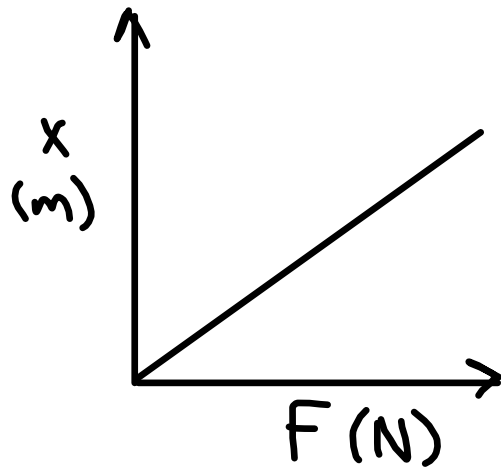# Forces from Springs

All objects deflect (stretch or compress) when forces are applied to them.

When the deflection is directly proportional to the size of the applied force, the object is said to behave like an ideal spring.

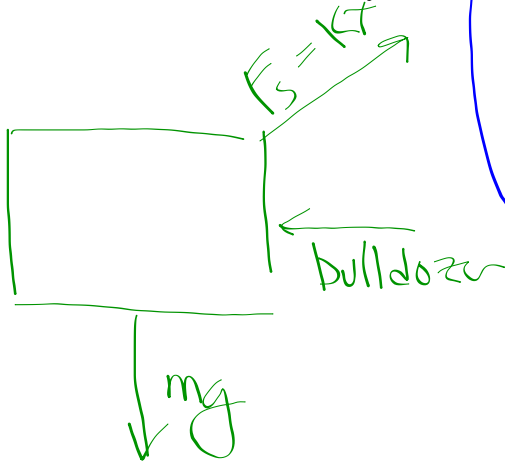Almost everything behaves like a spring to some extent. Therefore, springs are worth talking about.

An ideal spring behaves in a linear
fashion. The greater the applied
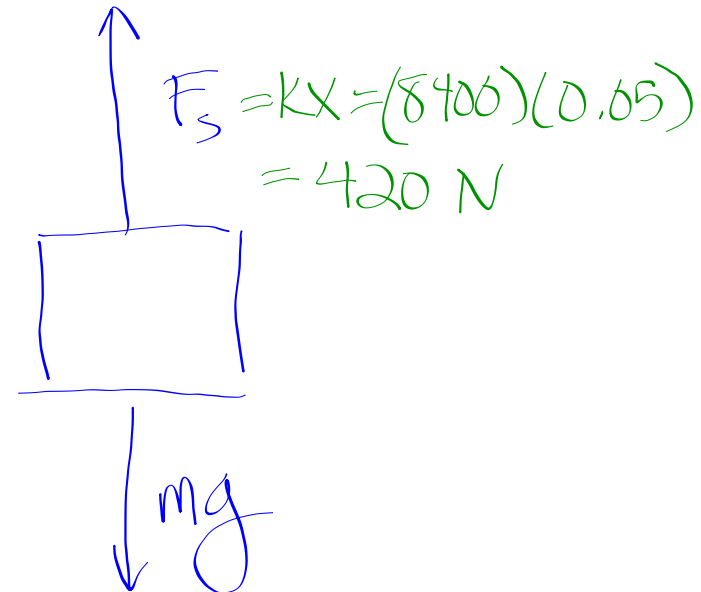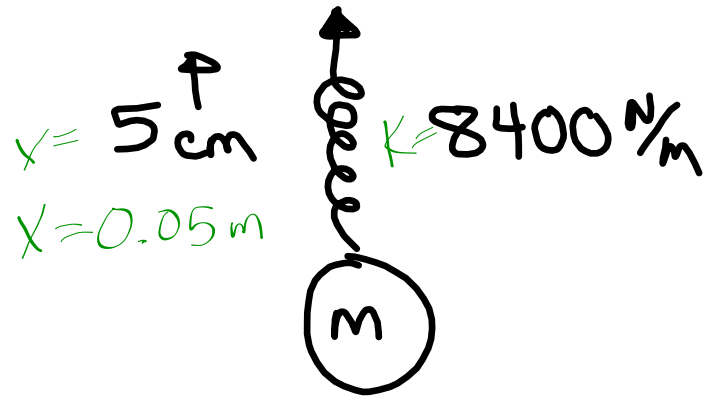force, the greater the deflection.

$$F_{spring} = kx$$

x = the deflection (in m, or ft) of spring
from its non-deflected length

k = spring constant (N/m, N/cm, lb/in,
etc...) This is unique for each spring

x (m)

F (N)

Fs = kg

bulldozer

mg

EXAMPLE 1 : (Static Equilibrium)

$x = 5 \text{ cm}$

$x = 0.05 \text{ m}$

$k = 8400 \, \text{N/m}$

(M)

$F_s = kx = (8400)(0.05)$
$= 420 \text{ N}$

mg

WHAT IS m?
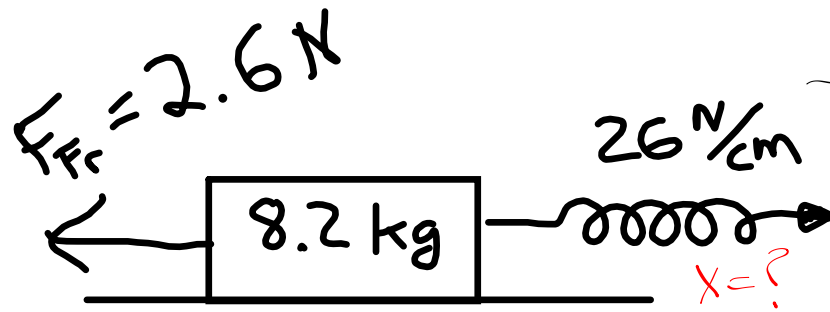
$\Sigma F_y = 0$

$F_s + -mg = 0$

$420 + -m(9.8) = 0$

$m = \dfrac{420}{9.8} = 42.9 \text{ kg}$

EXAMPLE 2 (Static Equilibrium)

$F_{Fr} = 2.6 \, N$

26 N/cm

[8.2 kg] ———mmmm→

$x = ?$

$F_{Fr} = -2.6 \, N$

$\boxed{}$ ← F_s

$+ →$

$\Sigma F_x = 0$

$-2.6 \, N + F_s = 0$

$F_s = 2.6 \, N$

$F_s = kx$

$2.6 \, N = 26 \, \frac{N}{cm} \cdot x$

$x = 0.1 \, cm$

Example 3 : (Static Equilibrium)

5 in

20 lb

27°

57°

← what is K?

44 lb

$-20 \sin 27$

20 lb

27°

$20 \cos 27$

F_S

57°

$-F_S \sin 57$

$-F_S \cos 57$

F_N

$mg = 44 \, lb$

$\Sigma F_y = 0$
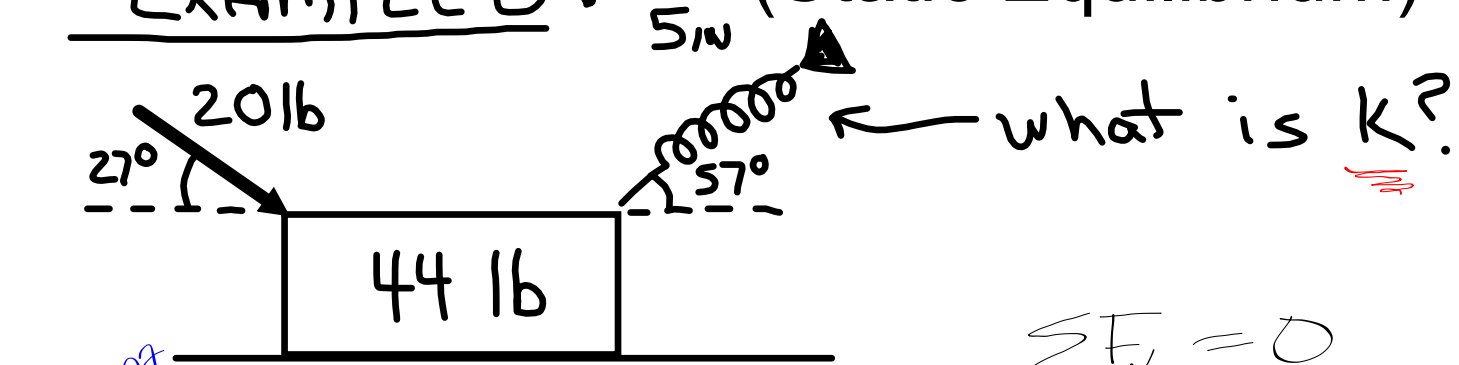
$F_N + {}^{-}44 + {}^{-}20 \sin 27 + {}^{-}F_S \sin 57 = 0$

$\Sigma F_x = 0$

$20 \cos 27 + {}^{-}F_S \cos 57 = 0$

$F_S = \dfrac{20 \cos 27}{\cos 57} = 32.7 \, lb$

$F_S = KX$

$32.7 \, lb = k \,(5in)$

$\boxed{k = 6.5 \, lb/in}$
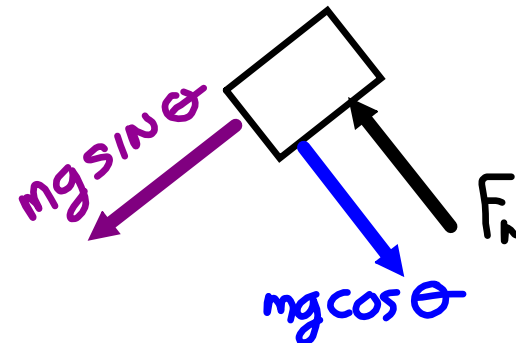
How should we handle inclines?

Use this reference
frame . . . because motion
will be along the incline
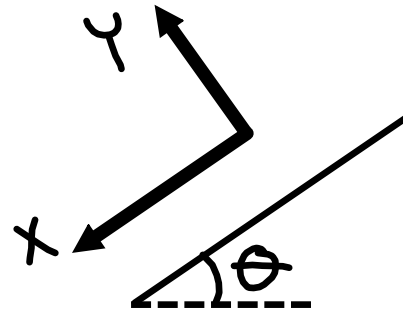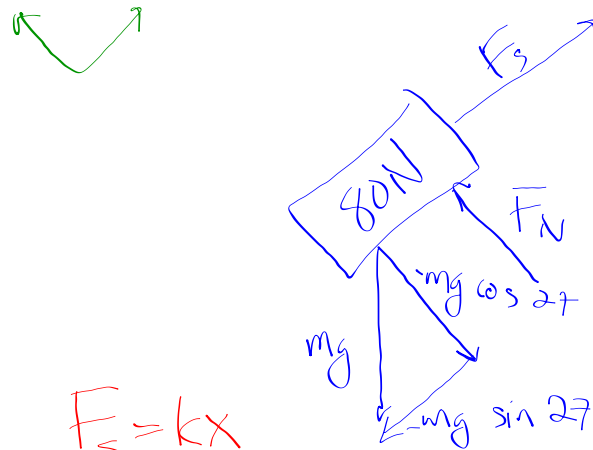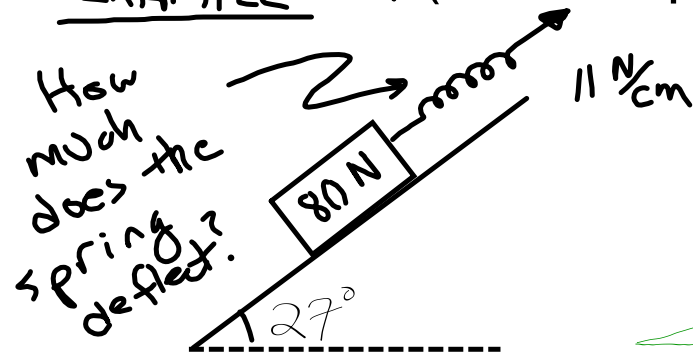
We need the force of gravity, which is vertically down,
resolved into X and Y components for this new reference
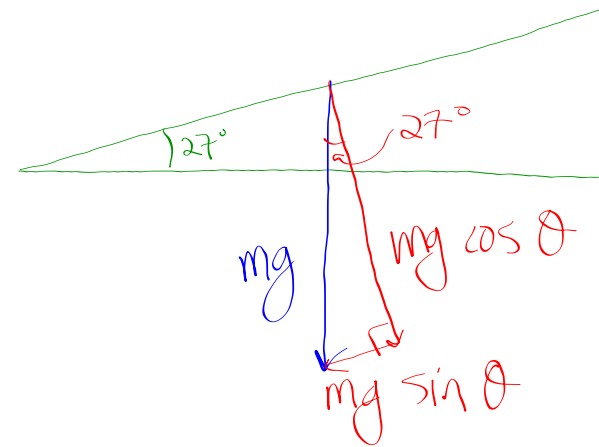frame
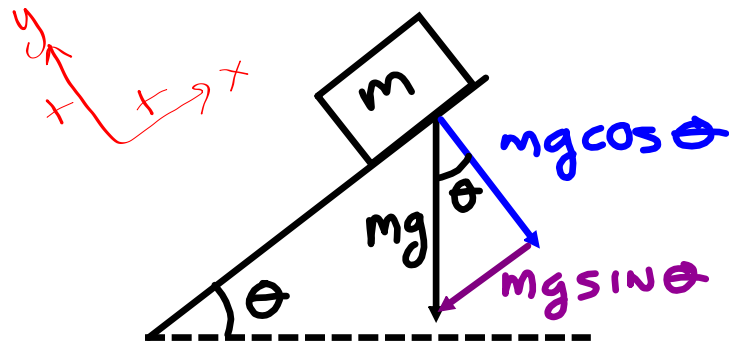
Sometimes (not always...)

$mg\cos\theta$

$mg\sin\theta$

$mg\sin\theta$

$mg\cos\theta$

F_N

7

EXAMPLE 4: (Static Equilibrium)

How much does the spring deflect?

80 N

$11 \frac{N}{cm}$

27°

F_s

80N

F_N

$-mg \cos 27$

mg

$-mg \sin 27$

$F_S = kx$

$36.3N = \frac{11 N}{cm} x$

$X = 3.3 \, cm$

27°   27°

mg $mg \cos \theta$

$mg \sin \theta$

$\Sigma F_X = 0$

$-mg \sin 27 + F_S = 0$

$F_S = 80 \sin 27$

$F_S = 36.3 N$