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**

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**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]

**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)

**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 Ω 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]

**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]