

---

**PHYSICS**

**9702/22**

Paper 2 AS Level Structured Questions

**May/June 2016**

MARK SCHEME

Maximum Mark: 60

---

**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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE<sup>®</sup>, Cambridge International A and AS Level components and some Cambridge O Level components.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	22

- 1 (a) acceleration = change in velocity / time (taken) or rate of change of velocity B1 [1]
- (b) (i)  $v = 0 + at$  or  $v = at$  C1  
 $(a = 36/19 =) 1.9 (1.8947) \text{ ms}^{-2}$  A1 [2]
- (ii)  $s = \frac{1}{2}(u + v)t$  or  $s = v^2/2a$  or  $s = \frac{1}{2}at^2$   
 $= \frac{1}{2} \times 36 \times 19 = 36^2/(2 \times 1.89) = \frac{1}{2} \times 1.89 \times 19^2$   
 $= 340 \text{ m} (342 \text{ m}/343 \text{ m}/341 \text{ m})$  M1 [1]
- (iii) 1.  $(\Delta KE =) \frac{1}{2} \times 95 \times (36)^2$  C1  
 $= 62000 (61560) \text{ J}$  A1 [2]
2.  $(\Delta PE =) 95 \times 9.81 \times 340 \sin 40^\circ$  or  $95 \times 9.81 \times 218.5$  C1  
 $= 200000 \text{ J}$  A1 [2]
- (iv) work done (by frictional force) =  $\Delta PE - \Delta KE$   
or  
work done =  $200000 - 62000$  (values from **1b(iii) 1.** and **2.**) C1  
(frictional force =  $138000/340 =$ )  $410 (406) \text{ N}$  [420 N if full figures used] A1 [2]
- (v)  $-ma = mg \sin 20^\circ - f$  or  $ma = -mg \sin 20^\circ + f$  C1  
 $-95 \times 3.0 = 95 \times 3.36 - f$   
 $f = 600 (604) \text{ N}$  A1 [2]
- 2 (a)  $p = F/A$  M1  
use of  $m = \rho V$  and use of  $V = Ah$  and use of  $F = mg$  M1  
correct substitution to obtain  $p = \rho gh$  A1 [3]
- (b) (i) (when  $h$  is zero the pressure is not zero due to) pressure from the air/atmosphere B1 [1]
- (ii) gradient =  $\rho g$  or  $P - 1.0 \times 10^5 = \rho gh$  C1  
e.g.  $\rho g = 1.0 \times 10^5/0.75 (= 133333)$   
 $\rho = 133333/9.81$   
 $= 14000 (13592) \text{ kg m}^{-3}$  A1 [2]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	22

- 3 (a) Young modulus = stress / strain B1 [1]
- (b) (i)  $E = (F \times l) / (A \times e)$  or  $e = (F \times l) / (A \times E)$  B1
- $e \propto 1/E$   
or  
ratio  $e_C / e_S = E_S / E_C$  or  $(1.9 \times 10^{11}) / (1.2 \times 10^{11})$  or 19/12 C1
- (ratio =) 1.6 (1.58) A1 [3]
- (ii) two straight lines from (0,0) with **S** having the steepest gradient B1 [1]
- 4 (a) longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction **or** in the same direction (of the propagation of energy) B1
- transverse: vibrations/oscillations (of the particles/wave) are perpendicular to the direction (of the propagation of energy) B1 [2]
- (b) LHS: intensity = power / area units:  $\text{kg m s}^{-2} \times \text{m} \times \text{s}^{-1} \times \text{m}^{-2}$  or  $\text{kg m}^2 \text{s}^{-3} \times \text{m}^{-2}$  B1
- RHS: units:  $\text{m s}^{-1} \times \text{kg m}^{-3} \times \text{s}^{-2} \times \text{m}^2$  M1
- LHS and RHS both  $\text{kg s}^{-3}$  A1 [3]
- (c) (i) change/difference in the observed/apparent frequency when the source is moving (relative to the observer) B1 [1]
- (ii) wavelength increases/frequency decreases/red shift B1 [1]
- (d) observed frequency =  $v f_S / (v - v_S)$  C1
- $550 = (340 \times 510) / (340 - v_S)$  C1
- $v_S = 25 (24.7) \text{ m s}^{-1}$  A1 [3]
- 5 (a) diffraction: spreading/diverging of waves/light (takes place) at (each) slit/element/gap/aperture B1
- interference: overlapping of waves (from coherent sources at each element) B1
- path difference  $\lambda$ /phase difference of  $360(^{\circ})/2\pi$  (produces the first order) B1 [3]
- (b)  $d \sin \theta = n \lambda$  or  $\sin \theta = N n \lambda$  C1
- $d = (2 \times 486 \times 10^{-9}) / \sin 29.7^{\circ} (= 1.962 \times 10^{-6})$  C1
- number of lines = 510 (509.7)  $\text{mm}^{-1}$  A1 [3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	22

6 (a) at least six horizontal lines equally spaced and arrow to the right B1 [1]

(b) charge used  $2e$  C1

$$\text{gain in KE} = 15 \times 1.6 \times 10^{-19} \times 10^3 = 2 \times 1.6 \times 10^{-19} \times V \text{ (p.d. across plates)}$$

or

$$F (= W/d) = 15 \times 1.6 \times 10^{-19} \times 10^3 / 16 \times 10^{-3} \quad \text{C1}$$

$$\text{(hence } V = 7500 \text{ V or } F = 1.5 \times 10^{-13} \text{ N)}$$

$$E = V/d \quad \text{or} \quad E = F/Q \quad \text{C1}$$

$$E = (7500 / 16 \times 10^{-3}) \quad \text{or} \quad E = (1.5 \times 10^{-13} / 3.2 \times 10^{-19})$$

$$E = 4.7 \times 10^5 \text{ (468 750) V m}^{-1} \quad \text{A1 [4]}$$

or

$$\text{KE} (= \frac{1}{2}mv^2) = 15 \times 10^3 \times 1.6 \times 10^{-19}$$

$$v = [(2 \times 15 \times 10^3 \times 1.6 \times 10^{-19}) / (6.68 \times 10^{-27})]^{1/2} = 8.5 \times 10^5 \text{ ms}^{-1} \quad \text{(C1)}$$

$$a (= v^2/2s) = (8.5 \times 10^5)^2 / 2 \times 16 \times 10^{-3} = 2.25 \times 10^{13} \text{ ms}^{-2}$$

$$F (= 6.68 \times 10^{-27} \times 2.25 \times 10^{13}) = 1.5 \times 10^{-13} \text{ N}$$

$$E = F/Q \quad \text{(C1)}$$

$$Q = 2e \quad \text{(C1)}$$

$$E = 4.7 \times 10^5 \text{ V m}^{-1} \quad \text{(A1)}$$

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9702	22

- 7 (a) charge exists only in discrete amounts B1 [1]
- (b) (i)  $E = I(R + r)$  or  $V = IR$  C1  
(total resistance =)  $2.7 + 0.30 + 0.25 (= 3.25 \Omega)$  M1  
 $I = 9.0 / (2.7 + 0.30 + 0.25)$  or  $9.0 / 3.25 = 2.8 \text{ A}$  A1 [3]
- (ii)  $V = IR_{\text{ext}}$  C1  
 $= 2.77 \times 3.0$  or  $2.8 \times 3.0$
- or
- $V = E - Ir$  (C1)  
 $= 9.0 - 2.77 \times 0.25$  or  $9.0 - 2.8 \times 0.25$
- $V = 8.3 (8.31) \text{ V}$  or  $8.4 \text{ V}$  A1 [2]
- (c) (i)  $I = nevA$
- $v = 2.77 / (8.5 \times 10^{29} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-6})$  M1  
 $= 8.1 (8.147) \times 10^{-6} \text{ ms}^{-1}$  or  $8.2 \times 10^{-6} \text{ ms}^{-1}$  A1 [2]
- (ii) A reduces by a factor 4 (1/4 less) or resistance of Z goes up by 4× M1  
current goes down but by less than a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up A1 [2]
- 8 (a) both electron and neutrino: lepton(s) B1  
both neutron and proton: hadron(s)/baryon(s) B1 [2]
- (b) (i)  ${}^1_1\text{p} \rightarrow {}^1_0\text{n} + {}^0_1\beta + {}^0_0\nu$
- correct symbols for particles M1  
correct numerical values (allow no values on neutrino) A1 [2]
- (ii) up up down or uud → up down down or udd B1 [1]
- (iii) weak (nuclear) B1 [1]