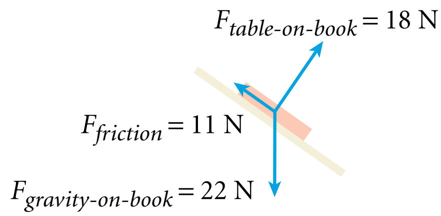
SAMPLE PROBLEM B

STRATEGY Determining Net Force

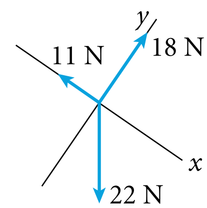
PROBLEM

Derek leaves his physics book on top of a drafting table that is inclined at a 35° angle. The free-body diagram at right shows the forces acting on the book. Find the net force acting on the book.



SOLUTION

1. Define the problem, and identify the variables.



(a)

Given: $F_{gravity\text{-}on\text{-}book} = F_g = 22$ N

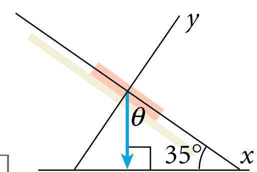
$F_{friction} = F_f = 11$ N

$F_{table\text{-}on\text{-}book} = F_t = 18$ N

Unknown: $F_{net} = ?$

2. Select a coordinate system, and apply it to the free-body diagram.

Choose the x-axis parallel to and the y-axis perpendicular to the incline of the table, as shown in **(a)**. This coordinate system is the most convenient because only one force needs to be resolved into x and y components.

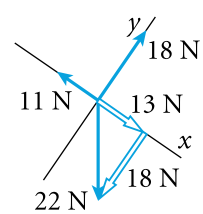


(b)

TIP *To simplify the problem, always choose the coordinate system in which as many forces as possible lie on the x- and y-axes.*

3. Find the x and y components of all vectors.

Draw a sketch, as shown in **(b)**, to help find the components of the vector $\mathbf{F_g}$. The angle θ is equal to 180°– 90° – 35° = 55°.



(c)

$$\cos\theta = \frac{F_{g,x}}{F_g} \qquad \sin\theta = \frac{F_{g,y}}{F_g}$$

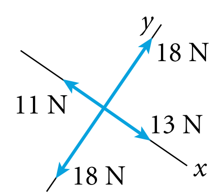
$$F_{g,x} = F_g \cos\theta \qquad F_{g,y} = F_g \sin\theta$$

$$F_{g,x} = (22\ \text{N})(\cos 55°) = 13\ \text{N} \qquad F_{g,y} = (22\ \text{N})(\sin 55°) = 18\ \text{N}$$

Add both components to the free-body diagram, as shown in **(c)**.

4. Find the net force in both the x and y directions.

Diagram **(d)** shows another free-body diagram of the book, now with forces acting only along the x- and y-axes.



(d)

For the x direction:

$$\Sigma F_x = F_{g,x} - F_f$$

$$\Sigma F_x = 13\ \text{N} - 11\ \text{N} = 2\ \text{N}$$

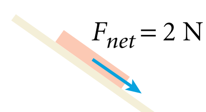
For the y direction:

$$\Sigma F_y = F_t - F_{g,y}$$

$$\Sigma F_y = 18\ \text{N} - 18\ \text{N} = 0\ \text{N}$$

5. Find the net force.

Add the net forces in the x and y directions together as vectors to find the total net force. In this case, $\mathbf{F_{net}}$ = 2 N in the $+x$ direction, as shown in **(e)**. Thus, the book accelerates down the incline.



(e)