M18/4/CHEMI/HP3/ENG/TZ1/XX/M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2018

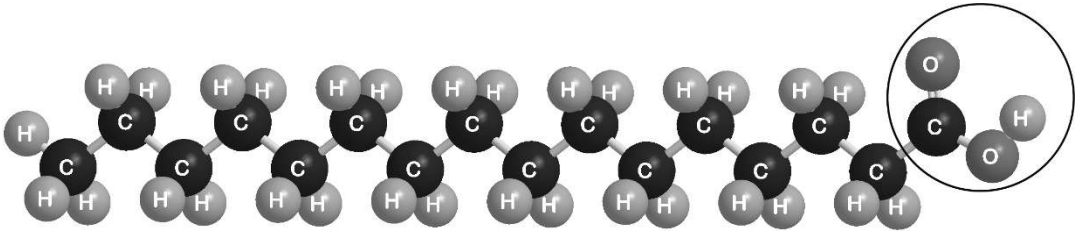
Chemistry

Higher level

Paper 3

29 pages

Section A

Question			Answers	Notes	Total
1.	a	i		*Must cut CH_2–CO bond **AND** enclose all of the –COOH group.*	**1**
1.	a	ii	*Any two of:* –COOH/CO/OH/carboxylate/carboxyl/hydroxyl/hydroxy group forms hydrogen bonds/H-bonds to water ✓ London/dispersion/instantaneous induced dipole-induced dipole forces occur between hydrocarbon chains ✓ hydrocarbon chain cannot form hydrogen bonds/H-bonds to water ✓ strong hydrogen bonds/H-bonds between water molecules exclude hydrocarbon chains «from the body of the water» ✓	*Accept "hydrophilic part/group forms hydrogen bonds/H-bonds to water".* *Accept "hydrophobic section" instead of "hydrocarbon chain".* *Award **[1 max]** for answers based on "the –COOH group being polar **AND** the hydrocarbon chain being non-polar".*	**2 max**

Question			Answers	Notes	Total
1.	b	i	*Above about 240 cm^2:* greater collision frequency/collisions per second between **«**palmitic acid**»** molecules and the barrier **«**as area reduced**»** ✓ *At less than about 240 cm^2:* molecules completely cover the surface ***OR*** there is no space between molecules ***OR*** force from movable barrier transmitted directly through the molecules to the fixed barrier ***OR*** **«**palmitic acid**»** molecules are pushed up/down/out of layer ✓	*For both M1 and M2 accept "particles" for "molecules".* *For M1 accept "space/area between molecules is reduced"* ***OR*** *"molecules moving closer together".*	**2**
1.	b	ii	amount of acid = **«**$5.0 \times 10^{-5}\,dm^3 \times 0.0034\,mol\,dm^{-3}$**»** = 1.7×10^{-7} **«**mol**»** ✓ number of molecules = **«**$1.7 \times 10^{-7}\,mol \times 6.02 \times 10^{23}\,mol^{-1}$ =**»** 1.0×10^{17} ✓	*Award* ***[2]*** *for correct final answer.* *Award* ***[1]*** *for "1.0×10^{20}".*	**2**
1.	b	iii	**«**area = $\frac{240\ cm^2}{1.0 \times 10^{17}}$**»** 2.4×10^{-15} **«**cm^2**»** ✓		**1**

Question			Answers	Notes	Total
2.	a		$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ ✓	*Accept "$CO_2(aq)$".*	1
2.	b		measure the volume of gas at different times «plot a graph and extrapolate» ***OR*** measure the mass of the reaction mixture at different times «plot a graph and extrapolate» ✓	*Accept other techniques that yield data which can be plotted and extrapolated.*	1
2.	c	i	method 2 ***AND*** the marble is in excess «so a little extra has little effect» ***OR*** large chips ***AND*** the marble is in excess «so a little extra has little effect» ***OR*** method 2 ***AND*** HCl is limiting reagent «so a little extra marble has little effect» ***OR*** large chips ***AND*** HCl is limiting reagent «so a little extra marble has little effect» ✓	*Accept, as a reason, that "as the mass is greater the percentage variation will be lower".*	1
2.	c	ii	surface area ***OR*** purity «of the marble» ✓	*Accept "shape of the chip".*	1
2.	d	i	variation of individual values is much greater «than this uncertainty» ***OR*** «uncertainty» does not take into account «student» reaction time ✓		1
2.	d	ii	$\text{«}\frac{121.96\,\text{s}}{2} = 60.98\,\text{s}\text{»} = 61\text{«s»}$ ✓		1
2.	d	iii	systematic ***AND*** always makes the time shorter «than the actual value» ***OR*** systematic ***AND*** it is an error in the method used «not an individual measurement» ***OR*** systematic ***AND*** more repetitions would not reduce the error ✓	*Accept, as reasons, "it always affects the value in the same direction" **OR** "the error is consistent".*	1

Section B

Option A — Materials

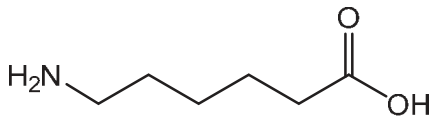
Question			Answers	Notes	Total
3.	**a**		«close packed» lattice of metal atoms/ions ✓ no spaces for water molecules to pass though the structure ✓		**2**
3.	**b**	**i**	composite ✓		**1**
3.	**b**	**ii**	melting point ***OR*** permeability ***OR*** density ***OR*** conductivity ***OR*** elasticity/stiffness ***OR*** brittleness/flexibility ***OR*** «tensile» strength ✓	*Accept "colour/transparency".*	**1**

(continued…)

(Question 3b continued)

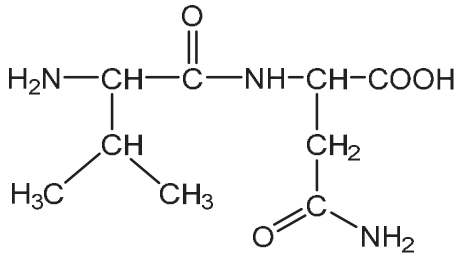
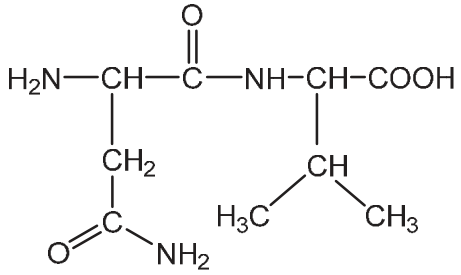
Question			Answers	Notes	Total
3.	**b**	**iii**	*Any three of:* hydrocarbon/carbon-containing gas/compound ✓ mixed with inert gas ✓ heat/high temperature ✓ **«**transition**»** metal catalyst ✓ hydrocarbon/carbon compound decomposes to form carbon **«**nanotubes**»** ✓ nanotubes form on catalyst surface ✓	*Accept "ethanol" or specific hydrocarbons.* *Accept "N_2", "H_2", "NH_3" or specific inert gases.* *Accept temperature or range within 600–800 °C.* *Accept specific metals such as Ni, Co or Fe.*	**3 max**
3.	**b**	**iv**	rod shaped molecules ✓		**1**

Question			Answers	Notes	Total
4.	a	i	both have «long» hydrocarbon chains ***OR*** both have chains comprising CH_2 units ✓ HDPE has little/no branching ***AND*** LDPE has «more» branching ✓	*Accept "CH_2–CH_2 units".* *Accept "HDPE more crystalline".*	**2**
4.	a	ii	HDPE is more rigid/less flexible ***OR*** HDPE has a higher melting point ***OR*** HDPE has greater «tensile» strength ✓	*Accept "HDPE has lower ductility".*	**1**
4.	b	i	form «temporary» activated complexes/reaction intermediates ✓	*Accept "consumed in one reaction/step **AND** regenerated in a later reaction/step".* *Accept "provides alternative mechanism".*	**1**
4.	b	ii	inductively coupled plasma/ICP spectroscopy using mass spectroscopy/mass spectrometry/MS/ICP-MS ***OR*** inductively coupled plasma/ICP spectroscopy using optical emission spectroscopy/OES/ICP-OES ✓	*Accept "atomic absorption/aa spectroscopy" or "MS/mass-spectroscopy/mass spectrometry".*	**1**

Question			Answers	Notes	Total
4.	c	i	 –NH_2 ***AND*** –COOH ✓ six C-atoms ✓	*Accept –COCl instead of –COOH.*	**2**
4.	c	ii	less ***AND*** a second molecule/product formed ✓	*Accept "not all the reactant molecules «in the equation» are converted «to product molecules»".*	**1**
4.	d		*Any two of:* many types «of plastics» exist ***OR*** «plastics» require sorting «by type» ✓ «plastics» need to be separated from non-plastic materials ***OR*** «often» composites/moulded on/bound to non-plastic/other components ✓	*Accept other valid factors such as thermal decomposition of some plastics, production of toxic fumes, etc.*	**2**
4.	e		«different classifications are appropriate for» different properties/applications/ purposes ✓		**1**

Question			Answers	Notes	Total
5.	**a**		ratio of electrons : aluminium ions = 3 : 1 ✓ amount Al **«**$\frac{1.296\times10^{13}\,\text{C}}{96500\,\text{C mol}^{-1}\times3}$**»** $= 4.48\times10^{7}$ **«**mol**»** ✓ mass Al **«**$= 4.48\times10^{7}\,\text{mol}\times26.98\,\text{g mol}^{-1}$**»** $= 1.21\times10^{9}$ **«**g**»** ✓	*Award **[3]** for correct final answer.*	**3**
5.	**b**		the smallest repeating unit **«**from which the crystal structure can be derived**»** ✓	*Accept "building block that the structure is made from".*	**1**
5.	**c**		**«**$n\lambda = 2d\sin\theta$**»** $1\times1.54\times10^{-10} = 2\times d\times\sin18$ ✓ d **«**$=\frac{1.54\times10^{-10}\,\text{m}}{2\times0.309}$**»** $= 2.49\times10^{-10}$ **«**m**»** ✓	*Award **[2]** for correct final answer.*	**2**
5.	**d**	**i**	type 1 ✓ superconductor ✓		**2**
5.	**d**	**ii**	collisions between electrons and **«**lattice of metal**»** ions become more frequent ***OR*** thermal oscillations/vibrations disrupt the Cooper electron pairs ✓		**1**
5.	**e**		$K_{sp} = [Al^{3+}][OH^{-}]^3$ **«**$= 3.3\times10^{-34}$**»** ✓ $[Al^{3+}] =$ **«**$\frac{3.3\times10^{-34}}{(1\times10^{-7})^3}$**=»** 3.3×10^{-13} **«**mol dm^{-3}**»** ✓	*Award **[2]** for correct final answer.*	**2**

Option B — Biochemistry

Question			Answers	Notes	Total
6.	a		 ***OR***  correct structures of Val ***AND*** Asn ✓ correct amide link ✓		**2**
6.	b		*Phenylalanine and valine:* London/dispersion/instantaneous induced dipole-induced dipole forces ***OR*** permanent dipole-induced dipole «interactions» ✓ *Glutamine and asparagine:* hydrogen bonds ✓	*Do **not** accept dipole-dipole interactions.*	**2**

Question			Answers	Notes	Total
6.	**c**	**i**	hydrolysis ✓		**1**
6.	**c**	**ii**	compare R_f with known amino acids ***OR*** compare distance moved with known amino acids ✓	*Accept "from R_f".*	**1**
6.	**d**		triplet/genetic code ***OR*** sequence of three bases/nucleotides ✓ instruction for **«**particular**»** amino acid ✓		**2**

Question			Answers	Notes	Total
7.	a		hydrolytic «rancidity» ✓ ester group ✓	*Accept a formula for ester group.*	2
7.	b		«stearic acid» straight chain/chain has no kinks/more regular structure ***OR*** «stearic acid» saturated/no «carbon-carbon» double bonds ✓ «stearic acid» chains pack more closely together ✓ stronger London/dispersion/instantaneous induced dipole-induced dipole forces «between molecules» ✓	*Accept "«stearic acid» greater surface area/electron density".*	3 max
7.	c	i	lowers risk of heart disease/atherosclerosis ***OR*** lowers LDL cholesterol ***OR*** increases HDL cholesterol ***OR*** aids brain/neurological development «in children» ***OR*** relieves rheumatoid arthritis ✓		1
7.	c	ii	soluble ***AND*** non-polar hydrocarbon chain ✓	*Accept as reasons "«predominantly» non-polar" **OR** "long hydrocarbon chain".*	1

(continued…)

(Question 7c continued)

Question			Answers	Notes	Total
7.	**c**	**iii**	not biodegradable ***OR*** stored/accumulate in fat ✓ biomagnification occurs ***OR*** concentration increases along food chain ✓	*Accept "stored/accumulate in bodies of prey/animals eaten".* *Accept "not excreted".*	**2**
7.	**c**	**iv**	add starch/cellulose/carbohydrates/additives/catalysts **«**to plastic during manufacture to allow digestion by micro-organisms**»** ***OR*** replace traditional plastics with polylactic acid/PLA-based ones ***OR*** blend traditional and polylactic acid/PLA-based plastics ✓	*Accept reference to biodegradable plastics other than PLA, for example polyhydroxyalkanoates (PHA), poly(butylene succinate) (PBS), polybutylene adipate terephthalate (PBAT) and polycaprolactone (PCL).*	**1**

Question			Answers	Notes	Total
8.	a		*Glucose:* readily passes through intestine wall/dissolves in blood ***OR*** is immediately available for energy/respiration ***OR*** transported rapidly around body ✓ *Starch:* must be hydrolysed/broken down «into smaller molecules» first ✓		**2**
8.	b		*Any two of:* long straight/unbranched chains ✓ multiple hydrogen bonds «between chains» ✓ microfibrils ***OR*** rigid/cable structure ✓		**2 max**

Question			Answers	Notes	Total
9.	a		binds at allosteric site ***OR*** binds away from active site ✓ changes shape of active site ***OR*** renders active sites ineffective ✓		2
9.	b		K_m is inverse measure of affinity of enzyme for a substrate ***OR*** K_m is inversely proportional to enzyme activity ***OR*** high value of K_m indicates higher substrate concentration needed for enzyme saturation ***OR*** low value of K_m means reaction is fast at low substrate concentration ✓	*Idea of inverse relationship must be conveyed.* *Accept "high value of K_m indicates low affinity of enzyme for substrate/less stable ES complex/lower enzyme activity".* *Accept "low value of K_m indicates high affinity of enzyme for substrate/stable ES complex/greater enzyme activity".*	1

Question			Answers	Notes	Total
10.	a		highly conjugated systems ***OR*** alternating single and double bonds ***OR*** many delocalized electrons ✓ electron transitions occur when visible light is absorbed ✓		**2**
10.	b		gaining protons ✓ decreases electron density/extent of conjugation «in aromatic backbone» ✓ increases energy of electron transitions ✓		**3**

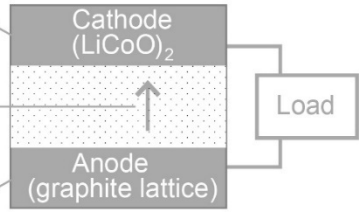
Option C — Energy

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>11.</td><td>a</td><td></td><td>
<table>
<tr><th>Gas</th><th>Source</th></tr>
<tr><td>methane/CH_4 ✓</td><td>animals
OR
anaerobic decomposition of organic waste
OR
bogs/marshes/rice paddies ✓</td></tr>
<tr><td>nitrogen(I) oxide/dinitrogen monoxide/N_2O ✓</td><td>bacterial action
OR
combustion of biomass ✓</td></tr>
<tr><td>ozone/O_3 ✓</td><td>effect of <u>UV</u> light on oxygen/O_2 ✓</td></tr>
</table>
</td><td>Accept “nitrous oxide”.

Accept “electrical discharges/lightning”.</td><td>2</td></tr>
<tr><td>11.</td><td>b</td><td></td><td>$CO_2\,(aq) + H_2O\,(l) \rightleftharpoons H^+\,(aq) + HCO_3^-\,(aq)$
OR
$CO_2\,(aq) + H_2O\,(l) \leftrightarrows H_2CO_3(aq)$ AND $H_2CO_3(aq) \rightleftharpoons H^+\,(aq) + HCO_3^-\,(aq)$ ✓</td><td>Accept $CO_2\,(aq) + H_2O\,(l) \rightleftharpoons 2H^+\,(aq) + CO_3^{2-}\,(aq)$.
Accept equations with single arrow.</td><td>1</td></tr>
<tr><td>11.</td><td>c</td><td></td><td>no change in polarity/dipole «moment when molecule vibrates» ✓</td><td>Do not accept “non-polar” or “no dipole moment” – idea of change must be there.</td><td>1</td></tr>
</table>

Question			Answers	Notes	Total
12.	a		*Any three of:* different molar masses ***OR*** different strengths of intermolecular forces ✓ different boiling points ✓ temperature in «fractionating» column decreases upwards ✓ «components» condense at different temperatures/heights ***OR*** «component with» lower boiling point leaves column first ✓		**3 max**
12.	b	i	*specific energy* « $= \frac{\text{energy released}}{\text{mass consumed}} = \frac{5470\ \text{kJ mol}^{-1}}{114.26\ \text{g mol}^{-1}}$ » $= 47.9$ «kJ g^{-1}» ✓ *energy density* « $= \frac{\text{energy released}}{\text{volume consumed}} = \text{specific energy} \times \text{density} = 47.9\ \text{kJ g}^{-1}$ $\times 0.703\ \text{g cm}^{-3}$» $= 33.7$ «kJ cm^{-3}» ✓	*Do **not** accept "–47.9 «kJ g^{-1}»".* *Do **not** accept "–33.7 «kJ cm^{-3}»" unless "–47.9 «kJ g^{-1}»" already penalized.*	**2**
12.	b	ii	energy is lost «to the surroundings» as heat/sound/friction ***OR*** energy is lost to the surroundings «as heat/sound/friction» ***OR*** incomplete combustion ✓	*Do **not** accept simply "energy is lost".*	**1**

Question			Answers	Notes	Total
13.	a		viscosity «of vegetable oils is too high» ✓ transesterification ***OR*** «conversion into» alkyl/methyl/ethyl esters ✓		2
13.	b		$R–CO–O–CH_3$ / RCOOMe ***OR*** $R–CO–O–C_2H_5$ / RCOOEt ✓		1

Question			Answers	Notes	Total
14.	a	i	$Li(CoO_2)_2 + Li^+ + e^- \rightarrow 2LiCoO_2$ ✓ Species moving: Lithium ions/Li^+ ✓ $Li \rightarrow Li^+ + e^-$ ✓ 	*Accept any balanced equation which shows Li oxidized to Li^+ for M3, such as* $LiC_6 \rightarrow Li^+ + C_6 + e^-$ *or* $Li_xC_6 \rightarrow xLi^+ + 6C + xe^-$	3
14.	a	ii	*Limiting factor:* internal resistance «of the cell» ✓ *Electrodes design:* large surface area ✓	*Accept "time it takes ions to diffuse between electrodes".* *Accept specific ways of increasing surface area, such as "porous electrodes".* *Accept "close together/small separation".*	2
14.	b	i	mass spectrometry/mass spectroscopy/MS ✓	*Accept "analysis of radiation emitted".*	1
14.	b	ii	uranium converted to uranium hexafluoride/UF_6 gas ✓ **ALTERNATIVE 1:** gas «allowed to» diffuse✓ lower mass isotope/^{235}U passes through more rapidly ✓ **ALTERNATIVE 2:** use of centrifuge ✓ higher mass isotope/^{238}U moves/closer to outside of centrifuge ***OR*** lower mass isotope/^{235}U stays in/removed from middle of centrifuge ✓		3

(continued…)

(Question 14b continued)

Question			Answers	Notes	Total
14.	**b**	**iii**	*critical mass:* mass required so that **«**on average**»** each fission/reaction results in a further fission/reaction ✓ *Any two for **[2 max]**:* neutron captured by **«**^{235}U**»** nucleus ✓ fission/reaction produces many neutrons/more than one neutron ✓ if these cause further fission/reaction a chain reaction occurs ✓	*Accept "minimum mass of fuel needed for the reaction to be self-sustaining".* *Accept answers in the form of suitable diagrams/equations.*	**3 max**
14.	**b**	**iv**	produce long lived/long half-life radioisotopes/radioactivity ***OR*** could be used to produce nuclear weapons ***OR*** **«**nuclear**»** accidents/meltdowns can occur ✓	*Accept "long lived/long half-life radioactive waste".*	**1**

Question			Answers	Notes	Total
15.	**a**		p-type ***AND*** has 3 **«**valence**»** electrons ***OR*** p-type ***AND*** fewer electrons **«**than silicon**»** ✓	*Do **not** accept "it is in group 3/13" as reason.*	**1**
15.	**b**		*Any two of:* cheaper ***OR*** ease of fabrication ✓ use light of lower energy/lower frequency/longer wavelength ✓ absorb wider range of wavelengths ✓ dye converts most/all absorbed photons into electrons ✓ plentiful /renewable resources **«**to construct DSSC cells**»** ✓ operate at lower **«**internal**»** temperatures/better at radiating heat away **«**since constructed with thin front layer of conductive plastic compared to glass box in photovoltaic cell**»** ✓ use of nanoparticles provides large surface area exposure to sunlight/sun/light ✓ can absorb better under cloudy/low light conditions ✓ better conductivity ✓ more flexible ✓		**2**
15.	**c**		B ***AND*** has greater/more **«**extensive**»** conjugation ✓	*Accept "more alternating single and double bonds".*	**1**

Option D — Medicinal chemistry

Question			Answers	Notes	Total
16.	**a**		*Any one of:* anticoagulant ✓ lower risk of heart attack/strokes ✓ prevent recurrence of heart attack/stroke ✓ prevent cancer of colon/oesophagus/stomach ✓	*Accept "prevents/reduces blood clots"* ***OR*** *"blood thinner".*	**1 max**
16.	**b**	**i**	fraction/proportion/percentage **«**of administered dosage**»** that reaches target **«**part of human body**»** ***OR*** fraction/proportion/percentage **«**of administered dosage**»** that reaches blood **«**plasma**»**/systemic circulation ✓	*Accept "the ability of the drug to be absorbed by the body"* ***OR*** *"the extent to which the drug is absorbed by the body".* *Do* ***not*** *accept "the amount/quantity of the drug absorbed".*	**1**
16.	**b**	**ii**	intravenous injection/IV ✓	*Accept "parenterally".* *Accept "react with alkali/NaOH"* ***OR*** *"convert to ionic form/salt".*	**1**
16.	**c**	**i**	*One absorption found in both spectra:* *Any one of:* 1050–1410 cm^{-1} **«**C–O in alcohols, esters, ethers**»** ✓ 1700–1750 cm^{-1} **«**C=O in carboxylic acids, esters**»** ✓ 2500–3000 cm^{-1} **«**O–H in carboxylic acids**»** ✓ 2850–3090 cm^{-1} **«**C–H in alkanes, alkenes, arenes**»** ✓ *One absorption found in only one of the spectra:* 3200–3600 cm^{-1} **«**O–H in alcohols, phenols**»** ✓	*Award* ***[1 max]*** *if candidate states bonds (C=O in both, O–H in salicylic acid only) but doesn't quote wavelength ranges.* *Accept a second/additional absorption at 1700–1750 cm^{-1} from C=O in ester.*	**2 max**

(continued…)

(Question 16c continued)

Question			Answers	Notes	Total
16.	**c**	**ii**	*Any two of:* ring is **«**sterically**»** strained ***OR*** ring breaks up/opens/reacts **«**easily**»** ***OR*** amide/amido 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 ✓ cells absorb water ***AND*** burst ***OR*** cells cannot reproduce ✓	*Award **[1 max]** for "interferes with cell wall production".* *Do **not** accept "cell membrane" instead of "cell wall".*	**2 max**

(continued…)

(Question 16c continued)

Question			Answers	Notes	Total
16.	**c**	**iii**	*Any two of:* leads to **«**bacterial**»** resistance/proportion of resistant bacteria increases ***OR*** leads to penicillinase-producing bacteria ✓ damage to/contamination of bodies of water/ecosystems ✓ destroys useful/beneficial bacteria ✓ destroyed bacteria replaced by more harmful bacteria ✓	*Accept "endocrine disruptor".* *Do **not** accept "increased cost of developing antibiotics".*	**2 max**
16.	**c**	**iv**	modify side chain ✓		**1**
16.	**d**	**i**	temporarily bind to/block/interfere with receptor sites in brain ***OR*** prevent transmission of pain impulses within CNS/central nervous system ✓		**1**
16.	**d**	**ii**	codeine has a wider therapeutic window ✓	*Accept "codeine has lower activity" **OR** "codeine has lower risk of overdose" **OR** "codeine is less potent" **OR** "codeine has fewer/milder side effects".* *Do **not** accept "lower abuse potential for codeine" **OR** "codeine less addictive" **OR** "codeine has a lower bioavailability" **OR** "codeine available without prescription" **OR** "codeine cheaper".*	**1**

Question			Answers	Notes	Total
16.	**e**		«pure» enantiomers rotate the plane «of plane-»polarized light «by equal angles» in opposite directions ✓ *Any two of:* find angle of rotation of pure enantiomers ✓ measure angle of rotation of mixture ✓ mixture has angle between that of two enantiomers ✓ ratio of angles gives purity ✓		**3 max**

17.	**a**	**i**	$MgCO_3\,(s) + 2HCl\,(aq) \rightarrow CO_2\,(g) + H_2O\,(l) + MgCl_2\,(aq)$ ✓	*Do **not** accept "H_2CO_3".*	**1**
17.	**a**	**ii**	$n(HCl) = 2\,n(CaCO_3) + 2\,n(MgCO_3)$ ***OR*** $n(HCl) = \frac{2 \times 0.680\ \text{«g»}}{100.09\ \text{«g mol}^{-1}\text{»}} + \frac{2 \times 0.080\ \text{«g»}}{84.32\ \text{«g mol}^{-1}\text{»}}$ ✓ «$n(HCl) = 0.0136\ \text{mol} + 0.0019\ \text{mol}$ =» 0.016 «mol» ✓	*Award **[2]** for correct final answer.* *Award **[1 max]** for correctly calculating amount of acid neutralized by just $CaCO_3$ (0.014 «mol») **OR** $MgCO_3$ (0.002 «mol»).*	**2**
17.	**b**		inhibits the secretion of stomach acid/H^+ ✓ «active metabolites» bind «irreversibly» to «receptors of the» proton pump ✓	*Accept "PPI/proton pump inhibitor".* *Do **not** award mark for "binds to H2/histamine receptors". (Ranitidine mode of action.)* *Accept "H^+/K^+ ATPase" for "proton pump".*	**2**

Question			Answers	Notes	Total
18.			blocks/inhibits neuraminidase/NA/«viral» enzyme which allows viruses to pass through cell membrane ✓ prevent virus from leaving/escaping host cell «thus it cannot infect other cells» ✓		**2**

19.	**a**		*Any two of:* radiation causes breaks in DNA chains ***OR*** radiation causes errors in DNA sequences ✓ «damage accumulates and» cells cannot multiply ✓ rapidly dividing/cancer cells more susceptible ✓	*Accept "alters DNA".*	**2 max**
19.	**b**		*Any two of:* radiation source delivered directly to «targeted» cancer cells ✓ by a carrier drug/protein/antibody ✓ several sites in body can be targeted «at same time» ✓		**2 max**

Question			Answers	Notes	Total
20.	**a**		«vapour pressure = $0.6 \times 17 + 0.4 \times 24 =$» 19.8 «kPa» ✓		**1**
20.	**b**		*Any three of:* different molar masses ***OR*** different strength of intermolecular forces ✓ different boiling points ✓ temperature in «fractionating» column decreases upwards ✓ «components» condense at different temperatures/heights *OR* «component with» lower boiling point leaves column first ✓		**3 max**