Mark scheme for Extension Worksheet – Topic 2, Worksheet 1

1 Let the acceleration be a. Then the distance travelled between $t = 1$ s and $t = 2$ s is $s_1 = \frac{1}{2}a \times 2^2 - \frac{1}{2}a \times 1^2 = \frac{3a}{2}$. The distance travelled in the next second is $s_1 = \frac{1}{2}a \times 3^2 - \frac{1}{2}a \times 2^2 = \frac{5a}{2}$; and so the ratio is $\frac{\frac{3a}{2}}{\frac{5a}{2}} = \frac{3}{5}$. [2]

2 We look for the curve that has zero slope at time zero and that is the blue curve which stretches from (0, 1) to (2.0, 5). [1]

3 Get the components of the force R along the horizontal and the vertical direction gives $R_x = R\sin\theta$ and $R_y = R\cos\theta$, demanding equilibrium: $R\sin\theta = 30$ and $R\cos\theta = 120$; dividing side by side gives $\tan\theta = \frac{30}{120} \Rightarrow \theta = 14°$; and $(R\sin\theta)^2 + (R\cos\theta)^2 = R^2 = 30^2 + 120^2 \Rightarrow R = 124$ N . [3]

4 **a** The vertical component of the tension force is $T\cos\theta$, and so $2T\cos\theta = W \Rightarrow T = \frac{W}{2\cos\theta}$. [2]

b If the strings are shortened the angle θ becomes larger and its cosine smaller; hence the tension increases. [2]

5 Treating the two blocks as one we see that the acceleration of each has to be: $a = \frac{9.0}{3.5} = 2.57$ m s^{-2} ; the net force on the top block is the frictional force f directed to the right; and so $f = ma = 1.5 \times 2.57 \approx 3.9$ N. [3]

6 **a** $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 0.30}$; $v = 2.4$ m s^{-1}. [2]

b The rate of change of the momentum of the sugar is the net force on the sugar; this is $\frac{\Delta m}{\Delta t}v = 0.040 \times 2.4 = 0.096$ N ; the weight of the sugar after 5.0 s is $mg = 5.0 \times 0.040 \times 9.8 = 1.96$ N so $R - 1.96 = 0.096 \Rightarrow R = 2.1$ N. [3]

c $\frac{2.1}{9.8} = 0.214$ kg $= 214$ g. [1]

7 The statement is false since impulse is $F_{ave} \times \Delta t$ where F_{ave} is the average force acting for an interval of time Δt; a small force can therefore have a very large impulse if it acts for a much longer time. [2]