Mastering Physics Assignment 2

Is available on Mastering Physics website

Seven practice problems + six for credit on material from chapter 3

Due Wednesday, October 10 at 11 pm

On Campus Machines

Use Firefox if problems with Internet Explorer!

GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007
(lecture schedule is approximate)

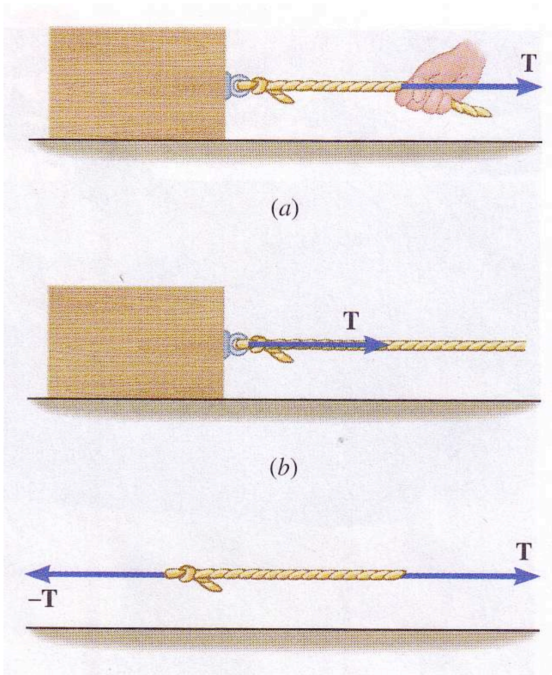
5	M	Oct 1	11			Tutorial and Test 1 (chapters 1, 2, 3)
	W	3	12	Chapter 5	Uniform circular motion	
	F	5	13			
6	M	8	Thanksgiving Day			Experiment 2: Measurement of g by free fall
	W	10	14	Chapter 5	Uniform circular motion	
	F	12	15	Chapter 6	Work and energy	
7	M	15	16			Tutorial and Test 2 (chapters 4, 5)
	W	17	17			
	F	19	18	Chapter 7	Impulse and momentum	
8	M	22	19			No lab or tutorial
	Tue	23	MID-TERM TEST, Ch 1-5, Tuesday, October 23, 7-9 pm			
	W	24	20	Chapter 7	Impulse and momentum	
	F	26	21	Chapter 8,	Rotational kinematics	

Week of October 8

Monday is a holiday!

Experiment 2: Measurement of g by free fall

The Tension Force



Tension – the force within a rope or cable that is used to pull an object.

A force **T** applied to the end of the rope is transferred to other end of the rope where it exerts the same force on the block.

The block exerts an equal and opposite force on the rope (Newton's 3rd law).

Objects in Equilibrium

An object is in equilibrium when its acceleration is zero – it remains at rest, or moves with constant velocity.

This implies that the net force acting on it is zero (first law).

$$F_x^{net} = 0$$
$$F_y^{net} = 0$$

- Equilibrium is often expressed in terms of the net force on an object being zero.

- The object may be moving, but at constant velocity.

Objects not in Equilibrium

Apply Newton's second law to motion in x and y:

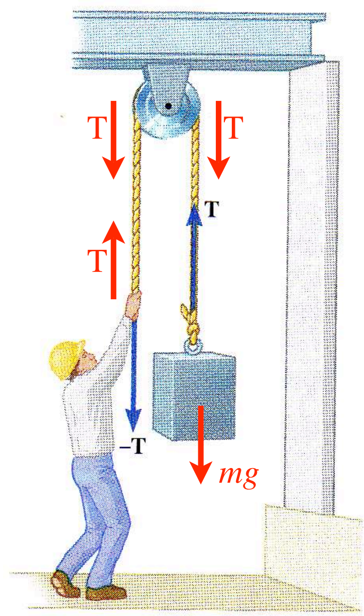
$$F_x^{net} = ma_x$$
$$F_y^{net} = ma_y$$

The Tension Force

The man pulls the rope with a force T.

The force is transmitted undiminished over the pulley (massless rope, frictionless pulley) and exerts an upward force T on the block.

If the block is in equilibrium: T = mg



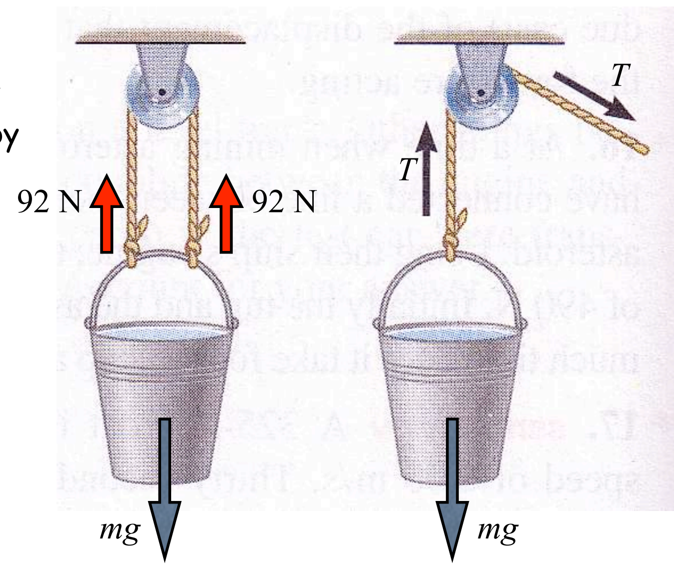
4.48/46: In the left hand diagram, the tension in the rope is 92 N. What is the tension in the right hand diagram?

The weight of the bucket on the left is supported by two tensions forces:

$mg = 92 + 92 = 184$ N

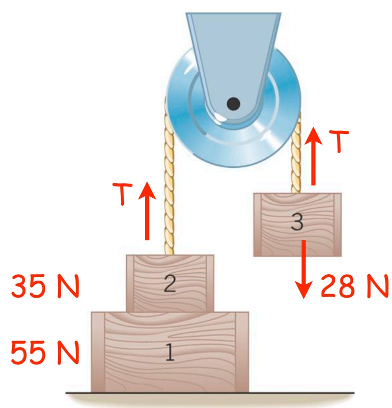
T in diagram at right is alone supporting the bucket. So,

$T = 184$ N



Clickers!

4.55: Box 1 is resting on a table with box 2 on top of box 1. A massless rope passes over a frictionless pulley to box 3. The weights of the boxes are:

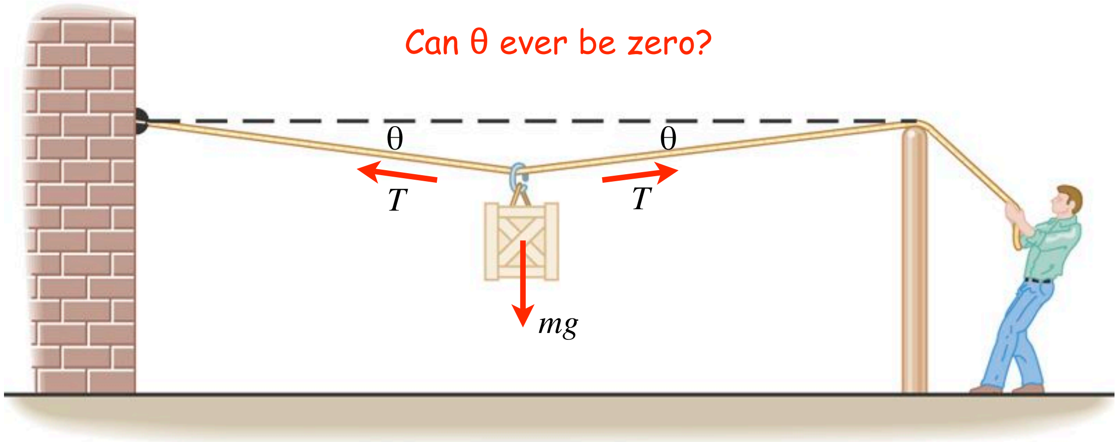


$W_1 = 55$ N
$W_2 = 35$ N
$W_3 = 28$ N

The magnitude of the normal force that the table exerts on box 1 is:

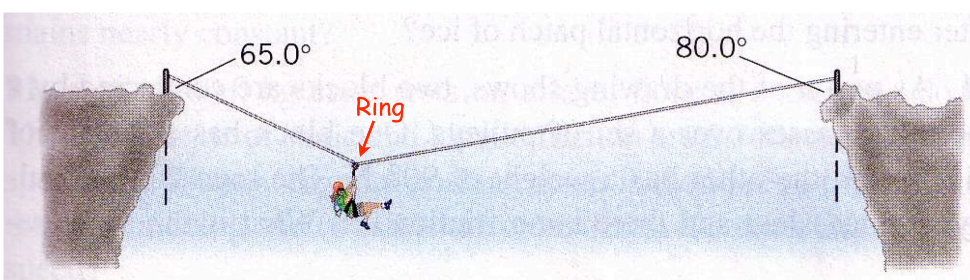
A) 55 N
B) 62 N ←
C) 90 N
D) 118 N
E) I made a mistake

4.C26: Can the person who is pulling the rope ever make the rope perfectly horizontal?



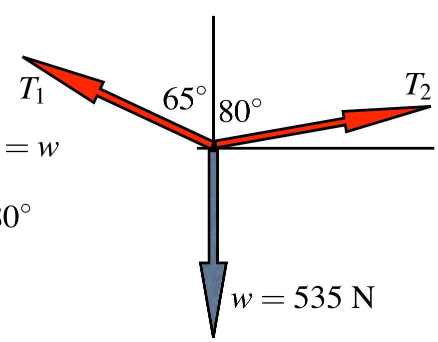
To support the weight:

$$mg = 2T\sin\theta$$



4.102/58: The mountaineer weighs 535 N. What are the tensions in the two sections of the cable?

Forces on the ring:



Vertically: $T_1\cos 65^\circ + T_2\cos 80^\circ = w$

Horizontally: $T_1\sin 65^\circ = T_2\sin 80^\circ$

Eliminate T_1, solve for T_2

$$\text{Vertically: } T_1 \cos 65^\circ + T_2 \cos 80^\circ = w \quad (1)$$

$$\text{Horizontally: } T_1 \sin 65^\circ = T_2 \sin 80^\circ \quad (2)$$

$$\text{So, } T_1 = T_2 \frac{\sin 80^\circ}{\sin 65^\circ} = 1.0866 \times T_2 \quad (2)$$

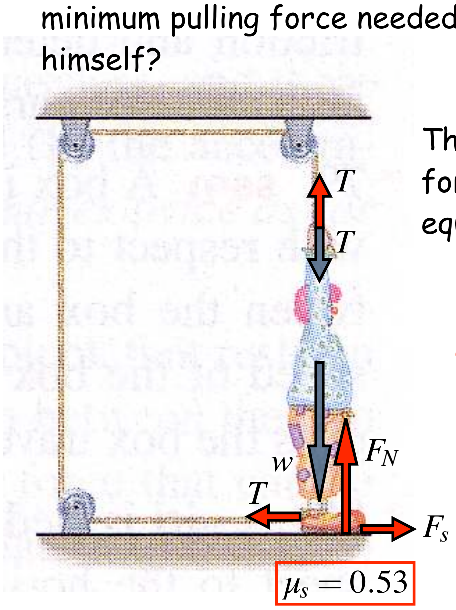
Substitute into (1):

$$T_2 \times 1.0866 \cos 65^\circ + T_2 \cos 80^\circ = w = 535 \text{ N}$$

$$T_2 = 535/0.63287 = 845 \text{ N}$$

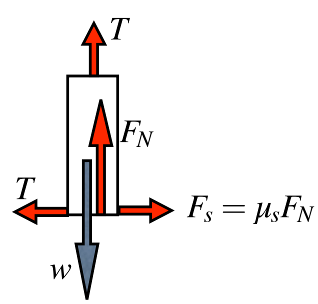
$$\text{and } T_1 = 1.0866 \times T_2 = 918 \text{ N}$$

4.54: A circus clown weighs 890 N. He pulls vertically on the rope that passes over three pulleys and is tied to his feet. What is the minimum pulling force needed to yank his feet out from beneath himself?



The clown pulls down on rope with force T. The rope pulls back with equal force.

Forces acting on the clown:



If T > F_s, his feet will slip

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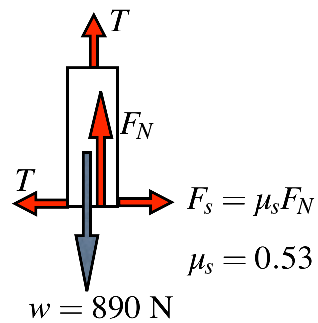


That is:

maximum value

$$T > F_s = \mu_s F_N \;\rightarrow\; \text{set } T = \mu_s F_N$$

What is F_N?

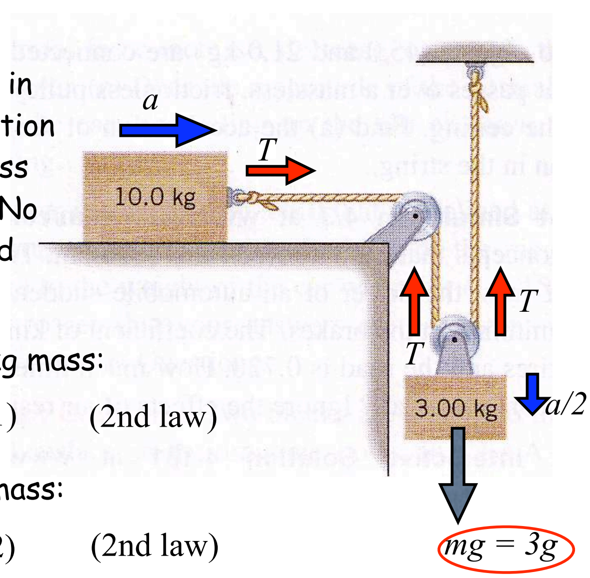
Forces in the vertical direction:

$$T + F_N = w = 890 \text{ N} \quad \text{or} \quad \mu_s F_N + F_N = 890 \text{ N}$$

So, $F_N = (890 \text{ N})/(1 + 0.53) = 582$ N

Substitute $T = \mu_s F_N = 0.53 \times 582 = 308$ N

4.83/85: Find the tension in the rope and the acceleration of the 10 kg mass (massless rope, frictionless pulley). No friction between block and table.



Force to the right on 10 kg mass:

$$T = ma = 10a \qquad (1) \qquad \text{(2nd law)}$$

Downward force on 3 kg mass:

$$3g - 2T = 3(a/2) \qquad (2) \qquad \text{(2nd law)}$$

So, from (1) and (2): $2T = 20a = 3g - 3a/2$

Therefore, $a = 1.37 \text{ m/s}^2$ and $T = 10a = 13.7$ N

All of the physics so far –

- Force, mass and Newton's three laws of motion
- Newton's law of gravity
- Normal, friction and tension forces.
- Apparent weight, free fall
- Equilibrium

The rest is –

- useful equations – the four famous equations
- how to apply all of the above

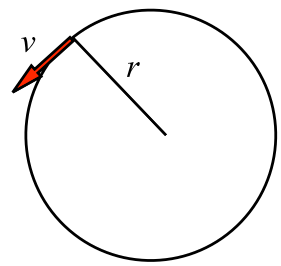
Chapter 5: Uniform Circular Motion

- Motion at constant speed in a circle
- Centripetal acceleration
- Banked curves
- Orbital motion
- Weightlessness, artificial gravity
- Vertical circular motion

Uniform Circular Motion

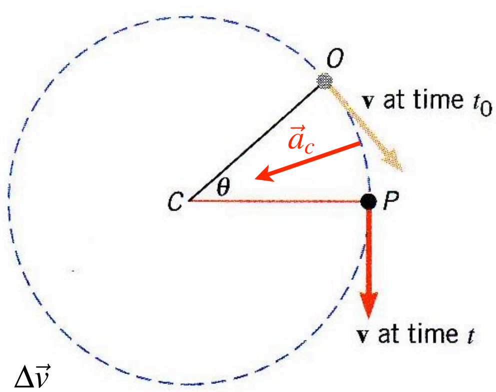
- An object is travelling at constant speed in a circular path.
- The velocity is changing because the direction of the speed is changing and so **the object is accelerated**.
- The period, T, of the motion is the time to go once around the circle.
- For an object travelling at speed v around a circle of radius r –

$$T = \frac{\text{circumference}}{\text{speed}} = \frac{2\pi r}{v}$$



Centripetal Acceleration

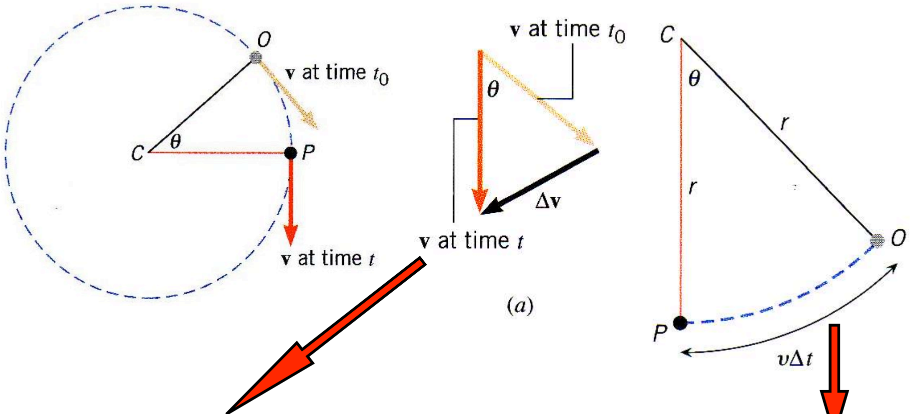
The object is accelerated toward the centre of the circle – this is the centripetal acceleration.



Centripetal acceleration, $\vec{a}_c = \frac{\Delta \vec{v}}{\Delta t}$

Work out the change in velocity in a short time interval...

Centripetal Acceleration



$\frac{\Delta v}{v} = \theta$ radians, if time interval Δt is short

Object travels $v\Delta t$ in time Δt

$\frac{v\Delta t}{r} = \theta$ radians

So, $\theta = \frac{\Delta v}{v} = \frac{v\Delta t}{r}$ $\quad a_c = \frac{\Delta v}{\Delta t} = \frac{v^2}{r}$ = centripetal acceleration

A car is driven at a constant speed of 34 m/s (122 km/h).

What is the centripetal acceleration in the two turns?

First turn: $r = 33$ m

Centripetal acceleration, $a_c = \frac{v^2}{r} = \frac{34^2}{33}$

$$a_c = 35.0 \text{ m/s}^2 = 3.6 \times g = 3.6g$$

Second turn, $r = 24$ m

$$a_c = \frac{34^2}{24} = 48.2 \text{ m/s}^2 = 4.9g$$