

7: The Laws of Motion

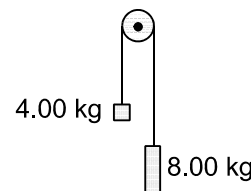
Worksheet C: PROBLEMS

Name _____

AP Physics B

Show your work on all problems, including a FREE-BODY DIAGRAM and the equations of force analysis. Assume $g = -9.80 \text{ m/s}^2$ and that air resistance is negligible. Show all units and express final answers with the proper number of significant figures.

1. A cord passing over a pulley with negligible friction and mass has a 4.00 kg object tied to one end and an 8.00 kg object tied to the other as shown at right. Compute the magnitude of the acceleration of the masses.



This device is called an Atwood's machine. Draw a separate FBD for each mass, using them to write an equation for each mass, and then solve those two equations simultaneously. When the tension accelerates one mass one direction, it accelerates the other mass in the opposite direction, so we arbitrarily designate one of the accelerations as negative, yielding these equations:

$$\vec{T} + \vec{F}_{g4} = m_4(\vec{a}) \text{ and } \vec{T} + \vec{F}_{g8} = m_8(-\vec{a})$$

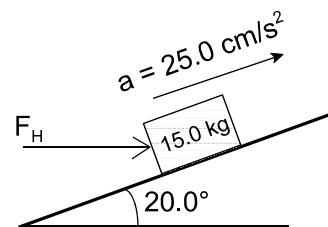
A computer simulation of this problem is available to check your answer.

2. A girl pulls a struggling 12.0 kg dog using a horizontal leash. The leash can sustain a maximum of 38.0 N of force before breaking. At one point, the dog is pulling with a force of 40.0 N opposite her pull. What is the minimum acceleration with which she must follow the dog in order to keep the leash from breaking?

3. A 15.0 kg block slides **up** a 20.0° incline with an acceleration of 25.0 cm/s^2 when a horizontal force is applied as shown. If the frictional force on the block is 134 N, what is the magnitude of the horizontal force?

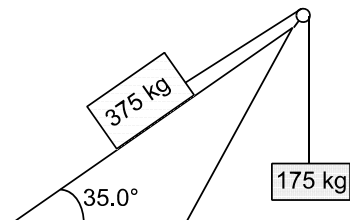
Frictional forces are always directly opposite the motion or attempted motion of a body. Since the block slides up the incline, friction will act down the incline's slope.

A computer simulation of this problem is available to check your answer.

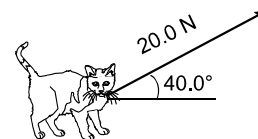


4. At launch, the space shuttle's engines provide a thrust of $29.0 \times 10^6 \text{ N}$, and it accelerates upward at 1.75 m/s^2 . What is the shuttle's mass?

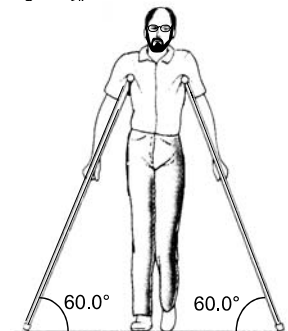
5. A 175 kg crate is being lifted upward by a pulley system as shown at right. A 375 kg mass is sliding down the rough 35.0° incline. There is 100 N of frictional force on the sliding mass. Calculate the magnitude of the acceleration of the crate. *Again draw separate FBD's for each object. Then either follow the procedure given for problem 1 **or** combine the masses into one and only use the external forces on the system of masses to find the answer.*



6. Mr. M was dragging his reluctant cat out for a walk. Fluffy's leash was angled at 40.0° degrees to the horizontal and had a tension of 20.0 N (see diagram). If Fluffy's mass was 4.00 kg and she accelerated forward at 1.75 m/s^2 , what was the size and direction of the frictional force on her?



7. Following a minor accident with Fluffy, Mr. M is using crutches to hobble about. He weighs 700 N and is supporting half of his weight with his feet. The two crutches are supporting the remaining half of his weight as depicted at right. Draw a free-body diagram of Mr. M and then calculate the magnitude of the overall force one of the crutches must provide in this situation.



8. A jet plane weighing 600,000 N started from rest down a runway and accelerated for takeoff at 2.00 m/s^2 . How much horizontal thrust did its engines provide?
A computer simulation of this problem is available to check your answer.