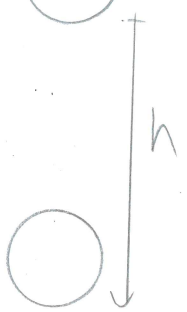
(1) (a) External force of air resistance

(b) $\frac{1}{2}$



	Before	After
K.E	0	$\frac{1}{2}(\frac{1}{2})v^2$
G.P.E	$\frac{1}{2}gh$	0
W_{in}	0	X
W_{out}	X	4h

W.E Principle.

$\times 4$ $\frac{1}{2}gh = \frac{1}{4}v^2 + 4h$ $\times 4$

$2gh = v^2 + 16h$

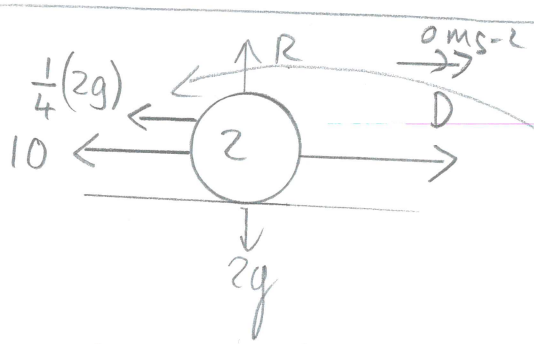
$2gh - 16h = v^2$

$2h(g-8) = v^2$

$\sqrt{2h(g-8)} = v^2$

(c) Air resistance wouldn't be constant.

(2)



Friction

$F_r = \mu R$

$= \frac{1}{4}(2g)$

$= \frac{1}{2}g$

Max Speed when $a=0$

$\therefore D - 10 - \frac{1}{4}(2g) = 0$ ← $F=ma$

$D = 10 + \frac{1}{2}g$

Power ← $P = Fv$

$600 = Dv$

$600 = (10 + \frac{1}{2}g)v$

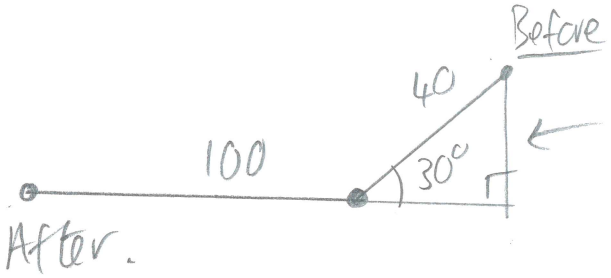
$\frac{600}{10 + \frac{1}{2}g} = v$

$40.268 = v$

$\therefore v < 41 ms^{-1}$

③ W.E Principle.

* let F be the pedalling force



	Before	After
K.E	0	$\frac{1}{2}(80)(10^2)$
G.P.E	$80g(20)$	0
W in	$140F$ *	X
W out	X	$140(100)$

$$80g(20) + 140F = \frac{1}{2}(80)(10^2) + 140(100)$$

$$1600g + 140F = 4000 + 14000$$

$$140F = 2320$$

$$F = 16.6N$$

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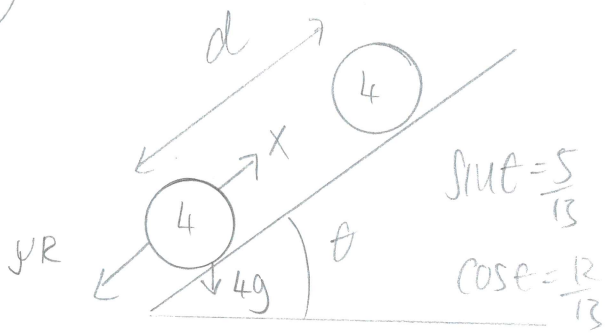
④



(a)

	Before	After
K.E	$\frac{1}{2}(4)(2^2)$	$\frac{1}{2}(4)(1^2)$
G.P.E	0	$(4g)\left(d\left(\frac{5}{13}\right)\right)$
W in	Xd	
W out		$d\left(\mu(4g)\left(\frac{12}{13}\right)\right)$

$$Xd + \frac{1}{2}(4)(4) = \frac{1}{2}(4)(1) + 4gd\left(\frac{5}{13}\right) + \mu(4dg)\left(\frac{12}{13}\right)$$

$$Xd + 8 = 2 + \frac{20gd}{13} + \frac{48dg}{13}\mu$$

$$\frac{Xd + 6 - \frac{20gd}{13}}{\frac{48dg}{13}} = \mu$$

$$\frac{13Xd + 78 - 20gd}{48dg} = \mu$$

$$\frac{d(13X - 20g) + 78}{48gd} = \mu$$

(4b) When $\alpha = 10$

$$\mu = \frac{10(13x - 20g) + 78}{480g}$$

As the plane is rough $0 < \mu \leq 1$

$$\therefore 0 < \frac{10(13x - 20g) + 78}{480g} \leq 1$$

$$0 < 10(13x - 20g) + 78 \leq 480g$$

$$-78 < 10(13x - 20g) \leq 4626$$

$$-7.8 < 13x - 20g \leq 462.6$$

$$\frac{941}{5} < 13x \leq \frac{3293}{5}$$

$$\frac{941}{65} < x \leq \frac{3293}{65}$$

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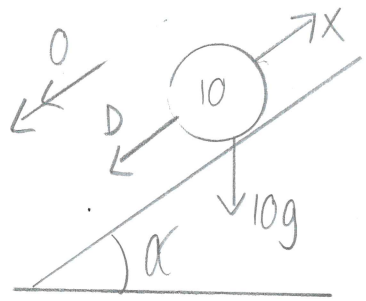
(5)



(a)

$\tan\alpha = \frac{1}{10}$

$\sin\alpha = \frac{1}{\sqrt{101}}$

$F = ma$ $\quad D + 10g\sin\alpha = X$

$D + 10g\left(\frac{1}{\sqrt{101}}\right) = X$

Power $\quad P = Fv$

$2000 = D(6)$

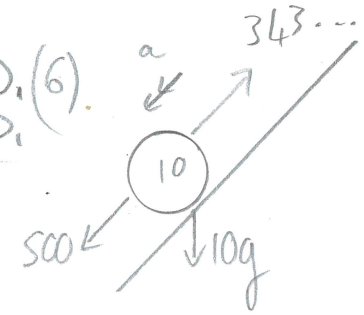
$\frac{1000}{3} = D$

$\frac{1000}{3} + 10g\left(\frac{1}{\sqrt{101}}\right) = X$

$X = 343\text{N}$ to 3sf

(b) Power $\quad 3000 = D_1(6)$

$500 = D_1$



$F = ma$

$500 + 10g\left(\frac{1}{\sqrt{101}}\right) - 343... = 10a$

$\frac{50}{3} = a$

$a = 16.7\,ms^{-2}$