Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**PHYSICS** **9702/21**

Paper 2 AS Level Structured Questions **October/November 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 October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.



© UCLES 2016

**1** **(a)** (density =) mass / volume B1 [1]

**(b)** **(i)** $d = [(6 \times 7.5) / (\pi \times 8100)]^{1/3}$

$= 0.12(1)$ m A1 [1]

**(ii)** percentage uncertainty = $(4 + 5) / 3$ (= 3%)
*or*
fractional uncertainty = $(0.04 + 0.05) / 3$ (= 0.03) C1

absolute uncertainty (= $0.03 \times 0.121$) = 0.0036 C1

$d = 0.121 \pm 0.004$ m A1 [3]

**2** **(a)** force per unit positive charge B1 [1]

**(b)** **(i)** time $= 5.9 \times 10^{-2} / 3.7 \times 10^{7}$
$= 1.6 \times 10^{-9}$ s ($1.59 \times 10^{-9}$ s) A1 [1]

**(ii)** $E = V / d$ C1

$= 2500 / 4.0 \times 10^{-2}$

$= 6.3 \times 10^{4}$ N C$^{-1}$ ($6.25 \times 10^{4}$ or 62500 N C$^{-1}$) A1 [2]

**(iii)** $a = Eq / m$ *or* $F = ma$ *and* $F = Eq$ C1

$= (6.3 \times 10^{4} \times 1.60 \times 10^{-19}) / 9.11 \times 10^{-31} = 1.1 \times 10^{16}$ m s$^{-2}$ A1 [2]

**(iv)** $s = ut + \frac{1}{2}at^2$

$= \frac{1}{2} \times 1.1 \times 10^{16} \times (1.6 \times 10^{-9})^2$ C1

$= 1.4 \times 10^{-2}$ (m) C1

distance from plate = 2.0 – 1.4
= 0.6 cm (*allow 1 or more s.f.*) A1 [3]

**(v)** electric force ≫ gravitational force (on electron)/weight
*or*
acceleration due to electric field ≫ acceleration due to gravitational field B1 [1]

**(vi)** $v_X$–$t$ graph: horizontal line at a non-zero value of $v_X$ B1

$v_Y$–$t$ graph: straight line through the origin with positive gradient B1 [2]

© UCLES 2016

**3** **(a)** force/load is proportional to extension/compression (provided proportionality limit is not exceeded) B1 [1]

**(b)** **(i)** $k = F/x$ *or* $k$ = gradient C1

$k = 600\,\text{N m}^{-1}$ A1 [2]

**(ii)** ($W$ =) ½$kx^2$ *or* ($W$ =) ½$Fx$ *or* ($W$ =) area under graph C1

($W$ =) $0.5 \times 600 \times (0.040)^2 = 0.48\,\text{J}$ *or* ($W$ =) $0.5 \times 24 \times 0.040 = 0.48\,\text{J}$ A1 [2]

**(iii)** **1.** ($E_K$ =) ½$mv^2$ C1

= ½ $\times$ $0.025 \times 6.0^2$

$= 0.45\,\text{J}$ A1 [2]

**2.** (work done against resistive force =) $0.48 - 0.45$ [= 0.03(0) J] C1

average resistive force = $0.030 / 0.040$ C1

$= 0.75\,\text{N}$ A1 [3]

**(iv)** efficiency = [useful energy out / total energy in] ($\times$100) C1

= [0.45 / 0.48] ($\times$100)

= 0.94 *or* 94% A1 [2]

**4** **(a)** the number of oscillations per unit time M1
of the source/of a point on the wave/of a particle (in the medium) A1 [2]
*or*
the number of wavelengths/wavefronts per unit time (M1)
passing a (fixed) point (A1)

**(b)** $T$ or period = $2.5 \times 250$ ($\mu$s) (= 625 $\mu$s) M1

frequency = $1 / (6.25 \times 10^{-4})$ or $1 / (2.5 \times 250 \times 10^{-6}) = 1600\,\text{Hz}$ A1 [2]

**(c)** **(i)** for maximum frequency: $f_o = f_s v / (v - v_s)$

$1640 = (1600 \times 330) / (330 - v_s)$ C1

$v_s = 8(.0)\,\text{m s}^{-1}$ ($8.049\,\text{m s}^{-1}$) A1 [2]

**(ii)** loudspeaker moving towards observer causes rise in/higher frequency B1
loudspeaker moving away from observer causes fall in/lower frequency B1 [2]
*or*
repeated rise and fall/higher and then lower frequency (M1)
caused by loudspeaker moving towards and away from observer (A1)

© UCLES 2016

**5** **(a)** wave incident on/passes by or through an aperture/edge B1
wave spreads (into geometrical shadow) B1 [2]

**(b)** $n\lambda = d \sin\theta$ C1

substitution of $\theta = 90°$ *or* $\sin\theta = 1$ C1

$4 \times 500 \times 10^{-9} = d \times \sin 90°$

line spacing = $2.0 \times 10^{-6}$ m A1 [3]

**(c)** wavelength of red light is longer (than 500 nm) M1

(each order/fourth order is now at a greater angle so) the fifth-order maximum cannot be formed/not formed A1 [2]

**6** **(a)** $\dfrac{\text{work done or energy (transformed) (from electrical to other forms)}}{\text{charge}}$ B1 [1]

**(b)** **(i)** **1.** $V = IR$ *or* $E = IR$ C1

$I = 14 / 6.0$
$= 2.3\ (2.33)$ A A1 [2]

**2.** total resistance of parallel resistors = $8.0\,\Omega$ C1

current $= 14 / (6.0 + 8.0)$
$= 1.0$ A A1 [2]

**(ii)** $P = EI$ (*allow* $P = VI$) *or* $P = V^2 / R$ *or* $P = I^2R$ C1

change in power $= (14 \times 2.33) - (14 \times 1.0)$
*or* $(14^2 / 6.0) - (14^2 / 14)$
*or* $(2.33^2 \times 6.0) - (1.0^2 \times 14)$

= 19 W (18 W if 2.3 A used) A1 [2]

**(c)** $I = Anvq$

ratio $= (0.50n / n) \times (1.8A / A)$ or ratio $= 0.50 \times 1.8$ C1

= 0.90 A1 [2]

© UCLES 2016

**7** **(a)** hadron not a fundamental particle/lepton is fundamental particle
*or*
hadron made of quarks/lepton not made of quarks
*or*
strong force/interaction acts on hadrons/does not act on leptons — B1 [1]

**(b)** **(i)** proton: up, up, down / uud — B1
neutron: up, down, down / udd — B1 [2]

**(ii)** composition: 2(uud) + 2(udd)
= 6 up, 6 down / 6u, 6d — B1 [1]

**(c)** **(i)** most of the atom is empty space
*or*
the nucleus (volume) is (very) small compared to the atom — B1 [1]

**(ii)** nucleus is (positively) charged — B1

the mass is concentrated in (very small) nucleus/small region/small volume/small core
*or*
the majority of mass in (very small) nucleus/small region/small volume/small core — B1 [2]

© UCLES 2016