

Markscheme

November 2020

Chemistry

Standard level

Paper 3

30 pages

No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without written permission from the IB.

Additionally, the license tied with this product prohibits commercial use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, is not permitted and is subject to the IB's prior written consent via a license. More information on how to request a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

De plus, la licence associée à ce produit interdit toute utilisation commerciale de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, n'est pas autorisée et est soumise au consentement écrit préalable de l'IB par l'intermédiaire d'une licence. Pour plus d'informations sur la procédure à suivre pour demander une licence, rendez-vous à l'adresse suivante : <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin que medie la autorización escrita del IB.

Además, la licencia vinculada a este producto prohíbe el uso con fines comerciales de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales— no está permitido y estará sujeto al otorgamiento previo de una licencia escrita por parte del IB. En este enlace encontrará más información sobre cómo solicitar una licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Subject details: Chemistry higher 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 [20marks].

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	oil is non-polar «and dissolves best in non-polar solvents» OR oil does not dissolve in polar solvents ✓	<i>Do not accept "like dissolves like" only.</i>	1
1.	b	solvent/oil is flammable OR solvent/oil must be kept below its flash point OR oxidation/decomposition of oil OR mixture has a low boiling point ✓	<i>Accept "to prevent evaporation of oil".</i>	1
1.	c	distillation «instead of evaporation» ✓	<i>Accept "pass vapour through a condenser and collect liquid". Do not accept "condensation" without experimental details.</i>	1

Question		Answers	Notes	Total
1.	d	<p><i>Experimental mass greater than actual mass of oil in crisps:</i> other substances «in the crisps» are soluble in the solvent OR not all the solvent evaporates ✓</p> <p><i>Experimental mass less than actual mass of oil in crisps:</i> not all oil dissolved/extracted✓</p>	<p>Accept “oil evaporated” OR “oil burned/decomposed” OR “oil absorbed by the filter” OR “assumption «all oil dissolved» was wrong” for M2.</p> <p>Do not accept examples of human errors OR faulty apparatus.</p>	2

Question		Answers	Notes	Total
2.	a	<p><i>Independent variable:</i> chain length OR number of carbon «atoms in alcohol»</p> <p>AND</p> <p><i>Dependent variable:</i> volume of NaOH OR K_c/equilibrium constant OR <u>equilibrium</u> concentration/moles of CH_3COOH ✓</p>		1
2.	b	<p>dilution/lower concentrations ✓</p> <p>less frequent collisions «per unit volume» ✓</p>	<p>Accept “lowers concentration of acid catalyst” for M1. M2 must refer to increase in activation energy or different pathway.</p> <p>Do not accept responses referring to equilibrium.</p>	2
2.	c	<p>equilibrium shifts to left</p> <p>OR</p> <p>more ethanoic acid is produced «as ethanoic acid is neutralized»</p> <p>OR</p> <p>prevents/slows down ester hydrolysis ✓</p>	<p>Accept “prevents equilibrium shift” if described correctly without direction.</p>	1
2.	d	<p>to determine volume/moles of NaOH used up by the catalyst/sulfuric acid «in the titration»</p> <p>OR</p> <p>to eliminate/reduce «systematic» error caused by acid catalyst ✓</p>	<p>Do not accept “control” OR “standard” alone.</p>	1

Question		Answers	Notes	Total
2.	e	<p>Percentage uncertainty:</p> $\left\langle \frac{0.4 \times 100}{6.5} = \right\rangle 6 \text{ «%» } \checkmark$ <p>Percentage error:</p> $\left\langle \frac{6.5 - 5.3}{5.3} \times 100 = \right\rangle 23 \text{ «%» } \checkmark$	Award [1 max] if calculations are reversed OR if incorrect alcohol is used.	2
2.	f	<p>Any two:</p> <p>large percentage error means large systematic error «in procedure» \checkmark</p> <p>small percentage uncertainty means small random errors \checkmark</p> <p>random errors smaller than systematic error \checkmark</p>	Award [2] for “both random and systematic errors are significant.”	2 max
2.	g	<p>corrosive/burns/irritant/strong oxidizing agent/carcinogenic</p> <p>OR</p> <p>disposal is an environmental issue</p> <p>OR</p> <p>causes other side reactions/dehydration/decomposition \checkmark</p>	Do not accept just “risk of accidents” OR “health risks” OR “hazardous”.	1

Section B

Option A — Materials

Question			Answers	Notes	Total
3.	a		carbon fibre reinforcing phase ✓ «in a» <u>matrix</u> phase of epoxy ✓	Award [1 max] for “reinforcing phase «embedded» in a <u>matrix</u> ”.	2
3.	b	i	can be recycled OR can be reformed when hot OR high impact/chemical/abrasion resistance ✓		1
3.	b	ii	Any three of: plasticizers embed/fit between «polymer» chains ✓ keep polymer strands/chains/molecules separated/apart ✓ weaken intermolecular/London/dispersion/attractive/forces/instantaneous induced dipole-induced dipole/forces «between chains» ✓ prevent chains from packing closely/forming regular packing/structure ✓	Accept “van der Waals/vdW” for “London”.	3 max

Question		Answers	Notes	Total
3.	c	<p>Any two of:</p> <p>readily released into environment</p> <p>OR</p> <p>have weak intermolecular forces «rather than covalent bonds between chains» ✓</p> <p>get into biological systems by ingestion/inhalation ✓</p> <p>interrupt endocrine systems</p> <p>OR</p> <p>affect release of hormones</p> <p>OR</p> <p>effect development of male reproductive system ✓</p> <p>considered carcinogenic</p> <p>OR</p> <p>can cause cellular damage ✓</p> <p>can cause early puberty in females ✓</p> <p>can cause thyroid effects ✓</p> <p>can cause asthma ✓</p>	<p>Do not accept just “are a health concern”.</p>	<p>2 max</p>

Question			Answers	Notes	Total
4.	a		<p><i>Excellent strength: defect-free AND rigid/regular 2D/3D ✓</i></p> <p><i>Excellent conductivity: delocalized electrons ✓</i></p>	<p><i>Accept “carbons/atoms are all covalently bonded to each other” for M1.</i></p>	2
4.	b	i	<p><i>Any of:</i></p> <p><i>ductility ✓</i></p> <p><i>strength/resistance to deformation ✓</i></p> <p><i>malleability ✓</i></p> <p><i>hardness ✓</i></p> <p><i>resistance to corrosion/chemical resistance ✓</i></p> <p><i>range of working temperatures ✓</i></p> <p><i>density ✓</i></p>	<p><i>Do not accept “conductivity”.</i></p>	1
4.	b	ii	<p><i>Anode: $2\text{Cl}^- \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$ ✓</i></p> <p><i>Cathode: $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}(\text{l})$ ✓</i></p>	<p><i>Accept $\text{Cl}^- \rightarrow \text{Cl}_2(\text{g}) + \text{e}^-$.</i></p> <p><i>Award [1 max] for correct equations at incorrect electrodes.</i></p>	2

(continued...)

(Question 4b continued)

4.	b	iii	<p>«$Q = I \times t = 3.00 \times 10.0 \times 3600 \Rightarrow 108\,000\text{ C}$ ✓</p> <p>«$\frac{Q}{F} = \frac{108\,000\text{ C}}{96\,500\text{ C mol}^{-1}} \Rightarrow 1.12\text{ «mol e}^{-}\text{»}$ ✓</p> <p>«$\frac{1.12\text{ mol}}{2} = 0.560\text{ mol Mg}$»</p> <p>«$m = 0.560\text{ mol} \times 24.31\text{ g mol}^{-1} \Rightarrow 13.6\text{ «g»}$ ✓</p>	Award [3] for correct final answer.	3
4.	b	iv	argon/Ar/helium/He ✓	Accept any identified noble/inert gas. Accept name OR formula. Do not accept “nitrogen/N ₂ ”.	1
4.	c		pores/cavities/channels/holes/cage-like structures ✓ «only» reactants with appropriate/specific size/geometry/structure fit inside/go through/are activated/can react ✓	Accept “molecules/ions” for “reactants” in M2.	2
4.	d		rod-shaped molecules OR «randomly distributed but» generally align OR no positional order AND have «some» directional order/pattern ✓	Accept “linear” for “rod-shaped”.	1

Option B — Biochemistry

Question			Answers	Notes	Total
5.	a	i	0.70 ✓	Accept any value within the range "0.67–0.73".	1
5.	a	ii	Ile AND larger R_f ✓ more soluble in non-polar solvent «mobile phase» OR not as attracted to polar «stationary» phase ✓	Only award M2 if Ile is identified in M1.	2
5.	b		hydrogen/H bonding «between amido hydrogen and carboxyl oxygen atoms» ✓		1
5.	c		tertiary: folding/shape of a single «polypeptide/protein» chain ✓ quaternary: arrangement/folding of four/several chains/proteins/polypeptides «held together by IMF» ✓	Accept "two or more polypeptides" for M2.	2

Question			Answers	Notes	Total
6.	a		$\begin{array}{l} \text{H}_2\text{C}-\text{OH} \quad \text{R}^1\text{COOH} \\ \\ \text{HC}-\text{OH} + \text{R}^2\text{COOH} \\ \\ \text{H}_2\text{C}-\text{OH} \quad \text{H}_3\text{PO}_4 \end{array}$ glycerol ✓ both fatty acids AND phosphoric acid ✓	Accept either names OR structures. Accept "long chain carboxylic acid" for "fatty acid". Penalise once only if an incorrect name is given for a correct structure or vice-versa.	2
6.	b	i	A: phosphate/ionic group AND B: alkyl/hydrocarbon «chain» ✓	Accept "glycerol «fragment»" OR "glycerophosphate" OR "ester" for A . Accept "fatty acid «tail»" for B . Do not accept terms such as "polar head", "non-polar tail", "hydrophilic" OR "hydrophobic" for components alone.	1

(continued...)

(Question 6b continued)

Question			Answers	Notes	Total
6.	b	ii	<p><i>Forces occurring between components labelled A:</i> hydrogen/H bonding OR ion-dipole OR ionic/electrostatic «repulsion and/or attraction» ✓</p> <p><i>Forces occurring between components labelled B:</i> dispersion/London/instantaneous dipoles/temporary dipoles ✓</p>	<p>Accept “dipole-dipole” for M1.</p> <p>Do not accept “van der Waals/vdW” for M1.</p> <p>Accept “van der Waals/vdW” for M2.</p>	2

Question		Answers	Notes	Total
6.	c	<p><i>Energy storage:</i> not water-soluble/no hydrogen/H bonding OR less oxidized/more reduced OR high energy stored in bonds OR high «negative» enthalpy of combustion/oxidation ✓</p> <p><i>Electrical insulator:</i> no delocalized electrons/conjugation ✓</p>	<p>Accept "potential energy" for "stored energy".</p>	2

Question			Answers	Notes	Total								
7.	a		<table border="1"> <thead> <tr> <th>Vitamin</th> <th>Soluble in</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>fat</td> </tr> <tr> <td>C</td> <td>water</td> </tr> <tr> <td>D</td> <td>fat</td> </tr> </tbody> </table> <p>all three correct ✓</p>	Vitamin	Soluble in	A	fat	C	water	D	fat		1
Vitamin	Soluble in												
A	fat												
C	water												
D	fat												
7.	b	i	$ \begin{array}{c} \text{CHO} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{CH}_2\text{OH} \end{array} $ <p>-CH₂- must be placed next to CHO AND 2OH's on central carbons must be on same side (LHS or RHS) ✓</p>	Accept crosses in place of C on three middle carbons.	1								
7.	b	ii	<p>Reaction type: condensation ✓</p> <p>Functional group: acetal/ether/glycosidic «linkage» ✓</p>	<p>Accept "nucleophilic substitution/S_N" for M1.</p> <p>Accept "glycoside" for M2.</p>	2								

Question		Answers	Notes	Total
8.	a	$\llcorner 0.3 \mu\text{g} \times 2000 \Rightarrow 600 \llcorner \mu\text{g X} \llcorner \checkmark$ $\frac{600 \mu\text{g}}{120 \text{ kg}}$ $\llcorner \frac{600 \mu\text{g}}{0.3 \mu\text{g kg}^{-1}} \Rightarrow 17 \checkmark$	Award [2] for correct final answer. M2 may also be correctly expressed to 1 SF.	2
8.	b	fat-soluble AND pass through lipid membranes/accumulate in cells/fatty tissues OR fat-soluble AND less easily excreted/metabolized \checkmark	Accept "water-soluble" only if an organometallic-protein interaction is mentioned.	1

Option C — Energy

Question		Answers	Notes	Total
9.	a	$\llcorner 21\,200 \text{ kJ dm}^{-3} \times 5.00 \text{ dm}^3 \Rightarrow 106000/1.06 \times 10^5 \llcorner \text{kJ} \llcorner \checkmark$		1
9.	b	alkane OR cycloalkane OR arene \checkmark	Accept "alkene". Do not accept just "hydrocarbon", since given in stem. Do not accept "benzene/aromatic" for "arene".	1

Question		Answers	Notes	Total
9.	c	<p><i>Advantages: [2 max]</i></p> <p>renewable ✓</p> <p>uses up waste «such as used cooking oil» ✓</p> <p>lower carbon footprint/carbon neutral ✓</p> <p>higher flashpoint ✓</p> <p>produces less SO_x/SO₂</p> <p>OR</p> <p>less polluting emissions ✓</p> <p>has lubricating properties</p> <p>OR</p> <p>preserves/increases lifespan of engine ✓</p> <p>increases the life of the catalytic converter ✓</p> <p>eliminates dependence on foreign suppliers ✓</p> <p>does not require pipelines/infrastructure «to produce» ✓</p> <p>relatively less destruction of habitat compared to obtaining petrochemicals ✓</p> <p><i>Disadvantages: [2 max]</i></p> <p>needs conversion/transesterification ✓</p> <p>takes time to produce/grow plants ✓</p>	<p>Accept “higher energy density” OR “biodegradable” for advantage.</p> <p>Accept “lower specific energy” as disadvantage.</p>	4

		<p>takes up land OR deforestation ✓</p> <p>fertilizers/pesticides/phosphates/nitrates «used in production of crops» have negative environmental effects ✓</p> <p>biodiversity affected OR loss of habitats «due to energy crop plantations» ✓</p> <p>cannot be used at low temperatures ✓ variable quality «in production» ✓ high viscosity/can clog/damage engines ✓</p>	<p><i>Do not accept “lower octane number” as disadvantage”.</i></p>	
--	--	---	--	--

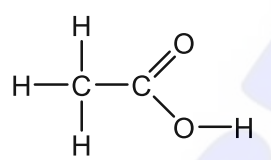
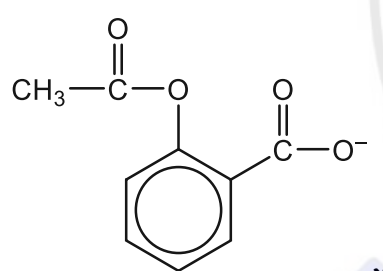
Question		Answers	Notes	Total
9.	d	<p><i>Any one:</i></p> <p>uses up fossil fuels more slowly ✓</p> <p>lower carbon footprint/CO₂ emissions ✓</p> <p>undergoes more complete combustion ✓</p> <p>produces fewer particulates ✓</p> <p>higher octane number/rating</p> <p>OR</p> <p>less knocking ✓</p> <p>prevents fuel injection system build up</p> <p>OR</p> <p>helps keep engine clean ✓</p>	<p>Accept an example of a suitable advantage even if repeated from 9c.</p>	1 max
9.	e	<p><i>Any two:</i></p> <p>biodiesel has smaller molecules/single «hydrocarbon» chain AND oil has larger molecules/multiple «hydrocarbon» chains ✓</p> <p>biodiesel is methyl/ethyl ester AND oil has «backbone of» glycerol joined to fatty acids ✓</p> <p>biodiesel contains one ester group AND oil contains three ester groups ✓</p>	<p>Do not accept properties such as “less viscous” or “lower ignition point”.</p>	2 max

Question			Answers	Notes	Total
9.	f	i	carbon dioxide allows sunlight/short wavelength radiation to pass through AND particulates reflect/scatter/absorb sunlight ✓	<p>Accept “particulates reflect/scatter/absorb sunlight AND carbon dioxide does not”.</p> <p>Accept “CO₂ absorbs IR «radiation» AND particulates reflect/scatter/absorb sunlight”.</p> <p>Do not accept “traps” for “absorbs”.</p>	1
9.	f	ii	<p>carbon dioxide is highly/more abundant «in the atmosphere» ✓</p> <p>methane is more effective/potent «as a greenhouse gas»</p> <p>OR</p> <p>methane/better/more effective at absorbing IR «radiation»</p> <p>OR</p> <p>methane has greater greenhouse factor</p> <p>OR</p> <p>methane has greater global warming potential/GWP✓</p>	Accept “carbon dioxide contributes more to global warming” for M1.	2
9.	f	iii	any value or range within 2850–3090 «cm ⁻¹ » ✓		1

Question		Answers	Notes	Total
10.	a	$\left\langle \frac{\text{mass \%}}{\text{fraction of U in UO}_2} = \right\rangle \frac{238.03}{238.03+2 \times 16} / 0.881/88.1 \% \checkmark$ $46.5 \text{ «kg»} \times 0.0157 \times 0.881 \times 0.9928 \text{ «} = 0.639 \text{ kg»} \checkmark$	<p>Award [1 max] for omitting mass composition (giving 0.725 kg).</p> <p>M2 is for numerical setup, not for final value of 0.639 kg.</p>	2
10.	b	<p>Alternative 1</p> $\left\langle \frac{2.23 \times 10^{10} \text{ year}}{4.46 \times 10^9 \text{ year}} = \right\rangle 5.00 \text{ «half-lives»} \checkmark$ $\text{«} m = 0.639 \text{ kg} \times (0.5)^5 = \text{» } 0.0200 \text{ «kg»} \checkmark$ <p>Alternative 2</p> $\left\langle \lambda = \frac{\ln 2}{4.46 \times 10^9 \text{ year}} = \right\rangle 1.554 \times 10^{-10} \text{ «year}^{-1}\text{»} \checkmark$ $\text{«} m = 0.639 \text{ kg} \times e^{-1.554 \times 10^{-10} \text{ year}^{-1} \times 2.23 \times 10^{10} \text{ year}} = \text{» } 0.0200 \text{ «kg»} \checkmark$	<p>Award [2] for correct final answer.</p>	2

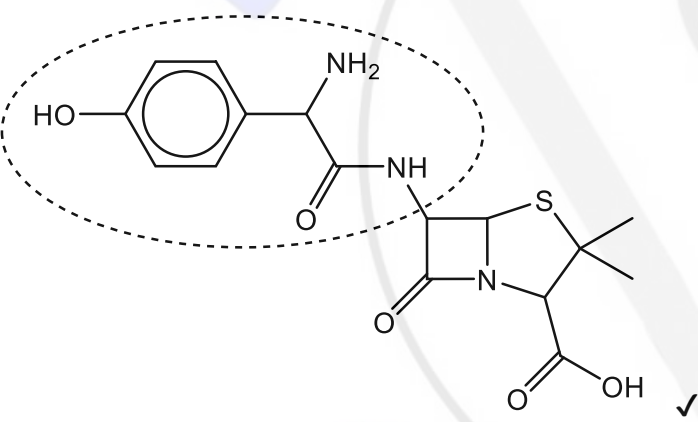
Question		Answers	Notes	Total
10.	c	<p>Any one:</p> <p>«genetic» mutations ✓</p> <p>«could cause» cancer ✓</p> <p>cells «in body» altered ✓</p> <p>cells «in body» cannot function ✓</p> <p>damaged DNA/proteins/enzymes/organs/tissue ✓</p> <p>«radiation» burns ✓</p> <p>hair loss ✓</p> <p>damage in foetuses ✓</p> <p>damages/weakens immune system ✓</p>	<p>Accept specific named types of cancer.</p>	1 max
10.	d	${}_{92}^{238}\text{U} \rightarrow {}_{90}^{234}\text{Th} + {}_2^4\text{He} \checkmark$	<p>Do not penalize missing atomic numbers in the equation.</p> <p>Accept "α" for "He".</p>	1
10.	e	<p>energy required to separate a nucleus into protons and neutrons/nucleons</p> <p>OR</p> <p>energy released when nucleus was formed from «individual/free/isolated» protons and neutrons/nucleons ✓</p>	<p>Do not accept "energy released when atom was formed".</p>	1

Option D — Medicinal chemistry

Question		Answers	Notes	Total
11.	a	 <p>OR CH₃COOH ✓</p>	Accept full OR condensed structural formula.	1
11.	b	to avoid dissolving the crystals/aspirin ✓	Accept "to avoid loss of product" OR "aspirin is less soluble in cold water".	1
11.	c	 <p>✓</p>	Accept a positive metal ion next to the COO ⁻ such as "Na ⁺ /K ⁺ ". Accept "-ONa/-OK" without showing the charges. Accept notations such as "RCOO ⁻ " OR "RCOONa" OR "RCOOK" but not "RO ⁻ " OR "RONa" OR "ROK".	1

Question		Answers	Notes	Total
11.	d	low/medium risk «of overdosing» AND «estimated» lethal dose is 30 times/much larger than therapeutic dose OR 30 times the dose results in chance of dying ✓	Accept “30 and low/medium risk due to large therapeutic index”. Do not accept “low/medium risk AND large therapeutic window”. Do not accept “30 times the dose” alone for the mark.	1

Question	Answers	Notes	Total
12.	<p>same reactant mole ratio «in both equations»</p> <p>OR</p> <p>$\text{Mg(OH)}_2(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ » AND</p> <p>$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ » ✓</p> <p>$n_{\text{Mg(OH)}_2} = \left\langle \frac{0.200}{58.32} \right\rangle \Rightarrow 3.43 \times 10^{-3}$ «mol» AND</p> <p>$n_{\text{CaCO}_3} = \left\langle \frac{0.220}{100.09} \right\rangle \Rightarrow 2.20 \times 10^{-3}$ «mol» ✓</p> <p>«tablet of» X neutralizes 6.86×10^{-3} «mol» HCl AND «tablet of» Y neutralizes 4.40×10^{-3} «mol» HCl ✓</p>	<p>Award [3] for correct final statement AND values in M3.</p>	<p>3</p>

Question			Answers	Notes	Total
14.	a	i	Any two: «secondary» carboxamide/amido ✓ ether ✓ carbonyl ✓	Accept amide Accept amino/amine. Accept alkenyl/alkene. Do not accept formula.	2 max
14.	a	ii	«drug» blocks/inhibits «viral» enzyme/neuraminidase/NA «activity» ✓ prevents virus from leaving/escaping host cells «thus cannot infect other cells» ✓	Do not accept other anti-viral methods (as question is specific to Zanamivir).	2
14.	b	i	 <p>The image shows the chemical structure of Zanamivir. A dashed circle is drawn around the amide group (the benzamide side chain) of the molecule. The rest of the molecule, including the imidazolidinone ring, the sulfur atom, and the carboxylic acid group, is not circled.</p>	Accept a circle that does not surround the amido group. Do not accept a circle that only surrounds the phenol group.	1

(continued...)

(Question 14b continued)

14.	b	ii	bacterial resistance «to older penicillins/antibiotics» ✓ prevent penicillinase/beta-lactamase/enzyme in bacterium to deactivate/open penicillin/beta-lactam ring ✓	Accept “antibiotic resistant bacteria” but not “antibiotic resistance” for M1. Accept “reduce allergic reactions from from penicillin” for M2. Award [1 max] for “increased efficiency” OR “increased stability in GIT”. Do not accept “bacteria develop tolerance”.	2
14.	c	i	codeine less soluble «in water» than morphine AND more soluble than diamorphine OR morphine > codeine > diamorphine «in terms of solubility in water» ✓ more/stronger/greater <u>hydrogen/H bonding</u> «due to more hydroxyl groups leads to greater solubility» ✓		2
14.	c	ii	opium poppy/plants/seeds ✓	Accept “poppy” OR “opioid”.	1