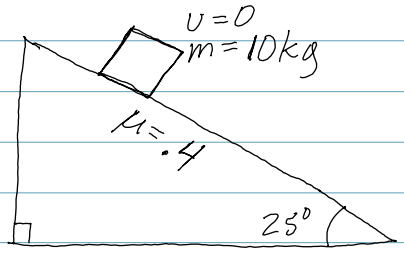
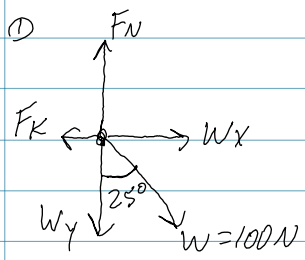
Newton's 2nd Law with Friction

1) 

How long will it take the box to slide 3.5 m down the slope?

① 

② $\sin 25^\circ = \frac{W_x}{100}$

$W_x = 42.262N$

③ $\cos 25^\circ = \frac{W_y}{100}$

$W_y = -90.631N$

④ $\Sigma F_y = 0 = F_N + W_y$

$0 = F_N - 90.631N$

$F_N = +90.631N$

⑤ $|F_K| = \mu_K |F_N|$

$F_K = 0.4(90.631)$

$F_K = -36.252N$

⑥ $\Sigma F_x = W_x + F_K$

$\Sigma F_x = 42.262 - 36.252$

$\Sigma F_x = 6.01N$

⑦ $\Sigma F = ma$

$6.01 = 10a$

$a = 0.601 m/s^2$

⑧ $v_0 = 0 m/s$

$a = .601 m/s^2$

$\Delta x = 3.5m$

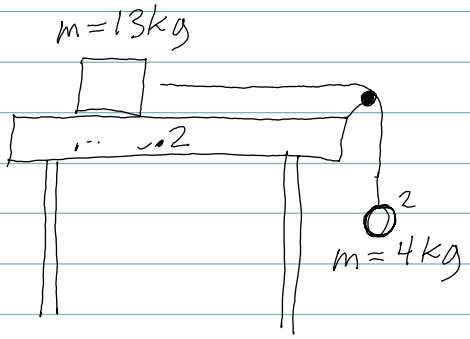
$t = ?$

$\Delta x = \frac{1}{2}at^2 + \cancel{v_0 t}$

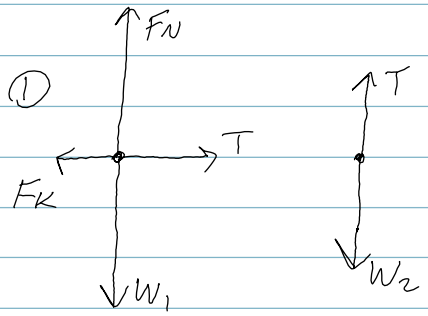
$3.5 = \frac{1}{2}(.601)t^2$

$t^2 = 11.647$

$\boxed{t = 3.41s}$

2) 

What is the tension in the string?



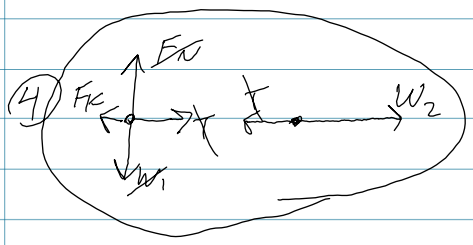
② $F_N = W_1$

$F_N = 130N$

③ $F_K = \mu F_N$

$F_K = .2(130)$

$F_K = -26N$



$\Sigma F = W_2 + F_K$

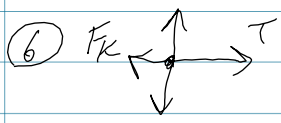
$\Sigma F = 40 - 26$

$\Sigma F = 14N$

⑤ $\Sigma F = ma$

$14 = (13+4)a$

$a = 0.824 m/s^2$

⑥ 

$\Sigma F_1 = m_1 a_1$

$\Sigma F_1 = 13(.824)$

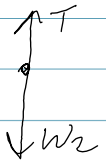
$\Sigma F_1 = 10.712N$

⑦ $\Sigma F_1 = F_K + T$

$10.717 = -26 + T$

$T = 36.71N$

OR

⑥ 

$\Sigma F_2 = m_2 a_2$

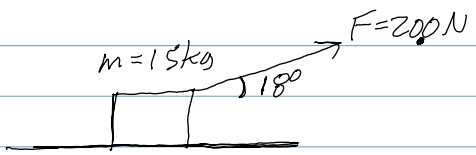
$\Sigma F_2 = 4(-.824)$

$\Sigma F_2 = -3.296N$

⑦ $\Sigma F_2 = T + W_2$

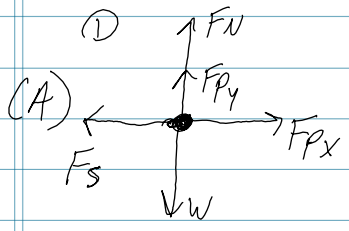
$-3.296 = T - 40$

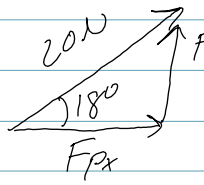
$T = 36.70N$

3) 

(A) What is the coefficient of friction if the box doesn't move?

(B) What is the acceleration of the box if the pulling force now pulls horizontal only, not at the 18° angle?

(A) ① 

② 

$\sin 18° = \frac{F_{Py}}{20}$

$F_{Py} = 6.180N$

$\cos 18° = \frac{F_{Px}}{20}$

$F_{Px} = 19.021N$

③ $\Sigma F_y = 0 = F_N + F_{Py} + W$

$0 = F_N + 6.180 - 150$

$F_N = 143.82N$

④ $\Sigma F_x = 0 = F_{Px} + F_S$

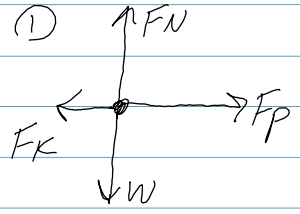
$0 = 19.021 + F_S$

$F_S = -19.021$

⑤ $|F_S| \leq \mu |F_N|$

$19.021 = \mu(143.82)$

$\boxed{\mu = 0.13}$

(B) ① 

② $F_N = W$

$F_N = 150N$

③ $F_K = \mu F_N$

$F_K = 0.13(150)$

$\boxed{F_K = 19.5N}$

④ $\Sigma F_x = F_P + F_K$

$\Sigma F_x = 20 - 19.5$

$\Sigma F_x = 0.5N$

⑤ $\Sigma F = ma$

$0.5 = 15(a)$

$\boxed{a = +0.033 m/s^2}$