1. $$\vec{A} = \frac{5}{\sqrt{2}\,13}\hat{i} + \frac{5}{\sqrt{2}\,13}\hat{j} - \frac{12}{13}\hat{k}$$

$$\vec{B} = \frac{12}{\sqrt{2}\,13}\hat{i} + \frac{12}{\sqrt{2}\,13}\hat{j} + \frac{5}{13}\hat{k}$$

(a) $$\vec{A}\cdot\vec{B} = \frac{1}{2}\frac{60}{13^2} + \frac{1}{2}\frac{60}{13^2} - \frac{60}{13^2}\ \boxed{= 0}$$

(b) since $\vec{A} \perp$ to $\vec{B}$ $(\vec{A}\cdot\vec{B} = 0)$

$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\underbrace{\sin\theta}_{1}$$

$$|\vec{A}|^2 = \frac{5^2}{2\cdot 13^2} + \frac{5^2}{2\cdot 13^2} + \frac{12^2}{13^2}$$

$$= \frac{5^2+12^2}{13^2} = \frac{25+144}{169} = \frac{169}{169} = 1$$

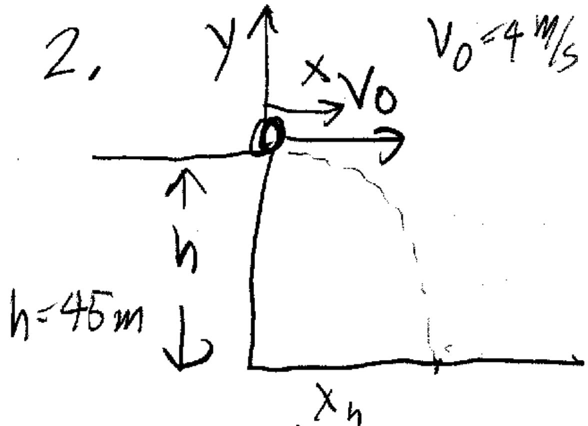
$$|\vec{B}|^2 = \frac{12^2}{2\cdot 13^2} + \frac{12^2}{2\cdot 13^2} + \frac{5^2}{13^2}$$

$$= \frac{12^2+5^2}{13^2} = \frac{144+25}{169} = 1$$

$$\boxed{|\vec{A}\times\vec{B}| = 1\cdot 1\cdot 1 = 1}$$

Could work out algebraically, but that is a lot more work.

2.



$$v_x = v_0 - at \qquad a = \frac{2}{3}\frac{m}{s^2}$$

$$x = v_0 t - \frac{1}{2}at^2$$

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

t when hits ground: $y = -h = -\frac{1}{2}gt^2$

$$t = \sqrt{\frac{2 \cdot h}{g}}$$

$$= \sqrt{\frac{2 \cdot 45}{10}} = \sqrt{\frac{90}{10}} = \sqrt{9 \frac{m}{(m/s^2)}}$$

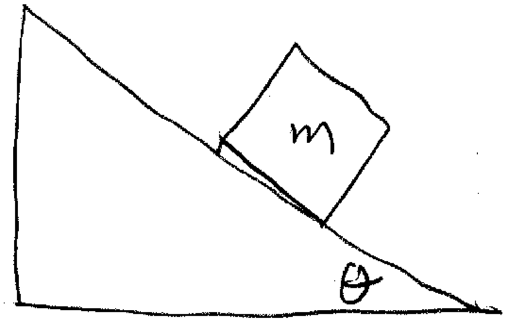
$$\boxed{t = 3\,s}$$

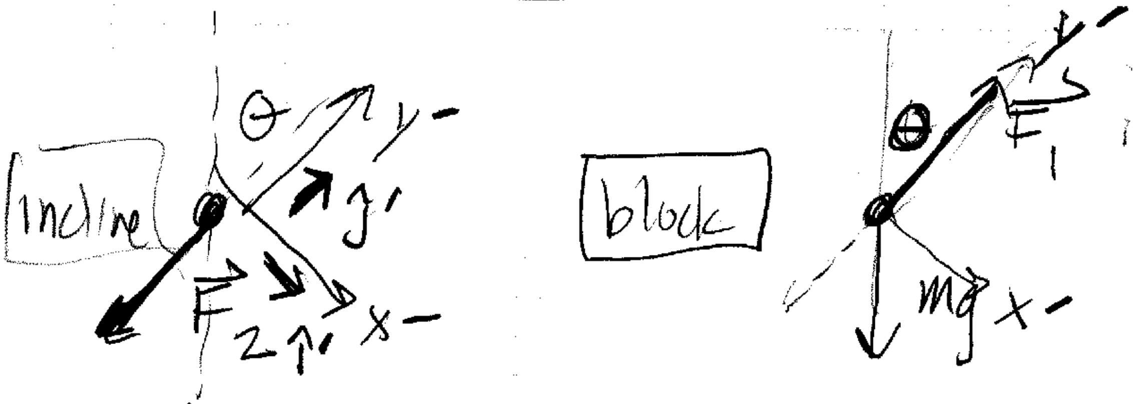
$$x_h = v_0 t - \frac{1}{2}at^2 = \sqrt{\frac{2h}{g}}\left(v_0 - \frac{1}{2}a\sqrt{\frac{2h}{g}}\right)$$

$$= 4 \cdot \frac{m}{\cancel{s}} \, 3\cancel{s} - \frac{1}{\cancel{2}} \cdot \frac{\cancel{2}}{\cancel{3}} \frac{m}{\cancel{s^2}} \cdot \cancel{3^2}^{\,3} \cancel{s^2}$$

$$\boxed{x_h = 12 - 3 = 9\,m}$$

3.





<u>Quickest</u>: draw coordinate system rotated so <u>x' is parallel to inclined surface</u>

$$m\ddot{y}' \cdot 0 = F_1 - mg\cos\theta$$

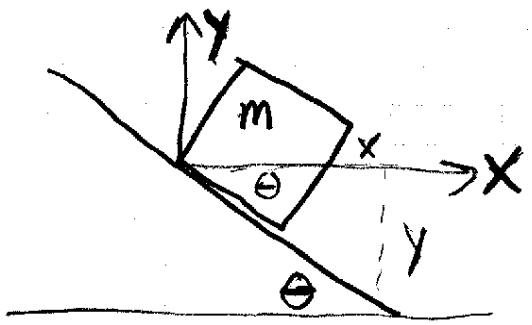
$$F_1 = mg\cos\theta$$

Newton III

$$\vec{F}_2 = -\vec{F}_1 = -mg\cos\theta\ \hat{j}'$$

where $+\hat{j}'$ is $\perp$ away from inclined plane

Can also do in vertical/horizontal coordinates:



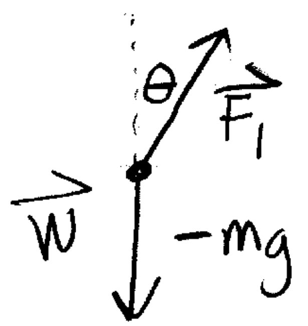
constraint:

$$\tan\theta = \frac{-y}{x}$$

$$x\tan\theta = -y$$

$$\ddot{x}\tan\theta = -\ddot{y}$$

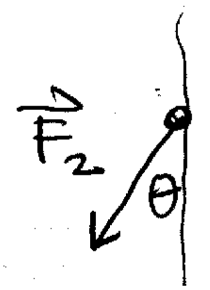
Forces on <u>mass</u>.



$$m\ddot{y} = F_1\cos\theta - mg$$

$$m\ddot{x} = F_1\sin\theta$$

on <u>incline</u>



(too massive to move!)

$$\vec{F}_2 = -\vec{F}_1$$

want to solve for F_1 ... eliminate $\ddot{y}, \ddot{x}$

$$\ddot{y} = -\ddot{x}\tan\theta \quad \text{(constraint)}$$

$$-m\ddot{x}\tan\theta = F_1\cos\theta - mg$$

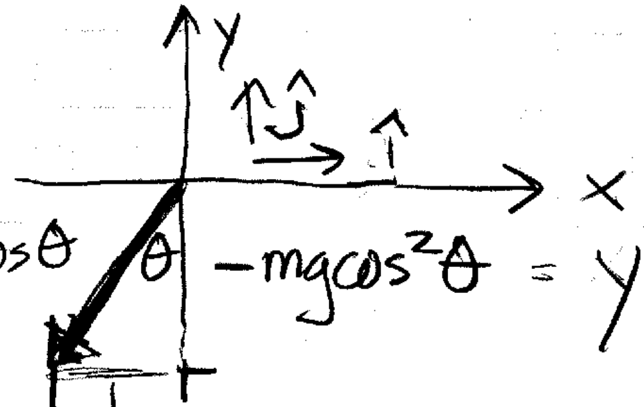
$$m\ddot{x} = F_1\sin\theta \quad \leftarrow \text{use to eliminate } \ddot{x}$$

$$-F_1\sin\theta\tan\theta = F_1\cos\theta - mg$$

$$mg = F_1(\cos\theta + \sin\theta\tan\theta)$$

$$= F_1\left(\frac{\cos^2\theta + \sin^2\theta}{\cos\theta}\right) = \frac{F_1}{\cos\theta}$$

$F_1 = mg\cos\theta$



$|\vec{F}_2| = mg\cos\theta$

$-mg\cos^2\theta$ = y component of $\vec{F}_2$

$-mg\cos\theta\sin\theta$ = x component $\vec{F}_2$

or $$\boxed{\vec{F}_2 = -mg\cos\theta\left(+\sin\theta\,\hat{\imath} + \cos\theta\,\hat{\jmath}\right)}$$