



Cambridge O Level

PHYSICS

5054/21

Paper 2 Theory

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MARK SCHEME

Maximum Mark: 80

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **15** printed pages.

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: - the specific content defined in the mark scheme - the specific skills defined in the mark scheme or in the level descriptions - the standard of response required as exemplified by the standardisation scripts.
2	Examiners must award whole marks (not half marks, or other fractions).
3	Examiners must award marks positively . This means that: - marks are not deducted for errors or omissions - marks are awarded for correct/valid answers as defined in the mark scheme and also for other valid answers which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate - the quality of spelling, punctuation and grammar are judged only when the mark scheme indicates that these features are specifically assessed in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must consistently apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the full range of marks defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and must not award marks with grade thresholds or grade descriptions 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.

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
	information missing or insufficient for credit
	used to highlight parts of an extended response
	evaluation attempted
	benefit of the doubt given
	contradiction in response, mark not awarded
	incorrect point or mark not awarded
	error carried forward applied
	incorrect or insufficient point ignored while marking the rest of the response
	two statements are linked
	mandatory mark not awarded
	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied.

Annotation	Meaning
POT	power of ten error
SEEN	point has been noted, but no credit has been given or blank page seen
SF	error in number of significant figures
TV	response is too vague or there is insufficient detail in response
	correct point or mark awarded
U	Incorrect unit
MO	method mark awarded
NAQ	question not answered
TE	transcription error

Mark Scheme Abbreviations:

;	separates marking points
/	alternative responses for the same marking point
R	reject the response
A	accept the response
I	ignore the response
ecf	error carried forward
AVP	any valid point
ora	or reverse argument
AW	alternative wording

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Question	Answer	Marks	Guidance
1(a)(i)	same change in speed / velocity in same time / unit time / in 1 s	1	A any named time period; same increase in speed over time; straight line on speed-time graph; rate of change in velocity is constant; increasing speed at a constant rate I formula alone; speed increases steadily; accelerates at a constant rate
1(a)(ii)	$(a =) v \div t$ in any form 0.8 (m/s ²)	1	
1(b)	straight line from (0,0) to (20,16) horizontal line from (20,16) to (100,16) straight line from (100,16) with a decrease of 6 m/s	1	A within ½ square penalise wrong value plotted for 16 once only; ecf from a misplotted value of speed or time at one point each time
1(c)	<i>acceleration / t = 20 to 100 (s):</i> forwards force larger than backwards force <i>deceleration / t = 100 (s) onwards:</i> resistive force acts alone or backwards force > forwards force	1	throughout A driving force / thrust for forwards force A resistive force / force from brakes / air resistance / resistance with road for backwards force; mention of resultant force forwards bod force of acceleration is forwards force I other regions / just 'forces are unbalanced' / 'resultant force acts' just 'backwards force increases'

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Question	Answer	Marks	Guidance
2(a)(i)	gravitational (potential) energy to kinetic energy (kinetic energy) to internal energy	1	A GPE to KE at Q; a change is needed A KE to heat energy / thermal energy I back to GPE at bottom of fall (in splashes); energy to sound
2(a)(ii)	lower / slower / smaller/ less for both temperature and average speed	1	A colder
2(b)(i)	(K.E. =) $\frac{1}{2}mv^2$ algebraic $\frac{1}{2} \times 2.5 \times 8^2$ numerical 80 (J)	1	Award of this mark also earns 1 st mark. not 2500
2(b)(ii)	GPE or (a)(iii) = mgh numerical or algebraic 3.3 (m)	1	A use of distance = $v^2/2g$ 3.265 accept 3.2 if 10 N/kg used

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Question	Answer	Marks	Guidance
3(a)(i)	$(F =) PA$ numerical or algebraic 12 N	1	
3(a)(ii)	(air) pressure/force outside syringe = (air) pressure / force inside syringe or atmospheric pressure (outside syringe) pushes to the right / inwards / produces zero resultant force	1	I pressure in syringe less than atmospheric pressure; comments about friction
3(a)(iii)	2.4×10^{-23} kg m/s or N s	1	A 2.35, 2.3×10^{-23} I formula mv not kg/m/s
3(a)(iv)	many particles in gas many hits per second / many hits in unit time / frequent hits	1	A atoms and molecules for particles; large number of collisions I no of particles increase A high(er) frequency of collisions; hit often I many hits etc. <u>on each other</u> ; hit rapidly
3(b)	$p_1 V_1 = p_2 V_2$ numerical or algebraic $1 \times 10^5 \times 90 = p \times 50$ 1.8×10^5 (Pa)	1	numerical calculation could involve 40 $2.2(5) \times 10^5$ gets 2 marks

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Question	Answer	Marks	Guidance
4(a)	Any 2 from: • can reflect / diffract / refract • travel through a vacuum / do not require a medium • transverse • are oscillating electric and magnetic fields • travel at the speed of light / same speed (in vacuum/air)	2	I no mass, no charge
4(b)	Any two from: • X rays pass through the spaces or X-rays make the image darker / go black • (most / all) X-rays absorbed by / cannot penetrate the teeth • X-rays partially absorbed by the tissue / some pass through tissue	2	X-rays reflected max 1 mark
4(c)(i)	oscillation / vibration longitudinal or backwards and forwards or in the direction of the sound / parallel to the direction of travel of the wave or formation of compressions and rarefactions	1	A backwards and forwards or any clear oscillation, eg up and down; left and right; to and fro A ultrasound longitudinal I left and right, up and down
4(c)(ii)	$(d =) vt$ algebraic or numerical 0.06 (0) m	1	A $\frac{1}{2} vt$; $\frac{1}{2} \times 8.0 \times 10^{-5} \times 1500$; 0.12m; 12cm
4(c)(iii)	(wavelength) decreases (in air) $v = f\lambda$ and frequency the same or each (complete) wave travels less distance (before the next arrives)	1	A frequency the same and $v \propto \lambda$

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Question	Answer	Marks	Guidance
5(a)(i)	move the bar (up and down continuously)	1	A left and right; vibrate the bar; use bar to disturb water / bar hits water / shake the bar I put bar in water; move support; bar touches water; just 'stretch and release bands'
5(a)(ii)	use a (barrier with a) slit or (two) obstacles with a gap or the <u>edge</u> of a barrier (in the water) or waves bend around an obstacle	1	I just 'create a hole'; have a gap; original wooden bar acts as obstacle NB must mention edge or gap or slit or similar
5(a)(iii)	(count) the number of oscillations / crests (passing a point) in a (measured) time or measure the time for a given number of waves or measure / or find the time for one wave / measure or find the period divide the number of waves by the time (in seconds) or count the number of crests / wavefronts pass / oscillations in one second or 1 / time for one wave (the period)	1	A (count) number of waves in any time; time for one wave to be formed I $v = f \lambda$ unless wavelength and speed measurement described; just 'find period' 1 mark for 'count no. of waves in unit time' just count no of waves / oscillations in one second / unit time 2 marks; if no measurement made, e.g. 'f is number of waves / oscillations per second/unit time', 1 mark
5(b)(i)	top or bottom of wave to the middle.	1	A at other point if clear
5(b)(ii)	($T =$) $1/f$ or 0.5 (0 s) seen for time 0.25 (s)	1	
5(b)(iii)	increases as it moves down (to the middle) moving fastest in the middle or decelerates (speed decreases) after middle / <u>near</u> bottom or stops at bottom	1	A increases top to bottom for this mark; needs to indicate increase while moving down/falling; just 'increases' TV

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Question	Answer	Marks	Guidance
6(a)(i)	$(I =) P/V$ in any form current in lamp = 3.3 (A) current in battery twice that in lamp / 6.7 or 6.6 (A)	1	3.33 penalise s.f. / fractions only once
6(a)(ii)	$(R =) V/I$ in any form or $(R =) P/I^2$ 1.8 (Ω)	1	ecf 12 / current in battery but accept current in lamp for 1 st mark accept $(R =) V^2/P$
6(a)(iii)	As the temperature (of the filament) rise(s) / lamp heats up the resistance (of the filament/lamp) increases	1	A lamp releases heat I heat lost / wires get hot I resistance is high (must be an increase)
6(b)	hot gas (near filament) / less dense particles rise or convection occurs hot <u>gas</u> less dense	1	A hot particles rise / hot metal atoms rise I hot particles / metal atoms less dense

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Question	Answer	Marks	Guidance
7(a)	current in <u>coil</u> / 12 V battery / solenoid / switch core (and armature) becomes magnetised / an electromagnet (unlike poles on core) attracts <u>armature</u> (and the iron armature moves)	1	not alternating current; current / emf in core I current in circuit accept current <u>around</u> core (i.e. in coil) if clear not in core I core becomes magnetic; solenoid magnetised A pulls armature to core
7(b)	magnetism stops or magnetic force stops or iron is a temporary magnet springy metal / gravity pushes armature or contacts down	1	I attraction stops; accept core / iron demagnetised
7(c)	steel is a permanent magnet the relay / heater would stay switched on / contacts still touch	1	A steel not a temporary magnet / does not (easily) lose magnetism / hard to demagnetise I steel stays magnetised for longer / takes time to lose; steel is a hard magnetic material A core would stay attracted / close to armature
7(d)	(relay in Figure 7.1) uses low voltage / low current (near switch / hand) / provides insulation (from 240 supply) or Figure 7.2 involves (possible) contact with high voltage / high current	1	A reverse arguments I no fuse; 240V blows up heater; to avoid shock

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Question	Answer	Marks	Guidance
8(a)(i)	Any one from: - cancer - cell death - mutations - radiation sickness	1	I just 'death'; skin irritations; cell damage; burns A any form of cancer, e.g. melanoma
8(a)(ii)	(alpha particle) attracts electron (in atom) atom loses an electron	1	alpha particle attracts electron from atom gets 2 not emission of alpha particle from atom causing loss of 2 electrons; reduces or increases proton no of atom; reacts / bonds with atoms;
8(a)(iii)	Any one from: - reduce exposure time - increase distance - use of shielding	1	I safety hazard sign; thick material A use tongs; use robots; avoid direct contact; limit exposure A lead (apron / suit), 1m concrete I wear protective gear / gloves / hazmat suit; bury in ground; avoid overexposure
8(b)(i)	${}^4_2\text{He}$	1	
8(b)(ii)	proton number or atomic number (Z) increases by 1 neutron number decreases by 1 or mass number / nucleon number (A) remains the same	1	A neutron changes into a proton and electron for both marks I electrons
8(c)	alpha particles no tick in any column beta particles tick, tick, blank gamma radiation (tick) tick, tick	1	No mark if candidates have placed no tick anywhere in the table (i.e. have not answered the question!)

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Question	Answer	Marks	Guidance
9(a)(i)	planets take different times to orbit the Sun / move at different (angular) speeds sometimes they are on the same side / sometimes on different sides of the Sun / do not always align or WTTE	1	different speeds / rates around Sun not Venus has larger orbital period than Earth, Earth moves faster than Venus A the orbits are elliptical / not circular; accept from diagrams with planets labelled
9(a)(ii)	4(.0)	1	A 4.(0) $\times 10^7$ with extra $\times 10^7$ km
9(b)	Incorrect and because Mars and Venus, or Mars and Earth, or Saturn and Jupiter do not follow the relationship Mars has less mass than Earth or Venus and a longer orbital period or Jupiter has larger mass than Saturn but a smaller orbital period	1	only one pair from Mars / Venus or Mars / Earth or Saturn / Jupiter needs to be mentioned or Jupiter has largest mass but not the largest period A values quoted A one of the pairs from first mark explained.
9(c)	(V =) M/d in any form $1.1 \times 10^{21} \text{ (m}^3\text{)}$	1	1.0909
9(d)	orbital speed = $2\pi R / T$	1	