

Markscheme

November 2017

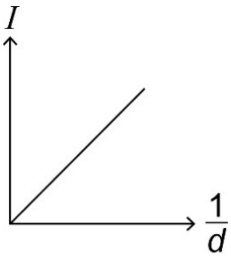
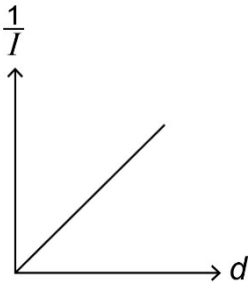
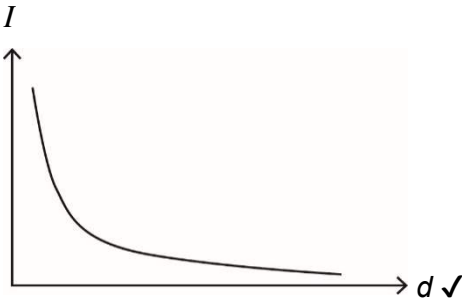
Chemistry

Standard level

Paper 3

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Section A

Question		Answers	Notes	Total
1.	a	<p>I</p>  <p>OR</p>  <p>OR</p> 	<p>Correct labels of axes required for mark.</p> <p>Accept d^{-1} instead of $\frac{1}{d}$.</p> <p>Accept I^{-1} instead of $\frac{1}{I}$.</p> <p>Plot of I vs d should not be linear.</p>	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 $y = -0.001631 x + 0.09939$ ✓	<i>Accept correctly rounded values for m and b in equation.</i> <i>Do not accept "y = mx + b".</i>	1
1.	b	iii	ions move «across electrolyte» ✓		1

Question		Answers	Notes	Total
2.	a	$\text{Mg(OH)}_2(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \checkmark$	Accept full or net ionic equation.	1
2.	b	Any two from: volume «of HCl» \checkmark concentration «of HCl»/[HCl] \checkmark temperature «of HCl» \checkmark mass of antacid/tablets \checkmark size of antacid particles/tablets OR surface area of antacid «particles»/tablets \checkmark	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	(\pm) 0.04 OR (\pm) 0.03 \checkmark		1

Question		Answers	Notes	Total
2.	d	<p>Any two of:</p> <p>uncertainty «(±)0.04/(±)0.03» means A and C cannot be distinguished ✓</p> <p>each measurement was conducted once ✓</p> <p>stomach pH should not be raised a lot «so antacid B is not necessarily effective» ✓</p> <p>mass/number of tablets/dose «of antacid» used was not controlled ✓</p> <p>actual environment in stomach is different ✓</p>	<p>Accept “amount of tablets” for “dose”.</p> <p>Do not accept “nature/composition of tablets differs”.</p> <p>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”.</p>	<p>2 max</p>

Question		Answers	Notes	Total
3.	a	-21 «°C» ✓		1
3.	b	<p>28 «%» ✓</p>	Accept any specific answer in the range 27 to 29 «°C».	1

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

Section B

Option A — Materials

Question			Answers	Notes	Total
4.	a		<p><i>Alloy:</i> mixture of <u>metal</u> with other metals/non-metals</p> <p>OR</p> <p>mixture of elements that retains the properties of a <u>metal</u> ✓</p> <p><i>Composite:</i> reinforcing phase embedded in matrix phase ✓</p>	<p><i>Award [1 max] for implying “composites only have heterogeneous/non-homogeneous compositions”.</i></p>	2
4.	b	i	<p>difference in ionic/atomic radius prevents layers sliding over each other ✓</p>	<p><i>Accept “difference in diameter/packing of cations prevents layers sliding over each other”.</i></p>	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.	<p><i>Any two of:</i></p> <p>greater selectivity ✓</p> <p>higher efficiency ✓</p> <p>longer life expectancy</p> <p>OR</p> <p>not easily poisoned ✓</p> <p>easier to recover ✓</p> <p>low«er» environmental impact ✓</p> <p>large range of conditions/temperatures/pressures supported ✓</p> <p>lower energy costs ✓</p> <p>increase in yield «per unit time» offsets cost of catalyst ✓</p>		2 max

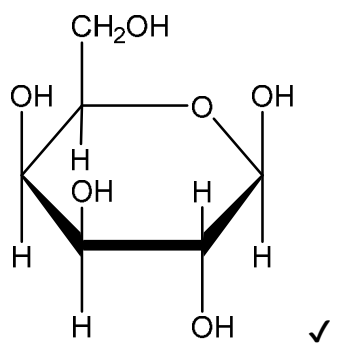
Question		Answers	Notes	Total
6.	a	$\text{Fe}(\text{CO})_5(\text{g}) \rightarrow \text{Fe}(\text{s}) + 5\text{CO}(\text{g}) \checkmark$ $2\text{CO}(\text{g}) \rightarrow \text{C}(\text{s}) + \text{CO}_2(\text{g}) \checkmark$		2
6.	b	large surface area «on which carbon nanotubes form» ✓		1
6.	c	unknown 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 ✓	<i>Do not accept vague responses.</i>	1

Question			Answers	Notes	Total
7.	a		<p>Any two of:</p> <p>ability to form a LC phase ✓</p> <p>chemically stable ✓</p> <p>«LC phase that is» stable over suitable temperature range ✓</p> <p>polar</p> <p>OR</p> <p>being able to change orientation with applied electric field ✓</p> <p>rapid switching speed «responds to changes of voltage quickly» ✓</p>	<p>Accept “ability of molecules to transmit light under certain conditions” OR “rod-shaped molecules” OR “stable to light/not light sensitive”.</p>	2 max
7	b	i	<p>branching in LDPE prevents close packing «of chains» ✓</p> <p>LDPE is more flexible/less rigid</p> <p>OR</p> <p>LDPE has lower «tensile» strength ✓</p>	<p>Do not accept “difference in density”.</p> <p>Award [1 max] for stating “branching in LDPE AND little/no branching in HDPE”.</p>	2
7.	b	ii	<p>B AND absence «of absorption of» C–H at 2850–3090 «cm⁻¹»</p> <p>OR</p> <p>B AND presence of «absorption of» C–F at 1000–1400 «cm⁻¹» ✓</p>		1
7.	c		<p>$(-C_2H_3Cl-)_2 (s) + 5O_2 (g) \rightarrow 4CO_2 (g) + 2H_2O (l) + 2HCl (g)$</p> <p>correct species in reactants and products ✓</p> <p>balanced ✓</p>	<p>Accept “$(-C_2H_3Cl-)_2 (s) + 5.5O_2 (g) \rightarrow 4CO_2 (g) + 3H_2O (l) + Cl_2 (g)$”.</p> <p>Award M2 only if M1 correct.</p>	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	$\left\langle \frac{1.24 \text{ g}}{280.50 \text{ g mol}^{-1}} \Rightarrow 0.00442 \text{ «mol»} \right\rangle$ ✓ 0.00884 mol of C=C OR ratio of linoleic acid : iodine = 1:2 ✓ $\left\langle \text{volume of } I_2 \text{ solution} = \frac{0.00884 \text{ mol}}{0.300 \text{ mol dm}^{-3}} \Rightarrow 0.0295 \text{ «dm}^3\text{»} / 29.5 \text{ «cm}^3\text{»} \right\rangle$ ✓	Award [3] for correct final answer.	3

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

Question		Answers	Notes	Total
9.	a	<p>«reaction in which» two reactants/molecules/functional groups bond/react «to form a larger molecule/single main product» ✓</p> <p>small/tiny molecule</p> <p>OR</p> <p>H₂O formed ✓</p>	<p>Accept formula or name of a specified small molecule other than water such as ammonia, ethanoic/acetic acid, ethanol, hydrogen sulfide etc. for M2.</p> <p>Do not accept just “molecule formed”.</p> <p>Award [1 max] for an example giving an equation of a condensation reaction such as the formation of a disaccharide.</p>	2
9.	b		<p>Accept “alpha” or “beta” form of galactose.</p>	1

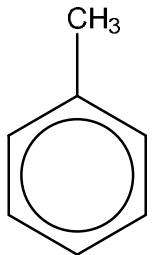
Question		Answers	Notes	Total
9.	c	<p><i>Any two of:</i></p> <p>makes the plastic more hydrophilic/water soluble ✓</p> <p>carbohydrates are broken down/hydrolysed by bacteria/microorganisms ✓</p> <p>makes plastic more accessible to bacteria as holes/channels are created</p> <p>OR</p> <p>plastic of lower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

Question		Answers	Notes	Total
10.	a	<p>«mainly» hydrocarbon/non-polar «structure» ✓</p> <p>forms London/dispersion/instantaneous induced dipole-induced dipole forces</p> <p>«with fats» ✓</p>	<p>Accept “forms van der Waals’/vdW forces”.</p> <p>Award [1 max] for “contains only one OH/hydroxyl AND cannot form «enough» H-bonds”.</p>	2
10.	b	<p>helps absorb calcium</p> <p>OR</p> <p>helps build bones</p> <p>OR</p> <p>helps keep bones healthy</p> <p>OR</p> <p>helps block the release of parathyroid hormone</p> <p>OR</p> <p>helps in muscle function</p> <p>OR</p> <p>helps immune system function</p> <p>OR</p> <p>cell growth</p> <p>OR</p> <p>reduction of inflammation</p> <p>OR</p> <p>protection from osteoporosis</p> <p>OR</p> <p>prevents rickets ✓</p>	<p>Accept helps prevent colon/breast/prostate cancer.</p> <p>Accept treat/prevent diabetes/heart disease/high blood pressure/multiple sclerosis.</p> <p>Accept other correct answers</p>	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	$M_r(\text{C}_8\text{H}_{18}) = 114.26$ AND $\Delta H_c^\ominus = -5470$ «kJ mol ⁻¹ » ✓ «specific energy = $\frac{5470 \text{ kJ}}{0.11426 \text{ kg}} \Rightarrow 4.79 \times 10^4/47873/47900$ «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	<p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)_2$</p> <p>OR</p> <p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow$  $+ 4\text{H}_2 \checkmark$</p> <p>isomerisation/reforming/platforming/cracking \checkmark</p> <p>Pt/Re/Rh/Pd/Ir</p> <p>OR</p> <p>catalyst \checkmark</p>	<p><i>A structural formula is only required for the organic product, not heptane.</i></p> <p><i>Accept any correctly balanced equation showing increased branching or cyclization OR aromatization OR cracking.</i></p> <p><i>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.</i></p> <p><i>Award M2 AND M3 for “catalytic isomerisation” OR “catalytic reforming” OR “catalytic cracking”.</i></p>	3
13.	b	<p>which specific carbon-based greenhouse gases are included</p> <p>OR</p> <p>whether non-carbon based greenhouse gases should be included</p> <p>OR</p> <p>whether CO/incomplete combustion should be included «as can be oxidized to CO₂»</p> <p>OR</p> <p>how to “sum” all steps in a process creating CO₂</p> <p>OR</p> <p>difficult to determine both direct and indirect production of GHG/greenhouse gas emissions \checkmark</p>	<p><i>Ignore reference to geopolitical issues (eg false recording of data by governments etc.).</i></p> <p><i>Accept “difficult to measure all sources of CO₂” but not “difficult to measure CO₂ released in atmosphere”.</i></p>	1

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

Question			Answers	Notes	Total
14.	a	i	<p><i>Fission</i>: heavy nuclei AND <i>Fusion</i>: light nuclei ✓ both increase in binding energy/energy yield «per nucleon» ✓</p>	<p>Accept “large nuclei” OR “greater atomic masses of nuclei” for fission AND “small nuclei” OR “smaller atomic masses of nuclei” for fusion.</p> <p>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»”.</p>	2
14.	a	ii	<p>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 ✓</p>	<p>Do not accept “no/less waste produced”.</p> <p>Accept “higher specific energy”.</p>	2 max
14.	b		6 «hours» ✓		1

Question		Answers	Notes	Total
15.	a	<p>«extensive» conjugation OR alternating single and double bonds ✓</p>		1
15.	b	$ \begin{array}{c} \text{H}_2\text{C}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-(\text{CH}_2)_6\text{CH}_3 \\ \\ \text{HC}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-(\text{CH}_2)_6\text{CH}_3 \\ \\ \text{H}_2\text{C}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-(\text{CH}_2)_6\text{CH}_3 \end{array} + 3\text{CH}_3\text{OH} \longrightarrow \begin{array}{c} \text{H}_2\text{C}-\text{OH} \\ \\ \text{HC}-\text{OH} \\ \\ \text{H}_2\text{C}-\text{OH} \end{array} + 3\text{CH}_3-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-(\text{CH}_2)_6\text{CH}_3 $ <p>ester product ✓ glycerol AND correct balancing ✓</p>	<p><i>Catalyst not required for equation.</i></p> <p><i>Award M2 only if M1 is correct.</i></p>	2

Option D — Medicinal chemistry

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

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 ₃ I/methyl iodide «in alkaline solution» ✓	Accept “react with CH ₃ Cl/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 $\frac{LD50}{ED50}$ AND in humans $\frac{TD50}{ED50}$ OR in animal studies lethal dose/LD50 AND in humans toxic dose/TD50 ✓		1
18.	b	intravenous/IV «injection» OR injection into the <u>bloodstream</u> ✓		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	<p>blocks/binds to H2/histamine receptors «in cells of stomach lining»</p> <p>OR</p> <p>prevents histamine binding to H2/histamine receptors «and triggering acid secretion» ✓</p> <p>prevents parietal cells from releasing/producing acid ✓</p>	<p>Accept "H2-receptor antagonist/H2RA"</p> <p>OR "blocks/inhibits action of histamine" for M1.</p>	2
20.	b	<p>ALTERNATIVE 1</p> $\text{pH} = \text{«p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]} \Rightarrow 6.35 + \log \left(\frac{0.400}{0.0200} \right) \checkmark$ <p>«pH ⇒ 7.65 ✓</p> <p>ALTERNATIVE 2</p> $K_a = 4.5 \times 10^{-7} \checkmark$ $\text{«}K_a = 0.400 \times \frac{[\text{H}^+]}{0.0200}, [\text{H}^+] \Rightarrow 2.3 \times 10^{-8} \text{ «mol dm}^{-3}\text{»}$ <p>«pH ⇒ 7.64 ✓</p>	<p>Award [2] for correct final answer.</p> <p>Do not accept "pH = 8".</p>	2

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