



Cambridge O Level

PHYSICS

5054/21

Paper 2 Theory

October/November 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.

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This document consists of **11** printed pages.

PUBLISHED**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 '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.

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Question	Answer	Marks
1(a)	$(p =) F / A$ or $2000 / (2 \times 0.040)$ or 50 000 (P-a)	C1
	25 000 Pa	A1
1(b)(i)	symmetrical left-to-right or symmetrical front-to-back or bench is stable	B1
	because centre of mass is in middle (horizontally) or centre of mass is within the base	B1
1(b)(ii)	(moment =) Fx or Wy or $2000 \times (1.1 - 0.25)$ or 2000×0.85 clockwise moment = anticlockwise moment or $Fx = Wy$ or	C1
	$Fx = 2000 \times (1.1 - 0.25)$ or $Fx = 2000 \times 0.85$ or $(F =) 2000 \times 0.85 / 0.25$	C1
	6800 N	A1

Question	Answer	Marks
2(a)	800 N c.a.o.	B1
2(b)(i)	$(F =) ma$ or 80×0.50	C1
	40 N	A1
2(b)(ii)	840 N	B1
2(c)	increasing gradient from origin to $t = 4.0$ s	B1
	decreasing gradient from end of first curve	B1
	line horizontal at origin or at $t = 8.0$ s (and beyond)	B1

Question	Answer	Marks
3(a)	(nuclear) fusion	B1
3(b)(i)	electromagnetic (waves)	B1
	produced by hot objects or infrared (radiation)	B1
3(b)(ii)	$3.0 \times 10^8 \text{ m/s}$	B1
3(b)(iii)	$(t =) x / v$ or $1.5 \times 10^{11} / 3.0 \times 10^8$	C1
	500 s	A1
3(c)	white surfaces are (good) reflectors / poor absorbers of <u>radiation</u>	B1
	less thermal energy absorbed / wearer stays cooler	B1

Question	Answer	Marks
4(a)	chemical (energy)	B1
4(b)(i)	energy cannot be created and energy cannot be destroyed	B1
	energy can be transferred from one form into another	B1
4(b)(ii)	some chemical energy is transferred to thermal energy (sound and light)	B1
	thermal energy lost to air / water / buildings / equipment	B1
4(c)	any one from: carbon dioxide produced; carbon monoxide produced; global warming; greenhouse gases nitrous oxide produced; sulfur dioxide produced; acid rain; rise in sea-level	B1

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Question	Answer	Marks
5(a)(i)	<u>electrons</u> are transferred from rod (on to cloth)	B1
5(a)(ii)	it / the cloth becomes negatively charged	B1
5(b)(i)	more negative (than positive) signs on left of sphere and more positive (than negative) signs on right	M1
	equal numbers of positive and negative signs and six or fewer	A1
5(b)(ii)	negative charges/electrons (on sphere) attracted by positive charges (on rod)	B1
	force of attraction greater than repulsion (of positive charges) or distance between negative (on sphere) and positive charges (on rod) less than distance between positive and positive	B1

Question	Answer	Marks
6(a)	1.5 V	B1
6(b)(i)	work done / energy transferred when charge passes through a component	C1
	$\frac{\text{work done / energy transferred}}{\text{charge passed}}$	A1
6(b)(ii)	4.5 – 2.5 or 2.0 (V) seen	C1
	$(R =) V / I$ or $2.5 / (2.0 / 28)$ or $R / 28 = 2.5 / 2.0$	C1
	35 Ω	A1

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Question	Answer	Marks
7E(a)	magnetic field lines cut the solenoid / coils or changing magnetic field in solenoid	B1
	an electromotive force / e.m.f. is <u>induced</u>	B1
	electromotive force / e.m.f. produces the current	B1
7E(b)	negative / opposite / reversed current / deflection / reading	B1
	negative e.m.f. / voltage (induced) or magnetic field cut in opposite direction or magnetic field changes in opposite sense / decreases (owtte)	B1
7O(a)	NOR (gate)	B1
7O(b)(i)	lower logic gate has an input of logic level 1 (and so its output / Y is 0) or the output X has a logic level 1 and so the inputs must both be 0 (Y is an input to the upper NOR gate)	B1
7O(b)(ii)	X changes to 0 and Y changes to 1.	B1
7O(b)(iii)	both X and Y stay at the new values or neither X nor Y changes	B1
7O(b)(iv)	the output shows which terminal (P or Q) last had the value 1.	B1

Question	Answer	Marks
8(a)(i)	magnetic field or magnet	B1
8(b)(i)	the current (in coil continually) reverses (direction) or the force (on the coil continually) reverses	B1
	the current (in the coil continually) reverses (direction) and the force (on the coil continually) reverses	B1

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Question	Answer	Marks
8(b)(ii)	cone moves forwards and air is compressed / hits (air) molecules	B1
	cone moves backwards and rarefaction produced / molecules sucked back	B1
	(air) molecules vibrate or production of compressions and rarefactions continues	B1
8(b)(iii)	vibration direction is parallel to energy travel / propagation direction	B1
	in <u>transverse</u> wave, vibration direction is perpendicular to propagation / energy travel direction	B1
8(b)(iv)	(time period =) 0.0050 (s) or 1 / 0.0050 or 200 (times per second)	C1
	400 (times per second)	A1
8(b)(v)	($\lambda =$) c / v or 340 / 200	C1
	1.7 m	A1
8(c)(i)	decreases / less loud / quieter	B1
	amplitude of sound / vibration decreases or (maximum) force on coil decreases	B1
8(c)(ii)	(pitch) stays the same / unchanged and no change to frequency / time period	B1

Question	Answer	Marks
9(a)(i)	molecules with similar / slightly smaller packing density and most molecules touching	B1
	random arrangement	B1
9(a)(ii)	molecules (of gas) further apart	B1
	(repulsive) forces between molecules (much) smaller	B1

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Question	Answer	Marks
9(a)(iii)	any two of: move faster / greater kinetic energy move further apart forces (slightly) smaller	B2
9(b)(i)	(ice point) where ice and water are in equilibrium or melting point / temperature of ice	B1
	(steam point) where water and steam (water vapour) are in equilibrium or boiling point / temperature of water	B1
9(b)(ii)	0 (°C) marked at level of thread in ice-water mixture or at ice point or 100 (°C) marked at level of thread in water-steam mixture or above boiling water or at steam point	B1
	interval between marks divided into 100 divisions	B1
9(c)(i)	it / range decreases	B1
	(a greater mass) expands more / further along the (capillary) tube (for same temperature increase) or range / it is inversely proportional to mass	B1
9(c)(ii)	it / range increases	B1
	range / it is proportional to square of diameter or more expansion / greater volume increase needed (for thread to reach end of the tube)	B1
	greater temperature increase needed (for greater volume increase)	B1

Question	Answer	Marks
10(a)	same number of protons (in nucleus) or same proton number or same number of electrons in a neutral atom or same atomic number	B1

Question	Answer	Marks
10(b)	one more proton	B1
	one fewer neutron	B1
	one more electron	B1
10(c)(i)	18 counts / minute	B1
10(c)(ii)	any two of: rocks / building (materials) / coal / radon space / Sun / cosmic rays weapons testing / nuclear waste	B2
10(c)(iii)	one count rate – 18 or one count rate – 18 calculated e.g. 74 – 18 or 56	B1
	one count rate – 18 halved or one count rate – 18 reduced by factor 2 ^N e.g. 56 / 2 or 28 or 56 / 4 or 14	B1
	one count rate – 18 reduced by factor 2 ^N + 18 e.g. 28 + 18 or 46 or 14 + 18 or 32	B1
	65 hours	B1
10(c)(iv)	(radioactive decay is) random	B1
	in time or impossible to predict when a beta-particle is emitted	B1
10(d)	correct upward curved path between plates	M1
	no more than 1 cm straight at beginning	A1