Markscheme

November 2024

Chemistry

Standard level

Paper 3

28 pages

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Subject details: Chemistry standard level paper 3 Markscheme

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 underlined 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**	**i**	gradient = $\frac{0.010}{5} = 0.0020$ ✓ [mercury ion] = 0.0020 x *t* /months«μg Hg g^{-1} $month^{-1}$» ✓	*Accept gradient in the range "0.0019-0.0021"* ***OR*** ***"****1/500" for M1.* *Accept "y = 0.0020 x" for M2.*	**2**
1.	**a**	**ii**	*Any one of:* rate of uptake equals rate of metabolism/excretion ✓ all «binding» sites/fish «muscles» occupied/saturated ✓	*Accept "equilibrium «between [CH_3Hg^+] in water and [CH_3Hg^+] in muscle»".* *Accept "fish have matured/stopped growing so maximum concentration reached"* ***OR*** *"fish reached maximum capacity to absorb".*	**1 max**
1.	**a**	**iii**	«methylmercury is fat soluble/lipophilic» easier to pass through «cell» membranes ***OR*** «methylmercury more» readily found in nature/ecosystem «than mercury» ***OR*** «methylmercury more» soluble in water/muscle tissue «than mercury» ✓	*Do* ***not*** *accept "ionic"* ***OR*** *"polar" alone.* *Do* ***not*** *penalize references to solid Hg.* *Accept "forms ion-dipole with water" but* ***not*** *"forms hydrogen bond with water."*	**1**
1.	**b**	**i**	«3.723 x 0.0052 =» 0.019 «μg» ✓	*Ignore uncertainty values.*	**1**
1.	**b**	**ii**	«0.0001/0.0052 x 100%=» 2 «%» ✓		**1**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**c**		*Any two of:* mass/length/size/age of fish/time in lake ✓ species/type of fish ✓ water-content of muscle tissue ✓ depth/area «in lake» where captured ✓ part/tissue of fish «sample taken from»✓ how tissue/CH_3Hg^+ is extracted✓ «water» temperature «when captured»✓	*Apply list principle (LP).* *Do **not** accept "mass of muscle sample" **OR** "same fish" alone **OR** "pH".*	**2 max**

Question			Answers	Notes	Total
2.	**a**		*Before heating:* displace oxygen/air ***OR*** avoid combustion/reaction/explosion of hydrogen ✓ *Until product has cooled:* prevent oxidation «of copper back to copper oxide» ***OR*** ensure reaction is complete ✓	*Accept "prevent «further» reaction of copper oxide with carbon dioxide/CO_2 **OR** moisture «in air»" OR "without continuous flow of H_2 reduction may be incomplete" OR "ensure only H_2 gas in reaction tube" for M1.*	**2**

(continued…)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**b**	**i**	mass of «reduction tube and» copper oxide/sample before «heating»✓ mass of «reduction tube and» sample/copper/Cu after «reduction/heating» ✓	*Apply LP.* *Do **not** accept mass of water as not a practical method.* *Accept weight for mass.* *Accept "mass before heating" for M1* *Accept "mass after heating" for M2*	**2**
2.	**b**	**ii**	subtract mass of sample/copper/Cu «following reduction» from mass of copper oxide ✓	*Accept "difference between masses before and after reduction."* *Mark can be scored based on part bi of this question.*	**1**

(continued…)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**c**		incomplete reduction/reaction/not all oxygen removed ***OR*** copper re-oxidized ***OR*** oxide was partly reduced before analysis ***OR*** impurities in sample ✓ repeat «heating in presence of H_2» until mass of product is constant ***OR*** heat for a longer time ***OR*** use a higher temperature ***OR*** increase surface area «of copper oxide» ✓	*Accept "sample wasn't heated/cooled long enough" for M1.* *Do **not** accept "not all oxygen burned" for M1.* *Improvement in M2 must be related to error identified in M1.* *Accept "handle/weigh product/copper/Cu metal in oxygen-free atmosphere" for M2.* *Accept "reduce distance between tube and heat source" for M2.*	**2**

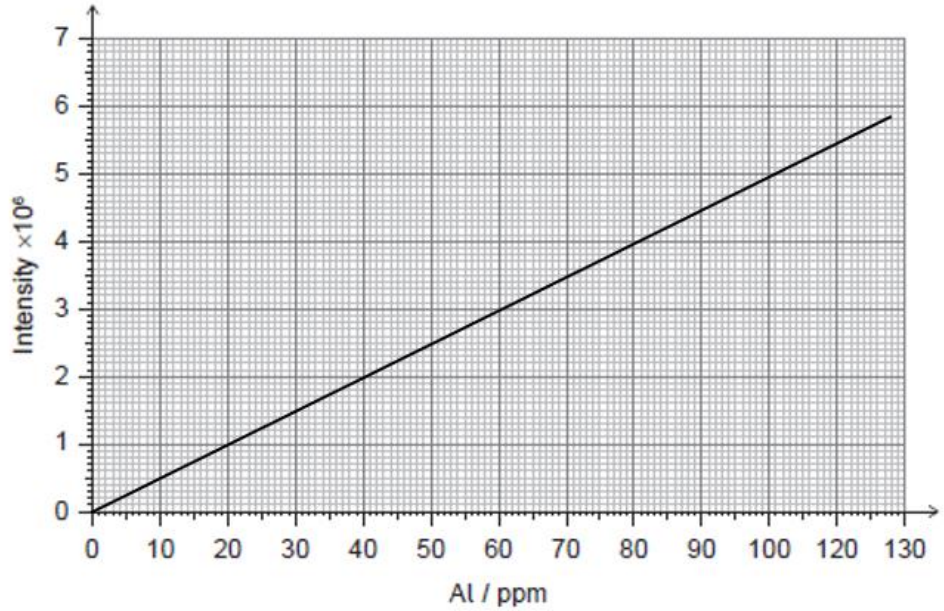
Section B

Option A — Materials

Question			Answers	Notes	Total
3.	**a**	**i**	*Any two of:* lowers the melting point «of alumina» ✓ lowers energy/electricity «consumption» ✓ lowers operating temperature ✓ improves conductivity ✓ acts as a solvent ✓	*Do **not** accept "lowers melting point of aluminium".* *Do **not** accept "lowers boiling point".*	**2 max**
3.	**a**	**ii**	*Bonding:* $\Delta\chi$ = 1.8 ***AND*** average χ = 2.5 ✓ ionic ***AND*** polar covalent ✓ *Electrical conductivity:* non/poor conductor/insulator✓	*Accept "50 to 60% ionic **AND** 40 to 50% polar covalent" **OR** any answer in the range given for M2.*	**3**

(continued…)

(Question 3 continued)

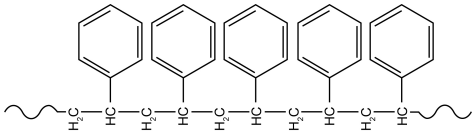
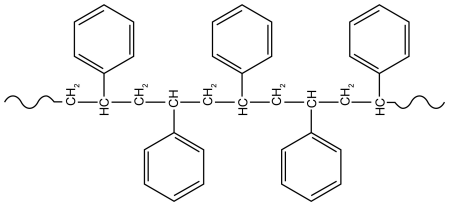
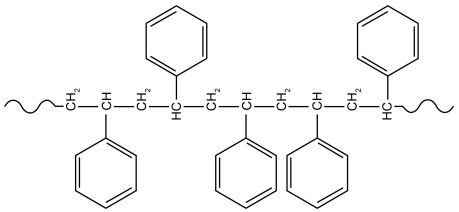
Question			Answers	Notes	Total
3.	**b**		 straight line through origin **AND** coordinate 40, 2 x 10^6 ✓		**1**
3.	**c**	**i**	«in Al alloy» different sizes of ions/particles ***OR*** Ni atoms disrupt regular structure ✓ prevent layers from slipping/sliding ✓	*Accept diagram representing lattice with different sized atoms/circles for M1.* *Difficulty sliding should be explained for M2.*	**2**
3.	**c**	**ii**	$2Al(s) + 2NaOH(aq) + 6H_2O(l) \rightarrow 2Na[Al(OH)_4](s) + 3H_2(g)$ ✓		**1**

(continued…)

(Question 3 continued)

Question			Answers	Notes	Total
3.	**c**	**iii**	large surface area ***OR*** «more» stable/reactive/versatile/easily modified ***OR*** hydrogen «from activation step» adsorbed by catalyst ✓	*Accept "less expensive relative to some other catalysts".*	**1**
3.	**c**	**iv**	observing presence of Ni increases rate «of the reaction while remaining unchanged/reformed» ✓	*Do not accept "trial and error".*	**1**

Question			Answers	Notes	Total
4.	**a**		hydrocarbon/carbon-containing gas/compound ✓	*Accept "ethanol"* ***OR*** *specific gaseous hydrocarbons* ***OR*** *carbon monoxide/dioxide/CO/CO_2*	**1**
4.	**b**		*Obtained using CVD:* heat/vaporize compound/hydrocarbon/carbon-containing gas «mixed with inert gas» ✓ *Formed into CNT:* hydrocarbon/carbon compound decomposes «to form carbon nanotubes» ✓		**2**

Question			Answers	Notes	Total
5.	**a**		 isotactic  neither  atactic ✓	[Source: Kathy L. Singfield, Ashley J. Rowe. Experiment to Teach Multiple Melting Phenomena in Semicrystalline Polymers Using Differential Scanning Calorimetry. *World Journal of Chemical Education*. Vol. 9, No. 3, 2021, pp. 68–76. https://pubs.sciepub.com/wjce/9/3/1 Licensed under CC BY 4.0 https://creativecommons.org/licenses/by/4.0/. Image adapted.]	**1**

(continued…)

(Question 5 continued)

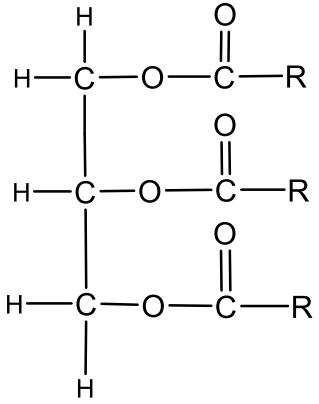
Question			Answers	Notes	Total
5.	**b**		«M_r desired product = 113.18» «∑ M_r ($(C_6H_{11}NO) + 1.5(H_2SO_4) + 3(NH_3)$) = 113.18 + 147.135 + 51.12 =» 311.44 ✓ «% atom economy = (113.18 ÷311.44) × 100 =» 36.34 % ✓	*Award **[2]** for correct final answer.*	**2**
5.	**c**	**i**	BP2 ***AND*** «long» alkyl/C_5H_{11} «group/chain» prevents close packing ***OR*** BP2 ***AND*** «long» alkyl/C_5H_{11} «group/chain» cause molecules to align ✓	*Accept "BP2 **AND** more polar".* *Do **not** accept any reference to rigid/rod-shaped.* *Accept "tail" for "long alkyl group."*	**1**
5.	**c**	**ii**	neither «BP1 nor BP2» contain a dioxin ring ***OR*** «BP1 and BP2 have» no oxygen/O ***OR*** «BP1 and BP2 are» not heterocyclic compounds «in contrast to dioxins». ✓		**1**

(continued…)

(Question 5 continued)

Question			Answers	Notes	Total
5.	**c**	**iii**	BP1 ***AND*** *Any one of:* contains chlorine/Cl «and BP2 does not» ✓ can produce chlorinated dioxins on combustion «and BP2 will produce less toxic combustion products» ✓ more likely to produce persistent organic pollutants/POP ✓ act on cell receptors «and BP2 does not» ✓	*Do **not** accept just polychlorinated biphenyl/PCB with no further explanation*	**1 max**

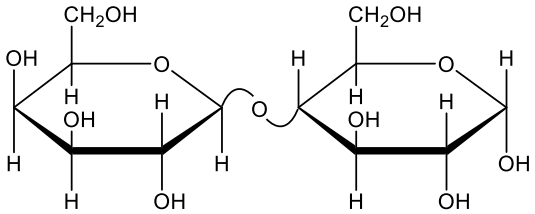
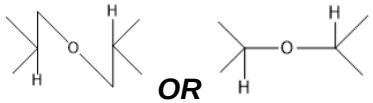
Option B — Biochemistry

Question			Answers	Notes	Total
6.	**a**	**i**	 + $3H_2O$ ✓ ✓	*Award **[1]** for the correct structural formula of the triglyceride.* *Award **[1]** for "3 moles of water".* *Penalize incorrect bond connectivity **OR** missing hydrogens once only for 6a i or 7b.*	**2**
6.	**a**	**ii**	condensation ✓	*Accept "esterification".* *Accept "nucleophilic substitution/S_N".*	**1**

(continued…)

(Question 6 continued)

Question			Answers	Notes	Total
6.	**b**	**i**	***ALTERNATIVE 1:*** 2 C=C bonds / 2 carbon to carbon double bonds ✓ mass of iodine per mole of acid = «2 x 253.80 g mol^{-1} =» 507.6 «g mol^{-1}» ✓ iodine number «=$\frac{507.6\ g\ mol^{-1}}{280.50\ g\ mol^{-1}} \times 100$ » = 181 ✓ ***ALTERNATIVE 2:*** 2 C=C bonds / 2 carbon to carbon double bonds ✓ «$\frac{100\ g}{280.50\ g\ mol^{-1}} \times 2$ » = 0.713 mol of I_2 «reacts with 100 g» ✓ Iodine number «= 0.713 mol x 253.80 g mol^{-1} » = 181 ✓	*Award **[3]** for correct final answer.*	**3**
6.	**b**	**ii**	straighter chain/fewer kinks in chain/more regular structure ✓ chains pack more closely together ✓ stronger London/dispersion/instantaneous dipole-induced dipole forces «between molecules» ✓	*Accept "greater surface area/electron density" **OR** "fewer carbon-carbon/C=C bonds" **OR** "less unsaturated" for M1* *Accept "stronger van der Waals'/vdW forces" for M3.* *Do **not** accept arguments based on size/molar mass/molecular mass of molecules alone.*	**3**

Question			Answers	Notes	Total
7.	**a**		proteins are charged at certain pH/pI ✓ attracted to electrode of opposite charge ***OR*** small/lighter/higher charged species travel further in gel ✓	*Do **not** penalize reference to amino acids instead of proteins.* *Do **not** accept answers related to DNA.*	**2**
7.	**b**	**i**	 ✓	*Award mark if hydrogens are drawn as shown and rings are connected with a single oxygen.* *Accept a straight line across the middle with the oxygen atom,*  ***OR***	**1**
7.	**b**	**ii**	carbonyl ✓ hydroxyl ✓	*Accept "aldehyde" for M1* *Accept "alcohol" **OR** "hydroxy" but **not** "hydroxide" for M2.*	**2**

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**c**		*Any two of:* lactose/substrate binds to active site ✓ weakens «glycosidic/ether» bond in substrate ✓ lowers activation energy/E_a ***OR*** provides alternate pathway✓ increases rate of reaction ***OR*** acts as catalyst ✓ lactose/substrate specific ✓	*Accept "favorable orientation/conformation of the substrate «enforced by enzyme»" for M1.*	**2 max**

Question			Answers	Notes	Total
8.			«most» vitamins cannot be synthesized by the body ***OR*** water-soluble vitamins are not stored in the body ✓	*Accept specific examples comparing foods containing/missing vitamins.*	**1**

Question			Answers	Notes	Total
9.	**a**		«host selectively» bonds/binds to cesium/Cs/Cs^+/metal «ions» ***OR*** complementary chemical structure of host molecule and metal ✓ «supramolecule/host and cesium» anchored/filtered/precipitated✓	*Do **not** accept "specifically bind" for M1 as this is rare for synthetic host molecule.* *Do **not** accept "trap" for M1* *Accept "supramolecule removed" for M2.* *Do **not** accept "removed" by itself for M2.*	**2**
9.	**b**		*Any one of:* require land «used for food production**»** ✓ increased use of fertilizers/pesticides/phosphorus/nitrogen «has negative environmental effects» ✓ ***OR*** eutrophication/ release methane/CH_4/greenhouse gas «during degradation» ✓ ***OR*** «bioplastics sometimes» degrade quickly/before end of use/ cannot be reused ✓ ***OR*** «bioplastics have» poor mechanical strength ✓	*Apply LP.* *Accept "more sensitive to light".*	**1 max**

Option C — Energy

Question			Answers	Notes	Total
10.	**a**	**i**	${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$ ✓	*Accept equations without atomic numbers but **not** incorrect atomic numbers.* *Accept "D for deuterium" and "T for tritium" including mass numbers.* *Do **not** accept N for n.* *Accept values on the right side of the symbols if consistent.*	**1**
10.	**a**	**ii**	helium/product has higher binding energy «per nucleon» than «the average of binding energies per nucleon for» reactants/deuterium and tritium ✓ mass deficit/defect converted to energy ✓	*Accept "binding energy of ^{4}He is higher than the sum of binding energies of ^{2}H and ^{3}H" for M1.* *Accept "binding energy is released as heat" for M2.* *Do **not** accept just "mass converted to energy" alone.*	**2**
10	**b**		electrons/atoms/ions/elements absorb «specific» photons/frequencies/wavelength/energies «and jump to higher levels» ✓ «continuous» spectrum is missing this frequency/wavelength ***OR*** «absorbed» frequency/wavelength of light is re-radiated in all directions ✓	*Accept correctly annotated diagram.* *Accept: "gasses in sun's atmosphere for element" in M1.* *Accept "black lines seen «in continuous spectrum» where photons absorbed" for M2.*	**2**

Question			Answers	Notes	Total
11.	**a**		UV has higher energy/shorter wavelength «for use on ISS» ✓ UV is absorbed «by O_3» in the atmosphere ***OR*** only a little/small percentage «of UV light» reaches the earth's surface ✓		**2**
11.	**b**		«1.3 watts m^{-2} X 3 =» 3.9 «watts» ✓ «3.9 watts x 20 % =» 0.78 «W» ✓	*Accept range of "3.6-4.2* «*watts*»" *for M1.* *Accept range of "0.72-0.84* «W»" *for M2.* *Accept range of "0.24-0.28* «W»" *for M2 if M1 is missing.*	**2**

(continued…)

(Question 11 continued)

Question			Answers	Notes	Total
11.	**c**		highly conjugated system ***OR*** many alternating single and double bonds ***OR*** many delocalized electrons ✓		**1**
11.	d		change in polarity/dipole ✓ bonds stretch/bend ***OR*** bond length/O-H distance changes ***OR*** bond angle/H-O-H angle changes ✓ different vibrations/vibrational modes absorb different wavelengths ✓	*Accept "bonds/molecules vibrate" for M2.* *Accept "molecules stretch"* ***OR*** *"molecules bend" for M2.* *Accept appropriate diagrams.*	3
11.	**e**		methane/CH_4 ✓	*Accept "N_2O".*	**1**

Question			Answers	Notes	Total
12.	**a**		$C_8H_{18}(l) + 12.5\ O_2(g) \rightarrow 8CO_2(g) + 9H_2O(g)$ ✓ «1 x 8(44.01) ÷ 114.26 =» 3.081«kg CO_2 produced» ✓	*Accept equation with whole number coefficients.* *Award **[2]** for correct final answer.* *Accept "3.09 «kg CO_2 produced»" if whole numbers are used for molar mass.*	**2**
12.	**b**	**i**	$C_6H_{12}O_6(aq) \rightarrow 2\ C_2H_5OH(aq) + 2\ CO_2(g)$ ✓		**1**
12.	**b**	**ii**	CO_2 «produced by burning ethanol» captured by crops «via photosynthesis» ✓	*Do **not** accept just "renewable" **OR** "carbon neutral" alone"*	**1**
12.	**c**		can be compressed more «before ignition» ***AND*** increased «engine efficiency» ✓ ***OR*** reducing spontaneous combustion/autoignition **AND** increased «engine efficiency»		**1**
12.	**d**		*Any one of:* «alkali» scrubbers ✓ react with CaO to produce carbonate ✓	*Apply LP.* *Accept "use as a feedstock" **OR** "convert to syngas".* *Do **not** accept carbon fixation/capture.*	**1 max**

Option D — Medicinal chemistry

Question			Answers	Notes	Total
13.	**a**	**i**	$\ll \frac{0.897 \times 180.17}{138.13} \gg =$ 1.17 «g» ✓		**1**
13.	**a**	**ii**	water ***AND*** incomplete drying/water retained in solid ***OR*** ethanoic acid ***AND*** not evaporated ✓	*Apply LP.* *Accept "ethanoic anhydride **AND** excess reagent".* *Accept "salicylic acid **AND** incomplete conversion/reaction".*	**1**
13.	**a**	**iii**	lower ***AND*** broader «range» ✓		**1**

(continued…)

(Question 13 continued)

Question			Answers	Notes	Total
13.	**b**	**i**	*Aspirin:* prevents/interferes with production of prostaglandins/substances responsible for pain/swelling/fever' ✓ *Morphine:* blocks impulses within the brain /CNS ***OR*** binds to the «opioid/pain» receptors in the brain/CNS ***OR*** effective against strong pain ✓	*Award **[1 max]** for "aspirin acts at the pain source **AND** morphine acts on the brain/CNS".* *Accept "blocks COX/cyclooxygenase" for M1.* *Accept "effective against pain due to cancer/surgery/serious injury" for M2.* *Accept "sedate patients/relieve anxiety/stress associated with severe/terminal illness" for M2.* *Do **not** accept **"**blocks impulses to the brain" for M2.*	**2**
13.	**b**	**ii**	*Any one of*: constipation ✓ loss of appetite/malnutrition ✓ nausea/vomiting ✓ drowsiness/mental clouding/euphoria/mood changes ✓ respiratory depression/asphyxia ✓	*Apply LP.*	**1 max**

(continued…)

(Question 13 continued)

Question			Answers	Notes	Total
13.	**c**		*Any one of:* strong analgesic ***OR*** relieves extreme pain ✓ relieves depression ***OR*** induces relaxation ***OR*** improves quality of life ✓	*Apply LP*	**1 max**
13.	**d**		*Any two of:* different functional groups ✓ affect binding between drug and receptor «sites/molecules» ***OR*** cause different solubility in lipids/blood-brain barrier/BBB ✓ codeine/diamorphine must be hydrolysed «before it can bind to opioid receptors» ✓	*Allow names or structures for M1.*	**2 max**

(continued…)

(Question continued)

Question			Answers	Notes	Total
13.	**e**		*Laboratory synthesis:* natural sources not depleted/not reliant on scarce resources ***OR*** new structures can be developed to target specific sites ***OR*** higher purity/concentration ✓ *Derivation from natural sources:* provide ready-made complex organic structures «that would be difficult to synthesize» ***OR*** active compounds may be beyond synthetic techniques ***OR*** can provide semi-synthetic approach ✓	*Do **not** accept "produced faster **OR** lower cost".*	**2**

Question			Answers	Notes	Total
14.	**a**		«irreversibly» binds/bonds to enzyme/transpeptidase ***OR*** inhibits enzyme/transpeptidase «in bacteria» that produces cell walls ***OR*** prevents cross-linking of bacterial cell walls ✓ cells absorb water ***AND*** burst ***OR*** cells cannot reproduce ✓	*Accept "reacts with" for "bonds to" for M1.* *Do **not** accept "cell membrane" for "cell wall" for M1.* *Accept "cells burst due to osmotic pressure" for M2.* *Accept "bacteria" for "cells" for M2.*	**2**

(continued…)

(Question 14 continued)

Question			Answers	Notes	Total
14.	**b**		«can lead to» antibiotic resistance in bacteria/microorganisms «in soil/water» ***OR*** «causes» changes in bacterial population ✓	*Accept "antibiotic resistant bacteria but **not** antibiotic resistance".* *Do **not** accept "bacteria develop tolerance".*	**1**
14.	**c**	**i**	*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 virus» ✓ ***OR*** bacteria reproduce by fission/budding «and viruses reproduce within a living host cell» ✓	*Apply LP.* *Accept "bacteria have flagella/cytoplasm/ribosomes «and viruses 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 that virus do not).* *Accept "bacteria are living «and viruses are not"»*	**1 max**

(continued…)

(Question 14 continued)

Question			Answers	Notes	Total
14.	**c**	**ii**	*Any two of:* prevents virus attaching to/entering host cell ✓ alters cell's genetic material/DNA «so that virus cannot use it to multiply» ✓ blocks enzyme activity in the host cell «so that virus cannot use it to multiply» ✓ prevents removal of protein coat/capsid ✓ prevents injection of viral DNA/RNA «into host cell» ✓ prevents release of «replicated» viruses «from host cell» ✓	*Apply LP.* *Accept "prevents synthesis of virus by host cell".* *Accept "alters RNA/DNA/genetic material of virus".* *Accept "blocks viral enzyme/reverse transcriptase"*	**2 max**

Question			Answers	Notes	Total
15.	**a**		$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$ ***OR*** $Ca(OH)_2(aq) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + 2H_2O(l)$ ✓	*Accept "$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$".*	**1**
15.	**b**		$pK_a = 10.32$ ✓ pH «= $pK_a + \log\left(\frac{[A^-]}{[HA]}\right) = 10.32 + \log\left(\frac{0.015}{0.020}\right)$ » = 10.20 ✓	*Accept "10.31" for M1.* *Accept "10.19" for M2.* *Award **[2]** for correct final answer.* *Award **[1 max]** if the final answer is not to 2 decimal places.*	**2**