

Cambridge IGCSE™

COMBINED SCIENCE**0653/41**

Paper 4 Theory (Extended)

October/November 2025**MARK SCHEME**Maximum Mark: 80

Published

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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).

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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
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- 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:

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GENERIC MARKING PRINCIPLE 5:

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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 'List rule' guidance

For questions that require ***n*** responses (e.g. State **two** reasons ...):

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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.

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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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

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Question	Answer	Marks
1(a)	E ; C ; A ;	3
1(b)(i)	20 ÷ 4000 seen OR actual L = measured L ÷ magnification ; 20 (mm) × 1000; seen OR 0.005 (mm) × 1000 ; 5 (µm) ;	3
1(b)(ii)	respiration occurs within mitochondria; Idea that the mitochondria provide energy (for movement of the flagellum) ;	2

Question	Answer	Marks
2(a)(i)	plasmolysis ;	1
2(a)(ii)	<i>any three from:</i> M1 water enters the cell ; <i>(Direction of water movement)</i> M2 by osmosis ; M3 pure water has a high(er) water potential / low(er) water potential inside cell ; <i>(Reason why water moves as it does)</i> M4 increase in turgor pressure / cell becomes turgid ;	3
2(b)(i)	cellulose ; starch ;	2

Question	Answer	Marks
2(b)(ii)	carbon dioxide AND water ; energy ; chlorophyll ;	3
2(c)(i)	algae → limpets → starfish → crabs → sharks ;; <i>organisms in correct order</i> <i>arrows in correct direction</i>	2
2(c)(ii)	limpets ;	1

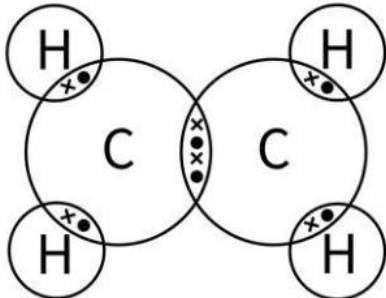
Question	Answer	Marks
3(a)(i)	either coronary artery labelled ;	1
3(a)(ii)	blocked / AW ;	1
3(a)(iii)	any two from: lack of exercise / AW ; stress ; smoking ; genetic predisposition ; age ; sex ; high blood pressure ; AVP;;	2

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Question	Answer	Marks
3(b)	Any two from (wall) is muscular (wall) is elastic; narrow <u>lumen</u> ; and then to withstand high (blood) pressure / maintain high (blood) pressure ;	3

Question	Answer	Marks
4(a)	$2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$ correct formulae ; correct balancing ;	2
4(b)	79 (cm ³) ; oxygen is 21% of air ;	2
4(c)(i)	M1 endothermic ; M2 EITHER products have higher <u>energy</u> than reactants / (thermal) <u>energy</u> is taken in OR Energy required for bond breaking greater than energy released when bonds form;	2
4(c)(ii)	any label showing activation energy from level of reactants to top of peak ;	1
4(c)(iii)	M1 energy needed for a reaction ; <i>but</i> M2 minimum energy needed to for a reaction ; ;	2
4(c)(iv)	increases rate of reaction ; is unchanged at the end of the reaction / idea that catalyst is not used up ;	2

Question	Answer	Marks
5(a)(i)	bubbles / chlorine / gas produced ;	1
5(a)(ii)	$\text{Zn}^{2+}(\text{l}) + 2\text{e}^{-} \rightarrow \text{Zn}(\text{s})$ correct equation ; correct state symbols ;	2
5(b)(i)	two types of atom shown, most touching at least one other atom and mixed ; more metal A atoms than metal B atoms ;	2
5(b)(ii)	atoms are different sizes ; (layers / atoms) can no longer slide ;	2

Question	Answer	Marks
6(a)	<i>ticks for:</i> is formed by cracking large alkanes (box 2); reacts with hydrogen to form ethane (box 3); decolourises aqueous bromine (box 5) ;	3
6(b)	bonding pair between each hydrogen and carbon and no extra electrons anywhere ; two bonding pairs between the carbons ; 	2

Question	Answer	Marks
6(c)	steam ; addition ; acid ;	3

Question	Answer	Marks
7(a)(i)	change in speed per unit time;	1
7(a)(ii)	(acceleration =) $\frac{\Delta v}{\Delta t}$; OR $(a =) \frac{7.8 - 2.2}{40}$; OR $(a =) \frac{5.6}{40}$; 0.14 ; m/s^2 ;	3
7(b)(i)	(KE =) $\frac{1}{2} m v^2$ OR $0.15 = \frac{1}{2} \times 0.060 \times v^2$ OR $v = \sqrt{\frac{2 \times 0.15}{0.060}}$; 2.2 (m/s) ;	2

Question	Answer	Marks
7(b)(ii)	M1 KE = GPE OR GPE = 0.15 (J) ; M2 (ΔGPE =) $mg\Delta h$ <i>But if M1 and M2 combined is seen give two marks</i> $0.15 = 0.060 \times 9.8 \times \Delta h$ OR $\Delta h = \frac{0.15}{0.060 \times 9.8} ;$ 0.26 (m) ;	3

Question	Answer	Marks
8(a)(i)	any named insulator, e.g. (named) wood, (named) plastic ; insulator ;	2
8(a)(ii)	M1 vibrations of particles ; M2 ref to movement / delocalised / free electrons ; M3 (energy transfer) by collisions between particles / contact between particles OR collisions between electrons and particles ;	3
8(b)	unit conversion GHz to Hz / 4.10×10^{11} Hz ; $v = f\lambda$ OR $3.0 \times 10^8 \div 4.10 \times 10^{11}$; 7.3×10^{-4} (m) ;	3

Question	Answer	Marks
9(a)	charge ;	1
9(b)	variable resistor ; heater ;	2
9(c)	LED connected the wrong way round / AW ;	1
9(d)	<i>length</i> idea that $R \propto L$ or B is 3× resistance of A seen or $0.48 / 0.16 \times 3$; seen <i>area</i> idea that $R \propto A^{-1} / R \propto d^{-2}$ or B is $\frac{1}{4} / \frac{1}{2}^2 \times$ resistance of A or $0.04 / 0.16 \times 0.25$; seen 0.12 (Ω) ;	3
9(e)	M1 $v = 2\pi r \div T$ or $r = 7800 \times 5400 \div 2\pi$; M2 (radius of orbit of satellite =) 6.7×10^6 m ; M3 (distance above Earth = $6.7 \times 10^6 - 6.380 \times 10^6$ =) 3.2×10^5 (m) ;	3

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Question	Answer	Marks
1(a)	C ; B ; E ;	3
1(b)	$6\text{CO}_2 + 6\text{H}_2\text{O} ;$ $\rightarrow$ $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 ;$	2
1(c)(i)	32 – 2 or (max rate =) 32 seen or (min rate =) 2 seen ; (max difference =) 30 (arbitrary units) ;	2
1(c)(ii)	increasing temperature / from 10 °C to 15 °C and linked to any three ;;; • increasing rate of photosynthesis • increasing enzyme activity ; • increasing kinetic energy / enzymes move faster ; • more frequency of (enzyme-substrate) collisions ; • more / faster formation of enzyme-substrate complexes ;	3

Question	Answer	Marks
2(a)(i)	one of the small dots labelled ; ribosome ;	2
2(a)(ii)	energy ; nutrient ;	2
2(a)(iii)	mitochondria ;	1
2(b)(i)	idea of involved in blood clotting ; clot prevents entry of bacteria / clotting forms a barrier to bacteria ;	2

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Question	Answer	Marks
2(b)(ii)	<u>antibiotics</u> and overuse / increased use / incorrect use / non-essential use resulted in <u>bacteria</u> become <u>resistant</u> to (antibiotics) ;	2
2(c)	any two from : hygienic food preparation ; personal hygiene / good hygiene; waste disposal ; sewage treatment ; AVP, e.g. vaccination ; ;	2

Question	Answer	Marks
3(a)(i)	arrow from mouse to hawk AND arrow from rabbit to hawk ;	1
3(a)(ii)	mouse / rabbit / topi ;	1
3(b)(i)	lion's prey have less food / move to new habitats ; (so) reduced number of prey / less food for lions ;	2
3(b)(ii)	idea of keeping biological species in a controlled environment such as a zoo, wildlife reserve, sanctuary, botanic garden, OR isolated from their natural habitat OR away from predators etc. ; for the purposes of reproduction / increasing populations ;	2

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Question	Answer	Marks
4(a)(i)	$\text{NaOH (aq)} + \text{HCl (aq)} \rightarrow \text{NaCl (aq)} + \text{H}_2\text{O(l)}$ fully correct equation ; correct state symbols ;	2
4(a)(ii)	yellow ; orange ;	2
4(a)(iii)	<i>ticks for:</i> turns universal indicator purple ; reacts with dilute sulfuric acid ;	2
4(b)(i)	energy (released by) bond making is greater than needed/absorbed for bond breaking OR energy involved in bond making is greater than energy involved in bond breaking ;	1
4(b)(ii)	<i>labelling:</i> reactants or $\text{NaOH} + \text{HCl}$ and products or $\text{NaCl} + \text{H}_2\text{O}$; pathway shows activation energy peaking and products at a lower energy level than the reactants ; overall energy change shown as difference between reactants and products and downward arrow ;	3

Question	Answer	Marks
5(a)(i)	carbon / coke, is combusted or coke / C reacts with oxygen ; carbon dioxide is formed / produced (during the extraction) ; carbon reacts with (reduces) carbon dioxide ;	3
5(a)(ii)	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ correct formulae ; correct balancing ;	2

Question	Answer	Marks
5(b)(i)	two bonding pairs between each oxygen and the carbon ; 4 non-bonding electrons / 2 lone pairs, on each oxygen ;	2
5(b)(ii)	any two from: use of renewable energy, e.g. wind, solar ; decreasing use of <u>fossil</u> fuels ; planting trees ; reduction in livestock farming ; AVP;	2

Question	Answer	Marks
6(a)(i)	C_nH_{2n+2} ;	1
6(a)(ii)	(<i>ethene</i>) alkene and (<i>ethane</i>) alkane ;	1
6(b)	hydrogen ; addition ; nickel / Ni ;	3
6(c)	<i>boiling point</i> any temperature higher than $-88\text{ }^{\circ}\text{C}$; <i>reason</i> idea of, longer chain length / larger molecule ;	2

Question	Answer	Marks
7(a)(i)	chemical ;	1
7(a)(ii)	kinetic ;	1

Question	Answer	Marks
7(a)(iii)	(feature) gradient ; (explanation) (gradient is) change in speed per unit time ;	2
7(a)(iv)	evidence of understanding that distance travelled = area under graph e.g. or $\frac{1}{2} \times 3 \times v$ (seen) or $5.6 = (\frac{1}{2} \times 3 \times v) + (2 \times v)$ or $5.6 \div 3.5$; 1.6 (m / s) ;	2
7(b)	(unit conversion) 0.072 seen (kg) ; GPE = $mg\Delta h$ or $0.072 \times 9.8 \times 0.46$; 0.32 (J) ;	3

Question	Answer	Marks
8(a)	use same initial temperature and volume of water in containers ; AND either record final temperatures (of water in both containers) after a fixed time ; container that has greater temperature decrease is better emitter ; OR measure time take for a <u>fixed temperature decrease</u> ; takes least time for the temperature decrease is better emitter ;	3

Question	Answer	Marks
8(b)(i)	no particles / medium in space / space is a vacuum ; AND either conduction / convection need particles / a medium (to transfer energy) ; OR radiation does not need a medium / particles ;	2
8(b)(ii)	protostar ; red giant ;	2
8(b)(iii)	new stars (with orbiting planets)	1

Question	Answer	Marks
9(a)	generator ; fuse;	2
9(b)(i)	(electrical) work done (by a source) moving charge around a (complete) circuit ; per <u>unit</u> charge / per coulomb ;	2
9(b)(ii)	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} / \frac{1}{12} + \frac{1}{24}$ OR $\frac{R_1 \times R_2}{R_1 + R_2}$ OR $\frac{12 \times 24}{12 + 24}$ OR $\frac{288}{36}$; ($R_{\text{parallel}} =$) 8.0 (Ω) ; (combined resistance = 8.0 + 15 =) 23 (Ω) ;	3

Question	Answer	Marks
9(c)	evidence that reflection must occur at halfway point between eyes and point P / $130 \div 2 / 65$; adjustment for length of mirror / subtraction of 40 ; ($x =$) 25 (cm) ;	3

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- 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	alternative 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

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	correct point or mark awarded
	incorrect point or mark not awarded
	information missing or insufficient for credit
	incorrect or insufficient point ignored while marking the rest of the response
	contradiction in response, mark not awarded
	benefit of the doubt given
	error carried forward applied
	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied
	response is too vague or there is insufficient detail in response
	incorrect point or mark not awarded

Annotation	Meaning
	point has been noted, but no credit has been given or blank page seen
	key point attempted / working towards marking point / incomplete answer / response seen but not credited / blank page seen
	blank page
	unclear response
	two statements are linked
	follow through
	irrelevant material that does not answer the question

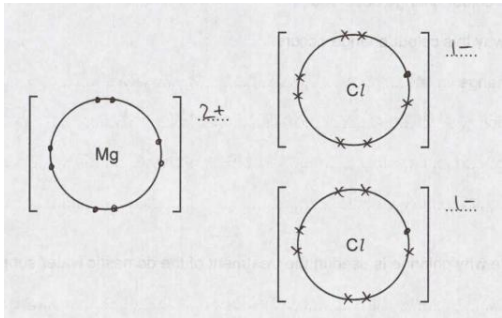
Question	Answer	Marks
1(a)(i)	D ; C ; B ;	3
1(a)(ii)	colon ; rectum ;	2
1(b)(i)	P ;	1
1(b)(ii)	enzyme will denature (at pH 7) ; <u>active site</u> changes shape ; (active site) no longer complementary to substrate / substrate no longer fits active site / enzyme-substrate complexes cannot form ;	3
1(c)	fats AND oils; fatty acids AND glycerol ;	2

Question	Answer	Marks
2(a)(i)	producer ;	1
2(a)(ii)	decomposer ;	1
2(a)(iii)	millipede ;	1
2(b)(i)	loss of water vapour from leaves ;	1
2(b)(ii)	increasing wind speed increases transpiration/rate / ora ;	1

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Question	Answer	Marks
2(c)	any four from: water leaves the cells ; references to osmosis ; cytoplasm/vacuole shrinks or cell membrane pulled away from the cell wall or cytoplasm pulled away from cell wall ; turgor pressure decreases ; cells are plasmolysed ; cells have a high(er) water potential or (external/sugar) solution has low(er) water potential ;	4

Question	Answer	Marks
3(a)	as (virus) protein coat ; (bacterial cell) plasmid ;	2
3(b)	any two from: skin ; hairs in the nose ; mucus ; stomach acid ; white blood cells / antibodies ; AVP ;	2
3(c)	substance (taken into the body) that modifies/affects (chemical) reactions in the body ;	1
3(d)	cause the body to make <u>antibodies</u> ; provide <u>active</u> immunity ;	2

Question	Answer	Marks
4(a)	$\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ correct formulae ; correct balancing ;	2
4(b)(i)	2.0 ;	1
4(b)(ii)	smaller the pieces the faster the reaction / ora ; (smaller pieces) surface area higher / greater exposure to acid with smaller pieces/powder ; (so) more collisions per second / more frequent collision / more (chance of) successful collisions ;	3
4(c)	8 dot electrons on outer shell of magnesium ion ; 7 X electrons on outer shell of both chloride ions and 1 dot electron ; correct charges on all ions ; 	3

Question	Answer	Marks
5(a)(i)	diatomic ;	1
5(a)(ii)	bromine – red-brown and liquid ; astatine – <u>black</u> and solid ;	2

Question	Answer	Marks
5(b)	<i>colour change:</i> (from colourless) to brown ; <i>explanation:</i> any two from: chlorine is more reactive than iodine ; chlorine displaces iodine ; iodine forms ;	3
5(c)(i)	to kill microbes/pathogens/bacteria ;	1
5(c)(ii)	sedimentation / filtration / addition/use of carbon ;	1

Question	Answer	Marks
6(a)(i)	C ₅ H ₁₀ ;	1
6(a)(ii)	$ \begin{array}{ccccccc} & & & \text{H} & \text{H} & \text{H} & \\ & & & & & & \\ \text{H} & - & \text{C} = & \text{C} - & \text{C} - & \text{C} - & \text{C} - \text{H} \\ & & & & & & \\ & & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $;	1
6(a)(iii)	any two from (family of similar compounds with) similar chemical properties ; trend in physical properties ; same general formula ;	2

Question	Answer	Marks
6(a)(iv)	<i>lines to:</i> reacts with hydrogen in the presence of a nickel catalyst ; reacts with steam in the presence of an acid catalyst ;	2
6(b)(i)	(g) and (s) ;	1
6(b)(ii)	incomplete ;	1
6(b)(iii)	respiratory problems / named respiratory disorder / cancer ;	1

Question	Answer	Marks
7(a)	$(12.0 - 9.6 =) 2.4 \text{ (V) ;}$	1
7(b)	$(I) = V \div R$ or $9.6 \div 6.0 ;$ 1.6 (A) ;	2
7(c)	M1 (unit conversion, 2 minutes) = 120 or $2 \times 60 \text{ (s) ;}$ M2 (total current = $0.80 + 1.6 = 2.4 ;$ M3 $(Q) = I \times t / 2.4 \times 120 ;$ M4 $290 ;$ M5 independent mark: C / coulomb(s) ;	5

Question	Answer	Marks
8(a)	$W = mg / 2.9 \times 9.8 ;$ 28 (N) ;	2

Question	Answer	Marks
8(b)	$F = ma / 2.9 \times 2.5 / 7.25 ;$ $L = F + W / (L =) 28.42 + 7.25 / (L =) 35.67 ;$ 36 (N) ;	3
8(c)(i)	useful energy output = efficiency $\times$ total energy input / $0.66 \times 150 ;$ 99 (J) ;	2
8(c)(ii)	$\Delta E_p = mg\Delta h$ or $99 = 2.9 \times 9.8 \times h$ or $99 = 28.42 \times h$ or $h = \frac{99}{2.9 \times 9.8} ;$ 3.5 (m) ;	2

Question	Answer	Marks
9(a)(i)	conduction / radiation	1
9(a)(ii)	idea that warm air is less dense or cold air is more dense ; warm air rises AND cold air falls ;	2

Question	Answer	Marks
9(a)(iii)	(air) particles collide with the walls ; particle collisions (with walls) are more frequent (as temperature increases) or particles collide with greater, speed or kinetic energy or force ; idea that more force per unit area = increased pressure ;	3
9(b)	vibration(s) ; parallel ;	2
9(c)	any two from: (Universe) expanded/started from a (single) point ; (point had) high density and temperature ; (Universe began) 13.8 billion years ago ;	2