

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](mailto: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**

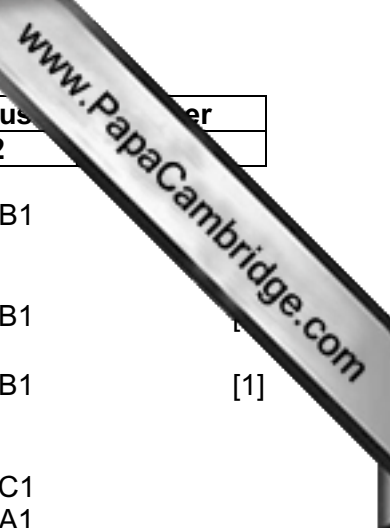
<p><b>9702 PHYSICS</b></p> <p><b>9702/21</b>      Paper 2 (AS Structured Questions), maximum raw mark 60</p>
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This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on 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.

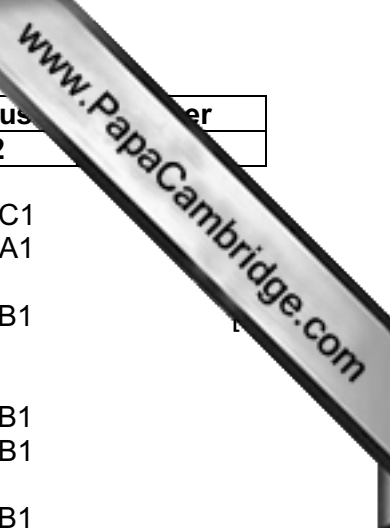
- CIE will not enter into discussions or correspondence in connection with these mark schemes.

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Page 2	Mark Scheme: Teachers' version	Syllabus
	GCE A/AS LEVEL – May/June 2009	9702

- 1 (a) (i) micrometer (screw gauge) / travelling microscope ..... B1
- (ii) *either* ohm-meter or voltmeter and ammeter  
or multimeter/avo on ohm setting ..... B1
- (iii) *either* (calibrated) c.r.o. or a.c. voltmeter and  $\times \sqrt{2}$  ..... B1 [1]
- (b) density = mass / volume ..... C1  
 $= 580 / 6^3 = 2.685 \text{ g cm}^{-3}$  ... (allow 2.68, 2.69, 2.7) ..... A1
- % uncertainty in mass =  $(10 / 580) \times 100 = 1.7\%$  ..... C1  
 % uncertainty in volume =  $3 \times (0.1 / 6) \times 100 = 5.0\%$  ..... C1  
 uncertainty in density =  $0.18 \text{ g cm}^{-3}$   
 density =  $2.7 \pm 0.2 \text{ g cm}^{-3}$  ..... A1 [5]  
 (answer  $2.69 \pm 0.09 \text{ g cm}^{-3}$  scores 4 marks)
- 2 (a) ball moving in opposite 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 )  
 $= 5.76 \text{ N s}$  ... (allow 5.8) ..... A1 [3]
- (ii) force =  $\Delta p / \Delta t$  or  $m\Delta v / \Delta t$  ..... C1  
 $= 5.76 / 0.08$  or  $1.2 \times 4.8 / 0.08$  ..... C1  
 $= 72 \text{ N}$  ..... A1 [3]
- (c)  $5.76 = 3.6 \times V$  ..... C1  
 $V = 1.6 \text{ m s}^{-1}$  ..... A1 [2]
- (d) *either* speed of approach =  $4.0 \text{ m s}^{-1}$  and  
 speed of separation =  $2.4 \text{ m s}^{-1}$  ..... M1  
 not equal and so inelastic ..... A1
- or kinetic energy before =  $9.6 \text{ J}$  and  
 kinetic energy after collision =  $4.99 \text{ J}$  ..... 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)  $90^\circ$  ..... B1 [1]
- (ii)  $130 = F \times 0.45$  (allow e.c.f. for angle in (i)) ..... C1  
 $F = 290 \text{ N}$  ..... A1 [2]  
 (allow 1 mark only if angle stated in (i) is not used in (ii))



Page 3	Mark Scheme: Teachers' version	Syllabus
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- 4 (a) (i) change of shape / size / length / dimension ..... C1  
 when (deforming) force is removed, returns to original shape / size A1
- (ii)  $L = ke$  ..... B1
- (b)  $2e$  ..... B1  
 $\frac{1}{2}k$  ...(allow e.c.f. from extension) ..... B1
- $\frac{1}{2}e$  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  $\pi$  rad /  $180^\circ$   
 or path difference (between waves from  $S_1$  and  $S_2$ ) is  $\frac{1}{2}\lambda / (n + \frac{1}{2})\lambda$  . 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  $\lambda = (56 \text{ cm,}) 18.7 \text{ cm, } 11.2 \text{ cm, } (8.0 \text{ cm})$  ..... B1  
 so two minima ..... B1 [4]
- 6 (a) (i)  $E = V / d$  ..... C1  
 $= 350 / (2.5 \times 10^{-2})$   
 $= 1.4 \times 10^4 \text{ N C}^{-1}$  ..... 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  
 $a = (2.24 \times 10^{-15}) / (9.1 \times 10^{-31})$   
 $= 2.46 \times 10^{15} \text{ m s}^{-2}$  ...(allow  $2.5 \times 10^5$ ) ..... A1 [2]
- (ii)  $s = \frac{1}{2}at^2$  ..... C1  
 $2.5 \times 10^{-2} = \frac{1}{2} \times 2.46 \times 10^{15} \times t^2$   
 $t = 4.5 \times 10^{-9} \text{ s}$  ..... 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  $\gg$  force/acceleration  
 due to gravitational field, allow 1 mark

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Page 4	Mark Scheme: Teachers' version	Syllabus
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- 7 (a) (i)  $R$  ..... B1
- (ii)  $0.5R$  ..... B1
- (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 /  $\gamma$  ..... B1 [1]
- (ii) alpha /  $\alpha$  ..... B1 [1]
- (iii) gamma /  $\gamma$  ..... B1 [1]
- (iv) beta /  $\beta$  ..... B1 [1]

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**MARK SCHEME for the May/June 2009 question paper**  
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<p><b>9702 PHYSICS</b></p> <p><b>9702/22</b>      Paper 2 (AS Structured Questions), maximum raw mark 60</p>
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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
- (b) density = mass / volume ..... C1  
unit of density:  $\text{kg m}^{-3}$  ..... C1  
unit of acceleration:  $\text{m s}^{-2}$  ..... C1  
unit of pressure:  $\text{kg m}^{-3} \text{ m s}^{-2} \text{ m}$  ..... B1  
 $\text{kg m}^{-1} \text{ s}^{-2}$  ..... 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 =  $(\frac{1}{2} \times 2.4 \times 9.0) - (\frac{1}{2} \times 1.6 \times 6.0)$  ..... C1  
= 6.0m (allow 6m) ..... A1 [3]  
(answer 15.6 scores 2 marks  
answer 10.8 or 4.8 scores 1 mark)
- alternative solution:  $s = ut - \frac{1}{2}at^2$   
=  $(9 \times 4) - \frac{1}{2} \times (9 / 2.4) \times 4^2$   
= 6.0m  
(answer 66 scores 2 marks  
answer 36 or 30 scores 1 mark)
- (c) (i) change in momentum =  $0.78 (9.0 + 4.2)$  (allow  $4.2 \pm 0.2$ ) ..... 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)  $g = \text{weight} / \text{mass}$  ..... C1  
=  $2.9 / 0.78$   
=  $3.7 \text{ m s}^{-2}$  ..... 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)  $90^\circ$  ..... B1 [1]
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 when (deforming) force is removed, returns to original shape / size ..... A1
- (ii)  $L = ke$  ..... B1
- (b)  $2e$  ..... B1  
 $\frac{1}{2}k$  (allow e.c.f. from extension) ..... B1
- $\frac{1}{2}e$  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  $\rightarrow$  550 nm ..... C1  
 separation =  $\lambda D / x$  ..... C1  
 $= (650 \times 10^{-9} \times 2.4) / (0.86 \times 10^{-3})$   
 $= 1.8 \text{ mm}$  ..... A1 [3]  
 (allow 2 marks from inappropriate estimate if answer is in range 10 cm  $\rightarrow$  0.1 mm)
- (c) no longer complete destructive interference /  
 amplitudes no longer completely cancel ..... M1  
 so dark fringes are lighter ..... A1 [2]
- 6 (a) (i)  $E = V / d$  ..... C1  
 $= 350 / (2.5 \times 10^{-2})$   
 $= 1.4 \times 10^4 \text{ N C}^{-1}$  ..... A1 [2]
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- (c) *either* gravitational force is normal to electric force  
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 due to gravitational field, allow 1 mark



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- 7 (a)  $\infty$  ..... A1
- $2R$  ..... A1
- $R$  ..... A1
- (b) (i)  $I_1 + I_3 = I_2 + I_4$  ..... A1 [1]
- (ii)  $E_2 - E_1 = I_3R$  ..... A1 [1]
- (iii)  $E_2 = I_3R + 2I_4R$  ..... A1 [1]
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- (iv) beta /  $\beta$  ..... B1 [1]