

Markscheme

November 2016

Chemistry

Standard level

Paper 3

23 pages

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Section A

Question			Answers	Notes	Total
1.	a	i	HOCl: +1 AND ClO ₂ : +4 ✓	Accept "I" and "IV" but not "1+/1" and "4+/4" notations.	1
1.	a	ii	«most» CT values are higher for «bacterium» B OR «generally» higher dosage needed for «bacterium» B ✓	Accept converse arguments. Accept "concentration" for "dosage".	1
1.	a	iii	«CT = $1.50 \times 10^{-5} \times 10^3 \text{ mg dm}^{-3} \times 9.82 \text{ min} \Rightarrow 1.47 \times 10^{-1} \text{ «mg min dm}^{-3}\text{»} \checkmark$		1
1.	a	iv	lower than CT value/minimum dosage/ $1.8 \times 10^{-1} \text{ «mg min dm}^{-3}\text{»}$ AND no/insufficient ✓	Accept "concentration" for "dosage".	1
1.	b	i	higher CT value at lower temperature OR higher dosage «of chlorine» needed at low temperature ✓	Accept "effectiveness decreases at lower temperature". Accept "concentration" for "dosage". Accept converse arguments.	1
1.	b	ii	labeled axes (y: CT and x: pH) AND curve with increasing gradient ✓	Do not accept axes the wrong way round. Accept a linear sketch.	1
1.	b	iii	values at pH 9.0 approximately 3 times values at pH 6.0 OR increase in CT values in same ratio ✓	The exact ratio is 2.9 times. Do not accept just "increase in value".	1
1.	b	iv	[HOCl] decreases AND [OCl ⁻] increases ✓		1

(continued)

(Question 1 continued)

Question		Answers	Notes	Total
1.	c	plastic disposal/pollution OR plastic bottles use up petroleum/non-renewable raw material OR chemicals in plastic bottle can contaminate water OR «prolonged» storage in plastic can cause contamination of water OR plastic water bottles sometimes reused without proper hygiene considerations ✓	Accept other valid answers. Accept economic considerations such as “greater production costs”, “greater transport costs” or “bottled water more expensive than tap water”.	1
2.	a	repeat steps 3 and 4 OR repeat step 5 OR conduct a third heating OR «re»heat AND «re»weigh ✓ water still present OR need two consistent readings OR heat to constant mass ✓	Accept “ensure even/strong heating” for M1. Do not accept “cleaning/washing the crucible”.	2

(continued)

(Question 2 continued)

Question		Answers	Notes	Total
2.	b	soot/carbon deposited OR incomplete combustion OR air hole of Bunsen burner closed/not fully open ✓ «value of x» lower ✓	Accept "using a yellow «Bunsen burner» flame" for M1. Only award M2 if M1 correct.	2
2.	c	all mass loss is due to water loss ✓ all the water «of crystallization» is lost ✓ crucible does not absorb/lose water ✓ crystal/BaCl ₂ does not decompose/hydrolyse/oxidize/react with oxygen/air «when heated» ✓	Accept "no loss of crystals/BaCl ₂ occurs", "no impurities in the «weighed hydrated» salt", "reaction goes to completion", "heat was consistent/strong", "crystal/BaCl ₂ does not absorb water during cooling", "balance has been calibrated" or "crucible was clean at the start". Do not accept "heat loss to surroundings" or "no carbon deposited on crucible". Reference to defects in apparatus not accepted. Do not penalize if BaCl ₂ .xH ₂ O is used for BaCl ₂ .	2 max

Section B

Option A — Materials

Question		Answers	Notes	Total
3.	a	MgO: ionic AND SiC: covalent ✓	Accept “covalent network/network covalent” for “covalent” but not just “network”.	1
3.	b	metallic «bonding» ✓		1
4.	a	« $0.300\text{A} \times 9.00 \times 10^3\text{s} \Rightarrow 2.70 \times 10^3\text{C}$ » ✓		1
4.	b	« $\text{mol e}^- = \frac{2700\text{C}}{96500\text{C mol}^{-1}} \Rightarrow 2.80 \times 10^{-2}\text{mol}$ » ✓		1
4.	c	« $\frac{1.07\text{g}}{0.0280\text{mol}} \Rightarrow 38.2\text{g}$ » ✓		1
4.	d	« $\frac{114.82\text{g}}{38.2\text{g mol}^{-1}} \text{e}^- \Rightarrow 3.01/3.00\text{mol e}^-$ » ✓		1
4.	e	In ³⁺ /3+ AND In ₂ (SO ₄) ₃ ✓	Do not accept “+3/3”.	1
5.	a	pores/cavities/channels/holes/cage-like structures ✓ «only» reactants with appropriate/specific size/geometry fit inside/go through/are activated/can react ✓	Accept “molecules/ions” for reactants.	2

(continued)

(Question 5 continued)

Question			Answers	Notes	Total
5.	b	i	iron«0»«penta»carbonyl/Fe(CO) ₅ catalyst decomposes OR $\text{Fe}(\text{CO})_5(\text{g}) \rightarrow \text{Fe}(\text{s}) + 5\text{CO}(\text{g})$ OR metal nanocatalyst/clusters/particles formed « <i>in situ</i> » ✓ $2\text{CO}(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{C}(\text{s})$ ✓	Accept “cobalt-molybdenum/Co-Mo/CoMo” as a catalyst. Accept “conversion of CO molecules into CNTs/SWNTs” for M2.	2
5.	b	ii	higher efficiency per unit mass/volume of the catalyst «due to higher surface to mass/volume ratio» OR greater selectivity «due to metal nanoclusters/surface topology/pore size» OR higher stability of the catalyst «due to lower tendency to aggregation» OR reduced cost of the catalyst/product/chemicals «as precious metals can be replaced with nanocatalysts made of inexpensive materials» ✓	Accept “high conversion efficiency”. Accept specific examples such as use of nanocatalysts in fuel cells/catalytic converters «leading to reduced use of Pt/Rh/Pd». Accept “nanocatalysts often operate under milder conditions «so less energy consumption involved/so promotes principles of green chemistry»”. Accept “lower energy consumption” OR “reduced carbon footprint” OR “reduced global warming”. Accept “nanocatalysts often have long lifetimes «so more economical»”. Accept “some nanocatalysts have enzyme mimicking activities”.	1

(continued)

Question			Answers	Notes	Total
6.	a	i	$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_2\text{C}=\text{C} \\ \\ \text{CH}_3 \end{array}$ <p>OR</p> $\text{H}_2\text{C}=\text{C}(\text{CH}_3)_2 \checkmark$		1
6.	a	ii	$\begin{array}{c} \text{H} \quad \text{CH}_3 \\ \quad \\ \text{---C---C---} \\ \quad \\ \text{H} \quad \text{CH}_3 \end{array}$ <p>OR</p> $-\text{CH}_2\text{C}(\text{CH}_3)_2- \checkmark$	Continuation bonds needed for mark. No penalty if square brackets present or "n" appears after the bracket/formula.	1
6.	b		«same mass of product as reactant, thus» 100 «%» ✓	Accept "less than 100%" only if a reason is given (eg, the catalyst is not converted into the product, or other reasonable answer).	1

(continued)

(Question 6 continued)

Question			Answers	Notes	Total
6.	c	i	due to stability of plastics/strong covalent bonds OR low volatility preventing good mixing with oxygen «gas» OR lack of/insufficient oxygen OR plastics are often parts of devices with non-combustible components «which mechanically prevent the combustion of plastic components» OR PVC already partly oxidised «because some C–H bonds are replaced with C–Cl bonds», so it cannot produce enough heat for complete combustion OR many industrial/household materials contain additives that reduce their flammability/act as flame retardants ✓		1
6.	c	ii	weakly bound to the PVC/no covalent bonds to PVC/only London/ dispersion/instantaneous induced dipole-induced dipole forces between DEHP and PVC AND leach/evaporate «from PVC» to atmosphere/food chain OR has low polarity/contains non-polar hydrocarbon chains AND fat-soluble/ deposits in the fatty tissues OR has unusual structural fragments/is a xenobiotic/difficult to metabolise AND stays in the body for a long time ✓		1

(continued)

Question		Answers	Notes	Total						
7.	a	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;"><i>Lyotropic LCs</i></td> <td style="width: 50%; text-align: center;"><i>Thermotropic LCs</i></td> </tr> <tr> <td>solutions</td> <td style="text-align: center;">AND pure substances</td> </tr> <tr> <td>LC over certain <u>concentration</u> range</td> <td style="text-align: center;">AND LC over a <u>temperature</u> range «between the solid and liquid phases»</td> </tr> </table>	<i>Lyotropic LCs</i>	<i>Thermotropic LCs</i>	solutions	AND pure substances	LC over certain <u>concentration</u> range	AND LC over a <u>temperature</u> range «between the solid and liquid phases»	<p><i>Do not award any credit if one type only is described as the question asks how they differ.</i></p>	2
<i>Lyotropic LCs</i>	<i>Thermotropic LCs</i>									
solutions	AND pure substances									
LC over certain <u>concentration</u> range	AND LC over a <u>temperature</u> range «between the solid and liquid phases»									
7.	b	<p>decreases AND as energy «added» overcomes interparticle forces OR decreases AND as energy «added» causes faster movement «of particles» ✓</p>		1						

(continued)

Option B — Biochemistry

Question			Answers	Notes	Total
8.	a		Name of the chemical link: ester/ethoxycarbonyl AND Name of the other product: water ✓	Do not accept formulas. Do not accept "esterification".	1
8.	b	i	coconut oil AND lowest «percentage of» unsaturated fatty acids OR coconut oil AND smallest number of C=C bonds OR coconut oil AND highest «percentage of» saturated fatty acids ✓	Accept "fats" for "fatty acids".	1
8.	b	ii	soybean oil AND highest «percentage of» polyunsaturated fatty acids OR soybean oil AND greatest number of C=C bonds OR soybean oil AND lowest «percentage of» saturated fatty acids ✓	Accept "fats" for "fatty acids".	1
8.	b	iii	Beef fat: «P/S = $\frac{3}{59} =$ » 0.05 AND Soybean oil: «P/S = $\frac{50 + 8}{14} =$ » 4.1 ✓		1
8.	b	iv	«higher proportion of» polyunsaturated fatty acids decrease risk of atherosclerosis/heart disease/cardiovascular disease/CVD OR «higher proportion of» polyunsaturated fatty acids which are less likely to be deposited on the walls of arteries «than saturated fatty acids» ✓	Accept converse arguments. Accept correct arguments in terms of HDL and LDL but not in terms of "good" and "bad" cholesterol. Accept "fats" for "fatty acids".	1

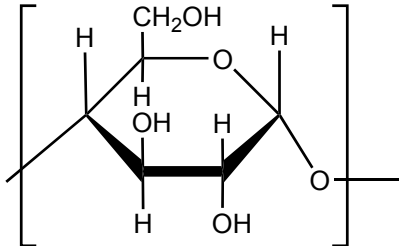
(continued)

(Question 8 continued)

Question			Answers	Notes	Total
8.	b	v	<p>Any two of:</p> <p>cotton seed oil has «a higher proportion of» longer chain/greater molar mass fatty acids ✓</p> <p>molecules of cotton seed oil have greater surface area/have higher electron density ✓</p> <p>stronger London/dispersion/instantaneous induced dipole-induced dipole forces between chains in cotton seed oil ✓</p>	<p>Accept converse arguments. Accept “fats” for “fatty acids”.</p> <p>Accept “molecules of cotton seed oil are packed more closely/have more regular structure” for M2.</p>	2 max
9.	a		CO ₂ AND H ₂ O AND sun ✓	<p>Accept names. Accept “sunlight/light/photons” instead of “sun”.</p>	1
9.	b	i	<p>both have formula C_x(H₂O)_y OR both contain several OH/hydroxyl «groups» AND a C=O/carbonyl «group» ✓</p>	<p>Accept “both have the formula C_nH_{2n}O_n / empirical formula CH₂O” but do not accept “both have same molecular formula/have formula C₃H₆O₃”. Accept “aldehyde or ketone” for “carbonyl”.</p>	1

(continued)

(Question 9 continued)

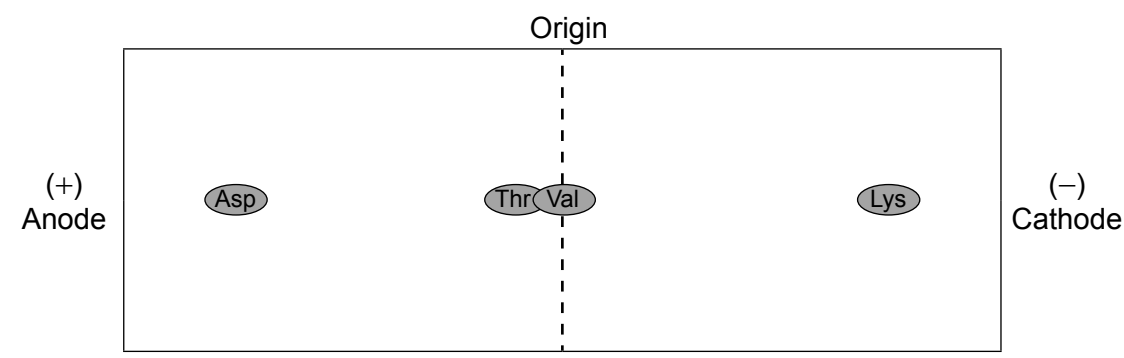
Question			Answers	Notes	Total				
9.	b	ii	<table border="1" style="width: 100%;"> <tr> <td style="text-align: center;">X</td> <td style="text-align: center;">Y</td> </tr> <tr> <td> RCHO/CHO OR C=O/carbonyl «group with C» bonded to H OR formyl «group» OR C=O/carbonyl «group» at end of chain/at C-1 «atom» </td> <td> R₂CO/RCOR' OR carbonyl/C=O «group with C» bonded to two C/R «groups» OR C=O/carbonyl «group» in middle of chain/at C-2 «atom» </td> </tr> </table> <p style="text-align: center;">AND</p>	X	Y	RCHO/CHO OR C=O/carbonyl «group with C» bonded to H OR formyl «group» OR C=O/carbonyl «group» at end of chain/at C-1 «atom»	R ₂ CO/RCOR' OR carbonyl/C=O «group with C» bonded to two C/R «groups» OR C=O/carbonyl «group» in middle of chain/at C-2 «atom»	Accept "alkyl" for "R". Accept "X: aldose/aldehyde AND Y: ketose/ketone". Accept "CO" for "C=O".	1
X	Y								
RCHO/CHO OR C=O/carbonyl «group with C» bonded to H OR formyl «group» OR C=O/carbonyl «group» at end of chain/at C-1 «atom»	R ₂ CO/RCOR' OR carbonyl/C=O «group with C» bonded to two C/R «groups» OR C=O/carbonyl «group» in middle of chain/at C-2 «atom»								
9.	c	i	 <p>continuation bonds AND open O on either but not both ends ✓</p>	Brackets are not necessary for the mark. Do not accept β-isomer. Mark may be awarded if a polymer is shown but with the repeating unit clearly identified. 3-D representation is not required.	1				

(continued)

(Question 9 continued)

Question			Answers	Notes	Total
9.	c	ii	<p><i>Advantage:</i> Any one of: biodegradable / break down naturally/by bacteria ✓ compostable ✓ does not contribute to land-fill ✓ renewable/sustainable resource ✓ starch grains swell AND help break up plastic ✓ lower greenhouse gas emissions ✓ uses less fossil fuels than traditional plastics ✓ less energy needed for production ✓</p> <p><i>Disadvantage:</i> Any one of: land use «affects biodiversity/loss of habitat» ✓ growing corn for plastics instead of food ✓ «starch» breakdown can increase acidity of soil/compost ✓ «starch» breakdown can produce methane «especially when buried» ✓ sensitive to moisture/bacteria/acidic foods ✓ «bioplastics sometimes» degrade quickly/before end of use ✓ cannot be reused ✓ poor mechanical strength ✓ eutrophication ✓ increased use of fertilizers/pesticides/phosphorus/nitrogen «has negative environmental effects» ✓</p>	<p><i>Ignore any reference to cost.</i></p> <p><i>Do not accept just “decompose easily”.</i></p> <p><i>Accept “prone to site explosions/fires” or “low heat resistance” for disadvantage.</i></p> <p><i>Only award [1 max] if the same example is used for the advantage and disadvantage.</i></p>	<p>2 max</p>

(continued)

Question			Answers	Notes	Total
10.	a		2-amino-4-methylpentanoic acid ✓	Accept 4-methyl-2-aminopentanoic acid.	1
10.	b	i	 <p>Lys on cathode side AND Asp on anode side ✓ Val at origin AND Thr on anode side but closer to origin than Asp ✓</p>	<p>Val and Thr need not overlap.</p> <p>Accept any (reasonable) size and demarcation of position so long as position relative to origin is correct.</p> <p>Accept crosses for spots.</p> <p>Award [1 max] for any two correct.</p> <p>Award [1 max] if net direction of spots is reversed.</p> <p>Award [1 max] if the four points are in the correct order but not in a straight line.</p>	2
10.	b	ii	different sizes/molar masses/chain lengths «so move with different speeds» ✓		1
10.	c		«20 ³ => 8000 ✓		1
10.	d	i	hydrogen bonds ✓		1
10.	d	ii	carboxamide/amide/amido OR C=O AND N-H ✓	Accept peptide.	1

(continued)

Option C — Energy

Question			Answers	Notes	Total
11.	a	i	$\left\langle \frac{1.58 \times 10^7 \text{ J}}{80.0 \text{ kg}} = \frac{15.8 \text{ MJ}}{80.0 \text{ kg}} = \right\rangle 1.98 \times 10^{-1} \text{ «MJ kg}^{-1}\text{»} \checkmark$		1
11.	a	ii	gasoline releases more energy from a given mass of fuel OR gasoline has higher specific energy \checkmark	<i>Do not accept volume in place of mass as question refers to specific energy, not energy density.</i>	1
11.	b	i	$\left\langle \frac{15.8 \text{ MJ}}{34.3 \text{ MJ dm}^{-3}} \right\rangle = 4.61 \times 10^{-1} \text{ «dm}^3\text{»} \checkmark$		1
11.	b	ii	$\left\langle 4.61 \times 10^{-1} \text{ dm}^3 \times 32.0 \text{ km dm}^{-3} \times 4 \right\rangle = 59.0/59.1 \text{ «km»} \checkmark$		1
12.	a		«tends to» decrease with longer/larger/heavier alkanes \checkmark «tends to» increase with bulkier/more branched alkanes \checkmark	<i>Accept “octane number decreases with the separation between branches” OR “increases with the more central position of branches”. Accept converse arguments.</i>	2
12.	b		$\text{C}_7\text{H}_{16} \rightarrow \text{C}_6\text{H}_5\text{CH}_3 + 4\text{H}_2 \checkmark$	<i>Accept “C₇H₈” for “C₆H₅CH₃”.</i>	1

(continued)

Question			Answers	Notes	Total
13.	a		<p>Any two of:</p> $\text{CO}_2(\text{g}) \xrightleftharpoons{\text{H}_2\text{O}(\text{l})} \text{CO}_2(\text{aq}) \checkmark$ $\text{CO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$ <p>OR</p> <p>HCO_3^- AND H^+ are formed «by dissolved CO_2» \checkmark</p> <p>«increasing $[\text{CO}_2]$» shifts equilibrium to right/increases acidity/ decreases pH \checkmark</p>	<p>$\text{H}_2\text{O}(\text{l})$ not required over equilibrium sign for M1. State symbols required in the equation in M1. Accept "H_2CO_3" at either side of the equilibrium in M2. Equilibrium sign required for M1 but not for M2.</p>	2 max
13.	b	i	<p>bond length/C=O changes OR «asymmetric» stretching «of bonds» OR bond angle/OCO changes \checkmark</p> <p>photon re-emitted in random direction OR polarity/dipole «moment» changes OR dipole «moment» created «when molecule absorbs IR» \checkmark</p>	<p>Accept "molecule bends" for M1. Accept appropriate diagrams.</p>	2
13.	b	ii	<p>CO_2 gas «ten times» more effective as greenhouse gas/GHG than H_2O OR CO_2 gas levels keep increasing «unlike H_2O» OR CO_2 has higher Global Warming Potential/GWP than H_2O OR CO_2 stays in the atmosphere for longer than H_2O \checkmark</p>	<p>Accept converse arguments.</p>	1

(continued)

Question			Answers	Notes	Total
14.	a		$ \begin{array}{c} \text{CH}_2\text{-O-CO-C}_{17}\text{H}_{33} \\ \\ \text{CH-O-CO-C}_{17}\text{H}_{33} \\ \\ \text{CH}_2\text{-O-CO-C}_{17}\text{H}_{33} \end{array} + 3 \text{CH}_3\text{-OH} \longrightarrow 3 \text{CH}_3\text{-O-CO-C}_{17}\text{H}_{33} + \begin{array}{c} \text{CH}_2\text{-OH} \\ \\ \text{CH-OH} \\ \\ \text{CH}_2\text{-OH} \end{array} $ <p>methyl ester formula AND glycerol formula ✓</p> <p>correct balancing ✓</p>	Award M2 only if M1 is correct.	2
14.	b		<p>«methyl esters have» low«er» viscosity/surface tensions OR «methyl esters have» high«er» volatility OR «combustion of vegetable oils» produces carbon deposits in engine/reduces engine life ✓</p>	Accept converse arguments.	1

15.	a	i	<p>product has higher binding energy «per nucleon»/more stable OR nucleons in product more tightly bound «with one another» ✓</p> <p>lighter elements «than Fe» can fuse/combine with loss of mass/mass defect «and release vast amount of energy» ✓</p>	Accept “mass is converted to energy” for M2.	2
15.	a	ii	<p>Any one of: deuterium/fuel is abundant/cheap ✓ «helium» products not radioactive ✓ fusion much less dangerous than fission ✓ large amounts/shipments of radioactive fuel not required ✓ far less radioactive waste «created by fast moving neutrons» has to be stored ✓</p>	<p>Accept “reduces greenhouse gas emissions/global warming” OR “no radioactive waste” OR “more reliable power” OR “fewer safety issues”.</p> <p>Do not accept “gives out a large amount of energy” as it is in the stem of the question.</p>	1
15.	b	i	$ \lambda = \frac{\ln 2}{t_{\frac{1}{2}}} = \frac{0.693}{25.3 \text{ days}} \Rightarrow 2.74 \times 10^{-2} \text{ day}^{-1} \checkmark $	Need correct unit for mark.	1

(continued)

(Question 15 continued)

Question			Answers	Notes	Total
15.	b	ii	<p>«4 half-lives; $1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8} \rightarrow \frac{1}{16} \Rightarrow \frac{1}{16} / 6.25 \times 10^{-2}$</p> <p>OR</p> <p>«$\frac{N}{N_0} = e^{-\lambda t} = e^{-0.0274 \times 101.2} \Rightarrow 6.25 \times 10^{-2} \checkmark$</p>	Accept 6.25%.	1

(continued)

Option D — Medicinal chemistry

Question			Answers	Notes	Total
16.	a	i	bond angles smaller/distorted OR instability resulting from abnormal bond angles OR bond angles «approximately» 90° instead of 109.5°/120° ✓	<i>Accept “109/110°” for “109.5°”.</i>	1
16.	a	ii	asterisks (*) on all 3 lactam ring carbon atoms ✓	<i>Must mark all 3 carbon atoms. Ignore asterisks on the RHS carbon atoms of the five-membered ring.</i>	1
16.	b	i	beta-lactam/four-membered ring «in clavulanic acid» reacts with enzyme/ beta lactamase ✓	<i>Accept “acts as enzyme inhibitor/suicide substrate/preferentially binds to enzyme”.</i>	1
16.	b	ii	antibiotics not effective against viruses OR viruses have no cell wall/cell structure/target structures to attack ✓ increasing exposure of bacteria «to antibiotic» increases resistance ✓	<i>Accept “antibiotics kill beneficial bacteria” for M2.</i>	2
17.	a		«oral bioavailability is» low OR drug is broken down/pH too low/unable to be absorbed from gut OR only a small proportion of the drug «taken by mouth» reaches the target organ ✓		1
17.	b		ethoxycarbonyl/carbonyl attached to oxygen ✓	<i>Accept “ester”.</i>	1

(continued)

(Question 17 continued)

Question		Answers	Notes	Total
17.	c	<p>Any one of: fermentation OR microbial production ✓</p> <p>genetically engineered bacteria/E.coli ✓</p> <p>sweetgum «seeds/leaves/bark» OR pine/fir/spruce tree «needles» OR <i>Ginkgo biloba</i> ✓</p>	<p>Accept other specific examples of more plentiful plant sources.</p>	1 max
18.	a	<p>ALTERNATIVE 1:</p> <p>«theoretical yield = $\frac{1.552\text{g}}{138.13\text{g mol}^{-1}} \times 180.17\text{g mol}^{-1} \Rightarrow 2.024\text{ «g»}$ ✓</p> <p>«experimental yield = $\frac{1.124\text{g}}{2.024\text{g}} \times 100 \Rightarrow 55.53\text{ «%»}$ ✓</p> <p>ALTERNATIVE 2:</p> <p>«$\frac{1.552\text{g}}{138.13\text{g mol}^{-1}} = 0.01124\text{ «mol salicylic acid/aspirin theoretical» AND$</p> <p>«$\frac{1.124\text{g}}{180.17\text{g mol}^{-1}} = 0.006239\text{ «mol aspirin experimental»}$ ✓</p> <p>«experimental yield = $\frac{0.006239\text{mol}}{0.01124\text{mol}} \times 100 \Rightarrow 55.51\text{ «%»}$ ✓</p>	<p>Accept answers in the range 55.4% to 55.7%.</p> <p>Award [2] for correct final answer.</p>	2

(continued)

(Question 18 continued)

Question		Answers	Notes	Total
18.	b	low temperature gives greater difference between solubility of aspirin and impurities OR «product» crystallizes out from cold solution/«ice-cold water/lower temperature» speeds up crystallization process OR aspirin/product has low solubility «in water» at low temperatures ✓		1
18.	c	recrystallized melting point is higher OR recrystallized melting point is closer to pure substance/literature value ✓ smaller range of values ✓		2
18.	d	intercepts pain stimulus at source/acts at site of pain OR interferes with production of pain sensitizing substances/prostaglandins «at site of pain» ✓		1

19.	a	«ranitidine» blocks/inhibits histamine binding to «H2» receptor OR ranitidine binds to same «H2» receptors «as histamine» OR competes with histamine for binding ✓		1
19.	b	proton pump OR H ⁺ /K ⁺ ATPase enzyme ✓	Accept “«secretory surface of» parietal cells”. Do not accept “stomach/stomach wall”.	1
19.	c	Al(OH) ₃ (s) + 3H ⁺ (aq) → Al ³⁺ (aq) + 3H ₂ O(l) OR Al(OH) ₃ (s) + 3HCl(aq) → AlCl ₃ (aq) + 3H ₂ O(l) ✓		1

(continued)

Question		Answers	Notes	Total
20.	a	<p><i>Similarity:</i> both contain «at least one» benzene/aromatic ring OR both contain amino «group» ✓</p> <p><i>Difference:</i> diamorphine has one benzene/aromatic ring AND methadone has two phenyl «groups» OR diamorphine has one vinylene/ethenylene/1,2-ethenediyl «group» AND methadone has no vinylene/ethenylene/1,2-ethenediyl «group» OR diamorphine has one ether «group» AND methadone has no ether «group» OR diamorphine has «two» ethanoate/acetate «groups» AND methadone has no ethanoate/acetate «groups» ✓</p>	<p>Accept “both contain carbonyl «groups»”. Accept “amine” for “amino «group»”.</p> <p>Accept “phenyl” for “benzene ring” in M1 and M2 although there are no phenyl groups in diamorphine, as the benzene ring in this compound is a part of a polycyclic structure. Do not accept “arene” or “benzene” alone in M1 and M2.</p> <p>Accept “alkenyl/alkene” for “vinylene/ethenylene/1,2-ethenediyl” and “ester” for “ethanoate/acetate”.</p> <p>Accept “methadone has a ketone/carbonyl AND diamorphine does not/has an ester/ethanoate/acetate”.</p> <p>Accept “diamorphine is a heterocycle/heterocyclic compound AND methadone is not a heterocycle/heterocyclic compound”.</p>	2
20.	b	<p>feeling depressed/anxious/irritable OR craving for opioids/heroin OR experience fever/cold sweats/nausea/vomiting/insomnia/muscle pain/cramps/diarrhea/increased rate of respiration/increased heartbeat/lacrimation ✓</p>	<p>Accept listed symptoms (eg, depression, anxiety, fever etc.).</p> <p>Some of the most common symptoms are listed here – there may be other valid ones. Accept “headaches”.</p>	1