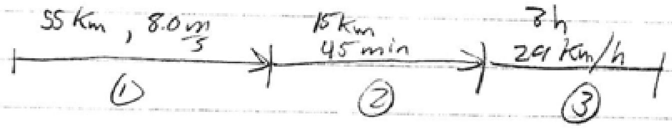
1)



	①	②	③	Total
d	55 km	15 Km	87 km	157 Km
v	$8.0\ \frac{m}{s} = 28.8\ Km/h$		29 Km/h	
t	1.91 h	45 min = 0.75 h	3 h	5.66 h

$t = \frac{d}{v}$

$= \frac{55}{28.8}$

$= 1.91\ h$

$d = vt$

$= (29)(3)$

$= 87\ Km$

$d_T = 55 + 15 + 87$

$= 157\ Km$

$t_T = 1.91 + 0.75 + 3$

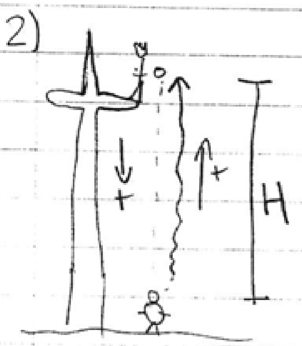
$= 5.66\ h$

$v_{AV} = \frac{d_T}{t_T}$

$= \frac{157}{5.66}$

$v_{AV} = 27.7\ \frac{Km}{h}$

2)



2 parts

Dropping (down is +)

$d = H$

$v_i = 0$

$a = 9.8\ \frac{m}{s^2}$

$t = T$

Sound (up is +)

$d = H$

$v = 340\ \frac{m}{s}$

$t = 5.2 - T$

$d = v_i t + \frac{1}{2}at^2$

$H = \frac{1}{2}(9.8)T^2$

$H = 4.9T^2$

$d = vt$

$H = 340(5.2 - T)$

$H = 1768 - 340T$

$4.9T^2 = 1768 - 340T$

$4.9T^2 + 340T - 1768 = 0$

$T = \frac{-340 \pm \sqrt{340^2 - 4(4.9)(-1768)}}{2(4.9)}$

$= \frac{-340 \pm \sqrt{115\,600 + 34652.8}}{9.8}$

$= \frac{-340 \pm \sqrt{150253}}{9.8}$

$= \frac{-340 \pm 388}{9.8}$

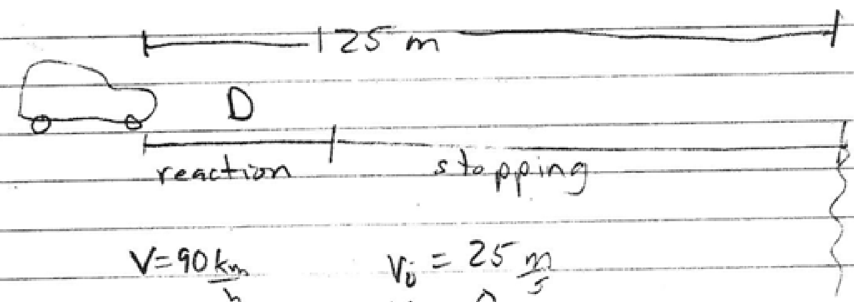
$= \frac{48}{9.8}$ or ~~< 0~~, inadmissible

$= 4.9$ s

Sub into $H = 4.9T^2$

$\boxed{H = 118 \text{ m}}$

3.



$V = 90 \frac{km}{h}$

$= 25 \frac{m}{s}$

$t = 1.5$ s

$d = D$

$d = vt$

$D = (25)(1.5)$

$= 37.5$

$V_i = 25 \frac{m}{s}$

$V_f = 0$

$d = 125 - D$

$a = ?$

$V_f^2 = V_i^2 + 2ad$

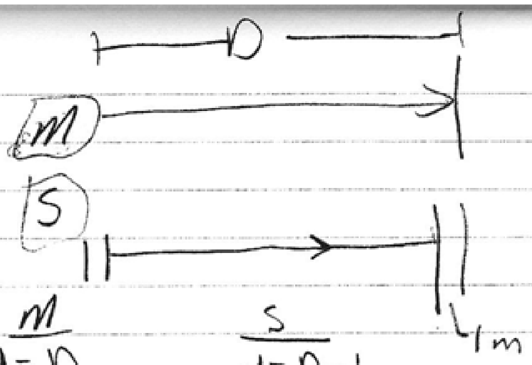
$0 = 25^2 + 2a(125 - 37.5)$

$= 625 + 2a(87.5)$

$-175a = 625$

$\boxed{a = -3.57 \frac{m}{s^2}}$

4)



M	S
$d = D$	$d = D - 1$
$t = T$	$t = T - 4.5\text{ s}$
$v_i = 0$	$v_i = 0$
$v_f = ?$	$v_f = ?$
$a = 1.2\ \frac{m}{s^2}$	$a = 15\ \frac{m}{s^2}$

$$d = v_i t + \frac{1}{2} a t^2$$

$$D = 0 + \frac{1}{2}(1.2)T^2 \qquad D - 1 = 0 + \frac{1}{2}(15)(T - 4.5)^2$$

$$D = 0.6T^2 \longrightarrow D - 1 = 7.5(T^2 - 9T + 20.25)$$

$$0.6T^2 - 1 = 7.5T^2 - 67.5T + 151.9$$

$$0 = 6.9T^2 - 67.5T + 152.9$$

$$T = \frac{67.5 \pm \sqrt{67.5^2 - 4(6.9)(152.9)}}{2(6.9)}$$

$$= \frac{67.5 \pm \sqrt{4556 - 4220}}{13.8}$$

$$= \frac{67.5 \pm \sqrt{336}}{13.8}$$

$$= \frac{67.5 \pm 18.3}{13.8}$$

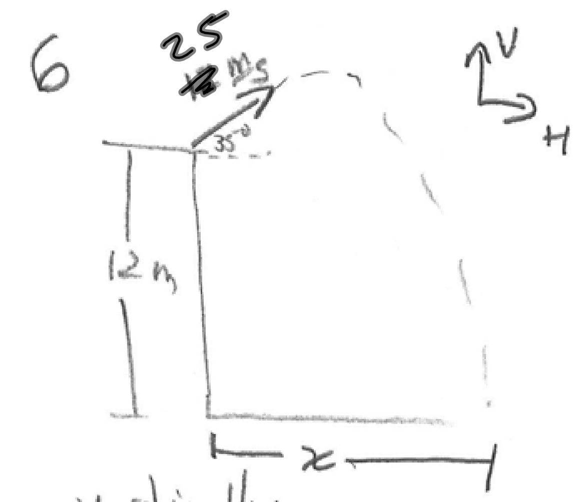
$= 3.56\text{ s}$ or $\boxed{6.22\text{ s}}$ → Sub into

$$D = 0.6T^2$$
$$= 0.6(6.22)^2$$
$$= 23.2\text{ m}$$

↑ inadmissible since it is less than 4.5 s (so Stewie hasn't started yet)

∴ The race is 23.2 m long.

6



25 m/s

25 sin 35 = 14.3 m/s

25 cos 35 = 20.5 m/s

Vertically

$v_i = 14.3\ \frac{m}{s}$

$a = -9.8\ \frac{m}{s^2}$

$d = -12\ m$

$t = T$

$d = v_i t + \frac{1}{2} a t^2$

$-12 = 14.3T - 4.9T^2$

$4.9T^2 - 14.3T - 12 = 0$

$T = \frac{14.3 \pm \sqrt{(-14.3)^2 - 4(4.9)(-12)}}{2(4.9)}$

$= \frac{14.3 \pm 21.0}{9.8}$

T < 0 inadmissible or T = 3.6 s

Horizontally

$v = 20.5\ \frac{m}{s}$

$d = x$

$t = 2.42\ s$

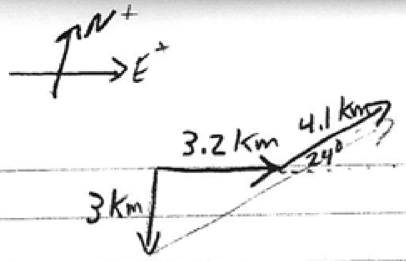
$d = vt$

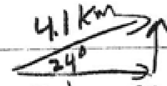
$x = (20.5)(3.6)$

$= 73.8\ m$

∴ The stone lands 73.8 m from the base of the cliff

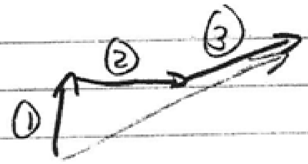
5.



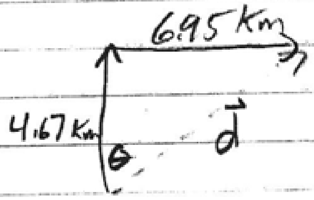


$4.1 \sin 24 = 1.67$ Km

$4.1 \cos 24 = 3.75$ Km



	N+ − S	E+ − W
①	3 Km	0
②	0	3.2 Km
③	1.67 Km	3.75 Km
	4.67 Km	6.95 Km



$d^2 = 4.67^2 + 6.95^2$

$= 70.1$

$d = 8.37$ Km

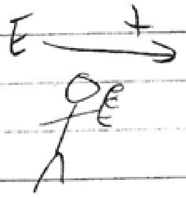
$\tan\theta = \frac{6.95}{4.67}$

$= 1.49$

$\theta = 56°$

∴ Charlie Brown must go 8.37 Km [N 56° E]

~~7~~ 6.



Calvino	Hobbes
m = 25 kg	m = 10 kg
$v_i = 0$	$v_i = 0$
$v_f = v$	$v_f = 3.5\frac{m}{s}$ (E)
a = ?	a = ?
t = ~~1~~ 0.8	t = ~~1~~ 0.8
F = ?	F = ?
d = ?	d = ?

Hobbes

$a = \frac{v_f - v_i}{t}$

$= \frac{3.5 - 0}{~~1~~\ 0.8}$

$a = ~~\frac{3.5}{1}~~\ 4.375 \frac{m}{s^2}$

∴ $F = ma$

$= (10)(~~\frac{3.5}{1}~~\ 4.375)$

= ~~35~~ 43.75 N

F = 43.75 N [E]

since F on Hobbes is $\frac{35}{T}$ (corrected to 43.75 N [E]), then F on Calvin is $-\frac{35}{T}$ (corrected to 43.75 N) (Newton's 3rd Law) or **43.75 N [W]**

Calvin

$F = ma$

$a = \frac{F}{m}$

$= \frac{-43.75}{25}$

$a = -1.75$

$V_f = V_i + at$

$V_f = 0 + ([illegible])(-1.75)(0.8)$

$V_f = -1.4\ \frac{m}{s}$

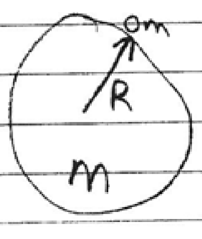
$\therefore$ Calvin's final velocity is $1.4\ \frac{m}{s}$ [W]

8. $F_g \propto m$ so if $m \times 2$ then $F_g \times 2$

$F_g \propto \frac{1}{r^2}$ so if $r \times 1.5$ the $F_g \times \frac{1}{1.5^2}$

$\therefore F_g \times 2 \times \frac{1}{1.5^2}$ so $\boxed{F_g \times 0.889}$

9.

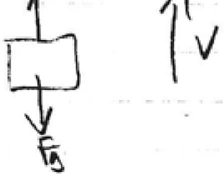


$F_g = mg$ and $F_g = \frac{GMm}{R^2}$

$\therefore mg = \frac{GMm}{R^2}$

$\boxed{g = \frac{GM}{R^2}}$

11)



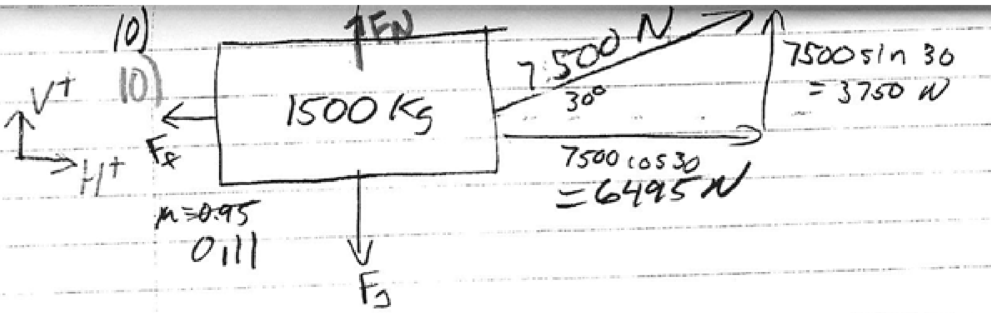
Since v is constant

$F = F_g$

$= mg$

$P = \frac{W}{t} = \frac{Fd}{t} = (mg)\left(\frac{d}{t}\right) = \boxed{mgv}$

10)



Vertically

$F_{NET} = 0$

$F_{NET} = F_N + 3750 - mg$

$0 = F_N + 3750 - (1500)(9.8)$

a) $F_N = 10950\ N$

b) $F_f = \mu F_N$

$= ~~10400\ N~~$

$= 1204.5\ N$

Horizontally

$F_{NET} = ma$

$F_{NET} = 6495 - \mu F_N$

c) ∴ $1500a = 6495 - ~~10400~~\ 1204.5$

$a = \frac{~~3900~~\ 5290.5}{1500}$

$= ~~2.6~~\ +3.53\ \frac{m}{s^2}$ ~~or a = 0 if $v_i = 0$~~

10 d) $W_f = \vec{F_f}\vec{d}$

Need $\vec{d}$

$a = 3.53\ \frac{m}{s^2}$

$v_i = 0$

$v_f = ?$

$t = 2s$

$d = v_i t + \frac{1}{2}at^2$

$d = \frac{1}{2}(3.53)(2)^2$

$= 7.06\ m$

$W_f = (1204.5)(7.06)\cos 180$

$= -8504\ J$

W_f always − since it always is in opp. direction to $\vec{d}$

e) $W_T = Fd\cos\theta$

$= (7500)(7.06)(\cos 30) = 46\,000\ J$

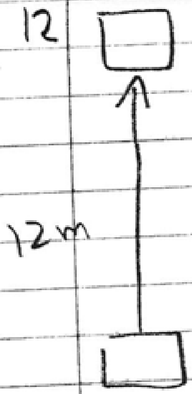
f) $\Delta E = W_{TOT}$

$= W_T + W_f$

$= (45856) + (-8504)$

$= 37\,000\ J$

12



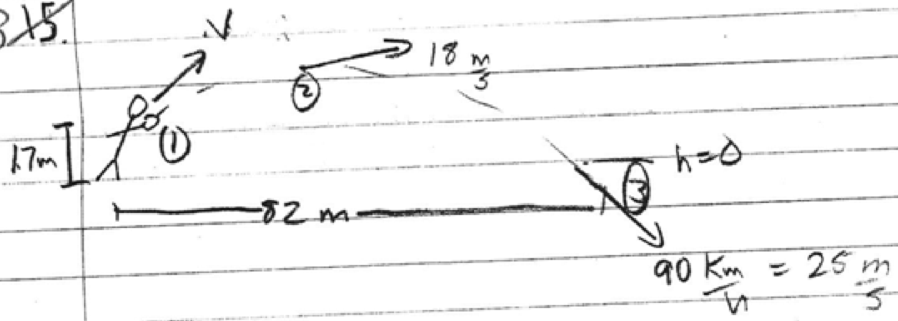
$\Delta E = mg\Delta h$
$= (450)(9.8)(12)$
$= 52920 \text{ J}$ ← OUTPUT

$P = \frac{E}{t}$
$E = Pt$
$= (6000)(24)$
$= 144\,000 \text{ J}$ ← INPUT

$v = 0.5 \frac{m}{s}$
$d = 12 m$
$t = \frac{d}{v}$
$= \frac{12}{0.5}$
$= 24 s$

$\text{eff.} = \frac{\text{OUT}}{\text{IN}} \times 100\%$
$= \frac{52920}{144000} \times 100\%$
$= 37\%$

13 ~~15~~.



a) At ①
$E_1 = \frac{1}{2}mv^2 + mgh$
$= \frac{1}{2}mv^2 + m(9.8)(1.7)$
$= \frac{1}{2}mv^2 + 16.6 m$

At ③ (h=0)
$E_3 = \frac{1}{2}m(25)^2 + \cancel{mgh}$
$= 312.5 m$

$E_1 = E_3$
$\frac{1}{2}\cancel{m}v^2 + 16.6\cancel{m} = 312.5\cancel{m}$

$\frac{1}{2}v^2 = 295.9$
$v = 24.3 \frac{m}{s}$

b) At ②
$E_2 = \frac{1}{2}m(18)^2 + m(9.8)$
$E_3 = E_2$
$312.5\cancel{m} = 162\cancel{m} + 9.8$
$150.5 = 9.8 H$
$H = 15.4 m$

c) **Method 1**

$m = 0.145\ g$
$v_i = 0$
$v_f = 24.3\ \frac{m}{s}$
$a = ?$
$d = 2.2\ m$
$F = ?$
$t = ?$

$v_f^2 = v_i^2 + 2ad$
$2ad = v_f^2 - v_i^2$
$a = \frac{v_f^2 - v_i^2}{2d}$
$= \frac{24.3^2}{2(2.2)}$
$= 134\ \frac{m}{s^2}$

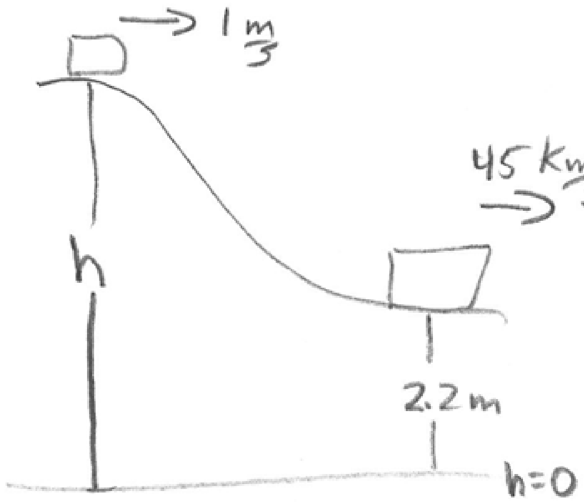
$F = ma$
$= (0.145)(134)$
$F = 19.43\ N$

Method 2

$E_i = 0$ (since $v = 0$)
$E_f = \frac{1}{2}mv^2$
$= \frac{1}{2}(0.145)(24.3)^2$
$= 42.8\ J$

$W = \Delta E$
$= 42.8\ J$
and $W = Fd$
$\therefore 42.8 = F(2.2)$
$F = 19.46\ N$

14.



① 20% energy lost means $E_f = 0.8 E_i$

② $E_f = mgh_f + \frac{1}{2} m v_f^2$

$= m(9.8)(2.2) + \frac{1}{2} m (12.5)^2$

$= 21.56m + 78.125m$

$= 99.685m$

③ $E_i = mgh_i + \frac{1}{2} m v_i^2$

$= 9.8mh + \frac{1}{2} m (1)^2$

$= 9.8mh + 0.5m$

④ $E_f = 0.8 E_i$

$99.685m = 0.8(9.8mh + 0.5m)$

$99.685 = 7.84h + 0.4$

$99.285 = 7.84h$

$h = 12.7\text{ m}$