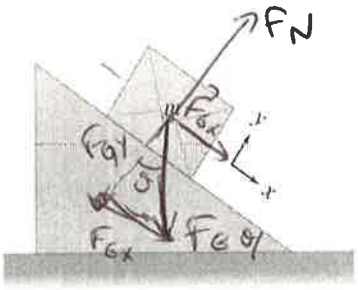
Name Key

Problem 1: (34 Points)

A box of mass m is placed on a smooth incline that makes an angle θ with the horizontal.

(a) Draw the Free Body Diagram



(8)

No friction force → smooth incline

$\Sigma \vec{F} = m\vec{a}$

(1) $\Sigma F_x = F_{Gx} = ma_x$ (4)

(2) $\Sigma F_y = F_N - F_{Gy} = m(a_y) = 0$

not motion on y

(b) Determine the normal force on the box.

(2) $\Rightarrow F_N - F_{Gy} = 0$

$F_N = F_{Gy} = F_G \cos\theta$

$\boxed{F_N = mg\cos\theta}$ (8)

(c) Determine the box's acceleration.

(1) $\Rightarrow F_{Gx} = ma$

$F_G \sin\theta = ma$

$mg \sin\theta = ma$

$\boxed{a = g\sin\theta}$ (8)

(d) Evaluate for a mass m = 20 kg and an incline of θ = 30°.

$F_N = mg\cos\theta = (20\text{ kg})\left(9.8\frac{m}{s^2}\right)\cos 30^\circ = 169.75\text{ N}$

$a = g\sin\theta = \left(9.8\frac{m}{s^2}\right)\sin 30^\circ = 4.9\frac{m}{s^2}$ (6)

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Problem 2: (33Points)

A constant force $\vec{F} = (3.0\hat{\imath} + 5.0\hat{\jmath})$N acts on an object as it moves along a straight-line path. If the object's displacement is $\vec{d} = (6.0\hat{\imath} + 2.0\hat{\jmath})$m, calculate the work done by $\vec{F}$.

$W = \vec{F} \cdot \vec{d}$ (8)

$= (3.0\hat{\imath} + 5.0\hat{\jmath})\,N \cdot (6.0\hat{\imath} + 2.0\hat{\jmath})\,m$ (12)

$= (3.0)(6.0) + (5.0)(2.0)$ (8)

$W = 18 + 10 = 28\,J$ (5)

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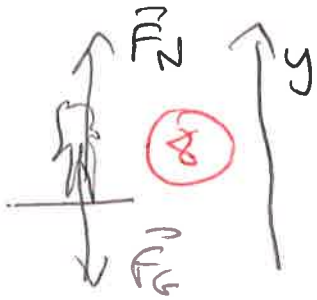
Problem 3: (33 Points)

You know your mass is 65 kg, but when you stand on a bathroom scale in an elevator, it says your mass is 76 kg. What is the acceleration of the elevator, and in which direction?

F_N : reading of the scale = W' : apparent weight.



(2) $W' = m'g$

(2) $\Sigma \vec{F} = m\vec{a}$

(4) $F_N - F_G = ma$

$F_N - mg = ma \Rightarrow a = \frac{F_N - mg}{m}$ (4)

(2) $m = 65\ kg$ reading

(2) $m' = 76\ kg$ (apparent mass)

$F_N = W' = m'g$ (2)

$$a = \frac{m'g - mg}{m} = \frac{g(m' - m)}{m} = \frac{(9.8\ m/s^2)(76\ kg - 65\ kg)}{65\ kg}$$ (4)

$a = 1.65\ m/s^2$

(3) it is positive so the acceleration is upward.