

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

**MARK SCHEME for the October/November 2009 question paper  
for the guidance of teachers**

**9702 PHYSICS**

**9702/21**

Paper 21 (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.

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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9702	21

- 1 (a) (i) car uses  $210 / 14 = 15$  litres of fuel ..... C1  
volume reading = 45 litres ..... A1 [2]
- (ii) from 'full' to '3/4' mark ..... B1 [1]
- (b) (i) line/graph does not pass through ('empty, 0) / there is an intercept ..... B1 [1]  
(do not allow 'non-linear')
- (ii) (meter shows zero fuel when there is some left in the tank so)  
acts as a 'reserve' ..... B1 [1]

[Total: 5]

- 2 (a) (i) (air) resistance increases with speed ..... M1  
resultant / accelerating force decreases ..... A1 [2]
- (ii) either (air) resistance is zero  
or weight / gravitational force is only force ..... B1 [1]
- (b) use of gradient of a tangent ..... M1  
acceleration =  $1.9 \pm 0.2 \text{ m s}^{-2}$  ..... A2 [3]  
(for values  $> \pm 0.2$  but  $\leq 0.4$ , allow 1 mark)  
(answer  $3.3 \text{ m s}^{-2}$  scores no marks)
- (c) (i) 1 weight =  $90 \times 9.8 = 880 \text{ N}$  ..... A1 [1]  
(use of  $g = 10 \text{ m s}^{-2}$  then deduct mark but once only in the Paper)  
2 accelerating force =  $90 \times 1.9 = 170 \text{ N}$  ...(allow ecf) ..... A1 [1]
- (ii) resistive force =  $880 - 170 = 710 \text{ N}$  ..... A1 [1]  
(allow ecf but only if resistive force remains positive)

[Total: 9]

- 3 (a) (i) either sum / total momentum (of system of bodies) is constant  
or total momentum before = total momentum after ..... M1  
for an isolated system / no (external) force acts on system ..... A1 [2]
- (ii) zero momentum before / after decay ..... M1  
so  $\alpha$ -particle and nucleus D must have momenta in opposite directions ..... A1 [2]
- (b) (i) kinetic energy =  $\frac{1}{2} mv^2$  ..... C1  
 $1.0 \times 10^{-12} = \frac{1}{2} \times 4 \times \underline{1.66} \times 10^{-27} \times v^2$  ..... M1  
 $v = 1.7 \times 10^7 \text{ m s}^{-1}$  ..... A0 [2]
- (ii)  $1.7 \times 10^7 \times 4u = 216u \times V$  ..... C1  
 $V = 3.1 \times 10^5 \text{ m s}^{-1}$  ..... A1 [2]  
(accept  $3.2 \times 10^5 \text{ m s}^{-1}$ , do not accept 220 rather than 216)

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
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- (c)  $(1.7 \times 10^7)^2 = 2 \times \text{deceleration} \times 4.5 \times 10^{-2}$  ..... C1  
*deceleration* /  $a = 3.2 \times 10^{15} \text{ m s}^{-2}$  ..... A1 [2]  
 (accept calculation based on calculating  $F = 2.22 \times 10^{11} \text{ N}$   
 and then use of  $F = ma$ )

[Total: 10]

- 4 (a) (i) returns to original shape / size / length etc. .... B1  
 when load / distorting forces / weight / strain is removed ..... B1 [2]
- (ii) 1  $R = \rho L / A$  ..... B1 [1]  
 2  $E = WL / Ae$  ..... B1 [1]
- (b)  $E = WR / e\rho$  ..... C1  
 $= (34 \times 0.44) / (7.7 \times 10^{-4} \times 9.2 \times 10^{-8})$  ..... C1  
 $= 2.1 \times 10^{11} \text{ Pa}$  ..... A1 [3]

[Total: 7]

- 5 (a) transfer / propagation of energy ..... M1  
 as a result of oscillations / vibrations ..... A1 [2]
- (b) (i) displacement / velocity / acceleration (of particles in the wave) ..... B1 [1]
- (ii) displacement etc. is normal to direction of energy transfer /  
 travel of wave / propagation of wave .....(not 'wave motion') ..... B1 [1]
- (iii) displacement etc. along / same direction of energy transfer /  
 travel of wave / propagation of wave .....(not 'wave motion') ..... B1 [1]
- (c) diffraction: suitable object, means of observation ..... M1  
*either laser or lamp and aperture*  
*or distant source* ..... M1  
 light region where darkness expected ..... A1
- interference: suitable object, means of observation and illumination ..... B1  
 light and dark fringes observed ..... B1  
 appropriate reference to a dimension for diffraction or  
 for interference ..... B1 [6]

[Total: 11]

- 6 (a) energy transferred from source / changed from some form to electrical ..... M1  
 per unit charge (to drive charge round a complete circuit) ..... A1 [2]
- (b) and power in R =  $I^2 X$  ..... M1  
 $E = I(X + r)$  ..... M1  
 power in cell =  $EI$  and algebra clear leading to ratio =  $X / (X + r)$  ..... A1 [3]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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(c) (i) 1.4 W ..... A1  
0.40  $\Omega$  .....(allow  $\pm 0.05 \Omega$ ) ..... A1 [2]

(ii) current in circuit =  $\sqrt{1.4/0.4} = 1.87 \text{ A}$  ..... C1  
1.5 = 1.87 ( $r + 0.40$ ) ..... C1  
 $r = 0.40 \Omega$  ..... A1 [3]

(d) either less power lost / energy wasted / lost ..... B1 [1]  
or greater efficiency (of energy transfer) .....

[Total: 11]

7 (a) deviation shown correctly ..... B1 [1]

(b) smaller deviation (not zero deviation) ..... M1  
acceptable path wrt position of N ..... A1 [2]

(c) the nucleus is (very) small ..... M1  
in comparison to the atom ..... A1 [2]  
(special case: 'atom is mostly empty space' scores 1 mark)

(d) deviation depends on charge on the nucleus / N / electrostatic repulsion ..... B1  
same charge so no change in deviation ..... B1 [2]

[Total: 7]