



Cambridge IGCSE™

COMBINED SCIENCE

0653/41

Paper 4

October/November 2022

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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This document consists of **13** printed pages.

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These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require <i>n</i> responses (e.g. State two reasons ...): - The response should be read as continuous prose, even when numbered answer spaces are provided. - Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. - Incorrect responses should not be awarded credit but will still count towards <i>n</i>. - Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should not be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. - Non-contradictory responses after the first <i>n</i> responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Mark scheme abbreviations

;	separates marking points
/	separates alternative responses for the same marking point
ecf	error carried forward
AVP	any valid point
ORA	or reverse argument
AW	alternative wording
<u>underline</u>	actual word given must be used by candidate (grammatical variants accepted)
()	the word / phrase in brackets is not required but sets the context

Question	Answer	Marks
1(a)(i)	(right) atrium ;	1
1(a)(ii)	vena cava ;	1
1(a)(iii)	<i>any two from:</i> blood passes through the heart twice (in one circuit of the body) ; the idea that one circulation is to lungs ; the idea that one circulation is to the body (tissues) ;	2
1(b)(i)	$80 \div 97 / 0.824742268$; 0.82 ;	2
1(b)(ii)	(incidence of) coronary heart disease increases with increased waist-to-hip ratio ;	1
1(b)(iii)	high fat diet / obesity ; causes blockage of <u>coronary</u> artery ;	2

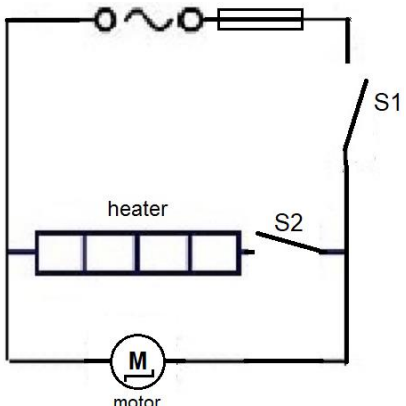
Question	Answer	Marks															
2(a)	<i>hydrogen test</i> lighted splint AND <i>positive result</i> pops ; <i>chlorine test</i> (damp) litmus paper AND <i>positive result</i> bleaches ;	2															
2(b)(i)	2NaCl (aq) AND 2H ₂ O (l) AND 2NaOH (aq) ;	1															
2(b)(ii)	sodium hydroxide ;	1															
2(c)	<table border="1"> <thead> <tr> <th>statement</th><th>true</th><th>false</th></tr> </thead> <tbody> <tr> <td>OH⁻ ions are attracted to the cathode.</td><td></td><td>✓</td></tr> <tr> <td>H⁺ ions gain electrons at the negative electrode.</td><td>✓</td><td></td></tr> <tr> <td>H⁺ ions come from the water in the solution.</td><td>✓</td><td></td></tr> <tr> <td>Hydrogen gas is made when OH⁻ ions lose electrons.</td><td></td><td>✓</td></tr> </tbody> </table> two or three correct ; all four correct ;	statement	true	false	OH ⁻ ions are attracted to the cathode.		✓	H ⁺ ions gain electrons at the negative electrode.	✓		H ⁺ ions come from the water in the solution.	✓		Hydrogen gas is made when OH ⁻ ions lose electrons.		✓	2
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OH ⁻ ions are attracted to the cathode.		✓															
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2(d)	<i>colour</i> red ; <i>pH</i> answer in range 1–3 ;	2															

Question	Answer	Marks
3(a)	Q, S ; P, R ;	2
3(b)(i)	1 200 000 (N) ;	1
3(b)(ii)	evidence of, $p = F \div A / 1\,200\,000 \div 0.125$; 9 600 000 ; Pa OR N / m ² ;	3
3(b)(iii)	evidence of, $W = Fd / 1.2 \times 10^6 \times 1500$; $1.8 \times 10^9 / 1\,800\,000\,000$ (J) ;	2
3(b)(iv)	evidence of, $KE = \frac{1}{2} m v^2 / \frac{1}{2} \times 120\,000 \times 80^2$; $3.8(4) \times 10^8 / 380\,000\,000$ (J) ;	2
3(b)(v)	(work done against) friction / air resistance ;	1

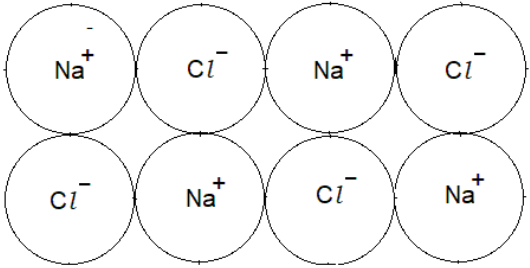
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4(a)(i)	(simple) sugar ;	1
4(a)(ii)	starch is broken down more quickly as temperature increases / activity of amylase increases as temperature increases ; increase in <u>kinetic</u> energy (of particles) / (particles) move faster ; increased frequency of collisions / increased number of successful collisions ;	3
4(a)(iii)	idea that, amylase is specific (to starch) ; protein molecules will not fit into <u>active site</u> / (shape of) <u>active site</u> not <u>complementary</u> to protein (shape) / (shape of) <u>active site</u> is <u>complementary</u> to starch (shape) ;	2
4(b)(i)	<i>any two from:</i> combustion ; respiration ; decomposition ; AVP ;	2
4(b)(ii)	fossilisation ;	1
4(c)	(snake is a) secondary consumer when it eats the <u>insect</u> ; tertiary consumer when it eats the <u>toad</u> ;	2

Question	Answer					Marks															
5(a)	C ;					1															
5(b)	<table><tr><td></td><td>bonds break</td><td>bonds form</td><td>energy is taken in</td><td>energy is given out</td></tr><tr><td>arrow A</td><td>✓</td><td></td><td>✓</td><td></td></tr><tr><td>arrow B</td><td></td><td>✓</td><td></td><td>✓</td></tr></table> two or three correct ; all four correct ;						bonds break	bonds form	energy is taken in	energy is given out	arrow A	✓		✓		arrow B		✓		✓	2
	bonds break	bonds form	energy is taken in	energy is given out																	
arrow A	✓		✓																		
arrow B		✓		✓																	
5(c)(i)	<i>similarity</i> <i>difference</i>	both produce, water / water vapour ; alkanes / hydrocarbons / diesel, also produce carbon dioxide ;				2															
5(c)(ii)	(carbon dioxide emissions cause) an <u>enhanced</u> greenhouse effect / contribute to climate change ;					1															
5(c)(iii)	hydrogen is a gas AND diesel is a liquid ; hydrogen, takes up more space / needs to be stored under pressure ;					2															

Question	Answer	Marks
6(a)(i)	evidence of, power = current $\times$ voltage ; fan current = $60 \div 240 = 0.25 \text{ A}$ / heater current = $2300 \div 240 = 9.58 \text{ A}$; current in fuse = $0.25 + 9.58 = 9.83 \text{ A}$; OR evidence of, power = current $\times$ voltage ; total power drawn = $2300 + 60 = 2360 \text{ W}$; current in fuse = $2360 \div 240 = 9.83 \text{ A}$;	3
6(a)(ii)	comparison of fuse rating with operating current, e.g. rating is, higher than / too close to, operating current ; appropriate matching conclusion, e.g. so fuse, does not blow / may blow, under normal operation ;	2
6(b)	 switch S1 in main circuit ; switch S2 in heater branch ;	2

Question	Answer	Marks
7(a)(i)	either ovary labelled ;	1
7(a)(ii)	toxins ; excretory ;	2
7(b)	idea that, fetus needs (some of the) vitamin D ; vitamin D needed, for bone (development) / to prevent rickets ;	2
7(c)	<i>nicotine</i> addictive ; <i>tar</i> prevents cilia working / causes (lung) cancer ;	2

Question	Answer	Marks
8(a)	any two metals from: sodium, magnesium, aluminium ; any two non-metals from: silicon, phosphorus, sulfur, chlorine, argon ;	2
8(b)	idea of achieving a full outer shell (for stability) ; sodium atom has one outer electron and chlorine atom has seven ; sodium atom loses one electron and chlorine atom gains one electron ;	3
8(c)(i)	 alternating arrangement as shown ;	1
8(c)(ii)	any two from: ions, have opposite charges / are positive and negative ; strong attraction (between ions) ; so high energy needed to break bonds ;	2
8(c)(iii)	potassium / rubidium / caesium / francium ;	1
8(c)(iv)	fluorine ;	1

Question	Answer							Marks
9(a)(i)		X-rays	ultraviolet			microwaves ;		1
9(a)(ii)	<i>volume</i> large(r) <u>amplitude</u> ; <i>pitch</i> high(er) <u>frequency</u> ;							2
9(b)	transverse / named example ; longitudinal / named example ;							2
9(c)(i)	3.0 × 10 ⁸ / 300 000 000 (m / s) ;							1
9(c)(ii)	evidence of, speed = distance ÷ time / 150 000 000 000 ÷ 300 000 000 ; 500 (s) (= 8 min 20 s) ;							2
9(c)(iii)	a shiny white surface is a, poor <u>absorber</u> / (good) <u>reflector</u> (of radiation) ;							1



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Question	Answer	Marks								
1(a)(i)	<table><tr><td>letter in Fig. 1.1</td><td>name of part</td></tr><tr><td>(B)</td><td>(left) ventricle ;</td></tr><tr><td>D ;</td><td>(septum)</td></tr><tr><td>(F)</td><td>valve ;</td></tr></table>	letter in Fig. 1.1	name of part	(B)	(left) ventricle ;	D ;	(septum)	(F)	valve ;	3
letter in Fig. 1.1	name of part									
(B)	(left) ventricle ;									
D ;	(septum)									
(F)	valve ;									
1(a)(ii)	arrow(s) showing correct direction ;	1								
1(a)(iii)	separates oxygenated and deoxygenated blood ; allows for different levels of blood pressure / AW ;	2								
1(b)(i)	20–29 / 80+ ;	1								
1(b)(ii)	$18 \times 100 \div 54$ / $18 + 36$ / 54 ; 33(%) ;	2								

Question	Answer	Marks
2(a)(i)	O ₂ ; C ; 2Fe ;	3
2(a)(ii)	hematite ;	1
2(a)(iii)	(nitrogen) comes from the air (which enters the furnace) ;	1
2(a)(iv)	sulfur dioxide ;	1
2(b)(i)	<u>mixture</u> of a metal with (an)other element(s) ;	1
2(b)(ii)	any two from: (stainless steel / ORA) is strong(er) ; is (more) malleable ; does not, corrode / rust (as easily) ; AVP ;	2

Question	Answer	Marks
3(a)(i)	S ;	1
3(b)(i)	$341 \times 3600 \div 1000 (= 1228 \text{ km / h})$;	1
3(b)(ii)	evidence of, acceleration = change in speed $\div$ time / $341 \div 20.0$; 17.1 ; m / s ² ;	3
3(b)(iii)	evidence of, $KE = \frac{1}{2}mv^2$ / $\frac{1}{2} \times 10600 \times 341 \times 341$; 6.16×10^8 (J) ;	2
3(b)(iv)	evidence of, $P = \Delta E \div t$ / $6.16 \times 10^8 \div 20.0$; 3.08×10^7 (W) ;	2

Question	Answer	Marks
4(a)(i)	cortex ; (spongy / palisade) mesophyll ;	2
4(a)(ii)	large surface area ; increases rate of absorption (of water) ;	2
4(b)	at higher humidity there is more water vapour in the air ; diffusion / concentration gradient, decreases (as humidity increases) ; less evaporation / less diffusion ;	3
4(c)	<i>any two from:</i> (pollen from) • insect-pollinated flowers is, sticky / covered in spikes ; • insect-pollinated flowers is produced in smaller quantities ; • wind-pollinated flowers is lighter ;	2

Question	Answer				Marks
5(a)		true for ethane only	true for ethene only	true for both ethane and ethene	2
	is a hydrocarbon			✓	
	is a saturated compound	✓			
	changes the colour of aqueous bromine		✓		
	one correct ; all three correct ;				
5(b)	4 ; double bond / two bonds each, containing two electrons ;				2
5(c)(i)	blue (to) pink ; water (vapour) is made ;				2
5(c)(ii)	limewater turns milky ; because carbon dioxide is made ;				2
5(d)	idea that, many (ethene) molecules join ; correct reference to, <u>monomer</u> / (addition) <u>polymerisation</u> ;				2

Question	Answer	Marks
6(a)(i)	evidence of, $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$; $\frac{72 \times 36}{72 + 36} / \frac{2592}{108} / \frac{72}{3} / \frac{1}{72} + \frac{1}{36} (= 24 \Omega)$;	2
6(a)(ii)	evidence of, $R = V \div I / 240 \div 24$; 10 (A) ;	2
6(b)	(total resistance increases so) current decreases ; current decreases so thermal energy output decreases ; evidence of, $P = VI / E = VIt$;	3
6(c)	resistance is inversely proportional to cross-sectional area ; wire in element 2 has greater cross-sectional area ;	2

Question	Answer	Marks
7(a)	Both types of digestion always form soluble molecules. ☐ Both types of digestion take place in the mouth. ☒ ; Both types of digestion use enzymes. ☐ Only chemical digestion takes place in the stomach. ☐ Only mechanical digestion involves no chemical change. ☒ ;	2
7(b)(i)	lipase / amylase ;	1
7(b)(ii)	<i>substrate</i> protein AND <i>product</i> amino acid ;	1
7(c)(i)	(protease) denatures / changes shape ; reference to <u>active site</u> ; will not, fit / bind with substrate (into active site) ;	3
7(c)(ii)	(protease) does not work / denatures, at low pH / in acid conditions ; gastric juice, contains hydrochloric acid / has a low pH ;	2

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Question	Answer	Marks
8(a)(i)	<i>any two from:</i> solid does not conduct / only liquid conducts / only conducts in molten state ; energy required to overcome forces (between ions) ; ions in a solid cannot move / ions in a liquid can move ;	2
8(a)(ii)	<i>temperature explanation</i> any temperature greater than 373 °C AND lead bromide must be, molten / a liquid / above the melting point of lead bromide ;	1
8(a)(iii)	<i>lead forms as a explanation</i> liquid AND lead has a lower melting point than lead bromide / idea that if lead bromide is liquid, it is above the melting point of lead / melting point of lead is below the temperature of the electrolysis / AW ;	1
8(b)	cathode gain atoms two correct ; all three correct ;	2
8(c)	orange / brown ;	1

Question	Answer							Marks							
9(a)(i)	<table><tr><td>gamma radiation</td><td>X-rays ;</td><td></td><td>visible light</td><td></td><td>microwaves ;</td><td></td></tr></table>							gamma radiation	X-rays ;		visible light		microwaves ;		2
gamma radiation	X-rays ;		visible light		microwaves ;										
9(a)(ii)	evidence of, $v = f\lambda$ / $3 \times 10^8 \div 2.48 \times 10^9$; 0.1(21) (m);							2							
9(a)(iii)	(X-rays) damage cells / cause cancer ;							1							
9(b)(i)	any two from: evaporation (from surface of liquid) ; convection (by heating air above the surface) ; conduction (through cups) ; radiation (from outside of cup) ;							2							
9(b)(ii)	(cup B / ORA) has greater surface area ; so increased (rate of) evaporation ;							2							



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- 2 The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
- 3 Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
- 4 The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
- 5 'List rule' guidance

For questions that require ***n*** responses (e.g. State **two** reasons ...):
 - The response should be read as continuous prose, even when numbered answer spaces are provided.
 - Any response marked *ignore* in the mark scheme should not count towards ***n***.
 - Incorrect responses should not be awarded credit but will still count towards ***n***.
 - Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.
 - Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Mark scheme abbreviations

;	separates marking points
/	separates alternative responses for the same marking point
ecf	error carried forward
AVP	any valid point
ORA	or reverse argument
AW	alternative wording
<u>underline</u>	actual word given must be used by candidate (grammatical variants accepted)
()	the word / phrase in brackets is not required but sets the context

Question	Answer	Marks
1(a)(i)	A stigma ; B anther ;	2
1(a)(ii)	ovary labelled ;	1
1(a)(iii)	<i>any two from:</i> stigma feathery ; anther outside (flower) ; no petals ;	2
1(b)(i)	grass → vole (→ coyote) → wolf correct order of organisms ; arrows in correct direction ;	2
1(b)(ii)	coyote / wolf ;	1
1(b)(iii)	coyote ;	1
1(c)	$6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ correct substrates (in either order) ; correct products (in either order) ;	2

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Question	Answer	Marks
2(a)	chloride ion has: (ORA chloride atom) (one) more electron / a full (outer) shell of electrons / 8 electrons in outer shell / 18 electrons ; a negative (charge) / charge of -1 ;	2
2(b)(i)	the number of electrons in the <u>atom</u> (17) is the same as the proton number ;	1
2(b)(ii)	the number of shells is the same as the period / AW ;	1
2(b)(iii)	<i>element X</i> bromine / iodine / astatine ; <i>reason</i> further down the group (so less reactive) ;	2
2(c)	chlorine has simple, molecules / covalent structure OR sodium chloride has, (giant) ionic structure / ionic lattice ; attractive forces between ions in sodium chloride are strong(er) than (attractive forces between) molecules in chlorine / attraction between ions is high due to opposite electrical charges / strong electrostatic attraction between ions ; more energy is required to separate ions in sodium chloride (hence higher melting point) / ORA ;	3

Question	Answer	Marks
3(a)(i)	N ;	1
3(a)(ii)	resultant force (to right) means boat, accelerates / goes faster / speed increases ;	1
3(b)(i)	$(142 \times 3600 \div 1000 =) 511$ (km / h) ;	1
3(b)(ii)	evidence of, $W = Fd$ / $15\,000 \times 504$; 7 600 000 ; J ;	3
3(c)(i)	130 (m / s) ;	1
3(c)(ii)	recognition that area under graph is used to calculate distance ; correct calculation of an area, e.g. $\frac{1}{2} \times 40 \times 130 = 2600$ OR $(80 - 40) \times 130 = 5200$; 7800 (m) ;	3

Question	Answer	Marks
4(a)(i)	Q coronary artery ; <i>explanation</i> (CHD occurs) when it becomes blocked ;	2
4(a)(ii)	<i>any two from:</i> stress ; genetic predisposition ; age ; gender / sex ;	2
4(b)(i)	correct numbers from graph / calculation of percentage, e.g. 144 and 60 or $(144 - 60) \div 60 \times 100$; 140(%) ;	2
4(b)(ii)	<i>any three from:</i> increase blood flow to muscle ; muscles require (more), energy / oxygen ; increased muscle contraction ; reference to respiration ; need to remove more carbon dioxide from muscle ;	3

Question	Answer	Marks
5(a)(i)	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ carbon dioxide shown ; equation balanced with 2 AND 3 ;	2
5(a)(ii)	<i>reducing agent</i> carbon monoxide AND <i>explanation</i> because it takes oxygen from iron (oxide) ;	1
5(b)(i)	idea that, oxidation is gain of oxygen ;	1
5(b)(ii)	<i>method</i> suitable method stated, e.g. painting / coating ; <i>description</i> corresponding description given, e.g. (stops oxidation) by providing a barrier against, water / oxygen ;	2
5(c)(i)	FeCl_2 ;	1
5(c)(ii)	bond breaking, absorbs / takes in, energy ; bond forming releases energy ; exothermic means, net release of energy / temperature rises ;	3

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Question	Answer	Marks
6(a)	correct voltmeter symbol AND in parallel with heating element ;	1
6(b)(i)	$(R_T = R_1 + R_2 = 54 + 36 =) 90 (\Omega) ;$	1
6(b)(ii)	(total resistance decreases so) current increases ; thermal energy proportional to current / $E = VIt ;$	2
6(c)(i)	evidence of, $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} ;$ $\frac{1}{41.0} + \frac{1}{53.0}$ OR $\frac{2173}{94} = 23.1(1702128) (\Omega) ;$	2
6(c)(ii)	evidence of, $I = V \div R / 240 \div 60.0 ;$ (current in main branch =) 4.0 (A) ; (heater 2 current = $4.0 - 2.3 =$) 1.7 (A) ;	3

Question	Answer	Marks
7(a)(i)	<i>any three from:</i> (tar causes an) increased production of mucus by goblet cells ; mucus blocks airways ; (tar) damages cilia ; (cilia) cannot (re)move, particles / pathogens ;	3
7(a)(ii)	(carbon monoxide) combines with <u>haemoglobin</u> ; idea of, reduced ability to transport oxygen ;	2
7(b)	good blood supply ; good ventilation (with air) ;	2

Question	Answer	Marks
8(a)(i)	argon ;	1
8(a)(ii)	the relative amounts of constituents can be changed in a mixture ; the relative amounts of constituents are fixed in a compound ; OR a mixture contains two or more substances not combined / joined / bonded ; a compound contains two or more elements chemically combined / joined / bonded ; OR mixtures maintain the properties of constituents ; compounds have properties different to those of the elements it contains ;	2
8(b)	(oxygen) is used in the, combustion / burning ; of, fuel / carbon compounds / hydrocarbons ;	2
8(c)	climate change / named environmental impact due to climate change ;	1
8(d)	sulfur dioxide ;	1

Question	Answer							Marks
9(a)(i)	(gamma radiation)			(visible light)	infrared (radiation) ;			1
9(a)(ii)	3.0 × 10 ⁸ (m / s) ;							1
9(a)(iii)	remote controllers for televisions / intruder alarms / AVP ;							1
9(b)(i)	convection radiation	(reduced by) vacuum / stopper ; (reduced by) silver (coating) ;						2
9(b)(ii)	(conduction) through the, solid material / plastic outer case / rubber supports / walls of glass container / plastic stopper ; molecular vibrations passed from one molecule to the next ;							2
9(b)(iii)	component reason	nitrogen	AND lowest boiling point (of the 3 components) ;					1