

# **Mark Scheme for June 2013**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## Annotations

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	separates marking points
not	answers which are not worthy of credit
reject	answers which are not worthy of credit
ignore	statements which are irrelevant
allow	answers that can be accepted
( )	words which are not essential to gain credit
—	underlined words must be present in answer to score a mark
e cf	error carried forward
AW	alternative wording
ora	or reverse argument
	correct response
	incorrect response
	benefit of the doubt
	benefit of the doubt <b>not</b> given
	error carried forward
	information omitted
	ignore
	reject

Highlighting is also available to highlight any particular points on the script.

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:  
2(b), 4(c), 6(b), 7(b)(iii) and 12(a)

Question		Answer	Marks	Guidance
1	(a)	5 ; H <sub>2</sub> O ;	2	<b>NOT</b> H <sup>2</sup> O etc <b>ALLOW</b> correct multiples
	(b)	Suitable e.g. HF, H <sub>2</sub> O, NH <sub>3</sub> ; Difference in <u>electronegativity</u> between atoms ; More electronegative element is negative / has δ- symbol AW causes electrons to be shared unevenly / causes one side of molecule to be negative etc ;	3	<b>IGNORE</b> minor errors on diagram Comparative electronegativities need to be correct  Third mark can be awarded from correct dipole on diagram. ECF from incorrect electronegativities above
	(c) (i)	4 ;	1	
	(ii)	Molecule is linear (in a straight line) ; Dipoles cancel out AW centre of positive charge is in same place as centre of negative charge ;	2	<b>ACCEPT</b> completely symmetrical
	(d) (i)	Between 0.125 and 0.135 ;	1	<b>IGNORE</b> unit
	(ii)	CO <sub>2</sub> in air increases ; As ocean (water) warms CO <sub>2</sub> becomes less soluble (in water) / less is dissolved ;	2	<b>ALLOW</b> CO <sub>2</sub> released into atmosphere owtte <b>IGNORE</b> any mention of water vapour / evaporation
	(e) (i)	H <sup>+</sup> ion or H <sub>3</sub> O <sup>+</sup> ;	1	Any other particle is <b>CON</b>
	(ii)	Only partially (slightly) ionised / dissociated ;	1	<b>ALLOW</b> "does not donate H <sup>+</sup> ions easily"
	(iii)	H <sup>+</sup> ; HCO <sub>3</sub> <sup>-</sup> ;	2	<b>ALLOW</b> 2H <sup>+</sup> + CO <sub>3</sub> <sup>2-</sup> (but must balance) <b>ALLOW</b> CO <sub>3</sub> <sup>-2</sup> Must show correct charge
		<b>Total</b>	<b>15</b>	

Question		Answer	Marks	Guidance	
2	(a)	Same atomic number / same no. of protons ; Different mass number / different number of neutrons ;	2	<b>ALLOW</b> same element <b>IGNORE</b> reference to electrons	
	(b)	(i)	Time on X axis, radioactivity on Y with labels and units ; At least half of graph used in each direction ; All points plotted correctly ; All points connected with line of best fit ;	4	<b>IGNORE</b> omission of arbitrary units  If ruler used for any part of graph award 0, curve should be approximately exponential
		(ii)	8 days ;	1	<b>ALLOW</b> ECF from graph (construction lines need to be shown)
		(iii)	54 ;	1	
	(c)	(Splitting) breaking apart of a(n) (atomic) <u>nucleus</u> (to produce smaller nuclei) ; Releasing energy / heat / neutrons absorbed and/or released ;	2	<b>NOT</b> decay (this <b>CONS</b> 1 <sup>st</sup> mark)	
		<b>Total</b>	<b>10</b>		

Question			Answer	Marks	Guidance
3	(a)	(i)	<u>Alpha helix</u> ;	1	Not just helix
		(ii)	Overall / large-scale / complex ; 3D structure of the protein ; Produced when the sequence / 2ndary structures has folded ; <i>Any 2 from 3</i>	2	<b>ALLOW</b> as determined by primary structure AW for 3 <sup>rd</sup> marking point
		(iii)	Cysteine forms sulfur-sulfur links ; Links between cysteine's maintain tertiary structure of protein ; Mutation means that cysteine not present / unable to form S-S bonds ;	3	Needs to be linked to inability to form link between cysteine
	(b)		A. (idea that) activity from graph increases to a peak at <u>6</u> ; B. then decreases at pHs above this ; <i>2 marks</i> C. presence of acids / alkalis / H <sup>+</sup> / OH <sup>-</sup> affects amino acids / protein / enzyme (causes changes to structure / charges etc.) ; D. new ionic interactions / altered charges on side groups may result ; E. alters the tertiary / 3-D structure / shape of enzyme AW denatured ; F. change of shape to <u>active site</u> ; G. prevent enzyme binding to substrate / enzyme- substrate fit ; <i>3 out 5 for explanation</i>	5	AW A. optimum at pH 6 B. activity declines above and below this <i>1 mark max</i> if optimum pH not stated  Need to link presence of acid with some change to enzyme structure  <b>ALLOW</b> 1 mark for any reference to protonation or deprotonation of amino acids  <b>IGNORE</b> "active site denatured"
			<b>Total</b>	<b>11</b>	

Question		Answer	Marks	Guidance
4	(a)	A. ozone (methane) has different bonds ; B. different bond lengths / strengths / masses of atoms ; C. (peaks in) IR spectrum shows frequencies of vibrations (of bonds / molecules) ; D. <u>different bonds</u> vibrate / absorb at different frequencies ;  <i>Any 3</i>	3	Gives examples e.g. double / single / C-H / O=O etc  Credit any reference to spectrum e.g. ozone has peak at $1000\text{cm}^{-1}$ methane unlikely to have same peak (in context of different bonds) etc.
	(b)	(i) Correct selection and rearrangement / $\lambda = c/f$ ; $\lambda = 3.0 \times 10^8 \text{ m/s} / 1.27 \times 10^{15} \text{ Hz}$ ; 236 nm / $2.36 \times 10^2 \text{ nm}$ / $2.36 \times 10^{-7} \text{ m}$ ;	3	Scores 2 if correct, <b>IGNORE</b> use of $10^{-9}$ Unit must be consistent with value for 3 <sup>rd</sup> mark
		(ii) $E = hf (1.27 \times 10^{15}) \times 6.63 \times 10^{-34} = 8.42 \times 10^{-19}$ ; Joules (J) ;	2	
		(iii) An atom (molecule/species) with an <u>unpaired</u> electron(s) ;	1	Must refer to the species which contains the unpaired electron(s)
		(iv) Radicals are very reactive species / can cause bonds to break (or form) / react with atoms (in DNA) ;	1	<b>IGNORE</b> ionise <b>ALLOW</b> break up / split DNA etc. <b>IGNORE</b> reference to DNA nucleus etc.
		<b>Total</b>	<b>10</b>	

Question		Answer	Marks	Guidance
5	(a)	Accept between 50-58 dm <sup>3</sup> ;	1	
	(b)	(i) Gas <u>molecules</u> gain (kinetic) energy ; Gas molecules do work on the atmosphere / push atmosphere outwards AW volume or surface area of gas must increase to keep pressure constant ; Distance between molecules increases / molecules more spread out ;  <i>Any 2</i>	2	Accept move around faster  Reference to density increasing is <b>CON</b>
		(ii) Work done / AW energy used when gas is compressed; Work done = energy transformed owtte ;  Greater <u>kinetic</u> energy of molecules ;	2	Only award 2 <sup>nd</sup> mark if some reference to work done on gas
	(c)	(i) <u>Hydrogen bonds</u> form between molecules ; Bond formation releases heat ;	2	Must mention hydrogen bonding for this mark.
		<b>Total</b>	<b>7</b>	

Question			Answer	Marks	Guidance
6	(a)	(i)	Glycine ;	1	
		(ii)	TACCGA ;	1	
	(b)	(i)	Matches codon with anticodon (on mRNA) ; Brings amino acid to ribosome AW attaches to a (specific) amino acid ;	2	Correct statements relating to parts b(i) and (ii) can gain credit in either answer
		(ii)	Contains (binding) site for mRNA / AW binds to mRNA ; Moves along mRNA strand ; ✓ Site for translation / protein synthesis / joins amino acids ;  <i>Any 2</i>	2	
	(c)	(i)	H bonds between bases (easily) broken ; New hydrogen bonds form / form between DNA strand and free nucleotides ; Bases must be complementary / A bonds to T and G to C ;	3	Needs to be in the context of replication i.e. that strands have become separated. Mention of (m)RNA is <b>CON</b>
		(ii)	A. hydrogen bonds between (atoms in) <u>amino acids</u> ; B. hydrogen bonds stabilise secondary ; structures / $\alpha$ helix / $\beta$ pleated sheet ; C. by forming bonds between peptide groups ; D. ensure specific 3D / tertiary) structure ; E. by forming bonds between side groups ;  <i>Any 3</i>	3	Reference to nucleotides is <b>CON</b>  Mention of primary structure <b>CON</b> for marking point B or D <b>IGNORE</b> reference to other intramolecular forces
			<b>Total</b>	<b>12</b>	

Question		Answer	Marks	Guidance
7	(a)	Coal ; Crude oil (oil) ; Natural gas / methane ;	1	Must have 2 for 1 mark
	(b)	Breaking (covalent) bonds is endothermic (requires energy) ; Formation of new (covalent) bonds is exothermic (releases energy) ; <i>If only intermolecular bonds mentioned, 1 max</i> Exothermic process has greater magnitude than endothermic (then net (overall) energy change is exothermic) ;	3	AW (covalent) bonds broken and formed;  Bond breaking = exothermic, bond forming = endothermic;  Can be ecf from above if net result is exothermic
	(c)	(i) <i>Compares biobutanol and bioethanol</i>  For: A. less plant material needed (because twice the yield) ; B. biobutanol can be made from greater range of plant material / feedstocks / AW wood / bio waste / material grown on marginal land etc ; C. biobutanol has a higher energy output per kilogram / energy density / has a higher energy efficiency ; D. biobutanol produces less NO <sub>x</sub> and CO / pollutants / acid rain / toxic products (owtte) ; Against: E. if genetically modified organisms released into environment impact could be unknown / needs expensive or lengthy testing ; F. tampering with nature owtte ; G. 4% is still a small yield (compared to e.g. fermentation processes) ; <i>Any 6</i>  <i>Sequencing: needs to make it clear that biobutanol is being compared with bioethanol. Max 5 marks if this is not clear</i>	6	Mark first of all as a comparison of biobutanol and bioethanol and then compare mark with what would be obtained by comparing biobutanol and fossil fuels. Award highest mark <b>NOT</b> higher yield alone  <b>NOT</b> just from cellulose alone without justification  <b>NOT</b> just more energy from biobutanol  <b>ALLOW</b> NO <sub>x</sub> as an example of greenhouse gas not reference to global warming without justification

Question	Answer	Marks	Guidance
	<p><i>If compares biobutanol with non-renewable fuels: Max 3</i></p> <p>For:</p> <p>A. carbon dioxide emitted is equal to carbon dioxide absorbed (owtte) ;</p> <p>B. makes use of waste plant material so reduces landfill ;</p> <p>C. less reliance on (non-renewable fossil fuels) ;</p> <p>Against:</p> <p>D. fertiliser use / transport for feedstock production emits CO<sub>2</sub> ;</p> <p>E. if genetically modified organisms released into environment impact could be unknown ;</p> <p>F. tampering with nature owtte ;</p> <p>G. technology for fossil fuel production is well-established ;</p> <p>H. Land use for biobutanol reduces use for crop plants ;</p> <p>I. Yield of biobutanol is small ;</p> <p><i>Sequencing: needs to make it clear that biobutanol is being compared with non-renewable fossil fuels. Max 2 marks if this is not clear</i></p>		
	<b>Total</b>	<b>10</b>	

Question		Answer	Marks	Guidance
8	(a)	Temperature ; Salinity ; Density ;	1	Any 1
	(b)	A. temperature is very low (in Antarctic) / AW in winter ; B. as a result water freezes / ice forms ; C. ice does not contain salt ; D. the resultant (sea) water has high salinity ; E. which is dense ;  <i>Any 4</i>	4	Any 4  Reference to fresh water etc with low salinity is CON
	(c)	(i)	$Q = mc\Delta T$ , $Q = 80 \times 4.2 \times 5 = 1680$ ; kJ ;	2  AW 1680000 J
		(ii)	A. warm water (at sea surface) loses heat / energy to atmosphere ; B. water (at sea surface) evaporates / water vapour formed ; C. (water's high s.h.c causes) large amount of heat to be transferred to atm owtte ; D. gas expands / become less dense and causes decrease in pressure ; E. (expanded air mass) rises and cools ; F. water vapour condenses as rain ;  <i>Max 5</i>	5
		<b>Total</b>	<b>12</b>	

Question		Answer	Marks	Guidance
9	(a)	Coulomb ; Electrons ; Low ; Transformer ; High ; Heat ;	6	
	(b) (i)	Power is joules (energy) per second / rate of transfer of energy / rate of doing work ;	1	Allow $W = J/s$
	(ii)	$W = J/s$ , $s = J/W$ ; $S = 10,500/15.0 = 700$ seconds AW 11.7 mins ; Answer to 2 s.f. ;	3	700s = 3 marks; 700 = 2 AW 11.7 or 12 = 3 <b>ACCEPT</b> 11.7 or 12 mins. Award 2 s.f. mark if answer is consistent with some valid working
	(iii)	$W = V \times I$ , $I = W/V$ ; $I = 15/240 = 0.0625$ ; Amps (A) ;	3	$15/240 = 1$ mark <b>ACCEPT</b> 0.06, 0.063 etc.
		<b>Total</b>	<b>13</b>	

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