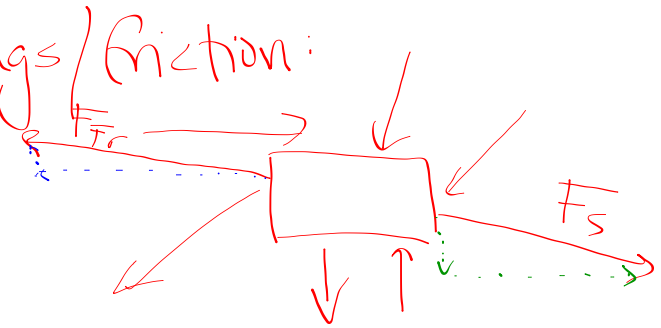
FBD – forces aligned to FOR

$\Sigma F = ma$

Springs / Friction:



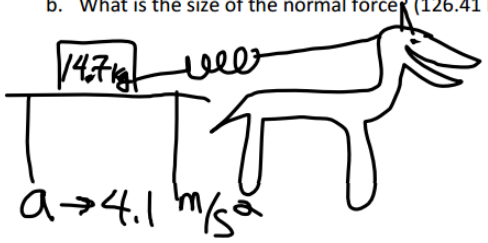
? ?

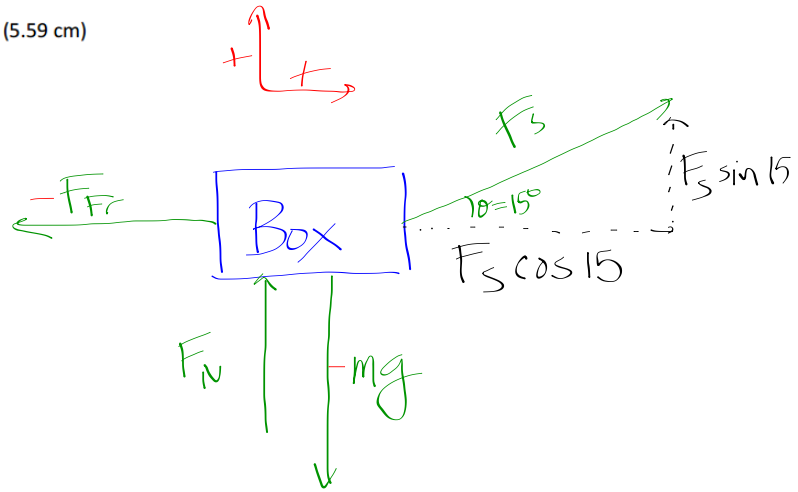
$F_s \cos 24 \ldots\ldots = \ldots\ldots a$

$F_s = kx$ solve system

?

1. A box is being pulled along a horizontal table by a rope connected to a donkey's shoulders at an angle of 15° to the table. There is a spring between the rope and the box with k = 12.2 N/cm. The mass of the box is 14.7 kg. If friction is opposing the box's motion with a constant force of 5.6 N, and the box is accelerating at 4.1 m/s^2 horizontally:
   a. How many centimeters does the spring stretch? (5.59 cm)
   b. What is the size of the normal force? (126.41 N)





$$\Sigma F_x = ma_x$$

$$-F_{Fr} + F_S \cos 15 = ma_x$$

$$-5.6\,N + F_S \cos 15 = (14.7\,kg)(4.1\,m/s^2)$$

$$F_S = 68.2\,N = kx$$

$$68.2\,N = 12.2\,N/cm \cdot x$$

$1\,N = 1\,\frac{kg \cdot m}{s^2}$

$$x = 5.6\,\frac{N}{N/cm} = N \cdot \frac{cm}{N} = cm$$

5.6 cm

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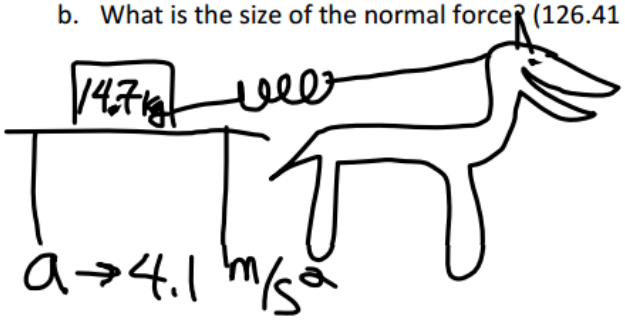
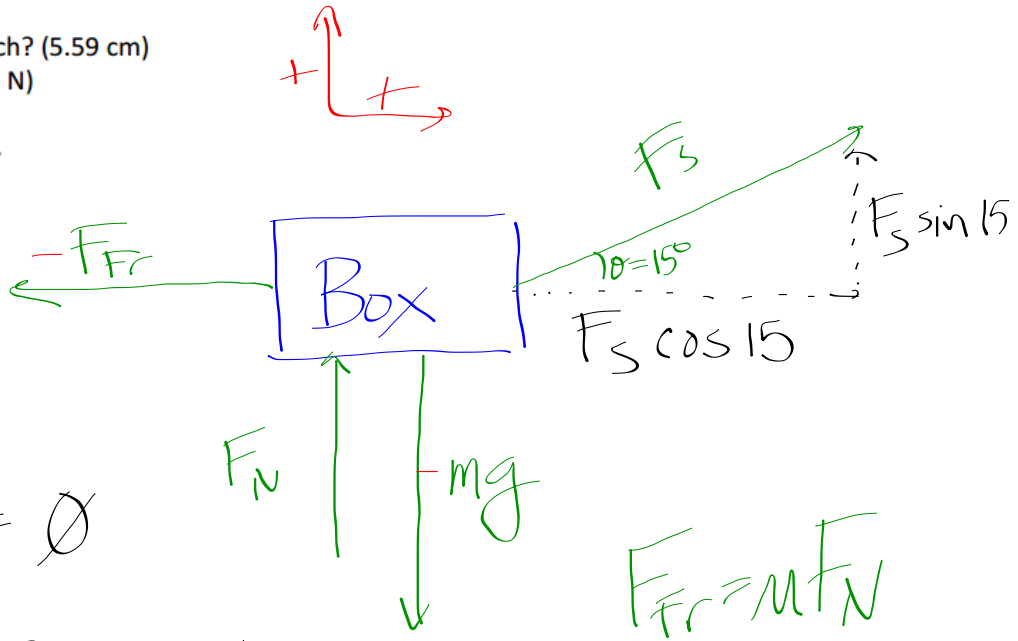




$$\Sigma F_y = ma_y = 0$$

$$F_N - mg + F_S \sin 15 = 0$$

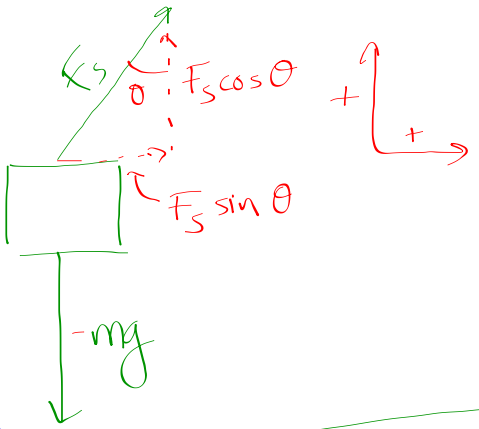
$$F_N - (14.7)(9.8) + (68.2\,N)(\sin 15) = 0$$

$$F_N = 126.41\ N$$

$$F_{Fr} = \mu F_N$$

2. A football with a mass of 0.32 kg is hooked to an airplane by a spring at a constant angle (with the vertical) of 24°. The spring is stretched out 11 cm. The football is not moving in the vertical direction.
   a. What is the spring constant of the spring (in N/cm)? (0.31 N/cm) ✓
   b. How quickly is the football accelerating horizontally? (4.36 m/s^2) ✓

$\Sigma F = ma$



$\Sigma F_x = ma_x$

$F_s \sin\theta = ma_x$

$a = \frac{F_s \sin\theta}{m} = \frac{(3.43)(\sin 24)}{0.32}$

$\Sigma F_y = ma_y = 0$

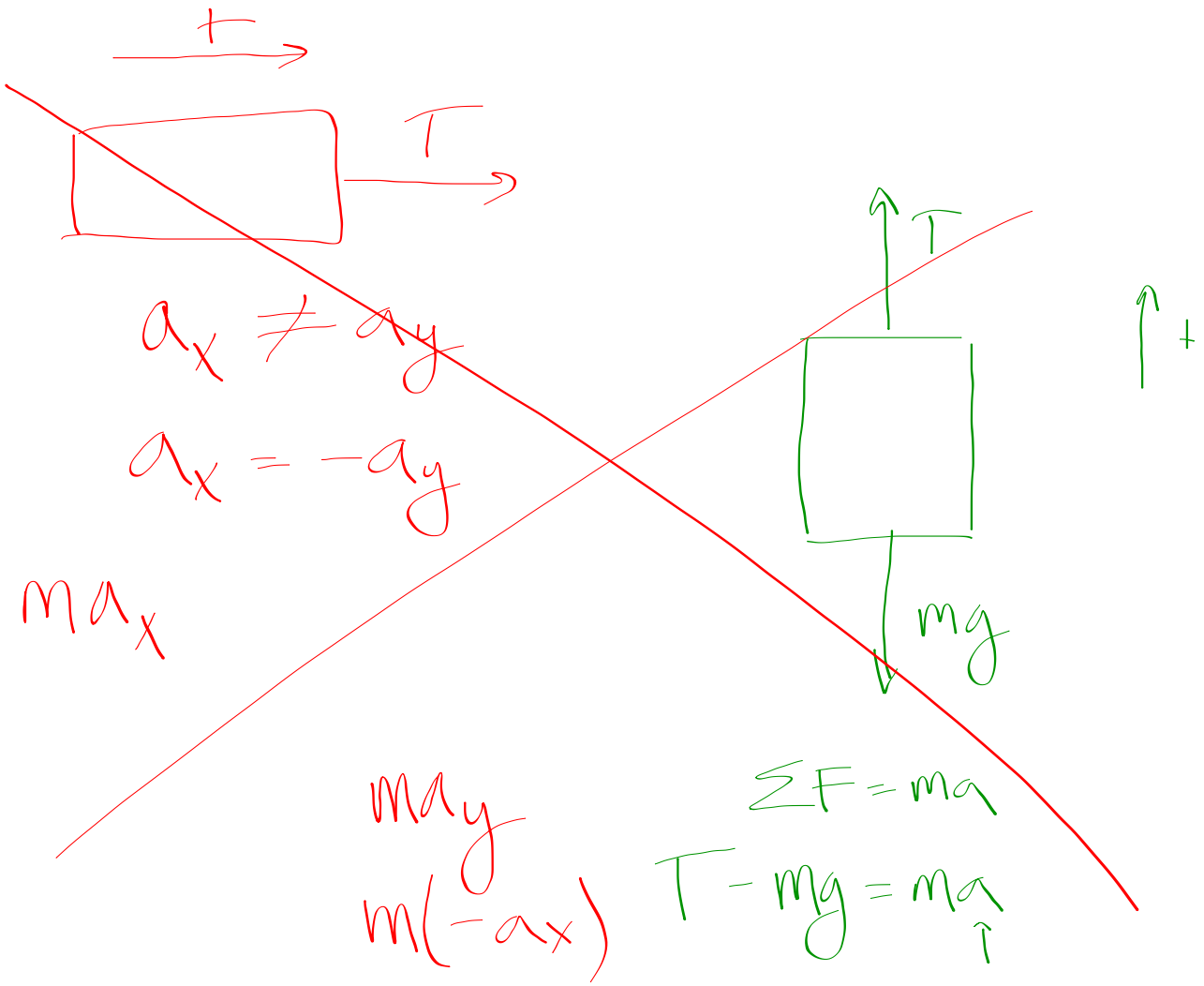
$F_s\cos\theta + -mg = 0$

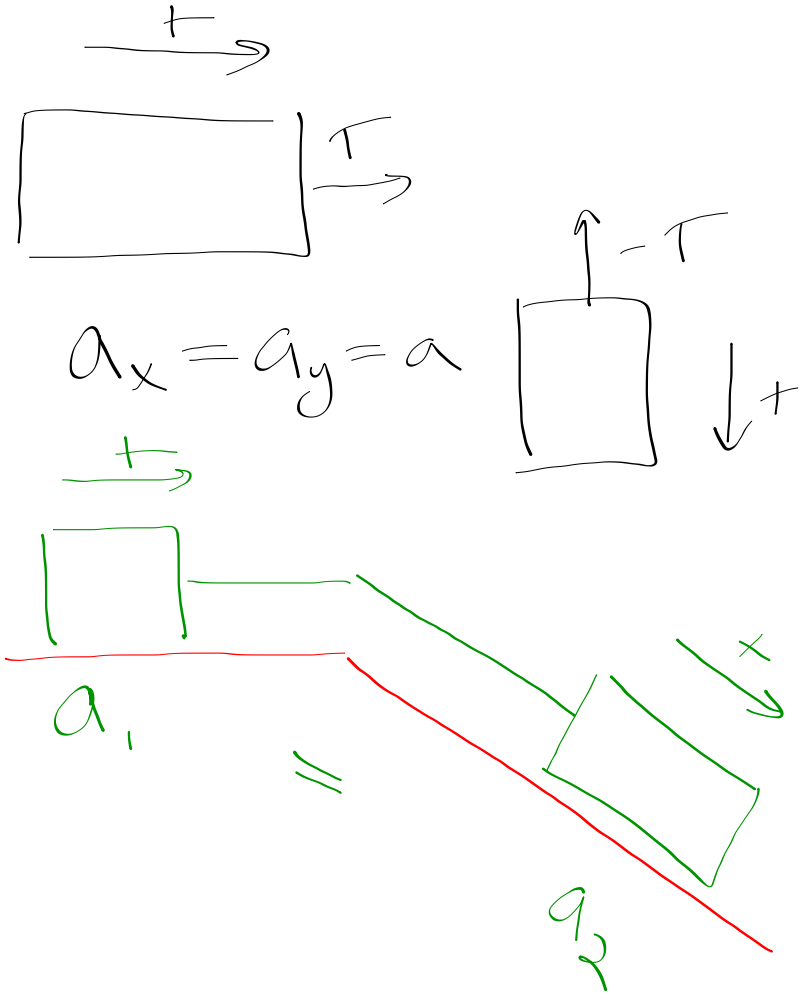
$F_s = \frac{mg}{\cos\theta} = \frac{(0.32)(9.8)}{\cos 24} = 3.43\ N$

$a = 4.36\ m/s^2$

$F_s = kx$

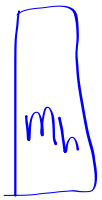
$k = \frac{F_s}{x} = \frac{3.43N}{11\ cm} = 0.31\ N/cm$


+
T
T
+
mg
$a_x \neq a_y$
$a_x = -a_y$
ma_x
ma_y
$m(-a_x)$
$\Sigma F = ma$
$T - mg = ma$


+
T
-T
$a_x = a_y = a$
+
+
x
a_1
=
a_2

m_c

$\Sigma F_c = m_c a$



$\Sigma F_h = m_h a$