

### Newton's Second Law

Read from Lesson 3 of the Newton's Laws chapter at The Physics Classroom:

<http://www.physicsclassroom.com/Class/newtlaws/u213c.html>  
<http://www.physicsclassroom.com/Class/newtlaws/u213d.html>

MOP Connection: Newton's Laws: sublevels 8 and 9

Free-body diagrams are shown for a variety of physical situations. Use Newton's second law of motion ( $\Sigma F = m \cdot a$ ) to fill in all blanks. Use the approximation that  $g = \sim 10 \text{ m/s}^2$ .

For All  
 $F = ma$   
 $F_w = m \cdot g$   
 $a = \frac{F_{net}}{m}$   
 $m = \frac{F_w}{g}$

a.

$F_{air} = 0.10 \text{ N}$   
 $F_{grav} = 0.10 \text{ N}$   
 $m = \frac{0.10 \text{ N}}{10 \text{ m/s}^2} = 0.01 \text{ kg}$   
 $a = \frac{0.10 \text{ N}}{0.01 \text{ kg}} = 0 \text{ m/s}^2$   
 $\Sigma F = 0 \text{ N}$

b.

$F_{air} = 20,000 \text{ N}$   
 $F_{grav} = 100,000 \text{ N}$   
 $m = 10000 \text{ kg}$   
 $a = 8.0 \text{ m/s}^2, \text{ down}$   
 $\Sigma F = 20,000 \text{ N}$

c.

$F_{air} = 12,800 \text{ N}$   
 $F_{grav} = 8000 \text{ N}$   
 $m = 800 \text{ kg}$   
 $a = 6.0 \text{ m/s}^2, \text{ up}$   
 $\Sigma F = 4800 \text{ N up}$

d.

$F_{norm} = 10,000 \text{ N}$   
 $F_{grav} = 10,000 \text{ N}$   
 $F_{frict} = 9000 \text{ N}$   
 $m = 1000 \text{ kg}$   
 $a = -9 \text{ m/s}^2$   
 $\Sigma F = -9000 \text{ N}$

e.

$F_{norm} = 5 \text{ N}$   
 $F_{app} = 124 \text{ N}$   
 $F_{grav} = 5 \text{ N}$   
 $a = 0.5 \text{ m/s}^2$   
 $m = 0.500 \text{ kg}$   
 $a = 248 \text{ m/s}^2$   
 $\Sigma F = 124 \text{ N, right}$

f.

$F_{norm} = 9000 \text{ N}$   
 $F_{app} = 1350 \text{ N}$   
 $F_{grav} = 9000 \text{ N}$   
 $m = 900 \text{ kg}$   
 $a = 1.50 \text{ m/s}^2, \text{ right}$   
 $\Sigma F = 1350 \text{ N}$

g.

$F_{norm} = 150 \text{ N}$   
 $F_{app} = 7.5 \text{ N}$   
 $F_{grav} = 150 \text{ N}$   
 $m = 15.0 \text{ kg}$   
 $a = 0.50 \text{ m/s}^2, \text{ right}$   
 $\Sigma F = 7.5 \text{ N}$

h.

$F_{norm} = 600 \text{ N}$   
 $F_{frict} = 100 \text{ N}$   
 $F_{grav} = 600 \text{ N}$   
 $m = 60 \text{ kg}$   
 $a = -1.6 \text{ m/s}^2$   
 $\Sigma F = -100 \text{ N}$

i.

$F_{norm} = 20,000 \text{ N}$   
 $F_{app} = 14,000 \text{ N}$   
 $F_{frict} = 10,000 \text{ N}$   
 $F_{grav} = 20,000 \text{ N}$   
 $m = 2000 \text{ kg}$   
 $a = 2.0 \text{ m/s}^2, \text{ right}$   
 $\Sigma F = 4000 \text{ N}$

$F_{app} + F_f = m \cdot a$   
 $14000 \text{ N} + F_f = 2000 \text{ kg} \cdot 2 \text{ m/s}^2$   
 $14000 \text{ N} + F_f = 4000 \text{ kg}$   
 $F_f = -10,000 \text{ N}$