
PHYSICS**0972/41**

Paper 4 Extended Theory

October/November 2019

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.

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.

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.

Question	Answer	Marks
1(a)(i)	$a = \Delta v / \Delta t$ or $a = (v - u) / t$ in any form words, symbols or numbers or $(a =) \Delta v / \Delta t$ or $(a =) (v - u) / t$ or $15 (- 0) / 5.0$ or $(a =)$ gradient 3.0 m / s^2	C1 A1
1(a)(ii)	$(F =) ma$ in any form words, symbols or numbers or $(F =) ma$ or 2300×3.0 6900 N	C1 A1
1(b)	accelerating or speed / velocity increasing at a decreasing rate or acceleration decreasing gradient (of graph is positive and) decreasing	B1 B1 B1
1(c)	air resistance or friction mentioned or resistive force air resistance or friction or resistive force increases (with speed)	B1 B1

Question	Answer	Marks
2(a)	any two from: shape size / volume / length / density / any linear dimension direction (of motion) / speed / velocity / momentum / kinetic energy / acceleration	B2
2(b)(i)	extension and tension / force / load mentioned extension is directly proportional to tension / force / load	C1 A1
2(b)(ii)1.	260 N	B1
2(b)(ii)2.	$k = F/x$ in any form words, symbols or numbers or $(k =) F/x$ or $260 / (0.94 - 0.63)$ or $260 / 0.31$ 840 N / m	C1 A1
2(b)(iii)	from chemical (potential energy) to elastic (potential) / strain (at end)	B1 B1

Question	Answer	Marks
3(a)	force \times time (for which it acts)	B1
3(b)(i)	$v = I/m$ or 0.019/0.00011 in any form words, symbols or numbers or ($v =$) I/m 170 m/s	C1 A1
3(b)(ii)	$KE = \frac{1}{2}mv^2$ in any form words, symbols or numbers or ($KE =$) $\frac{1}{2}mv^2$ $0.50 \times 0.00011 \times 170^2$ 1.6 J or 1.7 J	C1 C1 A1
3(c)	accept reverse comments if clearly about how the molecular structure of a solid differs from that of a liquid (molecules/they) have an irregular arrangement/not ordered/random arrangement (molecules/they) are (slightly) further apart (on average) (molecules/they are) not fixed in place	B1 B1 B1


Question	Answer	Marks
4(a)	it/cone vibrates any two from: alternating current (a.c.) (in coil/wire) or alternating magnetic field (neighbouring) air vibrates or vibrations passed on (producing) compressions and rarefactions/vibrations parallel to energy transfer vibrating at 15 000 Hz	B1 B2
4(b)	$\lambda = v/f$ in any form words, symbols or numbers or ($\lambda =$) v/f or 330/15 000 0.022 m	C1 A1
4(c)	at least two vertical wavefronts either to left of barrier or in gap at least one wavefront showing some diffraction approximately constant wavelength throughout and ~50% of gap width	B1 B1 B1

Question	Answer	Marks
5(a)	four or more radial arrows/lines outside surface at least one arrow pointing towards (centre of) sphere and none wrong	B1 B1
5(b)(i)	positive charges on left and negative charges on right of S equal numbers	M1 A1
5(b)(ii)	it moves towards/attracted towards the negatively charged sphere/to the left	B1
5(b)(iii)	electrons/negative charges move (along the wire) towards Earth/towards ground/down the wire S becomes positively charged	B1 B1
5(c)	electrons mentioned free (to move)/delocalised/mobile in metals/S or fixed in position in plastic/stand	M1 A1

Question	Answer		Marks
6(a)(i)	$I = P/V$ or in any form words, symbols or numbers or $(I =) P/V$ or 9000/230 39 A		C1 A1
6(a)(ii)	40 A or any greater integer value (in A) up to and including 60 A		B1
6(b)	$E = Pt$ or in any form words, symbols or numbers or $(E =) Pt$ or 9000×1.0 or <u>9000 J</u> seen 35 – 16 or 19 (°C) seen $m = E/(c\Delta T)$ or in any form words, symbols or numbers or $(m =) E/(c\Delta T)$ or $9000/(4200 \times 19)$ 0.11 kg		C1 C1 C1 A1
6(c)(i)	two different metal wires <u>joined</u> at one end and voltmeter between free ends	or	three metal wires and two different <u>joined</u> ABA and voltmeter between free ends
6(c)(ii)	any one from: quick response / makes measurements fast measures rapidly varying temperatures electrical output small heat capacity robust / rugged		B1

Question	Answer	Marks
7(a)	7/7.6/8/10 marked towards top of y-axis and 1(.0) towards right of x-axis a straight line of positive gradient from 0, 0 to point 1.0, 7.6	B1 B1
7(b)(i)	energy (transferred) per unit charge energy (transferred) from chemical or energy (transferred) to electrical or energy (transferred) around/in a (complete) circuit	B1 B1
7(b)(ii)	1. $I = V/R$ or in any form words, symbols or numbers or ($I =$) V/R or 12/7.6 1.6 A	C1 A1
	2. 4.2 V or 4.3 V	B1
	3. $Q = It$ or in any form words, symbols or numbers or ($Q =$) It or $1.6 \times 5.5 \times 60$ or 1.6×5.5 or 8.8 (C) 520 C or 530 C	C1 A1

Question	Answer	Marks
8(a)(i)	$n = \sin(i)/\sin(r)$ in any form words, symbols or numbers or $(n =) \sin(i)/\sin(r)$ or $\sin(53^\circ)/\sin(30^\circ)$ 1.6	C1 A1
8(a)(ii)	path emerging into air along correct path (by eye) and labelled R	B1
8(a)(iii)	ratio / division of two identical quantities / speeds / sine functions / (pure) numbers	B1
8(b)(i)	path labelled V with two correct refractions and below path of red light in glass	B1
8(b)(ii)	larger frequency results in smaller speed (in glass) or r.a. (reverse argument) or inversely related / proportional. any two from: more refraction / closer to normal / larger refractive index for larger frequency or r.a. violet light has larger frequency or o.r.a. violet light has a smaller speed (in glass) or o.r.a. violet light has larger refractive index or o.r.a.	B1 B2

Question	Answer	Marks
9(a)(i)	${}^8_3\text{Li}$	B1
9(a)(ii)	 <p>electron</p>	B1 B1 B1
9(b)(i)	radioactive emission / (background) radiation / decay is random	B1
9(b)(ii)	any one of: rocks, buildings, soil, Earth, space, cosmic rays, Sun, radon, nuclear waste, weapons testing	B1
9(b)(iii)	440 – 24 or 416 or 52 or 55 or 79 or 3 (half-lives) or 45/15 or $1/2^3$ or $1/8$ $1/2^3$ or $1/8$ or 52 or 55 or 79 76 (counts)	C1 C1 A1