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.

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

(b) (i) \( d = \left( \frac{(6 \times 7.5)}{(\pi \times 8100)} \right)^{1/3} \)

\[ = 0.12(1) \, \text{m} \] 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

\[ d = 0.121 \pm 0.004 \, \text{m} \] A1 [3]

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

(b) (i) time = \( 5.9 \times 10^{-2} / 3.7 \times 10^7 \)

\[ = 1.6 \times 10^{-9} \, \text{s} \] (1.59 \times 10^{-9} s) A1 [1]

(ii) \( E = V/d \)

\[ = \frac{2500}{4.0 \times 10^{-2}} \]

\[ = 6.3 \times 10^4 \, \text{NC}^{-1} \] (6.25 \times 10^4 or 62500 NC^{-1}) A1 [2]

(iii) \( a = Eq/m \) or \( F = ma \) and \( F = Eq \)

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

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

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

\[ = 1.4 \times 10^{-2} \, \text{m} \] C1

distance from plate = 2.0 – 1.4

\[ = 0.6 \, \text{cm} \] (allow 1 or more s.f.) A1 [3]

(v) electric force \( \gg \) gravitational force (on electron)/weight or acceleration due to electric field \( \gg \) 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) \( k = \frac{F}{x} \) or \( k = \text{gradient} \) C1

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

(ii) \( (W =) \frac{1}{2} kx^2 \) or \( (W =) \frac{1}{2} Fx \) 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. \( (E_k =) \frac{1}{2}mv^2 \) C1

\[ = \frac{1}{2} \times 0.025 \times 6.0^2 \]
\[ = 0.45 \text{ J} \] 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

\[ = \frac{0.45}{0.48} \times 100 \]
\[ = 0.94 \text{ or } 94\% \] A1 [2]

4 (a) the number of oscillations per unit time M1


or the number of wavelengths/wavefronts per unit time passing a (fixed) point (M1) (A1)

(b) \( T \) or period = \( 2.5 \times 250 \) (\( \mu \text{s} \)) (= 625 \( \mu \text{s} \)) M1

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

(c) (i) for maximum frequency: \( f_0 = f_s \frac{v}{(v - v_s)} \) C1

\[ 1640 = \frac{(1600 \times 330)}{(330 - v_s)} \]
\[ v_s = 8.049 \text{ m s}^{-1} \] 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]

repeated rise and fall/higher and then lower frequency caused by loudspeaker moving towards and away from observer (M1) (A1)
5 (a) wave incident on/passes by or through an aperture/edge
wave spreads (into geometrical shadow) B1 [2]

(b) \( n\lambda = d \sin \theta \) C1
substitution of \( \theta = 90^\circ \) or \( \sin \theta = 1 \) C1
\[ 4 \times 500 \times 10^{-9} = d \times \sin 90^\circ \]
line spacing = \[2.0 \times 10^{-6} \text{ m}\] 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) work done or energy (transformed) (from electrical to other forms) charge B1 [1]

(b) (i) 1. \( V = IR \) or \( E = IR \) C1
\[ I = \frac{14}{6.0} \]
\[ = 2.3 \text{ (2.33) A} \] A1 [2]
2. total resistance of parallel resistors = \[8.0 \text{ } \Omega\] C1
\[ \text{current} = \frac{14}{(6.0 + 8.0)} \]
\[ = 1.0 \text{ A} \] A1 [2]

(ii) \( P = EI \) (allow \( P = VI \)) or \( P = \frac{V^2}{R} \) 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) \( I = Anq \)
ratio = \((0.50n/n) \times (1.8 \text{ A/A}) \) 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:  \[2(uud) + 2(udd)\]
        \[= 6 \text{ up}, 6 \text{ down}/6u, 6d\]  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]