Cambridge Assessment International Education

Cambridge O Level

PHYSICS **5054/22**

Paper 2 Theory **May/June 2021**

MARK SCHEME

Maximum Mark: 75

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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 ***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	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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.

M marks	are method marks upon which further marks depend. For an M mark to be scored, the point to which it refers **must** be seen in a candidate's answer. If a candidate fails to score a particular M mark, then none of the A marks that follow can be scored.
B marks:	are independent marks, which do not depend on other marks. For a B mark to scored, the point to which it refers must be seen specifically in the candidate’s answers.
A marks	In general A marks are awarded for final answers to numerical questions. If a final numerical answer, eligible for A marks, is correct, with the correct unit and an acceptable number of significant figures, all the marks for that question are normally awarded. It is very occasionally possible to arrive at a correct answer by an entirely wrong approach. In these rare circumstances, do not award the A marks, but award C marks on their merits. However, correct numerical answers with no working shown gain all the marks available.
C marks	are compensatory marks. These can be scored even if the point to which they refer are not written down by the candidate, **provided subsequent working gives evidence that they must have known it.** For example, if an equation carries a C mark and the candidate does not write down the actual equation but does correct substitution or working which shows he knew the equation, then the C mark is scored. C marks are not awarded if a candidate makes two points which contradict each other. Points which are wrong but irrelevant are ignored.
brackets ( )	around words or units in the mark scheme are intended to indicate wording used to clarify the mark scheme, but the marks do not depend on seeing the words or units in brackets e.g. 10 (J) means that the mark is scored for 10, regardless of the unit given.
bold	indicates that this <u>must</u> be seen in the answer offered, or something very similar.
Spelling	Be generous about spelling and use of English. If an answer can be understood to mean what we want, give credit.
not	Indicates that an incorrect answer is not to be disregarded, and indeed may cancel another otherwise correct alternative offered by the candidate i.e. right plus wrong penalty applies.
Ignore	Indicates this is something which is not correct but is to be disregarded and does not cause a right plus wrong penalty.
ecf	meaning "error carried forward" is mainly applicable to numerical questions, but may in particular circumstances, but rarely, be applied in non-numerical questions. This indicates that if a candidate has made an earlier mistake and has carried an incorrect value forward to subsequent stages of working, marks indicated by ecf may be awarded, provided the subsequent working is correct, bearing in mind the earlier mistake. ecf applies from one marked section to another not within a section and should be applied except where specifically stated.

Significant Figures	Answers are normally acceptable to any number of significant figures ≥ 2. Any exceptions to this general rule will be specified in the mark scheme. Any rounding should be correct for the 2nd or 3rd figure (if given) but further figures should be ignored.
Units	Deduct one mark for each incorrect or missing unit from **an answer that would otherwise gain all the marks available for that answer: only 1 mark can be lost per question** even for different units. No deduction is incurred if the unit is missing from the final answer but is shown correctly in the working.
ae	meaning "arithmetic error". Deduct one mark if the **only** error in arriving at a final answer is clearly an arithmetic error. This deduction is for the last mark in a series (e.g. C1, A1), so a missing unit does not involve a further penalty.
Transcription	Deduct one mark if the **only** error in arriving at a final answer is because the candidate clearly made an error in copying a given numerical value or one previously calculated, e.g by transposing 2 digits. (n.b. A further penalty would apply if there was also an arithmetic error.)
Fractions	e.g. ½, ¼, 1/10 etc are only acceptable where specified.
Crossed out	Work which has been crossed out **and not replaced but can easily be read,** should be marked as if it had not been crossed out. Look to see if it has been replaced by work on a blank page or nearby.
Use of **NR**	(# key on the keyboard) Use this if the answer space for a question is completely blank or contains no readable words, figures or symbols.

annotation	suggested use
tick	mark awarded
cross	no mark awarded
BOD	benefit of doubt given
NBOD	no benefit of doubt given
on page comment	gives a text box to write comment, can be resized and lead line can be moved to point to particular point Use sparingly if at all
ECF	error carried forward
^	omission mark
?	unclear
U UU	unit penalty applied unit penalty not applied because already applied earlier in same question

annotation	suggested use
wavy line	used to highlight a particular point
CON	contradiction
POT	power-of-ten error
SF SFSF	error in number of significant figures significant figure error not penalized.
TV	too vague
I	ignore
Use the link tool for instances where a candidate has written an answer somewhere other than the expected answer zone.	

Ticks must be shown for all questions where the maximum mark is greater than 2.

Examples of how to apply the list rule

State **three** reasons…. [3]

A

1	Correct	✓	2
2	Correct	✓	
3	Wrong	×	

B
(4 responses)

1	Correct, Correct	✓, ✓	3
2	Correct	✓	
3	Wrong	ignore	

C
(4 responses)

1	Correct	✓	2
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D
(4 responses)

1	Correct	✓	2
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E
(4 responses)

1	Correct	✓	3
2	Correct	✓	
3	Correct, Wrong	✓	

F
(4 responses)

1	Correct	✓	2
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G
(5 responses)

1	Correct	✓	3
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H
(4 responses)

1	Correct	✓	2
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I
(4 responses)

1	Correct	✓	2
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1(a)(i)	vector quantity has direction / scalar quantity does not have direction	**B1**
1(a)(ii)	any two scalar quantities, e.g. mass, distance / length, time, speed	**B1**
	any two vector quantities, e.g. velocity, acceleration, displacement, force / weight	**B1**
1(b)	P and Q drawn in correct directions to meet at a point with correct size	**B1**
	triangle or parallelogram shown with all three vectors in correct directions **and** the resultant clear (e.g. as another vector)	**B1**

Question	Answer	Marks
2(a)	1.4 s	**B1**
2(b)(i)	same change in speed / velocity in the same time	**B1**
2(b)(ii)	slope / gradient changes	**B1**
2(c)	any clear statement or any use of area under graph **or** $d = s \times t$ **or** an (average) speed × time	**C1**
	calculation of any area between 1.4 and 7.0 s on Fig.2.1 e.g. 14 × 2.6; 36.4; 4 × 3; 12; ½ × 12 × 2.6; 15.6; 2.6 × 8; 20.8 (m) seen	**C1**
	48 m	**A1**

Question	Answer	Marks
3(a)	(mass =) meter reading / *g* meter reading / gravitational field (strength meter reading / acceleration due to gravity	**B1**
3(b)(i)	(sum of) clockwise moments = (sum of) anticlockwise moments (about any point)	**B1**

Question	Answer	Marks
3(b)(ii)	any attempt at using moments, e.g. $3 \times 30 = F \times 20$	**C1**
	4.5 N	**A1**
3(c)	force upwards (on brick due to water) **or** force due to water (on brick) **or** force downwards (on brick) is reduced / counteracted (by water) **or** force exerted <u>by</u> brick (on rule) reduced **or** force / tension in string reduced	**B1**
	(force caused by) <u>pressure</u> (of water) **or** reduced <u>anti</u>clockwise <u>moment</u>	**B1**

Question	Answer	Marks
4(a)(i)	tube in correct position and direction	**B1**
4(a)(ii)	reflection (of sound waves) mentioned	**B1**
	angle of incidence = angle of reflection **or** angle between A and surface = angle between B and surface	**B1**
4(b)	between 1000 m / s and 10 000 m / s	**B1**

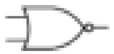
Question	Answer	Marks
5(a)	at least three straight lines perpendicular to plates	**B1**
	arrow on at least one line from positive to negative plate	**B1**
5(b)(i)	electrons / negative charge (on sand / grains) <u>move</u> to(wards) the positive plate / downwards / to(wards) or into the bottom layer	**B1**
5(b)(ii)	<u>positive</u> (sand grain) attracted to or by <u>negative</u> (plate)	**B1**

Question	Answer	Marks
5(c)	(E) = QV numerical or algebraic	**C1**
	0.8(0) J	**A1**

Question	Answer	Marks
6(a)	work done / energy (transfer) per unit time	**B1**
6(b)(i)	(I =) P / V in any form numerical or algebraic	**C1**
	1.7 A	**A1**
6(b)(ii)	6.9−7.2 Ω	**B1**
6(c)	resistance (of wire) is larger	**B1**
	power is less **and** **either** current is smaller **or** $P = V^2 / R$ ***or*** $P = VI$ **and** $V = IR$	**B1**

Question	Answer	Marks
7(a)	current (in coil) is (any one from) • away from A **or** towards B • from positive to negative • at right angles to magnetic field • makes the coil an (electro)magnet	**B1**
	left-hand rule stated, mentioned or used **or** force at right angle to field **and** current **or** top face of coil is a S-pole / bottom face a N-pole	**B1**
	forces in opposite directions (on opposite sides causing rotation) **or** unlike poles attract / like poles repel (only if coil is electromagnet)	**B1**
7(b)(i)	stronger magnetic field **or** (soft) iron becomes (temporary) magnet / magnetises easily	**B1**
	stronger / larger force	**B1**
7(b)(ii)	larger current / larger voltage / more turns on coil / wider coil / larger coil / thicker wire / stronger magnet	**B1**

Question	Answer	Marks
8(a)	top row 3(.0) V	**B1**
	potential divider formula / working shown e.g. 1200 / 2000 ($\times$ 6) or 800 / 2000 ($\times$ 6) **or** split 6 (V) in ratio 1200:800 **or** I = 6 / 2000	**C1**
	second row 3.6 (V)	**A1**

Question	Answer	Marks
	EITHER	
8(b)(i)	correct symbol with arrows <u>towards</u> resistor 	**B1**
8(b)(ii)	resistance decreases **and** output voltage increases	**B1**
8(b)(iii)	thermistor	**B1**
	OR	
8(b)(i)	correct symbol 	**B1**
8(b)(ii)	two (stable) states	**B1**
	switches (between states) by an applied signal **or** exhibits memory	**B1**

Question	Answer	Marks
9(a)(i)	chemical	**B1**
9(a)(ii)	electrical	**B1**
9(a)(iii)	ANY 2 from • light • sound • radio / microwave / electromagnetic (waves)	**B2**
9(b)	(Q =) It in any form	**C1**
	0.16 C	**A1**

Question	Answer	Marks
9(c)(i)	(E =) mcT numerical or algebraic in any form	**C1**
	$0.11 \times 830 \times 5$	**C1**
	460 J	**A1**
9(c)(ii)	energy output / energy input	**C1**
	useful energy output / (total) energy input	**A1**
9(c)(iii)	(energy input =) 460 + 5200 **or** 5660 (J) seen **or** 5200 ÷ (energy in **9(c)(i)** + 5200)	**C1**
	92% **or** 0.92	**A1**
9(c)(iv)	(thermal) energy <u>lost</u> / heat <u>lost</u> (from battery to environment)	**B1**
	energy input larger than calculated / 5660 (J) **or** temperature rise should be larger / is smaller than it should be **or** thermal energy / heat produced larger than 460 J / calculated	**B1**

Question	Answer	Marks
10(a)(i)	3 (.0) cm	**B1**
10(a)(ii)	number of waves per second **or** 5 / 10 **or** $f = 1 / T$	**C1**
	2(.0) Hz	**A1**
10(a)(iii)	(v =) $f\lambda$ **or** s = d / t numerical or algebraic in any form	**C1**
	6(.0) cm / s	**A1**
10(a)(iv)	frequency stays the same **and** speed increases	**B1**

Question	Answer	Marks
10(a)(v)	⩾ three consecutive incident wavefronts meeting straight refracted wavefronts on the boundary without any wavefronts in-between	**B1**
	constant wavelength shown between all refracted wavefronts	**B1**
	all wavefronts refracted in correct direction, i.e. lines between the vertical and the normal	**B1**
10(b)(i)	four colours from violet, indigo, blue, green, yellow, orange, red	**B1**
	correct order of four of the above colours	**B1**
10(b)(ii)	prism	**B1**
	slit (to produce narrow beam)	**B1**
	dispersion shown at first or second face, i.e. a ray becoming at least two rays at least one face	**B1**
	correct refraction on first and second faces for all rays shown	**B1**

Question	Answer	Marks
11(a)	electron	**B1**
11(b)	prevents exposure to radiation / for safety (of experimenter and others)	**B1**
	beta particles stopped / absorbed by metal / case **or** prevents radiation travelling in all directions / to surroundings	**B1**
11(c)(i)	decreases (slightly) / little change	**B1**
	particles spread out **or** <u>some</u> stopped / absorbed (by air)	**B1**
11(c)(ii)	no particles detected **or** <u>large</u> decrease	**B1**
	(>1m) <u>air</u> stops (beta) particles / <u>air</u> atoms / particles become ionised	**B1**

Question	Answer	Marks
11(d)	proton number of Y = 39	**B1**
	'nucleon' number of β = 0	**B1**
	nucleon numbers of Y and β add to 90	**B1**
11(e)(i)	*in (nuclear) fusion* <u>nuclei</u> come together	**B1**
	in (nuclear) fission a <u>nucleus</u> splits	**B1**
	either in (nuclear) fusion <u>small</u> nuclei come together **or** in (nuclear) fission <u>large</u> nuclei split **or** fission caused by neutron (hitting nucleus)	**B1**
11(e)(ii)	high temperature **or** particles moving at high speed	**B1**
	high pressure **or** high density (of particles)	**B1**