

6. (p. 68 #36) A 5000-kg helicopter accelerates upward at  $0.550 \text{ m/s}^2$  while lifting a 1500-kg car.

- a) What is the lift force exerted by the air on the blades of the helicopter?  
 b) What is the tension in the cable (ignore its mass) that connects car to helicopter?

The image contains two free-body diagrams and several equations.   
 Diagram (a) shows a helicopter with a mass of 5000 kg. An upward arrow is labeled 'F ?'. A downward arrow is labeled '-T'. Below the helicopter is a car with a mass of 1500 kg. An upward arrow from the car is labeled 'T'. A bracket to the right of these diagrams indicates 'acceleration =  $0.550 \text{ m/s}^2$ '.   
 Diagram (b) shows a free-body diagram for the car, labeled '1500 kg'. An upward arrow is labeled 'T'. A downward arrow is labeled 'mg =  $1500 \cdot 9.8 = 14,700 \text{ N}$ '.   
 To the right of diagram (a), there is a free-body diagram for the helicopter, labeled '5000 kg'. An upward arrow is labeled 'F'. Two downward arrows are labeled '-15525 N' and 'mg =  $5000 \cdot 9.8 = 49000 \text{ N}$ '.   
 Below diagram (b), the equation  $\Sigma F_y = ma_y$  is written, followed by  $T + -14,700 = (1500)(.55)$ , and then the final answer  $T = 15,525 \text{ N}$  is boxed. An arrow points from this box to the text 'tension in cable'.   
 To the right of the helicopter diagram, the equation  $\Sigma F_y = ma_y$  is written, followed by  $F + -15525 + -49000 = (5000)(.55)$ , and then the final answer  $F = 67,275 \text{ N}$  is boxed. An arrow points from this box to the text 'upward force on helicopter'.

acceleration =  $0.550 \text{ m/s}^2$

(a)

5000 kg

1500 kg

(b)

1500 kg

$mg = 1500 \cdot 9.8 = 14,700 \text{ N}$

$\Sigma F_y = ma_y$

$T + -14,700 = (1500)(.55)$

$T = 15,525 \text{ N}$

tension in cable

5000 kg

$mg = 5000 \cdot 9.8 = 49000 \text{ N}$

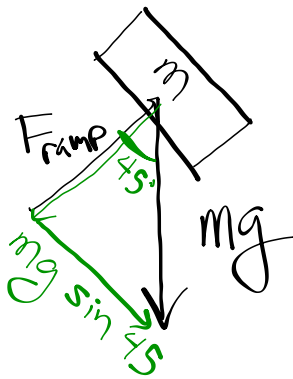
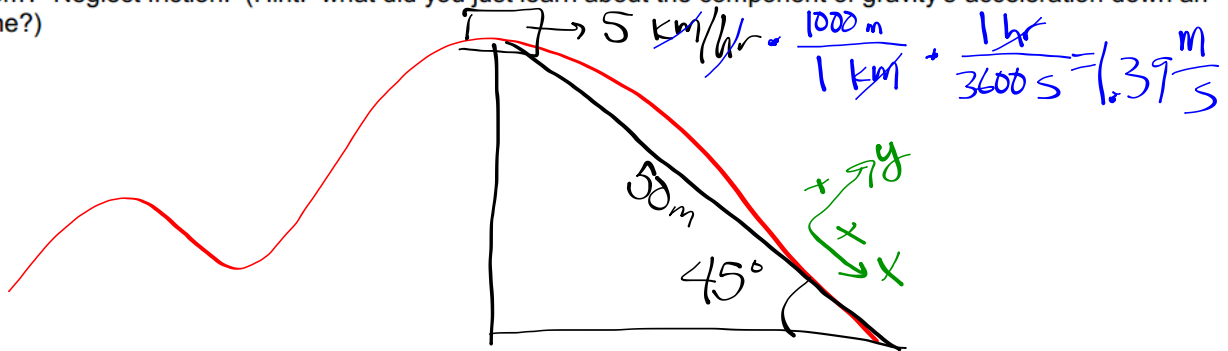
$\Sigma F_y = ma_y$

$F + -15525 + -49000 = (5000)(.55)$

$F = 67,275 \text{ N}$

upward force on helicopter

4. (p. 67 #28) A roller coaster reaches the top of the steepest hill with a speed of 5.0 km/h. It then descends the hill which is at an average angle of  $45^\circ$  and is 50-m long. What will its speed be when it reaches the bottom? Neglect friction. (Hint: what did you just learn about the component of gravity's acceleration down an incline?)



$$\sum F_x = ma_x$$

$$\frac{mg \sin 45}{m} = \frac{ma_x}{m}$$

$$a = g \sin 45 = 9.8 \sin 45$$

$$= 6.93 \text{ m/s}^2$$

$$x_0 = 0$$

$$x = 50$$

$$v_0 = 1.39 \text{ m/s}$$

$$v =$$

$$a = 6.93 \text{ m/s}^2$$

$$t =$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$= (1.39)^2 + 2(6.93)(50)$$

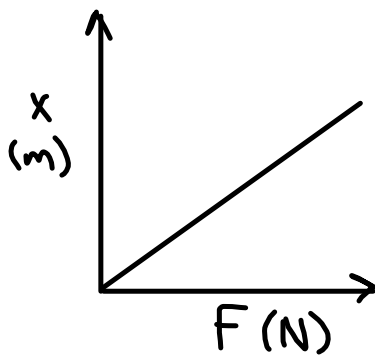
$$v = 26.4 \text{ m/s}$$

# 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.



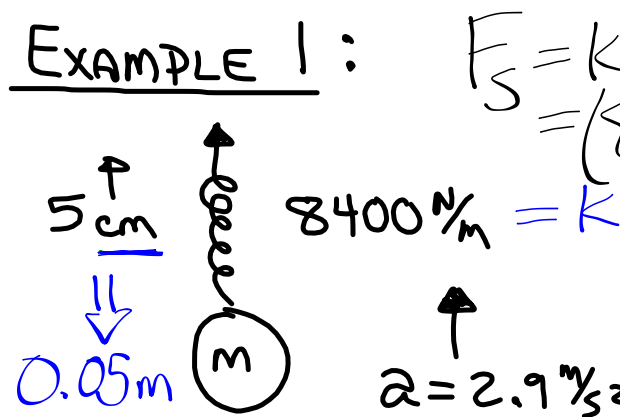

An ideal spring behaves in a linear fashion. The greater the applied force, the greater the deflection.

$$\mathbf{F_{spring} = kx}$$

$x$  = 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

EXAMPLE 1:  $F_s = kx$   
 $= (8400)(0.05)$   $F_s = 420 \text{ N}$   
 $8400 \text{ N/m} = k$   
 $a = 2.9 \text{ m/s}^2$   
 $5 \text{ cm}$   
 $0.05 \text{ m}$

WHAT IS  $m$ ?

$$\sum F_y = ma_y$$

$$420 + -mg = m(2.9)$$

$$420 + -m(9.8) = m(2.9)$$

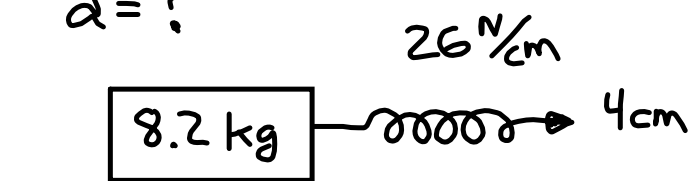
$$9.8m + 2.9m = 420$$

$$m(9.8 + 2.9) = 420$$

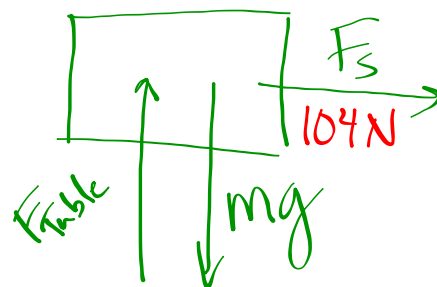
$$m = 33.07 \text{ kg}$$

EXAMPLE 2

$$a = ?$$



$$F_s = kx$$
$$= 26 \cdot 4 = 104 \text{ N}$$



$$\sum F_x = ma_x$$

$$104 = (8.2) a$$

$$a = 12.68 \text{ m/s}^2$$

