link.*	**2**
7.	**b**		**«**Asp isoelectric point lower than Phe and **»** Phe has a neutral/hydrocarbon side chain ✓ Asp side chain contains –COOH/carboxyl ✓	*Award **[1 max]** for "Asp has two carboxyl/–COOH groups and Phe has one carboxyl/–COOH group".* *Accept "Asp has an acidic side chain" for M2*	**2**

Question			Answers	Notes	Total
8.	a		enzyme denatures ***OR*** change of conformation/shape of active site ***OR*** substrate cannot bind to active site/binds less efficiently ✓	*Accept "change in structure" or "substrate doesn't fit/fits poorly into active site"*	**1**
8.	b		*Any two of:* acidic/basic/ionizable/COOH/carboxyl/NH_2/amino groups in the R groups/side chains **«**react**»** ✓ exchange/lose/gain protons/H^+ ✓ change in H-bonds/ionic interactions/intermolecular forces/London dispersion forces ✓	*Do **not** accept "enzyme denatures" **OR** "change of conformation/tertiary structure" **OR** "substrate cannot bind to active site/binds less efficiently" as this was the answer to 8(a).*	**2 max**
8.	c		breakdown of oil spills/industrial/sewage waste/plastics ***OR*** production of alternate sources of energy **«**such as bio diesel**»** ***OR*** involve less toxic chemical pathway **«**in industry**»** ✓	*Accept "**«**enzymes in**»** biological detergents can improve energy efficiency".*	**1**

Question			Answers	Notes	Total
9.	a		«one C=C bond» «1 mole iodine : 1 mole oleic acid» «$\frac{100 \times 253.80}{282.46}$ =» 89.85 «g of I_2» ✓	*Accept 90 «g of I_2».*	1
9.	b		atherosclerosis/cholesterol deposition «in artery walls»/increases risk of heart attack/stroke/cardiovascular disease/CHD ✓	*Accept "arteries become blocked/walls become thicker", "increases blood pressure", **OR** "blood clots".* *Do **not** accept "high cholesterol" **OR** "obesity"*	1
9.	c		no kinks in chain/more regular structure ***OR*** straight chain ***OR*** no C=C/carbon to carbon double bonds ***OR*** saturated ***OR*** chains pack more closely together ✓ stronger London/dispersion/instantaneous induced dipole-induced dipole forces «between molecules» ✓	*Accept "greater surface area/electron density" for M1.* *Accept "stronger intermolecular/van der Waals'/vdW forces" for M2.*	2

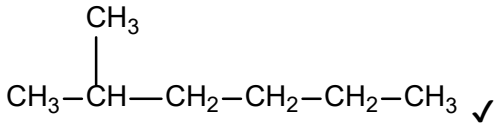
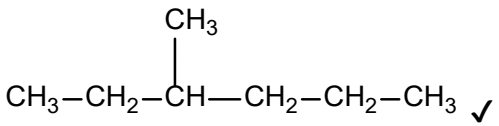
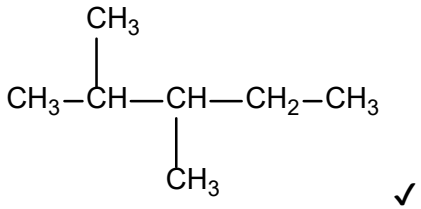
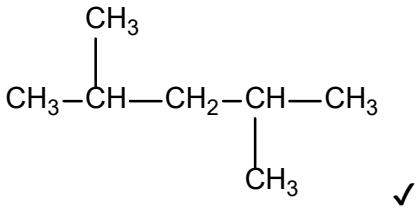
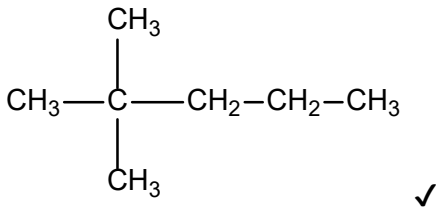
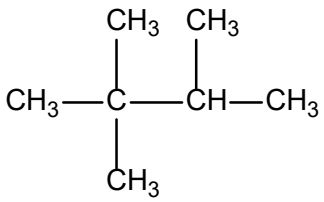
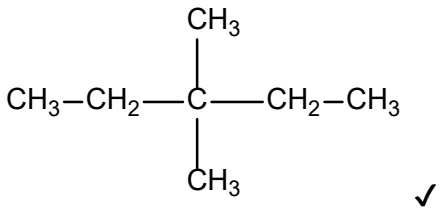
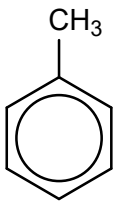
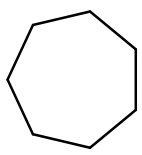
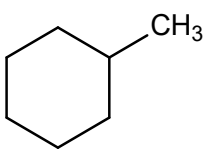
Question			Answers	Notes	Total
9.	d	i	*Similarity:* **«**derived from**»** propane-1,2,3-triol/glycerol/glycerin/glycerine ***OR*** **«**derived from**»** at least two fatty acids ***OR*** contains ester linkages ***OR*** long carbon chains ✓ *Difference:* phospholipids contain two fatty acids ***AND*** triglycerides three ***OR*** phospholipids contain phosphate/phosphato **«**group**»**/residue of phosphoric acid ***AND*** triglycerides do not ✓	*Do **not** accept "two fatty acids as both a similarity and a difference".* *Do **not** accept just "hydrocarbon/carbon chains".* *Accept "phospholipids contain phosphorus **AND** triglycerides do not".* *Accept "phospholipids are amphiphilic **AND** triglycerides are not" **OR** "phospholipids have hydrophobic tails and hydrophilic heads **AND** triglycerides do not".*	**2**
9.	d	ii	**«**concentrated**»** NaOH (aq)/sodium hydroxide ***OR*** **«**concentrated**»** HCl (aq)/hydrochloric acid ***OR*** enzymes/lipases ✓	*Accept other strong acids or bases.*	**1**

Question			Answers	Notes	Total
10.	a		hydroxyl ✓	*Accept "hydroxy" but **not** "hydroxide".* *Accept "alkenyl".* *Do **not** accept formula.*	1
10.	b		accumulates in fat/tissues/living organisms ***OR*** cannot be metabolized/does not break down **«**in living organisms**»** ***OR*** not excreted / excreted **«**very**»** slowly ✓ passes **«**unchanged**»** up the food chain ***OR*** increased concentration as one species feeds on another **«**up the food chain**»** ✓	*Accept "lipids" for "fat".*	2
10.	c		**«**solubility depends on forming many**»** H-bonds with water ✓ maltose has many hydroxyl/OH/oxygen atom/O **«**and forms many H-bonds**»** ✓	*Reference to "with water" required.* *Accept "hydroxy" for "hydroxyl" but **not** "hydroxide/OH^-".* *Reference to many/several OH groups/O atoms required for M2.*	2

Option C — Energy

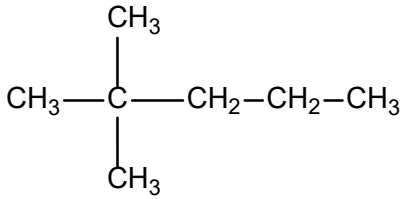
Question			Answers	Notes	Total
11.	**a**		«similar specific energy and» pentane has «much» larger energy density ✓ *Any two for **[2 max]**:* similar number of bonds/«C and H» atoms in 1 kg «leading to similar specific energy» ***OR*** only one carbon difference in structure «leading to similar specific energy» ✓ pentane liquid ***AND*** butane gas «at STP» ✓ 1 m^3 of pentane contains greater amount/mass than 1 m^3 of butane ✓	*Accept "both are alkanes" for M2.* *Accept "pentane would be easier to transport".* *Accept "same volume" for "1 m^3" and "greater amount" for "more moles" for M4.*	**3**
11.	**b**		«energy input =» 5.54×10^4 «MJ» ✓ «efficiency = $\frac{2.41 \times 10^4 \text{ MJ}}{5.54 \times 10^4 \text{ MJ}} \times 100$ =» 43.5 «%» ✓	*Award **[2]** for correct final answer.*	**2**

Question			Answers	Notes	Total
12.	**a**		low knocking/auto-ignition ***OR*** more efficient fuel ***OR*** high compression ***OR*** more power extracted ***OR*** more air going into engine / turbocharging ***OR*** less engine damage ✓	*Do **not** accept "pre-ignition".* *Accept "less CO_2 emissions since knocking engine uses more fuel «to produce the same power»".*	**1**

Question			Answers	Notes	Total
12.	b	i	*Any two of:*  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓  ✓	*Accept skeletal formulas or full or condensed structural formulas.* *Accept any other branched cycloalkane that contains 7 carbons.* *Do **not** accept any alkenes.* *Penalize missing hydrogens or bond connectivities once only in Option C.* *Accept hydrogen as the second product if the first product is toluene or a cycloalkane.*	**2 max**

(continued…)

(Question 12b continued)

Question			Answers	Notes	Total
12.	**b**	**ii**	 /$(CH_3)_3CCH_2CH_2CH_3$ ✓	*Accept a skeletal formula or a full or condensed structural formula.* *Penalize missing hydrogens or bond connectivities once only in Option C.*	**1**

Question			Answers	Notes	Total
13.	a	i	${}^{4}_{2}\text{He} + {}^{8}_{4}\text{Be} \rightarrow {}^{12}_{6}\text{C}$ ✓	*Do **not** penalize missing atomic numbers.*	1
13.	a	ii	***ALTERNATIVE 1*** binding energy per nucleon is larger in carbon-12/product **«**than beryllium-8 and helium-4/reactants**»** ✓ difference in **«**total**»** binding energy is released **«**during fusion**»** ✓ ***ALTERNATIVE 2*** mass of carbon-12/product **«**nucleus**»** is less than **«**the sum of**»** the masses of helium-4 and beryllium-8 **«**nuclei**»**/reactants ***OR*** two smaller nuclei form a larger nucleus ✓ mass lost/difference is converted to energy **«**and released**»** ***OR*** $E = mc^2$ ✓		2

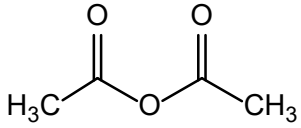
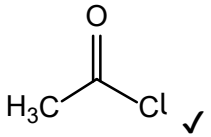
Question			Answers	Notes	Total
13.	b		***ALTERNATIVE 1*** 3 half-lives ✓ 0.500 g «of beryllium-8 remain» ✓ ***ALTERNATIVE 2*** $m = 4.00 \left(\frac{1}{2}\right)^{\frac{2.01 \times 10^{-16}}{6.70 \times 10^{-17}}}$ ✓ 0.500 g «of beryllium-8 remain» ✓ ***ALTERNATIVE 3*** $\lambda = \text{«}\frac{\ln 2}{6.70 \times 10^{-17}}\text{»} = 1.03 \times 10^{16}\ \text{«s}^{-1}\text{»}$ ✓ $m = \text{«}4.00\ e^{-1.03 \times 10^{16} \times 2.01 \times 10^{-16}}\ \text{=»}\ 0.500\ \text{«g»}$ ✓	*Award **[2]** for correct final answer.*	**2**

Question			Answers	Notes	Total
14.	**a**		$C_2H_5OH\,(l) + 3O_2\,(g) \rightarrow 2CO_2\,(g) + 3H_2O\,(l)$ ✓		**1**
14.	**b**		*Any two of:* **«**showing strong**»** correlation between **«**atmospheric**»** CO_2 concentration/greenhouse gas concentration and average **«**global/surface/ocean**»** temperature ✓ lab evidence that greenhouse gases/CO_2 absorb(s) infrared radiation ✓ **«**advanced**»** computer modelling ✓ ice core data ✓ tree ring data ✓ ocean sediments / coral reefs / sedimentary rocks data ✓	*Do **not** accept "global warming" for "average temperature".* *Do **not** accept "traps/reflects heat" **OR** "thermal energy".* *Evidence must be outlined and connected to data.* *Accept references to other valid greenhouse gases other than carbon dioxide/CO_2 such as methane/CH_4 or nitrous oxide/N_2O.*	**2 max**
14.	**c**		biofuel raw material/sugar/glucose formed by photosynthesis ***OR*** biofuel raw material/sugar/glucose uses up carbon dioxide during its formation ***OR*** biofuel from capturing gases from decaying of organic matter formed from photosynthesis✓ $6CO_2\,(g) + 6H_2O\,(l) \rightarrow C_6H_{12}O_6\,(aq) + 6O_2\,(g)$ ✓	*Accept arguments based on material coming from plant sources consuming carbon dioxide/carbon for M1.*	**2**
14.	**d**		transesterification ***OR*** **«**nucleophilic**»** substitution/S_N ✓		**1**

Option D — Medicinal chemistry

Question			Answers	Notes	Total
15.	**a**		*Any two of:* benzene/aromatic ring ✓ **«**tertiary**»** amino **«**group**»** ✓ ethenylene/1,2-ethenediyl **«**group**»** ✓ ether **«**group**»** ✓	*Accept "phenyl" for "benzene ring" although there are no phenyl groups as the benzene ring in this compound is a part of a polycyclic structure.* *Do **not** accept "arene" or "benzene" alone.* *Accept "amine" for "amino **«**group**»".* *Accept "alkenyl/alkene/vinylene" for ethenylene/1,2-ethenediyl **«**group**».*	**2 max**
15.	**b**		*Any three of:* morphine has **«**two**»** hydroxyl **«**groups**»** ***AND*** diamorphine has **«**two**»** ester/ethanoate/acetate **«**groups**»** ✓ morphine is more polar than diamorphine ***OR*** groups in morphine are replaced with less polar/non-polar groups in diamorphine ✓ morphine is **«**more**»** soluble in blood **«**plasma**»** ***OR*** diamorphine is **«**more**»** soluble in lipids **OR** diamorphine is more soluble in non-polar environment of CNS/central nervous system than morphine ✓ diamorphine crosses the blood–brain barrier/BBB **«**easily**»** ✓	*Accept "heroin" for "diamorphine".* *Accept formulas.* *Accept "hydroxy" for "hydroxyl" but **not** "hydroxide".* *Accept "acyl" for "ester **«**groups**»".* *Do **not** accept just "diamorphine is non-polar" for M2.* *Accept "water" for blood".* *Accept "fats" for "lipid".*	**3 max**

Question			Answers	Notes	Total
16.	**a**		hydrochloric acid/HCl **«**(aq)**»** ***AND*** strong **«**acid**»** ✓		**1**
16.	**b**		$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$ ✓	*Accept ionic equation.*	**1**
16.	**c**		blocks/binds to H2-histamine receptors **«**in cells of stomach lining**»** ***OR*** prevents histamine molecules binding to H2-histamine receptors **«**and triggering acid secretion**»** ***OR*** prevents parietal cells from producing/releasing acid ✓	*Do **not** accept "antihistamine" by itself.* *Accept "H2-receptor antagonist/H2RA" **OR** "blocks/inhibits action of histamine".* *Accept "blocks receptors in parietal cells **«**from releasing/producing acid**»**".* *Do **not** accept proton pump/ATPase inhibitor.*	**1**
16.	**d**		**«**$pK_a = 4.76$**»** **«**$pH = pK_a + \log\left(\frac{[CH_3COO^-]}{[CH_3COOH]}\right)$**»** **«**$pH = 4.76 + 0.40 =$**»** 5.16 ✓		**1**

Question			Answers	Notes	Total
17.	a		ethanoic anhydride/acetic anhydride/  ***OR*** ethanoyl chloride/acetyl chloride/  ✓	*Accept condensed structural formulas.* *Accept "ethanoic acid/acetic acid/CH_3COOH".* *Accept "$C_4H_6O_3$" **OR** "C_2H_3OCl".*	**1**
17.	b		react with sodium hydroxide/NaOH/**«**strong**»** base ***OR*** convert to **«**ionic**»** salt ✓ $C_6H_4(OCOCH_3)COOH\,(s) + NaOH\,(aq) \rightarrow C_6H_4(OCOCH_3)COONa\,(aq) + H_2O\,(l)$ ✓	*Accept other suitable bases (eg, $KOH/NaHCO_3/Na_2CO_3$) with corresponding equation for chosen base for M2.* *Accept "$CaCO_3$", although calcium salicylate is **not** water soluble.* *Accept ionic equation.* *Award **[2]** for M2.*	**2**

Question			Answers	Notes	Total
18.	**a**		Any one of: bacteria perform living functions **«**on their own and viruses do not without host cell**»** ***OR*** bacteria have cell walls **«**and viruses do not**»** ***OR*** bacteria do not have a capsid **«**and viruses do**»** ***OR*** bacteria larger than viruses ***OR*** bacteria reproduce by fission/budding **«**and viruses reproduce within a living host cell**»** ***OR*** bacteria affected by antibiotics **«**while viruses are not**»** ✓	*Accept "bacteria have flagella/ cytoplasm/ribosome **«**and virus can have head/protein tail/double stranded RNA/single stranded DNA**»"* *Accept "asexual reproduction" for bacteria.* *Accept other specific structural differences between bacteria and viruses, and examples of living functions that bacteria perform (such as excretion, reproduction* etc.) *that viruses do not.* *Accept "bacteria are living and viruses are not"*	**1**

Question			Answers	Notes	Total
18.	b		*Any two of:* HIV difficult to detect/remains dormant ✓ HIV mutates rapidly/quickly ✓ HIV replicates rapidly/quickly ✓ HIV destroys «T-» helper cells/white blood cells/lymphocytes ***OR*** HIV attacks immune system ✓ HIV has several «significantly different» strains/subtypes ✓	*Accept "virus" for "HIV".* *Do **not** accept "AIDS mutates" without mention of the HIV/virus.* *Penalize the use of "AIDS" for "HIV" once only.* *Accept "HIV metabolism linked to that of host cell" **OR** "drugs harm host cell as well as HIV".*	**2 max**

Question			Answers	Notes	Total
18.	**c**		ring is «sterically» strained ***OR*** angles of 90° instead of 109.5/109/120° angles ***OR*** angles smaller than 109.5/109/120°/tetrahedral/trigonal planar/triangular planar angle ✓ ring breaks up/opens/reacts «easily» ***OR*** amido/amide group «in ring» is «highly» reactive ✓ «irreversibly» binds/bonds to enzyme/transpeptidase ***OR*** inhibits enzyme/transpeptidase «in bacteria» that produces cell walls ***OR*** prevents cross-linking of «bacterial» cell walls ✓	*Accept arguments using correct descriptions of hybridization for M1.* *Do **not** accept "breaks/binds to cell walls" – a reference to the enzyme is needed for alternatives 1 and 2 for M3.* *Do **not** accept "cell membrane" for "cell wall" for M3.*	**3**

Question			Answers	Notes	Total
19.	a		«leads to bacterial» resistance «to antibiotics» ***OR*** destroys useful/beneficial bacteria ***OR*** useful/beneficial/less harmful bacteria replaced with «more» harmful bacteria ✓	*Accept "affects/disturbs micro-ecosystems".*	**1 max**
19.	b		*Any one of:* «most are» toxic «to living organisms» ***OR*** incomplete combustion/incineration can produce toxic products/dioxins/phosgene ***OR*** carcinogenic/can cause cancer ✓ accumulate in groundwater ***OR*** have limited biodegradability ✓ cost of disposal ✓	*Do **not** accept "harmful to the environment".* *Do **not** accept just "pollutes water".* *Do **not** accept "hazard of disposal".* *Accept "ozone depletion" only if there is some reference to chlorinated solvents.*	**1 max**