

## Mechanics Homework 1 - Modelling solutions

### Section 1

1.) a.) Perimeter =  $2(2\sqrt{3}) + 2(3\sqrt{3}) = 4\sqrt{3} + 6\sqrt{3} = \underline{\underline{10\sqrt{3} \text{ cm}}}$

b.) Area =  $(2\sqrt{3})(3\sqrt{3}) = 6 \times 3 = \underline{\underline{18 \text{ cm}^2}}$

c.) Diagonal =  $\sqrt{(2\sqrt{3})^2 + (3\sqrt{3})^2}$   
 $= \sqrt{12 + 27} = \underline{\underline{\sqrt{39} \text{ cm}}}$

2.)  $\frac{7-\sqrt{2}}{\sqrt{2}-1} = \frac{(7-\sqrt{2})(\sqrt{2}+1)}{(\sqrt{2}-1)(\sqrt{2}+1)} = \frac{7\sqrt{2}-2+7-\sqrt{2}}{2-1} = (5+6\sqrt{2}) \text{ cm}$

3.)  $\sqrt{(3\sqrt{11})^2 - (2\sqrt{6})^2} = \sqrt{99-24} = \sqrt{75} = \underline{\underline{5\sqrt{3} \text{ cm}}}$

4.)  $5x(x-10)(x-8) = 5x(x^2-18x+80) = 5x^3-90x^2+400x$

5.) a.)  $-2h^2+13h-20=0 \quad h=4 \text{ or } 2.5 \Rightarrow \underline{\underline{2.30 \text{ pm}}}$  and  $\underline{\underline{4 \text{ pm}}}$

b.) By symmetry,  $h=3.25 \Rightarrow T = -2(3.25)^2 + 13(3.25) - 20$   
 $= 1.125$

Max temperature is  $\underline{\underline{1.125^\circ \text{C}}}$  at  $\underline{\underline{3.15 \text{ pm}}}$

## Section 2

1) a)  $54 \text{ km h}^{-1} = \frac{54 \times 1000}{3600} = \underline{\underline{15 \text{ ms}^{-1}}}$

b)  $1500 \text{ mm per minute} = \frac{1500}{60 \times 1000} = \underline{\underline{0.025 \text{ ms}^{-1}}}$

c)  $24 \text{ g cm}^{-3} = \frac{24}{1000} \times 100^3 = \underline{\underline{24000 \text{ kg m}^{-3}}}$

d)  $140 \text{ tonnes per km}^2 = \frac{140 \times 1000}{1000^2} = \underline{\underline{0.14 \text{ kg m}^{-2}}}$

(12)

- 2) a) Cricket ball as particle, neglect air resistance  
b) Curling stone as particle, neglect friction  
c) Each body as particle, light string, inextensible string, smooth pulley  
d) Children as particles, seesaw as uniform rod.

(10)

3) a)  $t=0 \Rightarrow h = \underline{\underline{25 \text{ m}}}$

b) i.)  $-3(2^2) + 12(2) + 25 = \underline{\underline{37 \text{ m}}}$

ii.)  $-3(4^2) + 12(4) + 25 = \underline{\underline{25 \text{ m}}}$

c)  $10 = -3t^2 + 12t + 25 \Rightarrow 3t^2 - 12t - 15 = 0$   
 $\Rightarrow t = \underline{\underline{5 \text{ sec}}}$  (or -1)

d)  $h = -3(8^2) + 12(8) + 25 = -71 \text{ m}$  ie 71m below ground  
 $\Rightarrow$  not realistic.

(10)

Extension question : The period is proportional to the square root of the length of the string (in fact period  $T = 2\pi \sqrt{\frac{L}{g}}$ ) It is independent of mass. Assume pendulum is particle attached to light rod, small amplitude of oscillation (small displacement)