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 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.
1 (a) spacing = 380 or $3.8 \times 10^2$ pm

(b) time = $24 \times 3600$
   time = 0.086 (0.0864) Ms

(c) time = distance / speed = $\frac{1.5 \times 10^{11}}{3 \times 10^8}$
   = 500 (s) = 8.3 min

(d) momentum and weight

(e) (i) arrow to the right of plane direction (about 4° to 24°)

(ii) scale diagram drawn
   or use of cosine formula $v^2 = 250^2 + 36^2 - 2 \times 250 \times 36 \times \cos 45^\circ$
   or resolving $v = \sqrt{(36 \cos 45^\circ)^2 + (250 - 36 \sin 45^\circ)^2}$
   resultant velocity = 226 (220 – 240 for scale diagram) m s$^{-1}$
   allow one mark for values 210 to 219 or 241 to 250 m s$^{-1}$
   or use of formula ($v^2 = 51068$) $v = 230$ (226) m s$^{-1}$

2 (a) (i) accelerations (A to B and B to C) are same magnitude
   accelerations (A to B and B to C) are opposite directions
   or both accelerations are toward B
   (A to B and B to C) the component of the weight down the slope provides
   the acceleration

(ii) acceleration = $g \sin 15^\circ$
   $s = 0 + \frac{1}{2} at^2$
   $s = 0.26 / \sin 15^\circ = 1.0$

   $t^2 = \frac{1.0 \times 2}{9.8 \times \sin 15^\circ}$
   $t = 0.89$ s

(iii) $v = 0 + g \sin 15t$ or $v^2 = 0 + 2g \sin 15 \times 1.0$
   $v = 2.26$ m s$^{-1}$
   (using loss of GPE = gain KE can score full marks)

(b) loss of GPE at A = gain in GPE at C or loss of KE at B = gain in GPE at C
   $h_1 = h_2 = 0.26$ m and $\frac{1}{2} mv^2 = mgh$
   $h_2 = 0.5 \times (2.26)^2 / 9.81 = 0.26$ m
   $x = 0.26 / \sin 30^\circ = 0.52$ m

3 (a) power is the rate of doing work or power = work done / time (taken) or
   power = energy transferred / time (taken)

(b) (i) as the speed increases drag / air resistance increases
   resultant force reduces hence acceleration is less
   constant speed when resultant force is zero
   (allow one mark for speed increases and acceleration decreases)
(ii) force from cyclist = drag force / resistive force  
   \[ P = 12 \times 48 \]  
   \[ P = 576 \text{ W} \]  
   A0 [2]

(iii) tangent drawn at speed = 8.0 m s\(^{-1}\)  
   gradient values that show acceleration between 0.44 to 0.48 m s\(^{-2}\)  
   A1 [2]

(iv) \[ F = ma \]  
   \[ \frac{600}{8} - R = 80 \times 0.5 \]  
   [using \( P = 576 \)] \[ \frac{576}{8} - R = 80 \times 0.5 \]  
   \[ R = 75 - 40 = 35 \text{ N} \]  
   \[ R = 72 - 40 = 32 \text{ N} \]  
   A1 [3]

(v) at 12 m s\(^{-1}\) drag is 48 N, at 8 m s\(^{-1}\) drag is 35 or 32 N  
   \( R / v \) calculated as 4 and 4 or 4.4  
   and consistent response for whether \( R \) is proportional to \( v \) or not  
   B1 [1]

4 (a) e.m.f. = chemical energy to electrical energy  
   p.d. = electrical energy to thermal energy  
   idea of per unit charge  
   M1  
   M1  
   A1 [3]

(b) \[ E = I (R + r) \] or \[ I = E / (R + r) \]  
    (any subject)  
   B1 [1]

(c) (i) \[ E = 5.8 \text{ V} \]  
   B1 [1]

   (ii) evidence of gradient calculation or calculation with values from graph  
    e.g. \[ 5.8 = 4 + 1.0 \times r \]  
    \[ r = 1.8 \Omega \]  
    A1 [2]

(d) (i) \[ P = VI \]  
   \[ P = 2.9 \times 1.6 = 4.6 (4.64) \text{ W} \]  
   A1 [2]

   (ii) power from battery = 1.6 \times 5.8 = 9.28 or efficiency = \( \frac{VI}{EI} \)  
    efficiency = \( \frac{4.64 / 9.28 \times 100 = 50 \% \text{ or } (2.9 / 5.8) \times 100 = 50\%} \)  
    A1 [2]

5 (a) travel through a vacuum / free space  
   B1 [1]

(b) (i) B : name: microwaves wavelength: \( 10^{-4} \text{ to } 10^{-1} \text{ m} \)  
    C : name: ultra-violet / UV wavelength: \( 10^{-7} \text{ to } 10^{-5} \text{ m} \)  
    F : name: X –rays wavelength: \( 10^{-9} \text{ to } 10^{-12} \text{ m} \)  
    B1  
    B1  
    B1 [3]

   (ii) \[ f = \frac{3 \times 10^8}{500 \times 10^{-6}} \]  
    \[ f = 600 \times 10^{14} \text{ Hz} \]  
    A1 [2]
(c) vibrations are in one direction perpendicular to direction of propagation / energy transfer or good sketch showing this  M1 A1 [2]

6 (a) (i) electron  B1 [1]

(ii) any two: can be deflected by electric and magnetic fields or negatively charged / absorbed by few (1 – 4) mm of aluminum / 0.5 to 2 m or metres for range in air / speed up to 0.99c / range of speeds / energies  B2 [2]

(iii) decay occurs and cannot be affected by external / environmental factors or two stated factors such as chemical / pressure / temperature / humidity  B1 [1]

(b) 3 and 0 for superscript numbers 2 and –1 for subscript numbers  B1 B1 [2]

(c) energy = $5.7 \times 10^3 \times 1.6 \times 10^{-19}$ (= $9.12 \times 10^{-16}$ J)  C1

$$v^2 = \frac{2 \times 9.12 \times 10^{-16}}{9.11 \times 10^{-31}}$$  C1

$$v = 4.5 \times 10^7 \text{ m s}^{-1}$$  A1 [3]

(d) both have 1 proton and 1 electron 1 neutron in hydrogen-2 and 2 neutrons in hydrogen-3 (special case: for one mark ‘same number of protons / atomic number different number of neutrons’ )  B1 B1 [2]