The net force on the chopping block is given by $\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2$ and, according to Newton's second law, $\vec{F}_{\text{net}} = m\vec{a}$, where m is the mass of the block and $\vec{a}$ is its acceleration. Thus $\vec{a} = \vec{F}_{\text{net}}/m$. Carry out the vector addition in unit vector notation:

$$\vec{F}_{\text{net}} = (F_{1x} + F_{2x})\,\hat{\imath} + (F_{1y} + F_{2y})\,\hat{\jmath}\,.$$

The net force on the asteroid is the sum of the three forces of the astronauts: $\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$. Carry out the vector sum in unit vector notation. Use

$$\vec{F}_1 = (F_1 \cos 30°)\,\hat{\imath} + (F_1 \sin 30°)\,\hat{\jmath},$$
$$\vec{F}_2 = F_2\,\hat{\imath},$$

and

$$\vec{F}_3 = (F_3 \cos 60°)\,\hat{\imath} - (F_3 \sin 60°)\,\hat{\jmath},$$

where $F_1 = 32\,\text{N}$, $F_2 = 55\,\text{N}$, and $F_3 = 41\,\text{N}$.

According to Newton's second law the acceleration of the asteroid is given by $\vec{a} = \vec{F}_{\text{net}}/m$, where m is its mass. Once you have found $\vec{a}$ in unit vector notation use $a = \sqrt{a_x^2 + a_y^2}$ to find its magnitude and $\tan\theta = a_y/a_x$ to find the angle θ it makes with the positive x axis.

Remember that the mass of an object is an intrinsic property of the object and does not change if the object is moved to a place where the acceleration due to gravity is different. The weight, on the other hand, is given by mg and depends on the value of g at the position of the object.

The force of the elevator floor on the passenger is just right to give the passenger the same acceleration as the elevator. If up is positive, the net force on the passenger is $F_{\text{net}} = N - mg$, where N is the magnitude of the force of the floor and m is the mass of the passenger. According to Newton's second law $F_{\text{net}} = ma$, where a is the acceleration of the passenger (and elevator). Thus $N = m(g + a)$.

The maximum force occurs when the elevator has its maximum upward acceleration. The minimum force occurs when the elevator has its maximum downward acceleration. According to Newton's third law the force of the passenger on the floor has the same magnitude as the force of the floor on the passenger but it is in the opposite direction.

Since you know the initial speed and the stopping distance you can calculate the acceleration of the person's upper torso. Either solve $x = v_0 t + \frac{1}{2}at^2$ and $0 = v_0 + at$ simultaneously or else use $2ax = -v_0^2$. Once a value has been found for a use $F = ma$ to calculate the force.

The horizontal component of the net force on the refrigerator is $F\cos\theta$ and, according to Newton's second law, the acceleration of the refrigerator is

$$a = \frac{F}{m}\cos\theta,$$

where F is the magnitude of the applied force and m is the mass of the refrigerator.

At the end of time t the speed of the refrigerator is

$$v = at = \frac{Ft}{m}\cos\theta.$$

Find the ratio of this quantity to the speed for $\theta = 0$ ($\cos\theta = 1$).

Use $v^2 = v_0^2 + 2ax$ to show that after the refrigerator has gone a distance x its speed is

$$v = \sqrt{2ax} = \sqrt{\frac{2Fx}{m}\cos\theta}.$$

Find the ratio of this quantity to the speed for $\theta = 0$.

Because one of masses is not given you cannot find the acceleration of the four penguins by considering them as a single object. You must resort to solving the four Newton's second law equations, one for each penguin.

Take the axis to be positive to the right and label the tension forces of the cords T_1, T_2, T_3, and T_4, from left to right. You have been given T_2 and T_4. Similarly, label the masses of the penguins m_1, m_2, m_3, and m_4, again from left to right. Write down the Newton's second law equations:

$$T_1 = m_1 a \,,$$
$$T_2 - T_1 = m_2 a \,,$$
$$T_3 - T_2 = m_3 a \,,$$

and

$$T_4 - T_3 = m_4 a \,.$$

Systematically eliminate T_1, T_3, and a until you are left with a single equation in a single unknown, namely m_2. Solve for this quantity. You should get

$$m_2 = \frac{(m_1 + m_3 + m_4)T_2 - m_1 T_4}{T_4 - T_2} \,.$$

Think of the blocks as a single object with mass $m_1 + m_2 + m_3$, being pulled by the force T_3. Use Newton's second law to compute the acceleration. To find the tension forces, use the second law equations for the individual blocks.

(a) Take the axis to be positive to the right and write the horizontal component of Newton's second law:

$$T_3 = (m_1 + m_2 + m_3)a .$$

Solve for a.

(b) and (c) The horizontal component of Newton's second law for block 3 is

$$T_3 - T_2 = m_3 a .$$

Solve for T_2. The horizontal component of Newton's second law for block 2 is

$$T_2 - T_1 = m_2 a .$$

Solve for T_1.

You can check your solution by solving the second law equation for block 1 ($T_1 = m_1 a$).

Draw separate free-body diagrams for the man and for the sandbag. If T is the magnitude of the tension force of the rope, then Newton's second law for the sandbag is

$$T - m_s g = m_s a \,,$$

where m_s is the mass of the sandbag and a is its acceleration. Up was chosen to be the positive direction. Newton's second law for the man is

$$m_m g - T = m_m a \,,$$

where m_m is the mass of the man and down was chosen to be the positive direction. Notice that, in each case, the positive direction was chosen to be the direction of the acceleration. The sandbag and the man have the same acceleration (in both magnitude and sign) so the same symbol is used in the two second law equations. The magnitude of the tension force is also the same. The pulley simply causes the direction to be upward for both the man and the sandbag.

Use one of the second law equations to eliminate T from the other, then solve the resulting equation for a. Use $v^2 = v_0^2 + 2ay$ to find the speed after the man has accelerated through a distance y.

(a) Assume that the cord is not slack and the two boxes have accelerations of the same magnitude. For the pen box (on the horizontal surface) take the x axis to be horizontal and positive to the right. The horizontal component of Newton's second law for this box is

$$F + T = Ma \,,$$

where T is the tension force of the cord, M is the mass of the box, and a is its acceleration. For the pencil box (on the incline) take the x axis to be parallel to the incline and positive down the incline. Newton's second law for this box gives

$$mg \sin \theta - T = ma \,,$$

where m is the mass of the box and θ is the angle of the incline. Notice that the two x axes were chosen so the same symbol could be used for the accelerations. Also note that the cord pulls to the right on the pen box and pulls upward on the pencil box.

Use one of the second law equations to eliminate a from the other, then solve the resulting equation for T. Be sure you find an algebraic expression for T before substituting numerical values.

(b) When F has the greatest value for which the cord is taut, $T = 0$ and the boxes have accelerations with the same magnitudes. Set $T = 0$ in the expression you found for T in part (a), then solve for F. If the value of F is greater than the result you find here, then the acceleration of the pen box is greater in magnitude than the acceleration of the pencil box and the cord is slack.

CHAPTER 5   HINT FOR PROBLEM 48

The acceleration is parallel to the canal so the force of the water must be such that the perpendicular component of the total force vanishes and the parallel component leads to the given acceleration. Use Newton's second law to find the components of the force of the water.

Draw a free-body diagram for the barge. Label the force of the rope F_R and the force of the water F_W. You do not know the direction of this force but you suspect it is somewhere in the third quadrant, roughly opposite the force of the rope. Use θ_R to label the angle between the rope and the forward direction. Take the forward direction to be the positive x axis and take the y axis to be across the canal. Write Newton's second law in component form. The x component is

$$F_R \cos \theta_R + F_{Wx} = ma$$

and the y component is

$$F_R \sin \theta_R + F_{Wy} = 0 \,.$$

Solve for F_{Wx} and F_{Wy}. Then calculate the magnitude of the force and the angle it makes with the canal.

(a) Suppose the man pulls downward on the rope with a force of magnitude F. The rope then pulls upward on his hand with a force of the same magnitude. The tension force of the rope is F so, in addition, the rope pulls upward on the chair with force F. You want to calculate the value of F so the acceleration of the man and chair is 0.

Draw a free-body diagram for the man and chair, considered as a single object. The total force of the rope is $2F$, upward; the weight is mg, downward. Take the positive direction to be upward and write the vertical component of Newton's second law:

$$2F - mg = ma\,.$$

Set $a = 0$ and solve for F.

(b) Now set a equal to $1.30\,\text{m/s}^2$ and solve for F.

(c) and (d) If the person on the ground pulls down with a force of magnitude F, the force of the rope on the chair and man is F, upward. $2F$ is replaced by F in the second law equations.

(e), (f), (g), and (h) Now, consider the pulley. The rope is pulling down on it and the ceiling is pulling up. Since the pulley does not accelerate the vector sum of these forces must vanish. Solve for the force of the ceiling on the pulley. According to Newton's third law, the force of the pulley on the ceiling has the same magnitude but is in the opposite direction.

Draw a free-body diagram for the pulley. If F is the tension force of the rope, then the force of the rope on the pulley is $2F$. It is downward. Use F_c to label the force of the ceiling. Since the pulley is massless there is no force of gravity. Write Newton's second law:

$$F_c - 2F = 0\,.$$

Calculate F_c for each of the four cases.

CHAPTER 5   HINT FOR PROBLEM 56

Draw a free-body diagram for the lamp. There are two forces on it: the tension force T of the cord, up, and the force of gravity mg, down. Here m is the mass of the lamp. If up is taken as the positive direction, then Newton's second law for the lamp is

$$T - mg = ma \,,$$

where a is the acceleration of the lamp. The acceleration of the lamp is the same as the acceleration of the elevator.

In part (a) set T equal to $89\,\text{N}$ and a equal to $+24\,\text{m/s}^2$, then solve for m. Note that the acceleration is upward, so it is positive. In part (b) again set a equal to $+2.4\,\text{m/s}^2$, then solve for T Actually, you should be able to tell the value for the tension force without doing any arithmetic.