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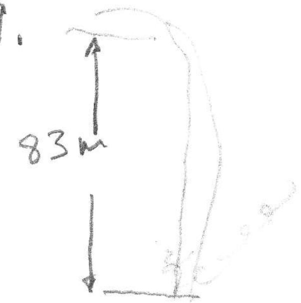
9.




Rate = 35,000 litres/s

1 litre water is 1 kg.

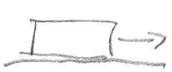
Calculate energy for 1 liter: $E_{pg} = mgh = (1\,kg)(9.8\,m/s^2)(83\,m)$

$$E_{pg} = 842.8\ J/liter$$

$$P = \left(842.8\ \frac{J}{L}\right)\left(\frac{35{,}000\ L}{s}\right)$$

$$\boxed{P = 29{,}498{,}000\ W \text{ or } 29.5\ MW}$$

10. Using UAM equations



$m = 2\,kg$
$V_i = 5\,m/s$
$V_f = 3\,m/s$
$\Delta x = 1\,m$

$$V_f^2 = V_i^2 + 2a\Delta x$$

$$\frac{V_f^2 - V_i^2}{2\Delta x} = a$$

$$a = \frac{(3\,m/s)^2 - (5\,m/s)^2}{2(1\,m)} = -8\,m/s^2$$

Now $V_i = 3\,m/s$ $V_f = 0\,m/s$ $\Delta x = ?$

$$\Delta x = \frac{V_f^2 - V_i^2}{2a} = \frac{0 - (3\,m/s)^2}{2(-8\,m/s)^2}$$

$$\boxed{\Delta x = 0.563\ m}$$

Now using energy.

$$\Delta E_k = E_{kf} - E_{ki} = \tfrac{1}{2} m V_f^2 - \tfrac{1}{2} m V_i^2$$

$$\Delta E_k = \tfrac{1}{2} m \left(V_f^2 - V_i^2\right)$$

$$= \tfrac{1}{2}(2.0\,kg)\left((5\,m/s)^2 - (3\,m/s)^2\right)$$

$$\Delta E_k = 16\ J$$

So, 16 J per meter of friction.

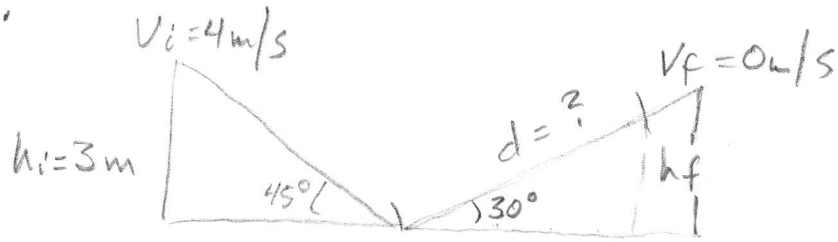
How much energy left. $E_k = \frac{1}{2}(2.0\,kg)(3\,m/s)^2$

$$E_k = 9\,J$$

$$\Delta x = \frac{9\ J}{16\ J/m} = 0.5625\,m$$

$$\boxed{\Delta x = 0.5625\,m}$$

11.




$$\sin 30° = \frac{h_f}{d}$$

$$\tfrac{1}{2} \cancel{m} V_i^2 + \cancel{m} g h_i = \tfrac{1}{2} \cancel{m} \cancel{V_f^2}^{\,0} + m g h_f$$

$$h_f = \frac{V_i^2}{2g} + h_i = \frac{(4\,m/s)^2}{2(9.8\,m/s^2)} + 3\,m$$

$$h_f = 3.816\,m$$

$$d = \frac{h_f}{\sin 30°} = \frac{3.816\,m}{\sin 30°}$$

$$\boxed{d = 7.63\,m}$$

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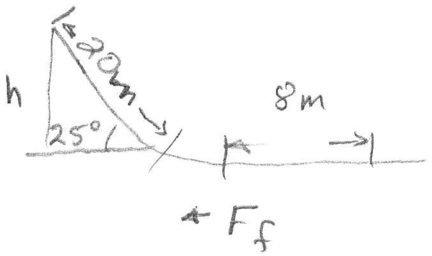
12.




$h = (20m)\sin 25° = 8.452m$

$m = 30.0\ kg$

$\Delta s = 8.00\ m$

$$E_{pg} = mgh = (30.0kg)(9.8m/s^2)(20m)(\sin 25°)$$

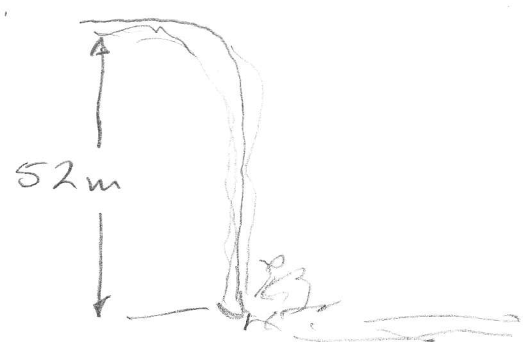
$$E_{pg} = 2485J$$

$$W = \vec{F}\cdot\Delta\vec{s} = F\cdot\Delta s\cos 0° = F_f\cdot\Delta s$$

$$F_f = \frac{W}{\Delta s} = \frac{2485J}{8.00m}$$

$$\boxed{F_f = 310.6\ N}$$

13.




$C = 4186\ J/kg\cdot°C$

Consider 1 kg of water going over the falls. The released potential energy is converted to kinetic energy then to heat.

$E_{th} = E_{pg} = mgh \qquad E_{th} = Q$

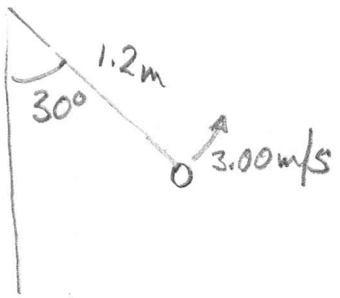
$Q = mC\Delta T \qquad \Delta T = \frac{Q}{mC} = \frac{\cancel{m}gh}{\cancel{m}C}$

$$\Delta T = \frac{(9.8m/s^2)(52m)}{4186\ J/kg\cdot°C} = 0.122\ °C$$

$$\boxed{\Delta T = 0.122°C}$$

Units $\frac{(m/s^2)(m)}{J}\cdot kg°C = \frac{J°C}{J}$

14.



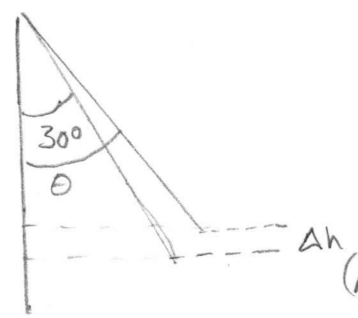

$m = 0.600kg$

a) As the mass swings, its mass is converted to an increase in potential energy.

$$\text{Increase: } E_{pg} = \frac{1}{2}mV^2 = \frac{1}{2}(0.600kg)(3.00m/s^2) = 2.70J$$

$$\cancel{m}gh = \frac{1}{2}\cancel{m}V^2$$

$$\text{Increase: } h = \frac{V^2}{2g} = \frac{(3.00m/s)^2}{2(9.8m/s^2)} = 0.459m$$




$\theta = ?$

$\Delta h = 0.459m$

$\Delta h = (1.2m)\cos 30° - 1.2m \cos\theta$

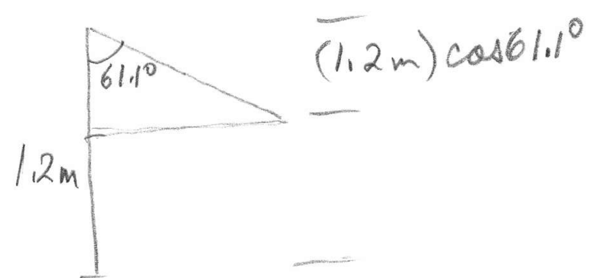
$(1.2m)\cos\theta = 1.2\cos 30° - \Delta h$

$\cos\theta = \cos 30° - \frac{\Delta h}{1.2m}$

$$\theta = \cos^{-1}\left(\cos 30° - \frac{0.459m}{1.2m}\right) = 61.1°$$

$$\theta = 61.1°$$

b). So the total max height of the mass is




$h = r - r\cos 61.1°$

$h = 1.2m - 1.2m\cos 61.1°$

$h = 0.62m$

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14. b) (cont'd)

So the velocity at the bottom of the arc comes from this max $E_{pg}$ converted to velocity!

For circular motion $F_c = m\frac{v^2}{r}$

This is the tension in the cord.

So, $$mgh = \tfrac{1}{2}mv^2$$

$$2mgh = mv^2$$

Replace $mv^2$ in $F_c$.

$$F_c = \frac{2mgh}{r}$$

$$= \frac{2mg(\cancel{r} - \cancel{r}\cos 61.1^\circ)}{\cancel{r}}$$

$$F_c = 2mg(1 - \cos 61.1^\circ)$$

$$F_c = 2(0.600\,kg)(9.8\,m/s^2)(1 - \cos 61.1^\circ)$$

$$F_c = 6.07\,N$$

This is the tension in the cord.

$$\boxed{F_T = 6.07N}$$