Dunman High School **Year 5 Holiday Home Revision Set A** Answers

1 **(a)** $v=\sqrt{\dfrac{Tl}{m}}=\sqrt{\dfrac{20(1.50)}{0.0095}}$ [M1]

$= 56\text{ m s}^{-1}$ [A1]

(b) $\dfrac{\Delta v}{v}=\dfrac{1}{2}\left(\dfrac{\Delta T}{T}+\dfrac{\Delta l}{l}+\dfrac{\Delta m}{m}\right)=\dfrac{1}{2}\left(0.05+0.01+0.02\right)=0.04$ [C1]

$\Delta v = 0.04 \times 56 = 2.2$ [M1]

$v = (56 \pm 2)\text{ m s}^{-1}$ [A1]

2 **(a)** $s = ut$

$150 = (45\cos 50)t$ [M1]

$t = 5.19\text{ s}$ [A0]

(b) $s = ut+\dfrac{1}{2}at^2$

$= (45\sin 50 \times 5.19)+\dfrac{1}{2}(-9.81)(5.19)^2$ [M1]

$= 47\text{ m}$ [A1]

(c) $v^2 = u^2 + 2as$

$0 = u^2 + 2(-9.81)(47)$ [M1]

$u = 30\text{ m s}^{-1}$ [A1]

(d) $v = u + gt$

$0 = 30 + (-9.81)t$ [M1]

$t = 3.1\text{ s}$ [A1]

Time to throw the apple after launch of arrow is 5.19 – 3.1 = 2.1 s. [A1]

3 **(a)** The principle of conservation of momentum states that the total momentum of a system of bodies is constant [B1], provided no external resultant force acts on it [B1].

(b) Elastic potential energy stored by spring $=\dfrac{1}{2}kx^2$

$=\dfrac{1}{2}(1330)(0.15)^2 = 14.96\text{ J}$ [M1]

Elastic potential energy stored by spring = Change in kinetic energy of A

$14.96=\dfrac{1}{2}(1.5)v^2-0$

$v = 4.47\text{ m s}^{-1}$ [A1]

(c) Let the common final velocity be v_2.

By conservation of momentum,

$m(4.47) = (2.5m)\, v_2 \quad (m = 1.5 \text{ kg})$ [M1]

$v_2 = 1.79 \text{ m s}^{-1}$ [A1]

(d) By conservation of energy,

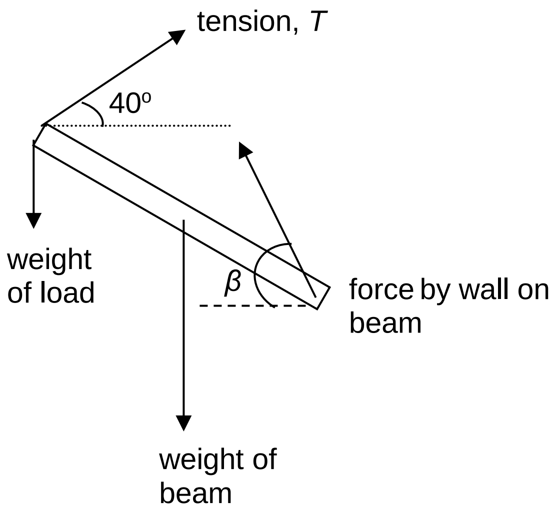
$$E_{ki} + E_{pi} + W_f = E_{kf} + E_{pf}$$

$$\frac{1}{2}(2.5\ m)(1.79)^2 + 0 + (-8.5)(s) = 0 + (2.5\ m)(9.81)(s)(\sin 30^\circ)$$ [M1]

$s = 0.223$ m [A1]

4 (a) Resultant force on it must be zero in any direction. [B1]
Resultant torque on it must be zero about any axis of rotation. [B1]

(b) (i)



All forces correctly labelled. [B1]

Correct directions of forces. [B1]

(ii) Let x be the distance of c.g of beam from the hinge.

By principle of moments,

Taking moments about hinge,

Sum of clockwise moments = sum of anticlockwise moments

$$120\sin 40^0(5\sin 70^0) + 120\cos 40^0(5\cos 70^0) = (5\times 9.81)(5\sin 70^0) + (20\times 9.81)(x\sin 70^0)$$ [M1]

$x = 1.57$ m [A1]

(iii) Vertical summation of forces:
$F_Y + (120)\sin 40^0 = 5g + 20g$
$F_Y = 168.1$ N

Horizontal summation of forces:
$F_X = (120)\cos 40^0$
$F_X = 91.93$ N

[C1]

$$F = \sqrt{F_X^2 + F_Y^2} = \sqrt{(91.93)^2 + (168.1)^2}$$ [M1]

$= 192$ N

$$tan\beta = \frac{168.1}{91.93}$$

$\beta = 61^0$ [A1]

4 (c)

(i)	Upthrust $= 800(4.50 \times 10^{-4})(9.81) = 3.5316 \approx 3.53$ N	[1] for correct substitution
(ii)	At equilibrium, $kx + U = mg$ $k = \dfrac{mg - U}{x}$ $k = \dfrac{8000(4.50 \times 10^{-4})(9.81) - 3.5316}{0.102} \approx 312\ \text{N m}^{-1}$	[1] for correct substitution [1] for correct answer
(iii) 1.	When the sphere is lifted out of the liquid, the volume of liquid displaced is reduced. This causes the upthrust acting on sphere to decrease. To maintain equilibrium, the tension will increase and the string breaks when the tension exceeds the maximum allowable value.	[1]
(iii) 2.	At breaking point, $T + U = mg$ $32.0 + 800(V)(9.81) = 8000(4.50 \times 10^{-4})(9.81)$ $V \approx 4.23 \times 10^{-4}\ \text{m}^3$	[1] for correct substitution [1] for correct answer

5 (a) $R \cos \theta = mg$ [C1]

$R \cos 20.0^0 = 1450\ (9.81)$ [M1]

$R = 1.51 \times 10^4$ N [A0]

(b) 90 km h^{-1} $= 25$ m s^{-1} [C1]

$$R \sin\theta = \frac{mv^2}{r}$$ [C1]

$$(1.51 \times 10^4) \sin(20^o) = \frac{1450(25)^2}{r}$$ [M1]

$r = 175$ m [A1]

6 $$g = \frac{Gm}{r^2}$$

$$g_8 = \frac{G(8.00)}{(0.200)^2} = 1.33 \times 10^{-8}\ \text{m s}^{-2} \text{ pointing to the left}$$

$$g_{15} = \frac{G(15.0)}{(0.300)^2} = 1.11 \times 10^{-8}\ \text{m s}^{-2} \text{ pointing to the right}$$

[C1]

g_{net} = (1.33 −1.11) × 10^{-8} m s^{-2}

= 2.22 × 10^{-9} m s^{-2} [A1]

to the left [A1]

7 **(a)** **(i)** For P: 'U shaped' graph: potential energy + kinetic energy = 15 mJ. [A1]

(ii) For T: straight line, parallel to *x*-axis, at 15 mJ. [A1]

(b) **(i)** Maximum kinetic energy = $\frac{1}{2}m\omega^2 A^2$

$15 \times 10^{-3} = \frac{1}{2}(0.150)(2\pi f)^2(5 \times 10^{-2})^2$ [M1]

$f = 1.4$ Hz [A1]

(ii) Using $a = (-)\omega^2 x$

$= (2\pi 1.4)^2(0.02)$ [M1]

$= 1.55$ or 1.6 m s^{-2} [A1]

(c) **(i)** It is the (continuous/ gradual) loss of energy (from the system) or decrease in amplitude [B1] due to (additional) force (acting on the mass) always opposing motion. [B1]

(ii) New kinetic energy = 0.8 × 15 = 12 mJ

From **(b) (i)** kinetic energy $\propto A^2$

$$\frac{KE_f}{KE_i} = \frac{12}{15} = 0.8 = \left(\frac{A}{5}\right)^2 \quad \text{[M1]}$$

$A = 4.5$ cm [A1]

OR Loss in kinetic energy = 0.2 × 15 = 3 mJ
So draw a horizontal line with kinetic energy = 3 mJ [C1]. The point of intersection with existing kinetic energy graph gives the amplitude on the *x*-axis = 4.5 cm. [A1]

8 **(a)**

(i) $Q = It = 0.03(60 \times 60) = 108$ C B1

(ii) $W = VQ = 2.5(108) = 270$ J OR $P = IV = 0.030(2.5) = 0.075$ W B1

$P = \frac{270}{60 \times 60} = 0.075$ W

(iii) $R = \frac{V}{I} = \frac{2.5}{0.03} = 83\ \Omega$ B1

(b)

(i) $R_{max} = \dfrac{V_{max}}{I} = \dfrac{5.0}{25} = 0.20\ \Omega$ B1

$R = \rho\dfrac{l}{A} = \rho\dfrac{l}{\pi\left(\dfrac{d}{2}\right)^2} = \rho\dfrac{4l}{\pi d^2}$ C1

$d_{min} = \sqrt{\rho\dfrac{4l}{\pi R_{max}}} = \sqrt{\left(4.8\times10^{-7}\right)\left(\dfrac{4\times15}{\pi\times0.20}\right)} = 6.77\times10^{-3}\ \text{m}$ A1

(ii) **1.** $R = \rho\dfrac{l}{A}$

Resistance per metre $= \dfrac{R}{l} = \dfrac{\rho}{A} = \dfrac{4.8\times10^{-7}}{\pi\left(\dfrac{d}{2}\right)^2} = \dfrac{4\left(4.8\times10^{-7}\right)}{\pi\left(0.35\times10^{-3}\right)^2}$ B1

$= 5.0\ \Omega\ \text{m}^{-1}$ A1

2. Resistance of filament, $R = V^2 / P = 12^2 / 30 = 4.8\ \Omega$ B1

Length of wire, $l = 4.8 / 5.0 = 0.96$ m B1