Location Entry Codes

UNIVERSITY of CAMBRIDGE International Examinations

As part of CIE's continual commitment to maintaining best practice in assessment, CIE has begun to use different variants of some question papers for our most popular assessments with extremely large and widespread candidature, The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions are unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiner's Reports.

Question Paper	Mark Scheme	Principal Examiner's Report
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
Please direct any questions about this to CIE's Customer Services team at: international@cie.org.uk

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

9702 PHYSICS

9702/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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 must be read in conjunction with the question papers and the report on the examination.

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CIE is publishing the mark schemes for the May/June 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

1 (a) (i) micrometer (screw gauge) / travelling microscope .... B1 [1]

(ii) *either* ohm-meter *or* voltmeter and ammeter
or multimeter/avo on ohm setting .... B1 [1]

(iii) *either* (calibrated) c.r.o. *or* a.c. voltmeter and × $\sqrt{2}$ .... B1 [1]

(b) density = mass / volume C1
= 580 / 6^3 = 2.685 g cm^{-3} …(*allow 2.68, 2.69, 2.7*) A1

% uncertainty in mass = (10 / 580) × 100 = 1.7% C1
% uncertainty in volume = 3 × (0.1 / 6) × 100 = 5.0% C1
uncertainty in density = 0.18 g cm^{-3}
density = 2.7 $\pm$ 0.2 g cm^{-3} .... A1 [5]
(*answer 2.69 $\pm$ 0.09 g cm^{-3} scores 4 marks*)

2 (a) ball moving in <u>opposite</u> direction (after collision) .... B1 [1]

(b) (i) change in momentum = 1.2 (4.0 + 0.8) C2
(*correct values, 1 mark; correct sign {values added}, 1 mark*)
= 5.76 N s …(*allow 5.8*) .... A1 [3]

(ii) force = Δp / Δt or $m\Delta v$ / Δt C1
= 5.76 / 0.08 or 1.2 × 4.8 / 0.08 .... C1
= 72 N .... A1 [3]

(c) 5.76 = 3.6 × V C1
V = 1.6 m s^{-1} .... A1 [2]

(d) *either* speed of approach = 4.0 m s^{-1} and
speed of separation = 2.4 m s^{-1} M1
not equal and so inelastic A1

or kinetic energy before = 9.6 J and
kinetic energy after collision = 4.99 J M1
kinetic energy after is less / not conserved so inelastic .... A1 [2]

3 (a) product of (magnitude of one) force and distance between forces M1
reference to *either* perpendicular distance between forces
or line of action of forces and perpendicular distance .... A1 [2]

(b) (i) 90° .... B1 [1]

(ii) 130 = F × 0.45 (*allow e.c.f. for angle in **(i)***) C1
F = 290 N .... A1 [2]
(*allow 1 mark only if angle stated in **(i)** is not used in **(ii)***)

4 **(a)** **(i)** change of shape / size / length / dimension C1
when (deforming) force is removed, returns to original shape / size A1 [2]

(ii) $L = ke$ .... B1 [1]

(b) $2e$ B1
$½k$ …(*allow e.c.f. from extension*) B1

$½e$ and $2k$ B1

$\frac{3}{2}e$ …(*allow e.c.f. from extension in part 2*) B1
$\frac{2}{3}k$ …(*allow e.c.f. from extension*) .... B1 [5]

5 **(a)** *either* phase difference is π rad / 180°
or path difference (between waves from S_1 and S_2) is $½\lambda$ / $(n + ½)\lambda$. B1
either same amplitude / intensity at M
or ratio of amplitudes is 1.28 / ratio of intensities is 1.28^2 .... B1 [2]

(b) path difference between waves from S_1 and S_2 = 28 cm B1
wavelength changes from 33 cm to 8.25 cm B1
minimum when λ = (56 cm,) 18.7 cm, 11.2 cm, (8.0 cm) B1
so two minima .... B1 [4]

6 **(a)** **(i)** $E = V / d$ C1
$= 350 / (2.5 \times 10^{-2})$
$= 1.4 \times 10^4$ N C^{-1} .... A1 [2]

(ii) force = Eq C1
$= 1.4 \times 10^4 \times 1.6 \times 10^{-19}$ M1
$= 2.24 \times 10^{-15}$ .... A0 [2]

(b) **(i)** $F = ma$ C1
$a = (2.24 \times 10^{-15}) / (9.1 \times 10^{-31})$
$= 2.46 \times 10^{15}$ m s^{-2} …(*allow* 2.5×10^5) .... A1 [2]

(ii) $s = ½at^2$ C1
$2.5 \times 10^{-2} = ½ \times 2.46 \times 10^{15} \times t^2$
$t = 4.5 \times 10^{-9}$ s .... A1 [2]

(c) *either* gravitational force is normal to electric force
or electric force horizontal, gravitational force vertical .... B2 [2]
special case: force/acceleration due to electric field >> force/acceleration due to gravitational field, allow 1 mark

7 **(a)** **(i)** R .... B1 [1]

(ii) $0.5R$ .... B1 [1]

(iii) $2.5R$ …(*allow e.c.f. from* ***(ii)***) .... B1 [1]

(b) **(i)** $I_1 + I_2 = I_3$ .... B1 [1]

(ii) $E_2 = I_3R + I_2R$ .... B1 [1]

(iii) $E_1 - E_2 = 2I_1R - I_2R$ .... B1 [1]

8 **(a)** rate of decay / activity / decay (of nucleus) is not affected by external factors / environment / surroundings .... B2 [2]
(*If states specific factor(s), rather than giving general statement above, then give 2 marks for two stated factors, but 1 mark only if one factor stated*)

(b) **(i)** gamma / γ .... B1 [1]

(ii) alpha / α .... B1 [1]

(iii) gamma / γ .... B1 [1]

(iv) beta / β .... B1 [1]

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1	**(a)**	e.g. time (s), current (A), temperature (K), amount of substance (mol), luminous intensity (cdl) *1 each, max 3* ……	B3	[3]
	(b)	density = mass / volume ……	C1	
		unit of density: kg m^{-3} ……	C1	
		unit of acceleration: m s^{-2} ……	C1	
		unit of pressure: kg m^{-3} m s^{-2} m ……	B1	
		kg m^{-1} s^{-2} ……	B1	[5]
		(*allow 4/5 for solution in terms of only dimensions*)		
2	**(a)**	2.4 s ……	A1	[1]
	(b)	in **(b)** and **(c)**, allow answers as (+) or (–)		
		recognises distance travelled as area under graph line ……	C1	
		height = (½ × 2.4 × 9.0) – (½ × 1.6 × 6.0) ……	C1	
		= 6.0 m (*allow 6 m*) ……	A1	[3]
		(*answer 15.6 scores 2 marks* *answer 10.8 or 4.8 scores 1 mark*)		
		alternative solution: $s = ut - ½at^2$ $= (9 × 4) - ½ × (9 / 2.4) × 4^2$ $= 6.0$ m		
		(*answer 66 scores 2 marks* *answer 36 or 30 scores 1 mark*)		
	(c)	**(i)** change in momentum = 0.78 (9.0 + 4.2) (*allow 4.2 ± 0.2*) ……	C1	
		= 10.3 N s (allow 10 N s) ……	A1	[2]
		(ii) force = $\Delta p / \Delta t$ or $m\Delta v / \Delta t$ ……	C1	
		= 10.3 / 3.5 / 0.08 = 2.9 N ……	A1	[2]
	(d)	**(i)** 2.9 N ……	A1	[1]
		(ii) g = weight / mass ……	C1	
		= 2.9 / 0.78 = 3.7 m s^{-2} ……	A1	[2]
3	**(a)**	product of (magnitude of one) force and distance between forces ……	M1	
		reference to *either* perpendicular distance between forces *or* line of action of forces & perpendicular distance ……	A1	[2]
	(b)	**(i)** 90° ……	B1	[1]
		(ii) 130 = $F \times 0.45$ (*allow e.c.f. for angle in **(i)***) ……	C1	
		F = 290 N ……	A1	[2]
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$½e$ and $2k$ B1

$\frac{3}{2}e$ (*allow e.c.f. from extension in part 2*) B1
$\frac{2}{3}k$ (*allow e.c.f. from extension*) .... B1 [5]

5 **(a)** constant phase difference .... B1 [1]

(b) allow wavelength estimate 750 nm → 550 nm C1
separation = $\lambda D / x$ C1
$= (650 \times 10^{-9} \times 2.4) / (0.86 \times 10^{-3})$
$= 1.8$ mm .... A1 [3]
(*allow 2 marks from inappropriate estimate if answer is in range 10 cm → 0.1 mm)*

(c) no longer complete destructive interference /
amplitudes no longer completely cancel M1
so dark fringes are lighter .... A1 [2]

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R .... A1 [3]

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