

**GCE**

**Science**

Unit **G642**: Science and Human Activity

Advanced Subsidiary GCE

**Mark Scheme for June 2015**

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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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## 1. 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
<u>    </u>	underlined words must be present in answer to score a mark
ECF	error carried forward
AW	alternative wording
ora	or reverse argument
✓	correct response
✗	incorrect response
BOD	benefit of the doubt
NBOD	benefit of the doubt <b>not</b> given
ECF	error carried forward
^	information omitted

Annotation	Meaning
<b>I</b>	ignore
<b>R</b>	reject

Question			Answer	Marks	Guidance
1	(a)	(i)	An atom (or molecule) with an <u>unpaired</u> electron (in its outer shell) ✓	1	Accept species
		(ii)	<b>Bonds</b> are broken ✓	1	
		(iii)	c = fλ correctly rearranged ✓ $\lambda = 3.0 \times 10^8 \text{ m s}^{-1} / 1.0 \times 10^{15} \text{ Hz} = 3.0 \times 10^{-7} \text{ m}$ ✓ = 300 nm ✓	3	Any correct conversion into nm gains mark Correct answer gets 3 marks if no working shown
		(iv)	Breaking of a (covalent) <u>bond</u> ✓ Generating 2 radicals/atoms (owtte) ✓AW each product gains one electron	2	Allow splitting of molecule Allow two identical products (not 2 molecules/ions/elements)
		(v)	Reactants and products labelled (in the same place on the axes for catalysed and uncatalysed reactions) ✓ Product line shown below reactants line ✓ Catalysed reaction shown with lower activation energy than uncatalysed ✓ Activation energy for both catalysed and uncatalysed reaction clearly indicated ✓	4	<b>ALLOW</b> 3 marks if all correct except that the reaction is shown as endothermic Lower hump for catalysed reaction gains mark Allow double headed arrow for activation energy
	(b)	(i)	The (reactant molecule) to which the enzyme binds ✓	1	Accept forms enzyme substrate complex
		(ii)	The temperature at which the <u>rate/activity</u> of the (enzyme-controlled) reaction is at its highest AW ✓	1	Answer must refer to rate or provide a suitable explanation of rate to gain the mark

Question	Answer	Marks	Guidance
(c)	<p><b>Description:</b> Rate of reaction would decrease/reaction would stop/ starch digestion would stop ✓ 1 mark</p> <p><i>Any three from:</i></p> <p><b>Explanation:</b> (Low pH) <b>increases</b> hydrogen ion (H<sup>+</sup>) concentration ✓ (which) alters charges/bonds in enzyme/ active site ✓ disrupts 3D/tertiary structure/folding of/ shape of <u>active site</u> ✓ (so) substrate no longer fits/bonds to (active site) ✓ 3 marks</p>	Max 4	<p>Accept graph showing rate of reaction at low pH</p> <p><b>ACCEPT</b> ionic and hydrogen bonds</p> <p><b>ACCEPT enzyme</b> may break up/ hydrolyse/ denature/AW</p> <p>Accept cannot form enzyme substrate complex</p>
	<b>Total</b>	<b>17</b>	

Question		Answer	Marks	Guidance
2	(a)	5(km) <b>AND</b> 40(km) <b>AND</b> 60(km) ✓	1	All 3 correct gets 1 mark <b>ACCEPT</b> 4-6 <b>ACCEPT</b> 40-42 <b>ACCEPT</b> 60-62  Ignore units
	(b) (i)	Air <u>molecules/particles</u> gain <u>kinetic energy</u> ✓ Molecules/particles are further apart ✓ Less dense (air rises) ✓	3	<b>ALLOW</b> air molecules move faster /greater speed <b>ALLOW</b> fixed number/mass of molecules take up more space/greater volume
	(ii)	<b>Name:</b> Coriolis effect ✓  <b>Cause:</b> (due to) Earth's rotation ✓	2	
	(c) (i)	$Q=mc\Delta T$ correctly rearranged <b>OR</b> $\Delta T = 20.0/(1 \times 4.18)$ ✓ $= 4.78/4.8$ (°C) ✓	2	<b>2 or more sig figs</b> Not 4.7
	(ii)	$\Delta T = 15.9 / 36.6 - 20.7$ ✓  $(20.0/15.9 =) 1.26/1.3$ (kJ kg <sup>-1</sup> °C <sup>-1</sup> ) ✓	2	<b>2 or more sig figs</b>  Not 1.2  ecf if temperature rise is calculated incorrectly
	(iii)	Water's (high specific heat capacity) means that it stores/absorbs/retains a lot of <u>energy</u> ✓ AW it takes a lot of <u>energy</u> to raise the temperature (of given mass by a given amount)	Max 3	<b>ALLOW</b> heat instead of energy

Question			Answer	Marks	Guidance
			<b>AND 2 from</b> Water currents transfer heat energy to other regions ✓ Water warms/cool slowly/ sea temperature doesn't change much ✓ Temperate climate of coastal regions OWTTE ✓		Must refer to temperature not heat/energy
			<b>Total</b>	<b>13</b>	



Question			Answer	Marks	Guidance
3	(a)	(i)	An anticodon ✓	1	
		(ii)	Hydrogen bond ✓	1	<b>ACCEPT</b> base pairing
	(b)		<p><b>Amino acid:</b> Methionine ✓</p> <p><b>Explanation:</b> (tRNA) anticodon pairs with (mRNA) complementary owtte codon ✓ <b>AW</b> UAC pairs with AUG ORA</p>	2	
	(c)		<p><b>Role of DNA:</b> (base) sequence of codons in DNA determines <u>sequence</u> of amino acids/<u>primary structure</u> of protein ✓ DNA unwinds/unzips (to expose base sequence)✓ Information/base sequence/triplet code/, copied/transcribed into mRNA ✓ (RNA) nucleotide bond to DNA strand ✓</p> <p><b>Role of mRNA:</b> <u>Sequence of bases</u> (in RNA) is complementary to DNA strand ✓ mRNA moves from <u>nucleus</u> to <u>ribosome(s)</u> ✓ mRNA binds/attaches to <u>ribosome(s)</u> ✓</p> <p><b>Role of tRNA:</b> (at ribosome) tRNA anticodon, pairs with mRNA codon ✓ (specific) amino acid attached to each tRNA molecule✓ <b>AW</b> tRNA brings amino acids (to ribosome) bonds form between amino acids (to build polypeptide /primary protein structure) ✓</p>	Max 6	<p>Marks may be awarded from an annotated diagram</p> <p><b>IGNORE</b> 'mRNA moves into cytoplasm' as too general</p> <p>Accept endoplasmic reticulum in place of ribosomes</p> <p><b>ACCEPT</b> triplet (base) code for (tRNA) anticodon <b>ACCEPT</b> triplet (base) code (mRNA) codon'</p>

Question		Answer	Marks	Guidance
		<b>QWC</b> for clear description of the process	1	Award QWC if candidate's answer describes roles of DNA <b>and</b> mRNA <b>and</b> tRNA <b>AND</b> the steps are ordered
	<b>(d)</b>	<b>(i)</b> <b>Any three from:</b> Gene (with particular trait) identified/located ✓  Gene removed/cut out (from DNA of donor organism) using (restriction) <u>enzymes</u> ✓  <u>restriction</u> enzymes recognise and cut <b>specific nucleotide/base sequences</b> ✓  Gene inserted into host DNA by vector ✓	Max 3	<b>ACCEPT</b> example of vector e.g. plasmid, virus, gold nanoparticle
		<b>(ii)</b> Use of marker gene for identification (e.g. uv light responsive) ✓  <i>Or (Idea of)</i> expression of gene in the host by observing characteristics ✓	1	
<b>Total</b>			<b>15</b>	

Question		Answer	Marks	Guidance
4	(a)	<p><i>Current</i> Flow of electric charge ✓</p> <p><i>Direct current</i> flow in one direction only (does not alternate) ✓</p>	2	Allow flow of any charged particle
	(b) (i)	<p>250mA = 0.25 A ✓</p> <p>so <math>P = 2.9 \times 0.25 = 0.725/0.73</math> ✓</p>	2	Ecf from first marking point Not 0.72 RE 725 scores 1 (even if no working)
	(ii)	<p><math>V = I \times R</math> correctly rearranged ✓</p> <p><math>R = 2.9/0.25 = 11.6</math> ✓</p> <p>12 ✓</p>	3	Rearrangement can be implicit in working  Must give answer to 2 sig figs 0.012 scores 2 without working or 3 with working ecf from b(i)
	(iii)	<p><math>I = C/s</math> so <math>C = I \times s</math> ✓</p> <p>1 hour = 3600 s, <math>C = 0.25 \times 3600 = 900</math> ✓</p> <p>C (Coulombs) ✓</p>	3	Allow Amp seconds
<b>Total</b>			<b>10</b>	

Question	Answer	Marks	Guidance
5 (a)	<p><b>LEVEL OF RESPONSE MARK SCHEME:</b>  <b>5-7 marks</b>  <b>Describes the features both types of study with accuracy, detail and clarity</b>  <b>AND</b>  <b>Gives valid examples of issues of data collection and/or ethical issues relevant for both types of study</b>  <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Clear and confident knowledge of relevant technical language.</i></p> <p><b>3-4 marks</b>  <b>Describes the features of one study with accuracy, detail and clarity and the second in only very general terms OR describes both studies but with some omissions of detail and clarity</b>  <b>AND</b>  <b>Gives valid examples of issues of data collection and/or ethical issues for one type of study OR makes only general comments relevant to both studies</b>  <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence. Sound grasp of relevant technical language</i></p> <p><b>1-2 marks</b>  <b>Describes valid features of at least one type of study, but in very general terms with many omissions</b>  <b>AND</b>  <b>Makes only general comments about issues of data collection and/or ethical issues relevant to at least one type of study</b></p>	Max 7	<p><b>ACCEPT</b> 'leukaemia' for 'health problem' throughout  <b>ACCEPT</b> '(alternating)magnetic fields' or 'high voltage (electricity) cables' for 'risk factor' throughout</p> <p><b>Features of case-controlled study:</b>  To establish whether there is a link between a risk factor and a health problem ;  Group of people with the health problem selected and their past level of exposure to the risk factor investigated ;  'Control' group (without the health problem) similarly representative in age, lifestyle (other variables) chosen and their past level of exposure to the risk factor also investigated ;  Comparison between the two groups for indication of greater exposure to the risk factor in the first group ;</p> <p><b>Features of cohort study:</b>  Group of people exposed to the risk factor identified ;  'Control' group (not exposed to the risk factor) similarly representative in age, lifestyle (other variables) also chosen ;  Monitor development of health problem over time/years ;</p> <p><b>Evaluation of case-controlled study :</b>  Difficulty of controlling all variables to enable valid data to be collected/conclusions to be made ;  Possible bias in the selection of the two groups/may be dependent on volunteers, so study may be biased and conclusions not valid ;</p> <p><b>Evaluation of cohort study :</b>  Problem of time taken to collect data e.g. lifetime ;</p>

Question	Answer	Marks	Guidance
	<i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i>		Problem of allowing (continued) exposure of group to risk factor ; Results less subject to bias ;
	<b>QWC</b> for legible description and spelling, punctuation and grammar	1	Do not award if legibility, spelling, punctuation and grammar detracts in any way from the overall clarity of the answer
<b>(b)</b>	<b>Any two from:</b> Use three phase circuit lines ✓ <b>OR</b> put power lines high(er) up ✓ <b>OR</b> bury power cables ✓ <b>OR</b> Arrange (underground) cables so that fields cancel out ✓	Max 2	Allow valid diagram to explain three phase  Ignore location
	<b>Total</b>	<b>10</b>	

Question			Answer	Marks	Guidance
6	(a)	(i)	$O_2$ ✓	1	
		(ii)	3 ✓	1	
		(iii)	(+)4 ✓ (+)6 ✓	2	4+ and 6+ scores 1
	(b)	(i)	(Day) 8 ✓	1	
		(ii)	<b>Any two from:</b> Repeat samples ✓  Take sample from same part of lake ✓  Take sample at same time of day ✓	Max 2	OVP
	(c)	(i)	$H^+$ ✓ $NO_3^-$ ✓	2	Both answers must show charges to gain marks
		(ii)	Burette ✓	1	
		(iii)	To see <b>colour</b> change of indicator clearly ✓	1	

Question		Answer	Marks	Guidance
	(d) (i)	<p><b>Reduction:</b> Loss of oxygen/ gain of electrons/decrease in oxidation number ✓</p> <p><b>Catalyst:</b> Catalyst speeds up rate of reaction ✓ Is not consumed in reaction/is unchanged at end of reaction OR lowers activation energy ✓</p>	1  2	Loss of electrons is CON  "isn't involved in the reaction" is CON
	(ii)	N <sub>2</sub> (nitrogen) or N <sub>2</sub> O (dinitrogen oxide) or NO nitrogen monoxide ✓	1	"N" is CON
<b>Total</b>			<b>15</b>	

Question			Answer	Marks	Guidance
7	(a)	(i)	(Same) proton number/atomic number <b>or</b> same chemical properties ✓  (different) mass numbers/nucleon number/number of neutrons <b>or</b> different physical properties ✓	2	
		(ii)	A = 231 ✓  Z = 90 ✓	2	
		(iii)	It takes 704 million years for a fixed, mass/activity/number of nuclei, of U 235 isotope ✓  to decay to exactly half of its starting mass/activity etc. ✓	2	Second marking point depends on first
	(b)		P = 90 ✓  N = 143 ✓  E = 90 ✓	3	
	(c)		Fossil  Combustion  Steam  Kinetic  Voltage  Current	Max 4	0 – 2 correct = 0 marks  3 correct = 1 mark  4 correct = 2 marks  5 correct = 3 marks  6 correct = 4 marks



Question	Answer	Marks	Guidance
(d)	<p style="text-align: center;"><b>LEVEL OF RESPONSE MARK SCHEME:</b></p> <p style="text-align: center;"><b>5-7 marks</b></p> <p><b>Describes at least two advantages and disadvantages of using both coal and nuclear fission with accuracy, detail and clarity</b></p> <p><b>AND</b></p> <p><b>Discusses each advantage / disadvantage by explaining how it arises from the use of the energy source OR by explaining how it can be considered to be a benefit or a problem</b></p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Clear and confident knowledge of relevant technical language.</i></p> <p style="text-align: center;"><b>3-4 marks</b></p> <p><b>Describes at least one advantage and disadvantage of using both coal and nuclear fission with some omissions of accuracy, detail or clarity OR describes the advantages and disadvantages of one energy source with accuracy, detail and clarity but the second in only general terms</b></p> <p><b>AND</b></p> <p><b>Discusses some of the advantage / disadvantages listed by explaining how they arise from the use of the energy source OR by explaining how they can be considered to be a benefit or a problem</b></p> <p><i>There is a line of reasoning presented with some structure.</i></p> <p><i>The information presented is in the most-part relevant and supported by some evidence. Sound grasp of relevant technical language</i></p>	Max 7	<p><b>Coal:</b></p> <p><i>Advantages:</i></p> <p>Coal reserves readily available; So will not run out in foreseeable future;</p> <p>Tried and tested technology; So no new technology will be needed;</p> <p><i>Disadvantages:</i></p> <p>CO<sub>2</sub> released by burning coal So impacts on global warming</p> <p>SO<sub>x</sub> released by burning coal Because coal contains C impurities OR NO<sub>x</sub> released when coal is burnt Because high temperatures cause gases in air to react together</p> <p>So causes acid rain (photochemical smog)</p> <p>Non-renewable source Because fossil fuels formed very slowly /are not being formed at present So will eventually run out / not sustainable</p> <p><b>Nuclear:</b></p> <p><i>Advantages:</i></p> <p>No CO<sub>2</sub> produced No impact on global warming</p>

Question	Answer	Marks	Guidance
	<p style="text-align: center;"><b>1-2 marks</b></p> <p><b>Describes some advantages / disadvantages of the two energy sources in general terms or with significant omissions</b></p> <p><b>AND</b></p> <p><b>Makes only very limited comments about the advantages / disadvantages in order to explain how they arise or why they</b></p> <p style="text-align: center;"><i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i></p>		<p>Reserves of uranium only slowly being depleted Because fuel can be reprocessed / only very small masses are used up in fission reactions</p> <p><i>Disadvantages:</i> Problems of disposal of waste Because waste contains radioactive substances OR emits radiation Will remain radioactive for millions of years Can cause major health problems</p> <p>Problems of accident ✓ Releases radioactive material into atmosphere /water sources</p> <p>Nuclear fuel needs to be strictly controlled Can be used in constructing weapons</p> <p>Costly to decommission nuclear power plants Because radioactive material must be made safe</p> <p>Non-renewable resource No new uranium ores being formed</p>
	<b>Total</b>	<b>20</b>	

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