Unit 5 - Newton's 2nd Law

1) A helicopter (700kg), sitting on the ground, accelerates up & reaches a height of 22m in 2s (assume a constant acceleration). It then travels at a constant velocity of 6.63m/s until it reaches a height of 500m. At this point the helicopter slows to hovering in 3s. (A) What is the acceleration of the helicopter during take-off? (B) What lifting force is the helicopter experiencing? (C) How many g's is the helicopter experiencing? (D) What does the lifting force drop to as it slows to hovering in 3.0s?

(A) $v_0 = 0$
$\Delta y = +22m$
$t = 2s$
$a = ?$
$\Delta y = \frac{1}{2}at^2 + v_{0y}t$
$+22 = \frac{1}{2}a(2)^2$
$\boxed{a = +11 m/s^2}$

(B) $F_{lift} = ?$ ↑ ; $W = 7000N$ ↓

① $F_{NET} = ma$
$F = 700(+11)$
$F = +7700N$

$\Sigma F_y = F_L + W$
$7700 = F_L - 7000$
$\boxed{F_L = 14,700N}$

(C) $1g = -10 m/s^2$

$+11 m/s^2 \Rightarrow 21 m/s^2$ away from -10

$\frac{21}{10} = \boxed{2.1 g's}$

$\frac{F_N/F_L}{W} = \frac{14,700}{7000}$

$\boxed{2.1 g's}$

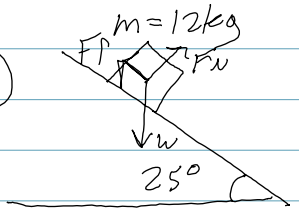
$v_f = 0 \quad v_0 = 6.63 \quad t = 3$

(D) F_{lift} ↑ ; $W = 7000N$ ↓

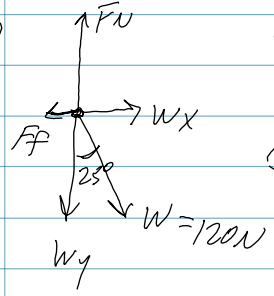
① $v_f = v_0 + at$
$0 = 6.63 + a(3)$
$a = -2.21 m/s^2$

② $F_{NET} = ma$
$F = 700(-2.21)$
$F_{NET} = -1547N$

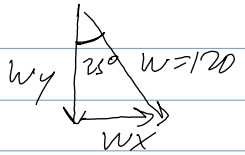
③ $\Sigma F_y = F_L + W$
$-1547 = F_L - 7000$
$\boxed{F_L = 5453N}$

2) 

A box slides down an incline that has a kinetic friction force of 15 N. What is the acceleration of the box?

① 

② $\Sigma F_x = W_x + F_f$

③ 

$\sin 20^\circ = \frac{W_x}{120}$

$W_x = 50.71\,N$

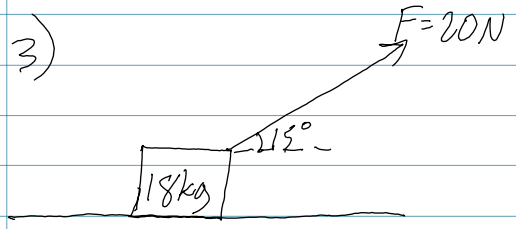
④ $\Sigma F_x = 50.71 - 15$

$\Sigma F_x = 35.71\,N$

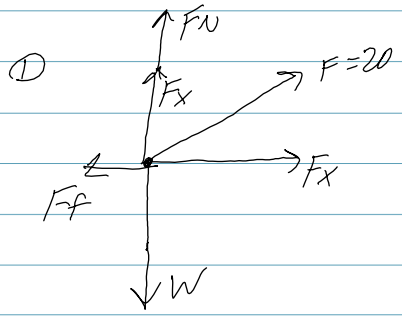
⑤ $F_{NET} = ma$

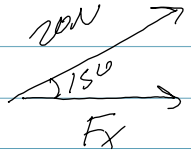
$35.71 = 12(a)$

$\boxed{a = 2.98\,m/s^2}$

3) 

What is the acceleration of the box if a frictional force of 16 N is resisting its motion?

① 

② 

$\cos 15^\circ = \frac{F_x}{20}$

$F_x = 19.32\,N$

③ $\Sigma F_x = F_x + F_f$

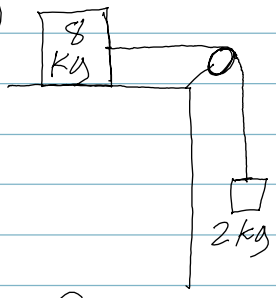
$\Sigma F_x = 19.32 - 16$

$\Sigma F_x = 3.32\,N$

④ $F_{NET} = ma$

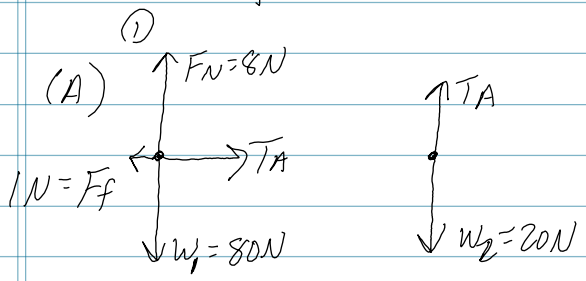
$3.32 = 18(a)$

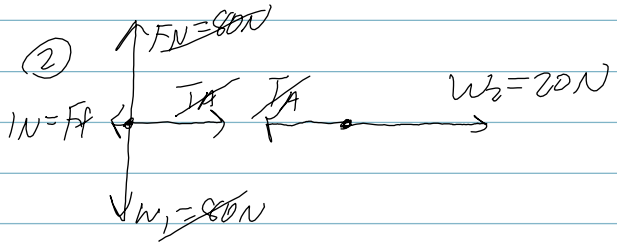
$\boxed{a = +0.18\,m/s^2}$

4) 

(A) What is the acceleration of the blocks if there is a frictional force of 1.0 N on the box on the table?

(B) What is the tension in the cable?

① (A) 

② 

$\Sigma F = F_f + W_2 \qquad \Sigma F = -1 + 20 = 19N$

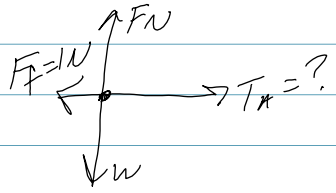
③ $F_{NET} = ma$

$19 = (8+2)\,a$

$\boxed{a = 1.9 m/s^2}$

2kg ⇒ down at $1.9 m/s^2$ → $-1.9 m/s^2$

8kg ⇒ right at $1.9 m/s^2$ → $1.9 m/s^2$

(B) 

$F_A = m_A a$

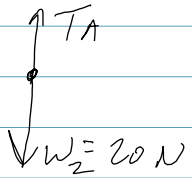
$F_A = (8)(1.9) = 15.2N$

$\Sigma F_A = F_f + T_A$

$15.2 = -1 + T_A$

$\boxed{T_A = 16.2N}$

OR



$F_B = m_B a$

$F_B = 2(-1.9 m/s^2) = -3.8N$

$\Sigma F_B = T_A + W_2$

$-3.8 = T_A - 20$

$\boxed{T_A = 16.2N}$