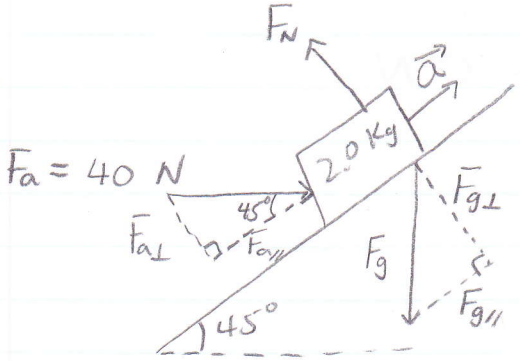
Incline Plane Problems

1.



$F_g = (2.0\ Kg)(-9.81\ m/s^2)$

$F_g = -19.62\ N$

$F_{g\perp} = F_g \cos 45° = -13.87\ N$

$F_{g//} = F_g \sin 45° = -13.87\ N$

$F_{a//} = F_a \cos 45° = 28.28\ N$

$F_{a\perp} = F_a \sin 45° = 28.28\ N$

$F_{net} = m\vec{a}$

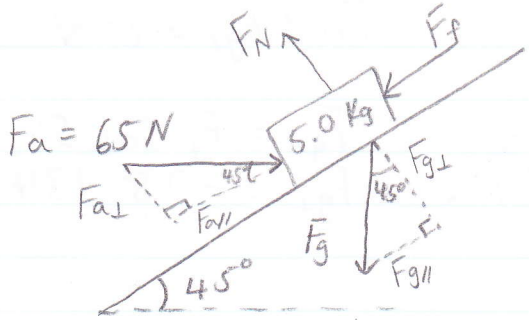
$F_{a//} + F_{g//} = m\vec{a}$

$28.28\ N - 13.87\ N = (2.0\ Kg)\vec{a}$

$\vec{a} = 7.205\ m/s^2$

$\vec{a} = 7.2\ m/s^2$

2.



$\mu = 0.10$

$F_{g\perp} = mg \cos 45° = (5.0\ kg)(9.81\ m/s^2) \cos 45°$

$F_{g\perp} = -34.68\ N$

$F_{g//} = mg \sin 45° = (5.0\ Kg)(9.81\ m/s^2) \sin 45°$

$F_{g//} = -34.68\ N$

$F_{a\perp} = 65\ N \cos 45° = -45.96\ N$

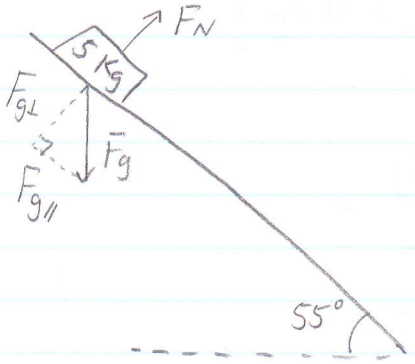
$F_{a//} = 65\ N \sin 45° = 45.96\ N$

$$F_N + F_{g\perp} + F_{a\perp} = 0\ N$$
$$F_N - 34.68\ N - 45.96 = 0\ N$$
$$F_N = 80.64\ N$$

$$F_f = \mu F_N$$
$$F_f = (0.10)(80.64\ N)$$
$$F_f = -8.064\ N$$

$$F_{net} = m\vec{a}$$
$$F_{g//} + F_{a//} + F_f = m\vec{a}$$
$$-34.68\ N + 45.96 - 8.064\ N = (5.0\ kg)\,\vec{a}$$
$$3.216\ N = (5.0\ kg)\,\vec{a}$$
$$\vec{a} = 0.6432\ m/s^2$$
$$\vec{a} = 0.64\ m/s^2$$

3.



$d = 0.50\ m$

$$F_N + F_{g\perp} = 0\ N$$

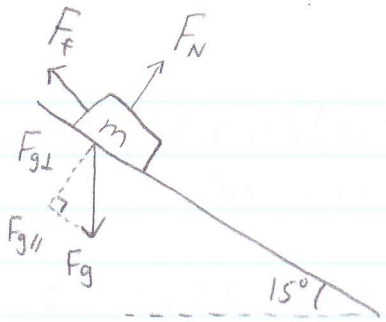
$$F_{g\perp} = F_g \cos 55°$$
$$F_{g\perp} = -28.134\ N$$

$$F_{g//} = F_g \sin 55°$$
$$F_{g//} = 40.18\ N$$

$$F_{net} = m\vec{a} \Rightarrow 40.18\ N = (5\ kg)\,\vec{a}$$
$$\vec{a} = 8.036\ m/s^2$$

$$d = V_i t + \tfrac{1}{2} a t^2, \quad V_i = 0\ m/s$$
$$0.50\ m = 0 + \tfrac{1}{2}(8.036\ m/s^2)\,t^2$$
$$t = 0.35\ s$$

4.



$F_f = \mu F_N$

$F_N = -F_{g\perp}$

$F_{g\perp} = F_g \cos 15°$

$F_{g\perp} = mg \cos 15°$

$F_f = \mu F_N = -(0.20)\, mg \cos 15°$

$F_{g//} = F_g \sin 15 = mg \sin 15°$

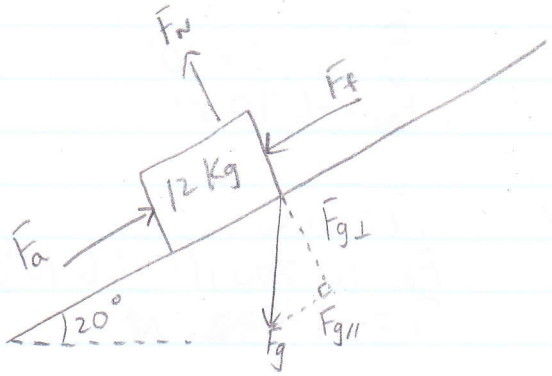
$F_{net} = m\vec{a} \Rightarrow F_f + F_{g//} = m\vec{a}$

$-(0.20)\cancel{mg}\cos 15° + \cancel{mg}\sin 15° = \cancel{m}\vec{a}$

$-1.895\ m/s^2 + 2.539\ m/s^2 = \vec{a}$

$\vec{a} = 0.644\ m/s^2$

5.



$\mu_s = 0.40$

$\mu_K = 0.20$

$F_{net} = m\vec{a}$, $F_a + F_f + F_{g//} = 0\ N$

$F_{g//} = F_g \sin 20 = -40.26\ N$

$F_{g\perp} = F_g \cos 20 = -110.62\ N = F_N$

$F_f = \mu F_N = (0.40)(110.62\ N) = -44.25\ N$ static

$F_a + (-44.25\ N) + (-40.26\ N) = 0\ N$

$F_a = 84.51\ N$ needed to start moving block

Kinetic friction: $F_f = (0.20)(110.62\ N)$

$F_f = -22.124\ N$

$F_a + F_{g//} + F_f = 84.51\ N - 40.26\ N - 22.124\ N$

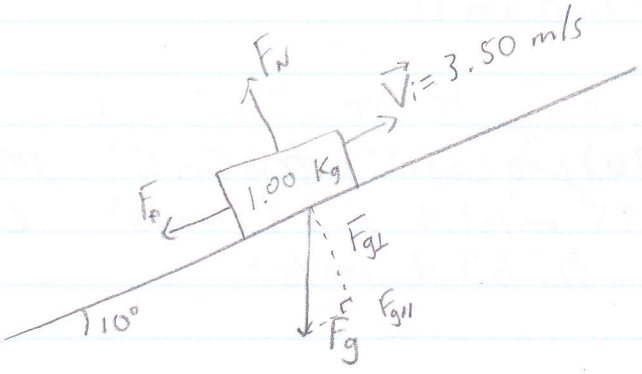
$= 22.126\ N$

$F_{net} = m\vec{a}$

$22.126\ N = (12\ kg)\ \vec{a}$

$\vec{a} = 1.844\ m/s^2 = 1.8\ m/s^2$

6.



$V_f = 0$ m/s

$\mu = 0.200$

$F_{g\perp} = F_g \cos 10°$ $\qquad$ $F_{g//} = F_g \sin 10°$

$F_{g\perp} = -9.66\ N$ $\qquad$ $F_{g//} = -1.70\ N$

$F_N = -F_{g\perp} = 9.66\ N$, $\qquad F_f = \mu F_N$

$F_f = (0.200)(9.66\ N)$

$F_f = -1.932\ N$

$F_{net} = m\vec{a}$

$F_f + F_{g//} = m\vec{a}$

$-1.932\ N - 1.70\ N = (1.00\ Kg)\ \vec{a}$

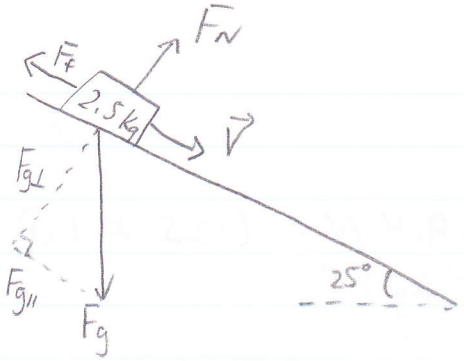
$-3.632\ m/s^2 = \vec{a}$

$V_f = V_i + at$

$0\ m/s = 3.50\ m/s + (-3.632\ m/s)\ t$

$t = 0.964\ s$

7.



$\vec{V}_i = 0$ m/s
$\vec{V}_f = ?$
$d = 0.800$ m
$\mu = 0.100$

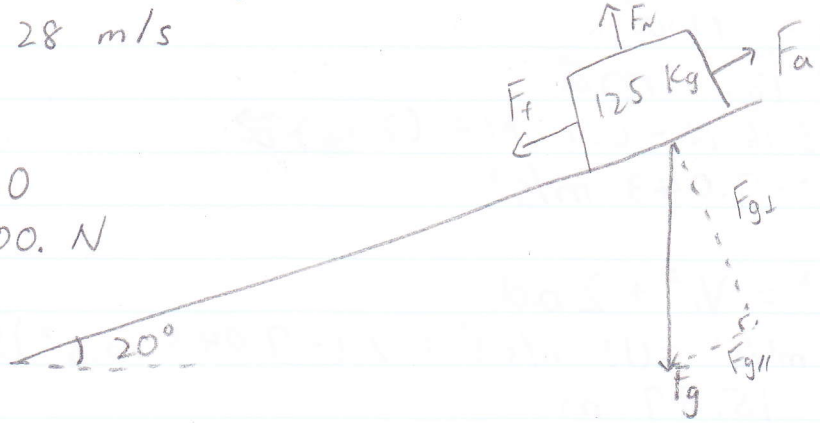
$F_{g\perp} = F_g \cos 25°$ $\quad F_{g\parallel} = F_g \sin 25°$
$F_{g\perp} = -22.23$ N $\quad F_{g\parallel} = 10.36$ N

$F_N = -F_{g\perp} = 22.23$ N
$F_f = \mu F_N = (0.100)(22.23\text{ N})$
$F_f = -2.223$ N

$F_{net} = m\vec{a} \Rightarrow F_f + F_{g\parallel} = m\vec{a}$
$-2.223\text{ N} + 10.36\text{ N} = (2.5\text{ kg})\vec{a}$
$\vec{a} = 3.25$ m/s^2

$V_f^2 = V_i^2 + 2ad$
$V_f^2 = 0\text{ m}^2/\text{s}^2 + 2(3.25\text{ m/s}^2)(0.800\text{ m})$
$V_f = 2.28$ m/s

8.



$\mu = 0.60$
$F_a = 1000.$ N

$F_{g\perp} = F_g \cos 20°$ $\quad F_{g\parallel} = F_g \sin 20°$
$F_{g\perp} = -1152.3$ N $\quad F_{g\parallel} = -419.4$ N
$F_N = -F_{g\perp} = 1152.3$ N
$F_f = \mu F_N = (0.60)(1152.3\text{ N})$
$F_f = -691.38$ N

$F_{net} = m\vec{a}$

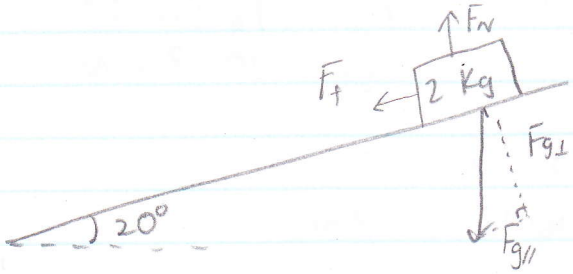
$F_a + F_f + F_{g//} = m\vec{a}$

$1000\ N - 691.38\ N - 419.4\ N = (125\ Kg)\vec{a}$

$1000\ N - 1110.78 = (125\ Kg)\vec{a}$

F_{net} is negative, so the box will not move.

9.



$\mu = 0.40$

$V_i = 15\ m/s$

$V_f = 0\ m/s$

$F_{g//} = F_g \sin 20°$ $\quad$ $F_{g\perp} = F_g \cos 20$

$F_{g//} = -6.71\ N$ $\quad$ $F_{g\perp} = -18.44\ N$

$F_N = -F_{g\perp} = 18.44\ N$

$F_f = \mu F_N = (0.40)(18.44\ N)$

$F_f = -7.376\ N$

$F_{net} = m\vec{a}$

$F_f + F_{g//} = m\vec{a}$

$-7.376\ N - 6.71\ N = (2\ kg)\vec{a}$

$\vec{a} = -7.043\ m/s^2$

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

$0\ m^2/s^2 = (15\ m/s)^2 + 2(-7.043\ m/s^2)(d)$

$d = 15.97\ m$

$d = 16\ m$