PHYSICS **9702/23**

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 (= 0.03×0.121) = 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* $F = ma$ <u>and</u> $F = Eq$ 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 $\gg$ 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) $k = F/x$ or $k =$ gradient   C1

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

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

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

(iii) 1. $(E_K =)$ ½mv^2 C1

$= ½ \times 0.025 \times 6.0^2$

$= 0.45 \, J$ 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

$= 0.75 \, N$ 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 $= 2.5 \times 250$ (μs) ($= 625 \, \mu s$)   M1

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

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

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

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

(ii) loudspeaker moving towards observer causes rise in/hig<u>her</u> frequency   B1
loudspeaker moving away from observer causes fall in/low<u>er</u> frequency   B1   [2]
or
<u>repeated</u> 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 $= 2.0 \times 10^{-6}\,\text{m}$ A1   [3]

     (c) wavelength of red light is long<u>er</u> (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

              $I = 14/6.0$

                $= 2.3\,(2.33)\,\text{A}$ A1   [2]

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

             current $= 14/(6.0 + 8.0)$

                      $= 1.0\,\text{A}$ 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 $(2.33^2 \times 6.0) - (1.0^2 \times 14)$

                        $= 19\,\text{W}$ (18 W if 2.3 A used)   A1   [2]

     (c) $I = Anvq$

        ratio $= (0.50n/n) \times (1.8\,A/A)$ *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 up, 6 down / 6u, 6d   B1   [1]

(c) (i) <u>most</u> of the atom is empty space
or
the nucleus (volume) is (very) small <u>compared to the atom</u>   B1   [1]

(ii) <u>nucleus</u> 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]

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