Homework 6 solutions

(1)a)

$a_f = -g$

$v_f = -gt + c$ at $t=0$ $v_f = 0 \Rightarrow c = 0$

$s_f = -\frac{1}{2}gt^2 + c$ at $t=0$ $s_f = h \Rightarrow c = h$

$s_f = -\frac{1}{2}gt^2 + h$ ✓

$a_s = -g$

$v_s = -gt + c$ at $t=0$ $v_s = U \Rightarrow c = U$

$v_s = -gt + U$

$s_s = -\frac{1}{2}gt^2 + Ut + c$ at $t=0$ $s_s = 0 \Rightarrow c = 0$

$s_s = -\frac{1}{2}gt^2 + Ut$ ✓

because the seal is rising when it catches the fish $v_s > 0$

$$v_s = -gt + U$$

$$\Rightarrow \quad U - gt > 0 \checkmark$$

$$U > gt.$$

when seal catches the fish $s_f = s_s$

$$\Rightarrow \quad -\tfrac{1}{2}gt^2 + h = -\tfrac{1}{2}gt^2 + Ut$$

$$Ut = h$$

$$t = h/U \checkmark$$

$$U > gt$$

$$U > g\left(\frac{h}{U}\right)$$

$$U > \frac{gh}{U}$$

$$U^2 > gh \checkmark \Rightarrow \quad u > \sqrt{gh}$$

(a) $S_s = -\frac{1}{2}gt^2 + ut$

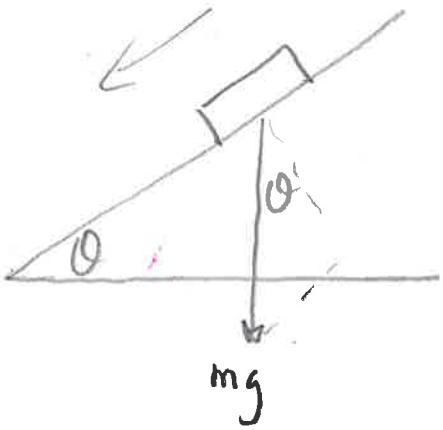
at $t = \frac{h}{u}$ $\quad S_s = -\frac{1}{2}g\left(\frac{h}{u}\right)^2 + u\left(\frac{h}{u}\right)$.

$S_s = \frac{-gh^2}{2u^2} + h$ ✓

$S_s = h - \frac{gh^2}{2u^2}$

$S_s = h\left(1 - \frac{gh}{2u^2}\right)$

(2)



$ma = mg\sin\theta$ ✓

$a = g\sin\theta$ ✓

$u = 0$

$s = s$ ✓

$v = ?$

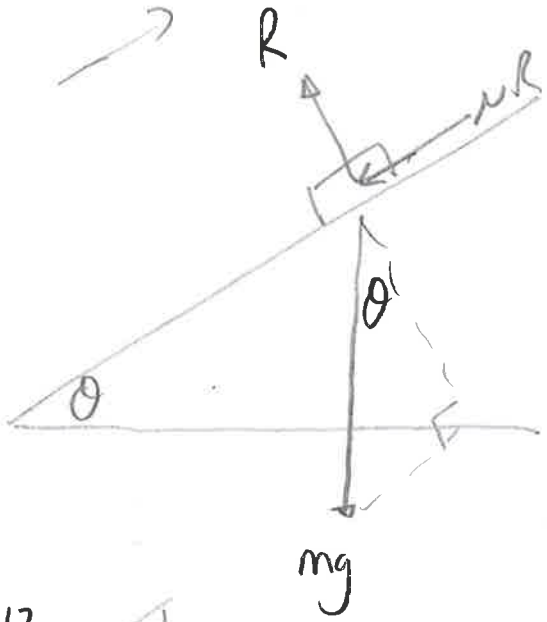
$a = g\sin\theta$

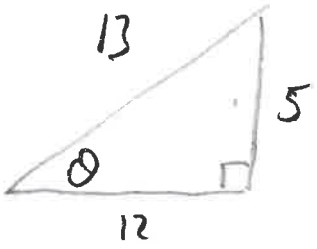
$v^2 = u^2 + 2as$

$v^2 = 2gs\sin\theta$ ✓

$v = \sqrt{2gs\sin\theta}$

(3)





$u = \sqrt{gL}$

$v = 0$

$s = L$ ✓

$ma = -mg\sin\theta - \mu R$

$R = mg\cos\theta$ ✓

$ma = -mg\sin\theta - \mu mg\cos\theta$

$a = -g\sin\theta - \mu g\cos\theta$ ✓

$a = \frac{-5}{13}g - \frac{12}{13}\mu g$

$v = 0$
$u = \sqrt{gL}$
$s = L$

$v^2 = u^2 + 2as$

$0 = (\sqrt{gL})^2 + 2\left(\frac{-5}{13}g - \frac{12}{13}\mu g\right)L$ ✓

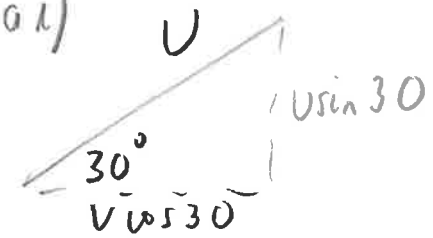
$0 = gL - \frac{10}{13}gL - \frac{24}{13}\mu gL$ ✓

$\frac{24}{13}\mu gL = \frac{3}{13}gL$ ✓

$\mu = \frac{1}{8}$ $(\mu = 0.125)$ ✓

(3)

4ai)



horizontal distance

$x = (U\cos 30)t$

$x = \frac{\sqrt{3}}{2}Ut$ ✓

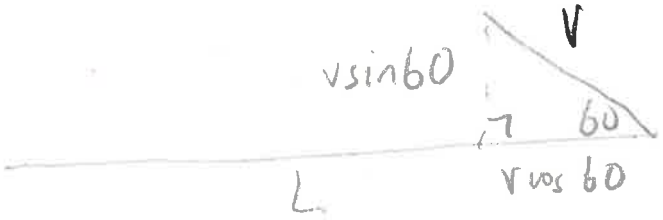
vertical distance

$y = ut + \frac{1}{2}at^2$

$y = (U\sin 30)t - \frac{1}{2}gt^2$

$y = \frac{1}{2}Ut - \frac{1}{2}gt^2$ ✓

ii)



$y = (v\sin 60)t - \frac{1}{2}gt^2$

$y = \frac{\sqrt{3}}{2}vt - \frac{1}{2}gt^2$ ✓

distance $x = L - (v\cos 60)t$ ✓

$x = L - \frac{1}{2}vt$

bi) will collide when A and B are at the same height

$\frac{1}{2}ut - \frac{1}{2}gt^2 = \frac{\sqrt{3}}{2}vt - \frac{1}{2}gt^2$ ✓

$\frac{1}{2}u = \frac{\sqrt{3}}{2}v$ ✓

$u = \sqrt{3}v$

bii) also x positions will be the same

$$\frac{\sqrt{3}}{2}Ut = L - \frac{1}{2}vt \qquad U = \sqrt{3}v$$

$$\Rightarrow \quad \frac{\sqrt{3}}{2}(\sqrt{3}v)t = L - \frac{1}{2}vt \checkmark$$

$$\frac{3}{2}vt = L - \frac{1}{2}vt$$

$$L = 2vt$$

$$vt = L/2 \checkmark$$

$$x = L - \frac{1}{2}vt$$

$$x = L - \frac{1}{2}(L/2) \checkmark$$

$$x = L - \frac{1}{4}L$$

$$x = \frac{3}{4}L \checkmark$$