2014 Y6 H1 Physics Prelim P2 MS

1 **(a)** $s_Y = u_Y t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2s_Y}{a}} = \sqrt{\frac{2\times 20}{9.81}}$ [M1]

$= 2.0$ s [A1]

(b) Both helicopter and package have the same horizontal velocity and travel the same horizontal distance in the time taken for the package to reach the ground. [C1]

$s = 0$ m [A1]

(c) $v_X = 8.0$ m s^{-1} [M1]

$v_Y = u_Y + at = 9.81\times 2.0 = 19.8$ m s^{-1} [M1]

$v = \sqrt{v_X^2 + v_Y^2} = \sqrt{8.0^2 + 19.8^2} = 21.4$ m s^{-1} [A1]

$\theta = \tan^{-1}\left(\frac{19.8}{8.0}\right) = 68\ °$

Direction: 68 ° below the horizontal [A1]

2 **(a)** KE $= \frac{1}{2}mv^2 = \frac{1}{2}(0.400)(2.5)^2 = 1.3$ J [M1]

(b) **(i)** Elastic potential energy is the energy stored in a body as a consequence of its shape. [B1]

(ii) Considering principle of conservation of energy:

$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$ [C1]

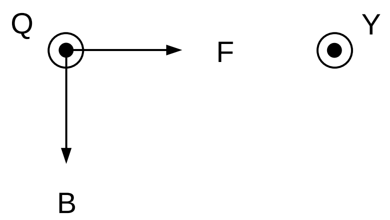
$x = v\sqrt{\frac{m}{k}} = 2.5\sqrt{\frac{0.400}{20}}$

$= 0.35$ m [A1]

(iii) The force constant of the spring is doubled. [C1]
Hence the maximum compression of the spring is smaller. [A1]

(c) The horizontal distance travelled by both trolleys is the same. Because the average horizontal speed of trolley B is higher than that of trolley A [M1], trolley B will reach the finish line first. [A1]

3 **(a)** **(i)**



(ii) The force acting on PQ increases in magnitude as PQ approaches XY. [M1]
Hence wire PQ moves towards XY with increasing velocity and acceleration. [A1]

(b) **(i)** When wire PQ is placed near CD
the <u>magnetic force</u> on CD [B1]
(due to magnetic field generated by current in PQ)

is <u>upwards</u> and <u>greater</u> than weight of CD [B1]

(ii) as CD moves away from PQ, magnetic force decreases [B1]

CD can remain in equilibrium
when magnetic force on CD is equal to weight of CD [B1]

4 **(a)** **(i)** arrow from -0.85 eV level to -1.5 eV level [B1]

(ii) $\Delta E = \frac{hc}{\lambda}$

$= (1.5 - 0.85)(1.6 \times 10^{-19})$ [C1]

$\lambda = \frac{hc}{\Delta E} = \frac{(6.63\times10^{-34})(3\times10^{8})}{(1.5-0.85)(1.6\times10^{-19})} = 1.9 \times 10^{-6}\ \mathrm{m}$ [A1]

(b) continuous spectrum crossed by darker lines [B1]
three darker lines [B1]

electrons in gas absorb photons [B1]
with energies equal to excitation energies [B1]
photons re-emitted in all directions [B1]

5 **(a)** Take log on both sides of the equation
lg(q) = lg(ρ/2) + n lg(v) [C1]

A graph of lg q against lg v will be a straight line [A1]

with gradient = n and y-intercept = lg (ρ/2) [A1]
if the equation is valid.

(b) **(i)** 3.650

(ii) point plotted correctly [B1]

(c) **(i)** at lower altitude, P_S is larger
blocked tube, no change in P_T [M1]

$q = P_T - P_S$ and hence the calculated v will decrease. [A1]

(ii) sensible answer eg ice,dirt [B1]

6 **(a)** Force is the rate of change of momentum of an object which is free to move. The direction of the force is in the direction of the change of momentum.

(b) **(i)** $T_B - W_Y \sin\theta = m_Y a$ [M1]

$T_B = W_Y \sin\theta + m_Y a = m_Y(g\sin\theta + a)$ [A1]

(ii) $T_A - T_B - W_X \sin\theta = m_X a$ [M1]

$T_A = T_B + W_X \sin\theta + m_X a = m_Y(g\sin\theta + a) + m_X(g\sin\theta + a)$

$= (m_X + m_Y)(g\sin\theta + a)$ [A1]

(iii) $\dfrac{T_A}{T_B} = \dfrac{m_X + m_Y}{m_Y} = \dfrac{95}{50} = 1.9$ [A1]

(iv) Rope B will break first. [B1] When tension in rope B reaches 500 N, the tension in rope A will only be 950 N < 1000 N. [B1]

(c) Let F_P and F_Q be the resultant forces acting on blocks P and Q respectively.

$F_P = T + m_P g\sin\theta = m_P a$ -------------- Eqn 1

$F_Q = m_Q g\sin\theta - T = m_Q a$ -------------- Eqn 2 [M1]

$a = \dfrac{T + m_P g\sin\theta}{m_P} = \dfrac{T}{m_P} + g\sin\theta$ (from Eqn 1)

$m_Q g\sin\theta - T = m_Q\left(\dfrac{T}{m_P} + g\sin\theta\right) = \left(\dfrac{m_Q}{m_P}\right)T + m_Q g\sin\theta$ [M1]

$\left(1 + \dfrac{m_Q}{m_P}\right)T = 0$ [M1]

$T = 0$ N [A1]

(d) The distance between the blocks will remain the same. [B1] Both blocks start from rest and have the same constant acceleration of $g\sin\theta$ along the slope [B1], so both blocks will have the same speed at any point in time. [B1]

(e) **(i)** Considering rotational equilibrium about M:

Sum of clockwise moments = anticlockwise moment

$(W_B \times 7.0) + (W_M \times 12.0) + (400 \times 16.0) = T \times 32.0\sin 25°$ [M1]

$T = 1370$ N [A1]

(ii) $(W_B \times 7.0) + (W_M \times L) + (400 \times 16.0) = 1800 \times 32.0\sin 25°$ [M1]

$L = 18.4$ m [A1]

7 **(a)** **(i)** Diffraction is the spreading of waves at an edge or a slit so that the waves do not travel in straight lines. [B1]

(ii) Fig 2.1(a) approximately circular wavefronts [B1]
Centred on gap [B1]
Fig. 2.1(b) wavefronts plane at centre [B1]
Curved at edges [B1]
Constant wavelength (in both (a) and (b)) [B1]

(b) **(i)** to produce coherent sources at the two slits [B1]

(ii) intensity = k(amplitude)^2 → amplitude of each wave = $\sqrt{\frac{I}{k}}$

resultant intensity = k(resultant amplitude)^2

$$= k\left[\sqrt{\frac{I}{k}} + \sqrt{\frac{I}{k}}\right]^2$$ [C1]

$= 4\,I$ [A1]

(iii) π rad OR 180° [B1]

(iv) light from s_1 and s_2 interferes destructively
leaves light from s_3 at P [M1]
P not dark [A1]

(c) **(i)** Sound wave gets reflected after hitting closed end of pipe [B1]
Stationary wave formed by interference / superposition / overlap of incident wave and reflected wave [B1]
Nodes and antinodes form along the length of the stationary wave [B1]

(ii) At displacement antinodes (where there are no heaps), wave has maximum amplitude of vibrations [B1]
At displacement nodes (where there are heaps), amplitude of vibration is zero [B1]
Dust is pushed to settle at displacement nodes [B1]

(iii) $2.5\lambda = 39.0$ cm [C1]
$v = f\lambda$
$v = 2.14 \times 10^3 \times 15.6 \times 10^{-2}$
$= 334$ m s^{-1} (allow 330 but not 340) [A1]

8 **(a)** The resistance R of a conductor is defined as the ratio $\frac{V}{I}$ where V is the potential difference across the conductor and I is the current flowing in it.

(b) **(i)** Read off the values of V and I for any point on the graph. The ratio $\frac{V}{I}$ is the resistance of component C.

(ii) $R = \frac{V}{I} = \frac{7.6}{0.80}$ [M1]

$= 9.5\ \Omega$ [A1]

Acceptable range: 9.30 – 9.55

(c) $V_C = 4.0\text{ V}$ [C1]

$V_r = 12 - 6.0 - 4.0 = 2.0\text{ V}$

$I_r = I_8 = \frac{6.0}{8.0} = 0.75\text{ A}$

$r = \frac{V_r}{I_r} = \frac{2.0}{0.75} = 2.67\ \Omega$ [A1]

$I_R = 0.75 - 0.65 = 0.10\text{ A}$

$R = \frac{V_R}{I_R} = \frac{4.0}{0.10} = 40\ \Omega$ [A1]

(d) **(i)** 0 V. [B1] There is no electrical component connected between points K and M, and the total resistance of wires and switch connecting points K and M is negligible. [B1] Applying the equation $V = IR$, potential difference across the points must be zero.

(ii) $V_C = 9.6\text{ V}$

$I_{total} = I_C + I_8 = 1.3 + \frac{9.6}{8.0} = 2.5\text{ A}$ [M1]

Let R_{eff} be the effective resistance of resistor R and the LDR.

$R_{eff} = \frac{V_{LDR}}{I_{total}} = \frac{14 - 9.6}{2.5} = 1.76\ \Omega$ [M1]

$\frac{1}{R_{eff}} = \frac{1}{R} + \frac{1}{R_{LDR}}$

$R_{LDR} = 2.26\ \Omega$ [A1]

(e) (i) $V_K = \left(\dfrac{8.0}{8.0+6.0}\right)\times 14 = 8.0\text{ V}$ [M1]

When light of high intensity is incident :

$V_M = 8.0 - 3.6 = 4.4\text{ V}$ [M1]

$V_M = \left(\dfrac{R_{LDR}}{R_{LDR}+8.0}\right)\times 14$ [M1]

$R_{LDR} = 3.67\ \Omega$ [A1]

When dark :

$V_M = 8.0 + 5.2 = 13.2\text{ V}$

$V_M = \left(\dfrac{R_{LDR}}{R_{LDR}+8.0}\right)\times 14$

$R_{LDR} = 132\ \Omega$ [A1]

(ii) Device should be connected across points L and M. [B1]
When intensity of light is low, resistance of LDR is high. Applying the potential divider principle, the potential difference across points L and M will be low, and device is switched off. [B1]
When intensity of light is high, resistance of LDR is low. The potential difference across points L and M will be high, and device is switched on. [B1]