Markscheme

November 2017

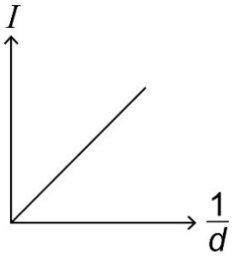
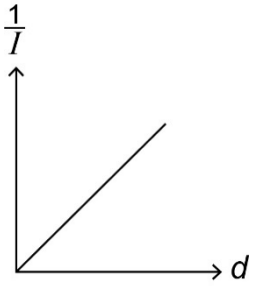
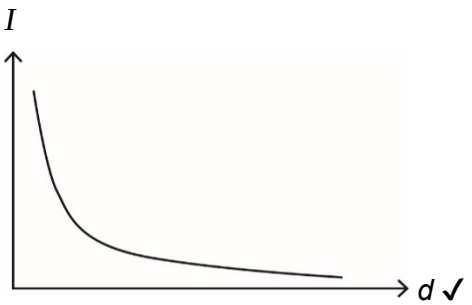
Chemistry

Standard level

Paper 3

29 pages

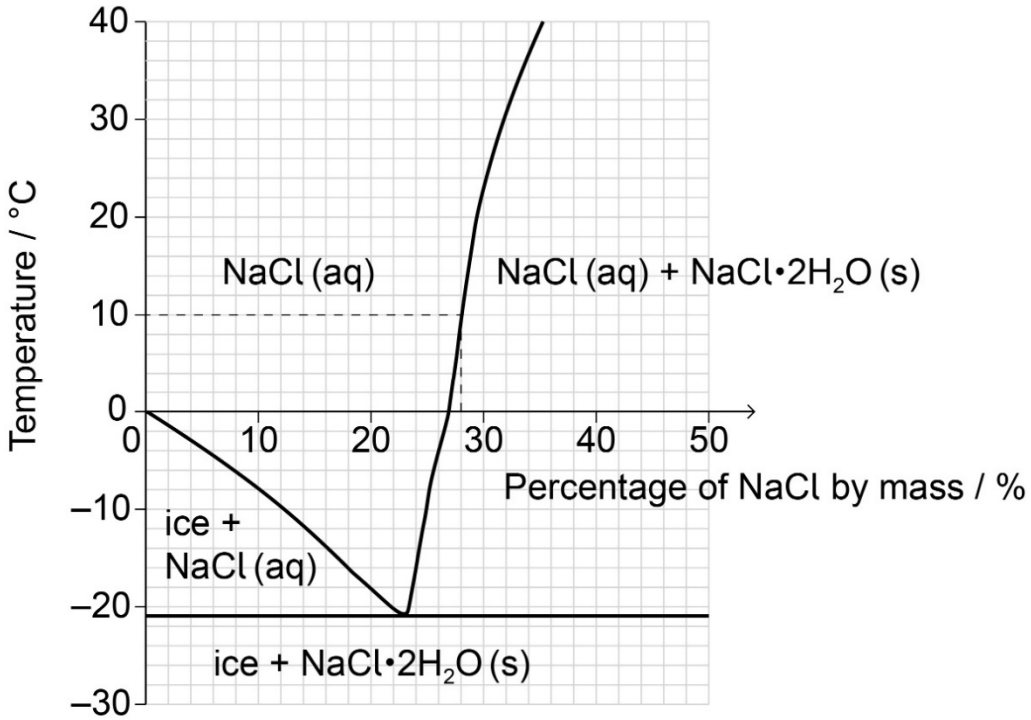
Section A

Question			Answers	Notes	Total
1.	a		 ***OR***  ***OR*** 	*Correct labels of axes required for mark.* *Accept d^{-1} instead of $\frac{1}{d}$.* *Accept I^{-1} instead of $\frac{1}{I}$.* *Plot of I vs d should not be linear.*	**1**

Question			Answers	Notes	Total
1.	b	i	negative correlation ***OR*** model/prediction matches results ***OR*** 99% of variance accounted for ✓		1
1.	b	ii	$I = -0.001631\ d + 0.09939$ ***OR*** $y = -0.001631\ x + 0.09939$ ✓	*Accept correctly rounded values for m and b in equation.* *Do **not** accept "$y = mx + b$".*	1
1.	b	iii	ions move «across electrolyte» ✓		1

Question			Answers	Notes	Total
2.	a		$Mg(OH)_2\,(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + 2H_2O\,(l)$ ✓	*Accept full or net ionic equation.*	1
2.	b		*Any two from:* volume «of HCl» ✓ concentration «of HCl»/[HCl] ✓ temperature «of HCl» ✓ mass of antacid/tablets ✓ size of antacid particles/tablets ***OR*** surface area of antacid «particles»/tablets ✓	*Accept "number of tablets/different doses".* *Do **not** accept "same pH meter" **OR** "initial pH" **OR** "concentration of antacid/[antacid]".* *A variable must be given so do **not** accept answers such as "stirring", "whether tablets are whole or crushed" etc.*	2 max
2.	c		(±) 0.04 ***OR*** (±) 0.03 ✓		1

Question			Answers	Notes	Total
2.	**d**		*Any two of:* uncertainty **«**(±)0.04/(±)0.03**»** means **A** and **C** cannot be distinguished ✓ each measurement was conducted once ✓ stomach pH should not be raised a lot **«**so antacid B is not necessarily effective**»** ✓ mass/number of tablets/dose **«**of antacid**»** used was not controlled ✓ actual environment in stomach is different ✓	*Accept "amount of tablets" for "dose".* *Do **not** accept "nature/composition of tablets differs".* *Accept an answer such as "time frame is too short since some antacids could be long-acting drugs if they contain a gelatinisation/delaying agent" but **not** just "time frame is too short since some antacids could be long-acting drugs".*	**2 max**

Question			Answers	Notes	Total
3.	a		–21 «°C» ✓		1
3.	b		 28 «%» ✓	*Accept any specific answer in the range 27 to 29 «°C».*	1

Question			Answers	Notes	Total
3.	c		$M_r = 94.48$ ✓ «$2\ \frac{(1.01\times 2+16.00)}{94.48}\times 100 =$» 38.15 «%» ✓	*Award M2 only if answer is to 2 decimal places.* *Award **[2]** for correct final answer.* *Award **[1 max]** for 38.10 %.*	**2**
3.	d		rust/corrosion «of cars and bridges» ***OR*** waste of important raw material ***OR*** soil/water salination/pollution «from run off» ***OR*** erosion of/damage to the road surface ***OR*** specific example of damage to the ecosystem ***OR*** «outdoor» temperatures may go below effective levels for NaCl «to lower freezing point» so NaCl could be wasted ***OR*** roads can refreeze causing hazards ✓	*Do **not** accept "tyre damage".* *Do **not** accept "economic issues" **OR** "environmental issues" unless specified (eg accept "increase in costs for local councils road budgets" but **not** "cost" alone).* *Do **not** accept "makes roads more slippery".*	**1**

Section B

Option A — Materials

Question			Answers	Notes	Total
4.	**a**		*Alloy:* mixture of <u>metal</u> with other metals/non-metals ***OR*** mixture of elements that retains the properties of a <u>metal</u> ✓ *Composite:* reinforcing phase embedded in matrix phase ✓	*Award **[1 max]** for implying "composites only have heterogeneous/non-homogeneous compositions".*	**2**
4.	**b**	**i**	difference in ionic/atomic radius prevents layers sliding over each other ✓	*Accept "difference in diameter/packing of cations prevents layers sliding over each other".*	**1**

(continued…)

(Question 4b continued)

Question			Answers	Notes	Total
4.	**b**	**ii**	concern about Hg poisoning ***OR*** **«**composite**»** is white **«**so looks more like tooth**»** ***OR*** galvanic response potential exists ***OR*** local allergic potential ***OR*** less damage/destruction of healthy tooth tissue ***OR*** long term corrosion requires replacement ***OR*** gradual darkening of tooth ✓	*Accept other correct responses.*	**1**
4.	**c**		*Any three of:* sample injected into argon **«**plasma**»** ✓ atoms **«**of sample**»** are excited/ionised ***OR*** electrons are promoted ✓ electrons drop back/recombine with ions ***AND*** emit photons of characteristic energies/wavelengths/frequencies ✓ total number of photons is proportional to concentration of element ✓ actual concentration found from <u>calibration/standard</u> curve ✓	*Accept "graph/plot" for "curve".*	**3 max**

Question			Answers	Notes	Total
5.			*Any two of:* greater selectivity ✓ higher efficiency ✓ longer life expectancy ***OR*** not easily poisoned ✓ easier to recover ✓ low«er» environmental impact ✓ large range of conditions/temperatures/pressures supported ✓ lower energy costs ✓ increase in yield «per unit time» offsets cost of catalyst ✓		**2 max**

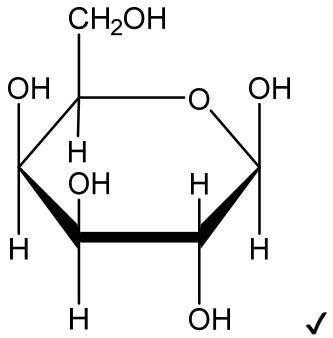
Question			Answers	Notes	Total
6.	a		$Fe(CO)_5\,(g) \rightarrow Fe\,(s) + 5CO\,(g)$ ✓ $2CO\,(g) \rightarrow C\,(s) + CO_2\,(g)$ ✓		2
6.	b		large surface area «on which carbon nanotubes form» ✓		1
6.	c		unknown health effects ***OR*** unknown effect on immune systems ***OR*** unknown environmental effects ***OR*** greater inflammatory response ***OR*** lung damage/toxicity ***OR*** hazardous effect on biodiversity ***OR*** risk of explosion ✓	*Do **not** accept vague responses.*	1

Question			Answers	Notes	Total
7.	**a**		*Any two of:* ability to form a LC phase ✓ chemically stable ✓ «LC phase that is» stable over suitable temperature range ✓ polar ***OR*** being able to change orientation with applied electric field ✓ rapid switching speed **«**responds to changes of voltage quickly**»** ✓	*Accept "ability of molecules to transmit light under certain conditions"* ***OR*** *"rod-shaped molecules"* ***OR*** *"stable to light/not light sensitive".*	**2 max**
7	**b**	**i**	branching in LDPE prevents close packing **«**of chains**»** ✓ LDPE is more flexible/less rigid ***OR*** LDPE has lower **«**tensile**»** strength ✓	*Do* ***not*** *accept "difference in density".* *Award* ***[1 max]*** *for stating "branching in LDPE* ***AND*** *little/no branching in HDPE".*	**2**
7.	**b**	**ii**	**B** ***AND*** absence **«**of absorption of**»** C–H at 2850–3090 **«**cm^{-1}**»** ***OR*** **B** ***AND*** presence of **«**absorption of**»** C–F at 1000–1400 **«**cm^{-1}**»** ✓		**1**
7.	**c**		$(-C_2H_3Cl-)_2\,(s) + 5O_2\,(g) \rightarrow 4CO_2\,(g) + 2H_2O\,(l) + 2HCl\,(g)$ correct species in reactants and products ✓ balanced ✓	*Accept "*$(-C_2H_3Cl-)_2\,(s) + 5.5O_2\,(g) \rightarrow 4CO_2\,(g) + 3H_2O\,(l) + Cl_2\,(g)$*".* *Award M2 only if M1 correct.*	**2**

Option B — Biochemistry

Question			Answers	Notes	Total
8.	**a**	**i**	$C_9H_{16}O$ ✓		**1**
8.	**a**	**ii**	ratio of oxygen to carbon in linoleic acid lower ***OR*** linoleic acid less oxidized ***OR*** linoleic acid more reduced ✓	*Accept "«average» oxidation state of carbon in linoleic acid is lower".*	**1**
8.	**b**	**i**	«electrophilic» addition/A_E ***OR*** oxidation–reduction/redox ✓		**1**
8.	**b**	**ii**	« $\frac{1.24\,g}{280.50\,g\,mol^{-1}}$ =» 0.00442 «mol» ✓ 0.00884 mol of C=C ***OR*** ratio of linoleic acid : iodine = 1:2 ✓ «volume of I_2 solution = $\frac{0.00884\,mol}{0.300\,mol\,dm^{-3}}$ =» 0.0295 «dm^3» / 29.5 «cm^3» ✓	*Award **[3]** for correct final answer.*	**3**

Question			Answers	Notes	Total
8.	c		*Any two of:* increases **«**ratio of**»** HDL **«**to LDL**»** cholesterol ***OR*** decreases LDL cholesterol **«**level**»** ✓ removes plaque from/unblocks arteries ***OR*** decreases risk of heart disease ✓ decreases risk of stroke **«**in the brain**»** ✓	*Accept "essential fatty acid".* *Do **not** accept "bad cholesterol" for "LDL cholesterol" **OR** "good cholesterol" for "HDL cholesterol".* *Do **not** accept general answers such as "source of energy" **OR** "forms triglycerides" **OR** "regulates permeability of cell membranes" etc.*	**2 max**

Question			Answers	Notes	Total
9.	a		«reaction in which» two reactants/molecules/functional groups bond/react «to form a larger molecule/single main product» ✓ small/tiny molecule ***OR*** H_2O formed ✓	*Accept formula or name of a specified small molecule other than water such as ammonia, ethanoic/acetic acid, ethanol, hydrogen sulfide etc. for M2.* *Do **not** accept just "molecule formed".* *Award **[1 max]** for an example giving an equation of a condensation reaction such as the formation of a disaccharide.*	**2**
9.	b		 ✓	*Accept "alpha" or "beta" form of galactose.*	**1**

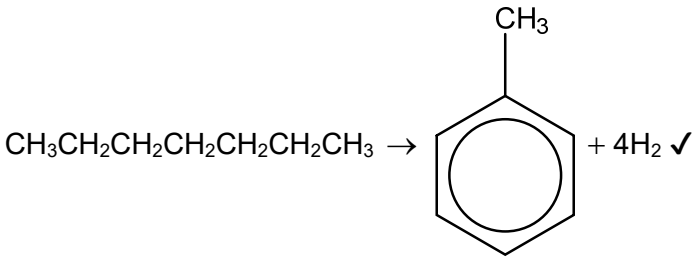
Question			Answers	Notes	Total
9.	**c**		*Any two of:* makes the plastic more hydrophilic/water soluble ✓ carbohydrates are broken down/hydrolysed by bacteria/microorganisms ✓ makes plastic more accessible to bacteria as holes/channels are created ***OR*** plastic of lower density is more permeable/susceptible to water/oxygen/heat/pressure ✓ weakens intermolecular/London/dispersion/instantaneous induced dipole-induced dipole forces «between polymer chains in the plastic» ✓	*Accept "van der Waals/vdW" for "London" forces.*	**2 max**

Question			Answers	Notes	Total
10.	a		«mainly» hydrocarbon/non-polar «structure» ✓ forms London/dispersion/instantaneous induced dipole-induced dipole forces «with fats» ✓	*Accept "forms van der Waals'/vdW forces".* *Award **[1 max]** for "contains only one OH/hydroxyl **AND** cannot form «enough» H-bonds".*	**2**
10.	b		helps absorb calcium ***OR*** helps build bones ***OR*** helps keep bones healthy ***OR*** helps block the release of parathyroid hormone ***OR*** helps in muscle function ***OR*** helps immune system function ***OR*** cell growth ***OR*** reduction of inflammation ***OR*** protection from osteoporosis ***OR*** prevents rickets ✓	*Accept helps prevent colon/breast/prostate cancer.* *Accept treat/prevent diabetes/heart disease/high blood pressure/multiple sclerosis.* *Accept other correct answers*	**1**

Question			Answers	Notes	Total
11.			conformation/shape altered ***OR*** active site altered ***OR*** tertiary structure altered ✓ acidic/basic/ionizable/COOH/carboxyl/NH_2/amino groups in the R groups/side chains **«**react**»** ✓ exchange/lose/gain protons/H^+ ✓ ionic/H-bonds altered ✓	*Accept "substrate doesn't fit/fits poorly into active site"* ***OR*** *"enzyme denatures" for M1 but* ***not*** *"affects potential of enzyme to form complex with substrate".*	**4**

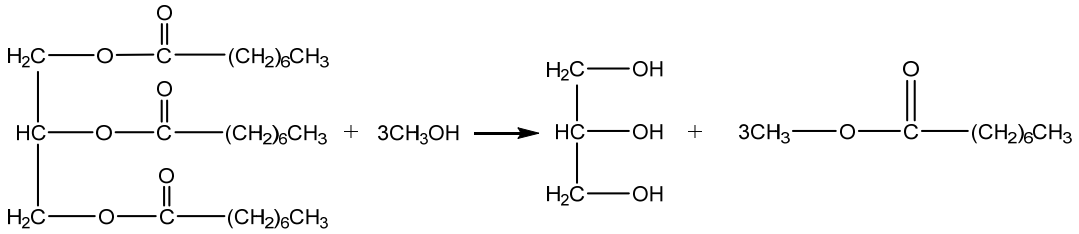
Option C — Energy

Question			Answers	Notes	Total
12.	**a**		M_r (C_8H_{18}) = 114.26 ***AND*** $\Delta H_c^{\ominus}$ = –5470 **«**kJ mol^{-1}**»** ✓ **«**specific energy = $\frac{5470\ kJ}{0.11426\ kg}$ **=»** 4.79×10^4/47873/47900 **«**kJ kg^{-1}**»** ✓	*Award **[2]** for correct final answer.* *Accept "48 × 10^3 **«**kJ kg^{-1}**»**" **OR** "47.9 × 10^3 **«**kJ kg^{-1}**»**".*	**2**
12.	**b**		wood is less useful because it requires **«**about three times**»** more mass for same energy ✓	*Accept "octane is more useful because it has higher specific energy".*	**1**
12.	**c**		*Any one of:* wind ✓ tidal/wave ✓ hydro-electric ✓ solar ✓ thermal/geothermal ✓ plant oil ✓	*Accept "biofuel/biodiesel/**«**bio**»**ethanol" but **not** just "water" or "fuel cells".*	**1 max**

Question			Answers	Notes	Total
13.	a		$CH_3CH_2CH_2CH_2CH_2CH_2CH_3 \rightarrow CH_3CH(CH_3)CH_2CH(CH_3)_2$ ***OR***  $CH_3CH_2CH_2CH_2CH_2CH_2CH_3 \rightarrow$ + $4H_2$ ✓ isomerisation/reforming/platforming/cracking ✓ Pt/Re/Rh/Pd/Ir ***OR*** catalyst ✓	*A structural formula is only required for the organic product, not heptane.* *Accept any correctly balanced equation showing increased branching or cyclization **OR** aromatization **OR** cracking.* *Suitable supports for catalysts may be included for M3 (eg silica, alumina, zeolite) but the symbol or name of an appropriate metal must be given (typically a noble metal). Ignore temperature and other conditions.* *Award M2 **AND** M3 for "catalytic isomerisation" **OR** "catalytic reforming" **OR** "catalytic cracking".*	**3**
13.	b		which specific carbon-based greenhouse gases are included ***OR*** whether non-carbon based greenhouse gases should be included ***OR*** whether CO/incomplete combustion should be included «as can be oxidized to CO_2» ***OR*** how to "sum" all steps in a process creating CO_2 ***OR*** difficult to determine both direct and indirect production of GHG/greenhouse gas emissions ✓	*Ignore reference to geopolitical issues (eg false recording of data by governments etc.).* *Accept "difficult to measure all sources of CO_2" but **not** "difficult to measure CO_2 released in atmosphere".*	**1**

Question			Answers	Notes	Total
13.	**c**		*Any three of:* incoming solar radiation is short wavelength/high frequency/high energy/UV ✓ radiated/emitted as long wavelength/low frequency/low energy/IR «radiation» ✓ energy/IR «radiation» absorbed by **«**bonds in**»** greenhouse gases ✓ energy radiated/emitted as IR «radiation» some of which returns back to Earth ✓	*Do **not** accept "reflected" **OR** "bounced" **OR** "trapped".*	**3 max**
13.	**d**		bond length changes ***OR*** «asymmetric» stretching «of bonds» ***OR*** bond angle changes/bends ***OR*** polarity/dipole «moment» changes ***OR*** a dipole «moment» is created «when the molecule absorbs IR» ✓	*Accept "vibration of bonds" **OR** appropriate diagram*	**1**

Question			Answers	Notes	Total
14.	**a**	**i**	*Fission:* heavy nuclei ***AND*** *Fusion*: light nuclei ✓ both increase in binding energy/energy yield **«**per nucleon**»** ✓	*Accept "large nuclei"* ***OR*** *"greater atomic masses of nuclei" for fission* ***AND*** *"small nuclei"* **OR** *"smaller atomic masses of nuclei" for fusion.* *Award* ***[1 max]*** *for "Fission: heavy nuclei* ***AND*** *increase in binding energy* **«***per nucleon***»***" ***OR*** *"Fusion: light nuclei* ***AND*** *increase in binding energy"* **«***per nucleon***»***".*	**2**
14.	**a**	**ii**	*Any two of:* no/less radioactive waste produced ✓ abundance/low cost of fuel ✓ larger amounts of energy released per unit mass ✓ does not require a critical mass ✓ can be used continuously ✓ fusion reactor less likely to cause large-scale technological disaster ✓	*Do* ***not*** *accept "no/less waste produced".* *Accept "higher specific energy".*	**2 max**
14.	**b**		6 **«**hours**»** ✓		**1**

Question			Answers	Notes	Total
15.	a		«extensive» conjugation ***OR*** alternating single and double bonds ✓		1
15.	b		 ester product ✓ glycerol ***AND*** correct balancing ✓	*Catalyst not required for equation.* *Award M2 only if M1 is correct.*	2

Option D — Medicinal chemistry

Question			Answers	Notes	Total
16.			*Any two of:* emits weak ionising radiation ***OR*** low activity/radioactivity ✓ can be stored until material becomes inactive ***AND*** then disposed with normal waste ✓ **«**isotopes**»** have short lives ***OR*** exist for a short period of time ✓	*Award **[1 max]** for "low-level waste/ LLW".*	**2 max**

Question			Answers	Notes	Total
17.	a		prevents/interferes with the production of prostaglandins ***OR*** prevents/interferes with the production of substances responsible for inflammation/pain/fever ✓ at the site of injury/source of pain ✓		**2**
17.	b	i	react with CH_3I/methyl iodide **«**in alkaline solution**»** ✓	*Accept "react with CH_3Cl/methyl chloride"* ***OR*** *"react with methyl halide".* *Accept name or formula of a suitable specific methylating reagent (eg trimethylphenylammonium chloride etc.).* *Accept "hydroxy/alcohol" but* ***not*** *"hydroxide" for "hydroxyl****".***	**1**
17.	b	ii	*Any two of:* interact with opioid receptors in the brain ✓ alter the structure of brain cells ***OR*** alter the way the brain works **«**so that it only works normally when the opiates are present**»** ***OR*** prevents transmission of pain impulses inside the brain ✓ release dopamine **«**that the person craves**»** ***OR*** give a feeling of pleasure/euphoria **«**that the person craves**»** ✓ withdrawal symptoms **«**prevent patient from terminating drug use**»** ✓	*Accept specific withdrawal symptoms.*	**2 max**

Question			Answers	Notes	Total
18.	**a**		in animal studies $\frac{\text{LD50}}{\text{ED50}}$ ***AND*** in humans $\frac{\text{TD50}}{\text{ED50}}$ ***OR*** in animal studies lethal dose/LD50 ***AND*** in humans toxic dose/TD50 ✓		**1**
18.	**b**		intravenous/IV **«**injection**»** ***OR*** injection into the bloodstream ✓		**1**

19.	**a**		Any two of: amido ✓ ether ✓ carbonyl ✓	*Accept "amide/carboxamide".* *Accept "alkenyl/alkene".* *Accept "amino/amine".*	**2 max**
19.	**b**		by preventing the virus from leaving the host cell ✓ by inhibiting viral enzymes/neuraminidases **«**needed to release virus**»** ✓		**2**

Question			Answers	Notes	Total
20.	**a**		blocks/binds to H2/histamine receptors **«**in cells of stomach lining**»** ***OR*** prevents histamine binding to H2/histamine receptors **«**and triggering acid secretion**»** ✓ prevents parietal cells from releasing/producing acid ✓	*Accept "H2-receptor antagonist/H2RA"* ***OR*** *"blocks/inhibits action of histamine" for M1.*	**2**
20.	**b**		***ALTERNATIVE 1*** $\text{pH} = \text{«p}K_a + \log \frac{[A^-]}{[HA]} \text{=»} 6.35 + \log \left(\frac{0.400}{0.0200}\right)$ ✓ **«**pH **=»** 7.65 ✓ ***ALTERNATIVE 2*** $K_a = 4.5 \times 10^{-7}$ ✓ $\text{«}K_a = 0.400 \times \frac{[H^+]}{0.0200}\text{, } [H^+] \text{=»} 2.3 \times 10^{-8} \text{ «mol dm}^{-3}\text{»}$ **«**pH **=»** 7.64 ✓	*Award* ***[2]*** *for correct final answer.* *Do* ***not*** *accept "pH = 8".*	**2**

Question			Answers	Notes	Total
21.			ring is «sterically» strained ***OR*** angles of 90° instead of 109.5/109/120° angles ***OR*** angles smaller than 109.5/109/120°/tetrahedral/trigonal planar/triangular planar angle ✓ ring breaks up/opens/reacts «easily» ***OR*** amido/amine group «in ring» is «highly» reactive ✓ binds to/reacts with/interferes with/inactivates <u>transpeptidase</u> ***OR*** binds to/reacts with/interferes with/inactivates <u>enzyme</u> responsible for bacterial cell wall formation/cross-linking ✓		**3**