Relative velocity in 1-D

You are walking along a road, heading west at 8 km/hr.

There is also a truck passing, traveling at 40 km/hr west.

How fast is the truck traveling relative to you?

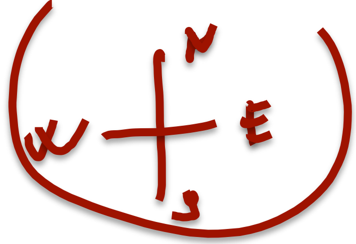
(or v-v)

(1) 48 km/hr west

(2) 32 km/hr west

(3) 32 km/hr east

(4) 48 km/hr east



$? = \leftarrow + \longrightarrow = \longrightarrow$

Relative velocity questions (2-D motion)

You have a boat and you're trying to cross a river.

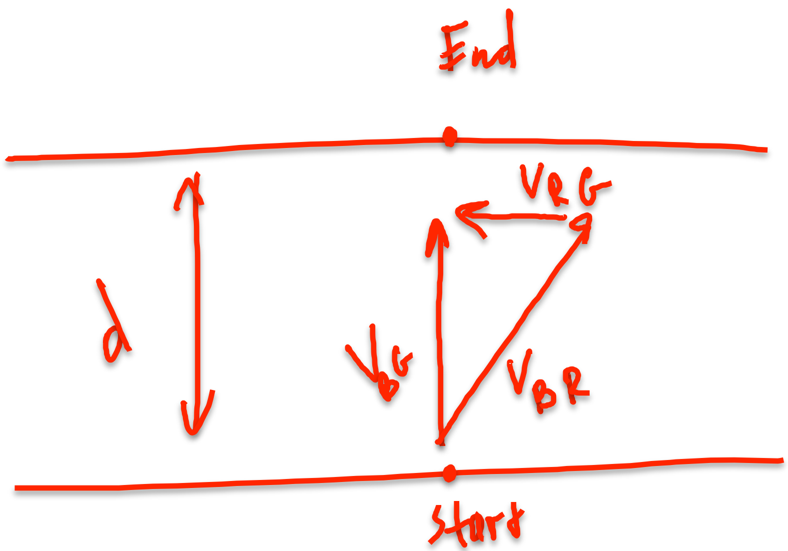
1) How should you aim your boat to reach the far shore and cover the shortest distance?

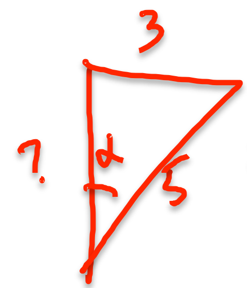
1. In the direction of the stream
2. Perpendicularly to the stream
3. None of the above

2) If the current in the river is 3 m/s and your boat can travel at 5 m/s in a lake, how should you aim your boat so you land at the point directly across the river? If the river is 100 m wide, how long does it take you to cross?

Shortest distance

$\sin\alpha = \frac{3}{5}$





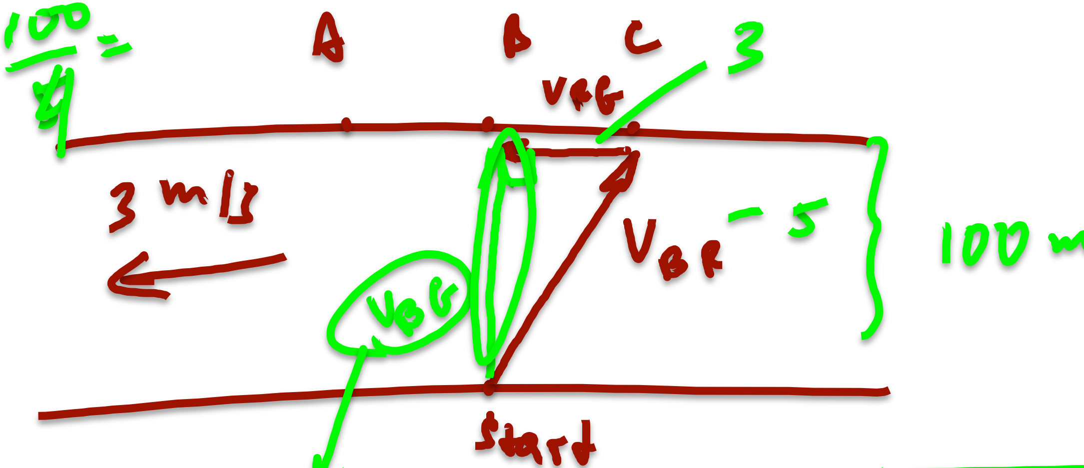
$\Rightarrow ? = 4\ m/s$

$d = d_{BG} = V_{BG} \cdot t$

$t = \frac{d}{4}$

$s = v \cdot t$

$t = \frac{s}{v} = \frac{100}{4} =$



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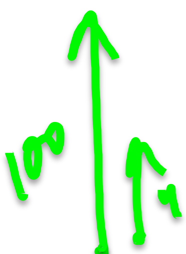
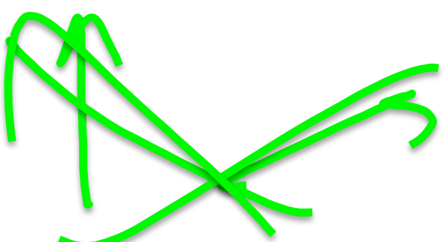


$V_{BF} = \sqrt{V_{BR}^2 - V_{RF}^2}$



Another Relative velocity Question

You have a boat and you're trying to cross a river that has parallel banks. If there is no current in the river, the quickest way to cross is to aim your boat directly across the river.

If the water is flowing down the river, how should you aim your boat to reach the far shore in ***the shortest time***?

(1) Angle the boat upstream, and go against the current, landing somewhere upstream.

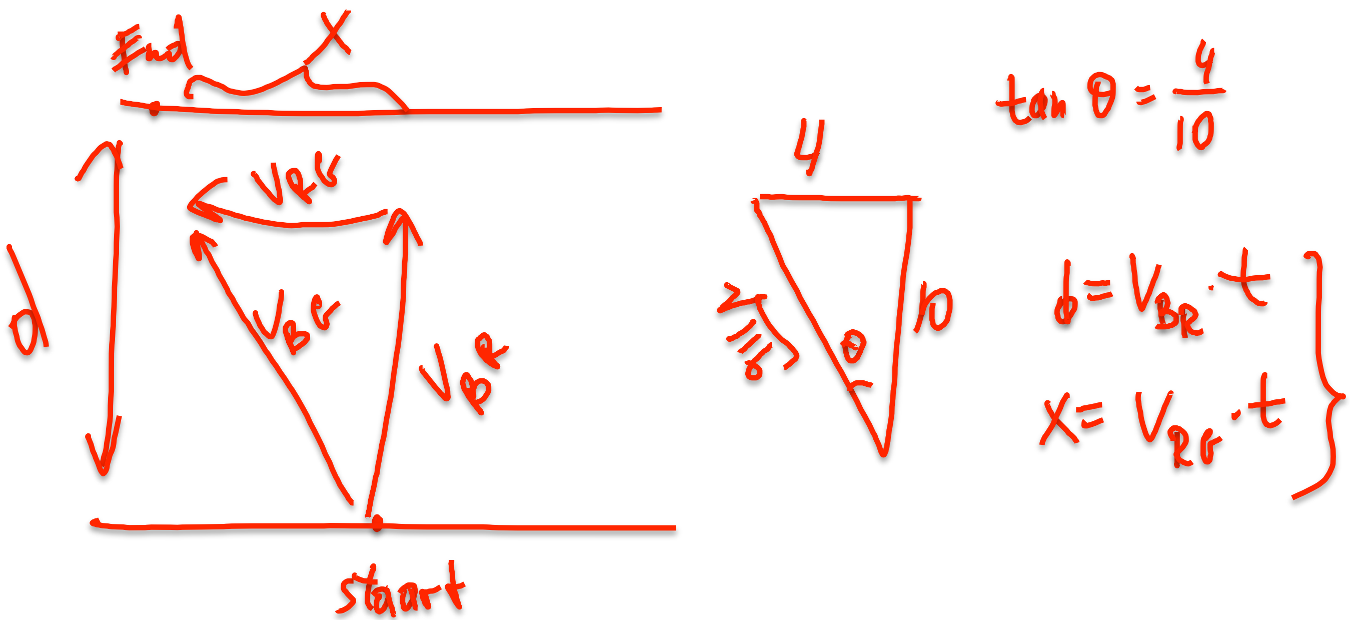
(2) Angle the boat upstream in such a way that you land at the point directly across from where you started.

(3) Point your boat directly across the river and get carried some way downstream.

(4) Angle your boat downstream and get carried even further downstream.

Relative velocity Question

You have a boat and you're trying to cross a river that has parallel banks. The speed of the boat in a lake is 10 m/s. The speed of the stream is 4 m/s. How should you aim your boat to reach the far shore in ***the shortest time***? If the river is 600 m wide, where do you land?



Practice at home

A training plane makes a round trip. First it flies 112 km east and then it flies right back. On its way due to east a pilot sees a cloud and he measures that the speed of the plane is 300 m/s relative to the cloud. If it is known that during the whole trip there was a strong wind due to east and the speed of the wind relative to the ground was 20 m/s, how long was the trip?

Practice at home

A training plane makes a round trip. First it flies 112 km north and then it flies right back. The cruse speed of the plain is 300 m/s. The weather report says that during the flight a steady wind due to east affects the flight. The speed of the wind relative to the ground was 20 m/s, how long was the trip?

This week's topics

Inertia, force, list of forces, Newton's 1st law, Newton's 2nd law, Newton's 3rd law, principle of superposition of forces, FBD, force of gravity vs. apparent weight, weightless, kinetic friction vs. static friction, coefficient of friction, a pulley, an ideal string, an Atwood's machine, methods for applying Newton's laws (***the last topic of test 1***)

A book is at rest on a table top. Which of the following force(s) is(are) acting on the book?

1. A downward force due to gravity.
2. The upward force by the table.
3. A net downward force due to air pressure.
4. A net upward force due to air pressure.

(A) 1 only

(B) 1 and 2

(C) 1, 2, and 3

(D) 1,2, and 4

(E) none of forces, since the book is al fest there are no forces acting on it.

If we put a book on a table and give it a push, what is going to happen, and why?

Force

A force is a push or a pull.

A force is a vector, so it has a direction associated with it.

Force is a measure of interactions between 2 objects.

A ***force*** is a push or a pull.

Contact forces arise from physical contact .

Action-at-a-distance forces do not require contact and include gravity and electrical forces.

Mechanical Forces:

1. Gravity; close to the Earth $|F_g| = mg$
2. Weight; $|W| = mg$
3. Normal force; $|N|$ = force acting form the support perpendicularly to the surface of the support
4. Apparent weight; $|AW| = |(-1)*|N||$
5. Measured weight; $|MW| = |AW|$
6. Elastic force – in springs; $|F_{el}| = k|Dx|$
7. Tension – force in the rope (an applied force)
8. A push – an applied force
9. Static friction – frictional force preventing an object from moving; $|F_{sf}| < m_{sf}|N|$
10. Kinetic friction – frictional force resisting the motion; $|F_{cf}| = m_{cf}|N|$
10. Buoyant force – from a fluid around an object; $|F_b| = |W_{df}|$

SI Unit for Force

? =

1

2

3

$$\frac{kg \cdot m^{?}}{s^2}$$

SI Unit for Force

$$(\mathrm{kg})\left(\frac{\mathrm{m}}{\mathrm{s}^2}\right)=\frac{\mathrm{kg}\cdot\mathrm{m}}{\mathrm{s}^2}$$

? = 1

This combination of units is called a *newton* (N).

Newton's First Law

- Aristotle (384-322 BC) thought that objects were naturally at rest.
- Galileo (1564-1642) realized that the Greeks weren't accounting for forces such as friction.
- Newton summarized Galileo's thoughts in the following statement:

Newton's first law: an object at rest tends to remain at rest, and an object in motion tends to remain in motion with a constant velocity (constant speed and direction of motion), ***unless*** it is acted on by a nonzero net force.

1. Force is a Cause (Reason, Source) for Acceleration

No forces = > no acceleration

Motion does not necessarily require a force to sustain it.

2. The net force is the key

Force is a vector. When many forces are acting - add up all the forces ***as vectors***, to find the net force acting on an object.

We represent the net force symbolically using: $\Sigma \mathbf{F}$.
(The Greek letter sigma symbolizes a sum, and here we're summing all the forces).

When the net force is 0 => no acceleration.
When the net force is not 0 => there is acceleration.
(works both ways!)
If a zero net force acts on an object its velocity is *unchanged*.
If there is a none-zero net force => the velocity changes.

The *net force* is the vector sum of all of the forces acting on an object.

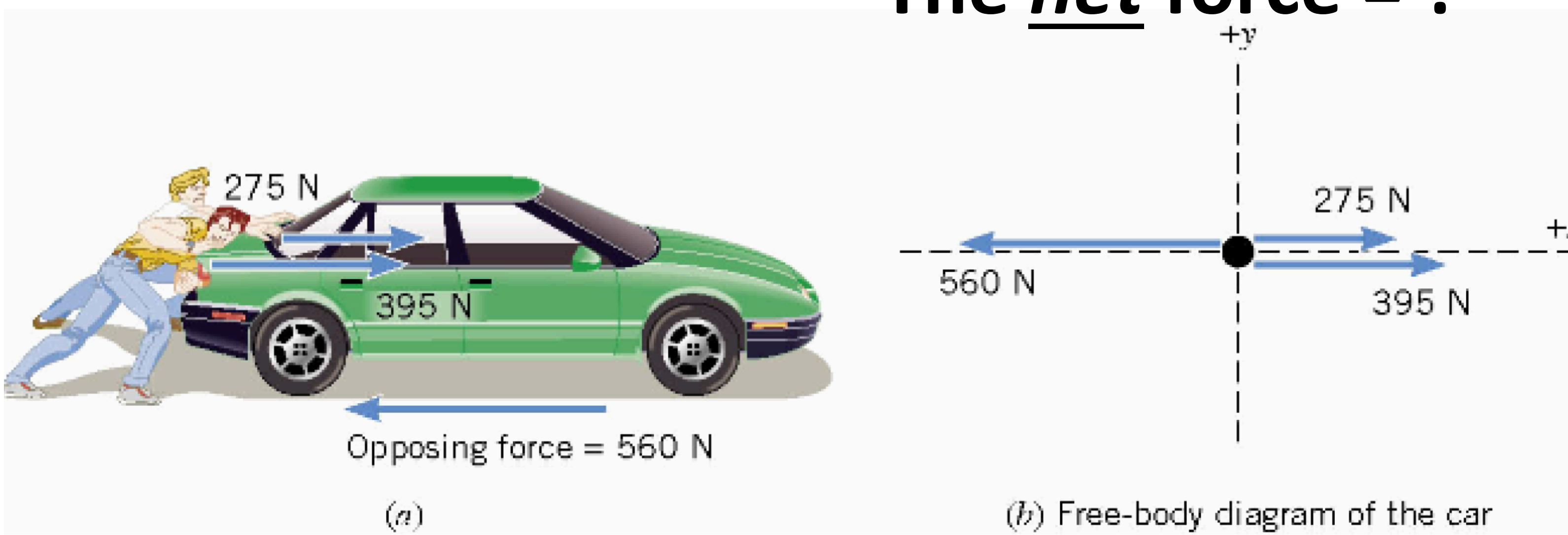
Mathematically, the net force is written as

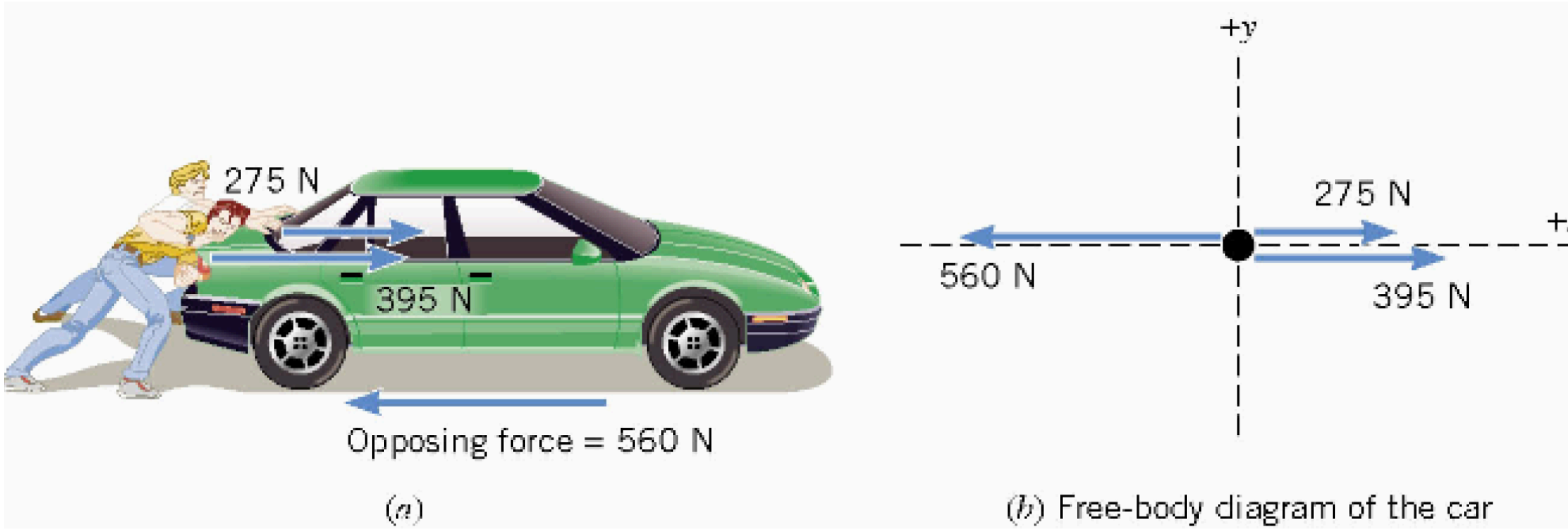
$$\sum \vec{\mathbf{F}}$$

where the Greek letter sigma denotes the vector sum.

A ***free-body-diagram*** is a diagram that represents the object and the forces that act on it.

The <u>*net*</u> force = ?





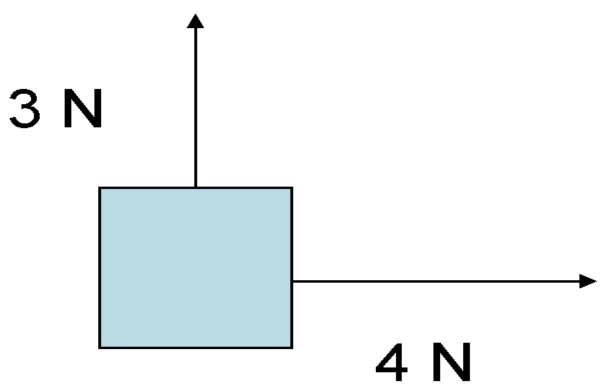
The net force in this case is:

275 N + 395 N – 560 N = +110 N

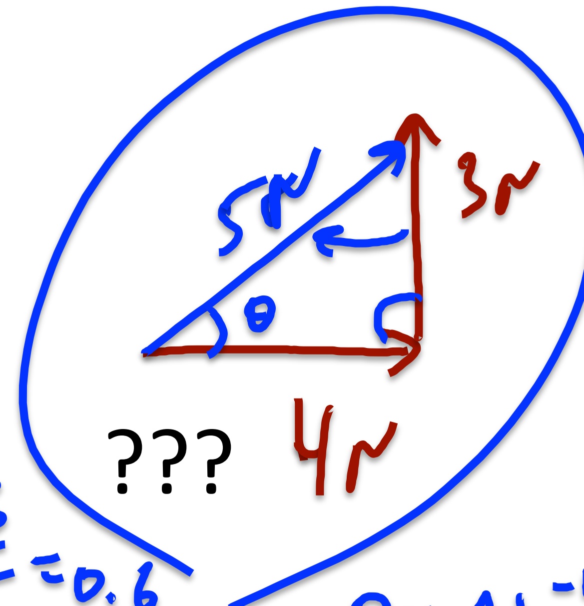
and is directed along the + x axis of the coordinate system.

Individual Forces

~~Net F = 3+4~~



Net Force

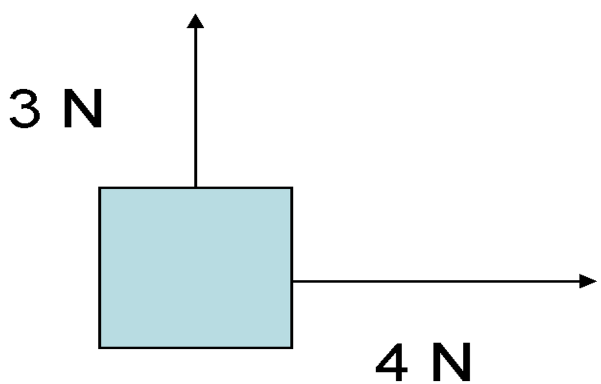


$\tan\theta = \frac{3}{5} = 0.6$

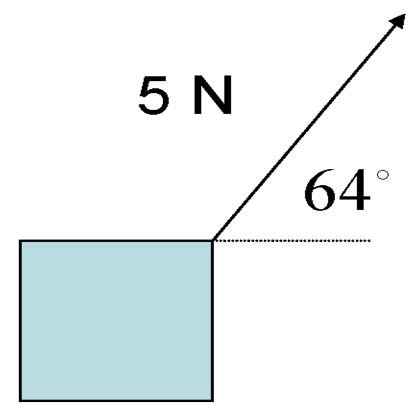
$\theta = \tan^{-1} 0.6$

The magnitude of the net force (in N) is … (press the button)

Individual Forces

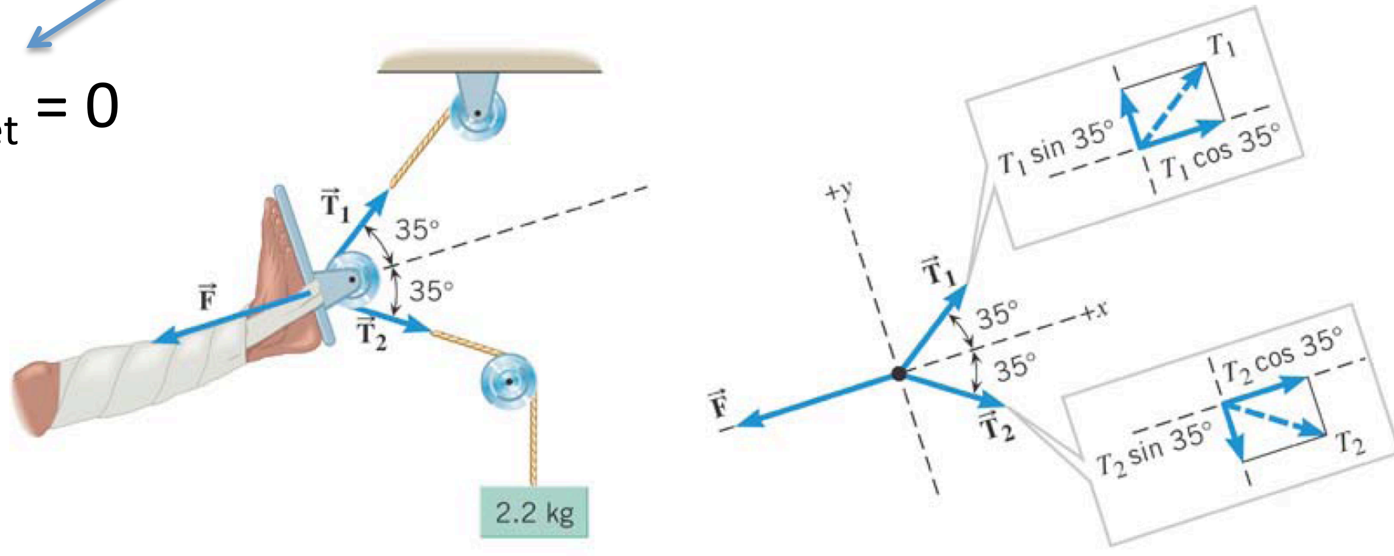


Net Force



Equilibrium Application of Newton's Laws of Motion

$\boldsymbol{F}_{\text{net}} = 0$



(a)

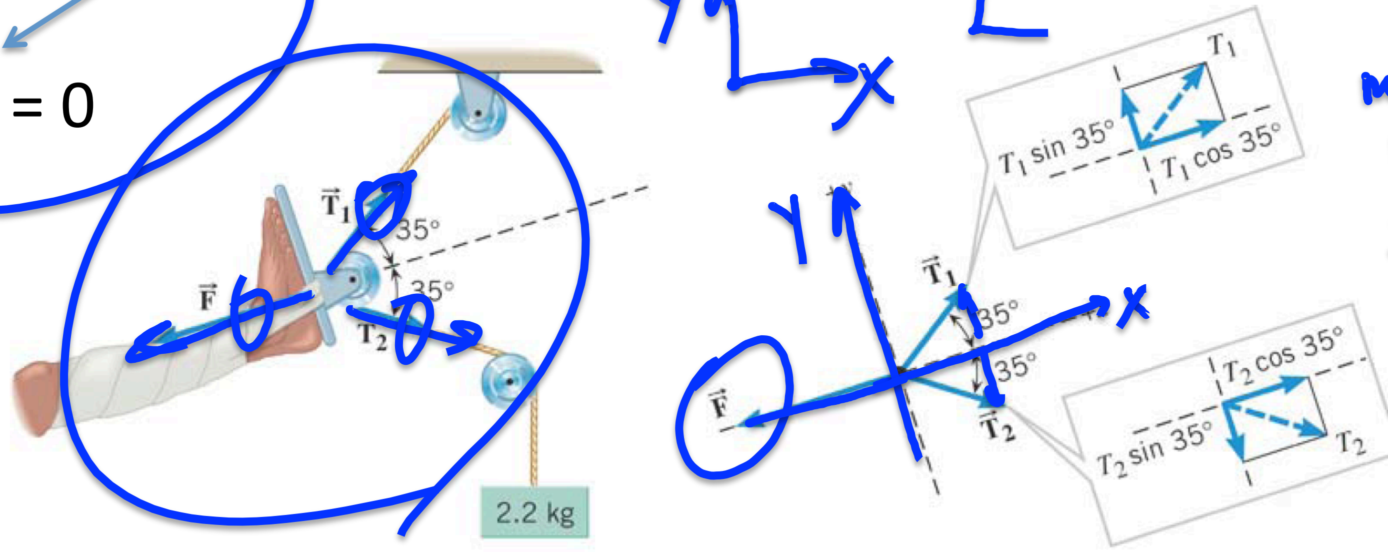
(b) Free-body diagram for the foot pulley

$$+T_1 \sin 35^\circ - T_2 \sin 35^\circ = 0$$

$$+T_1 \cos 35^\circ + T_2 \cos 35^\circ - F = 0$$

Equilibrium Application of Newton's Laws of Motion

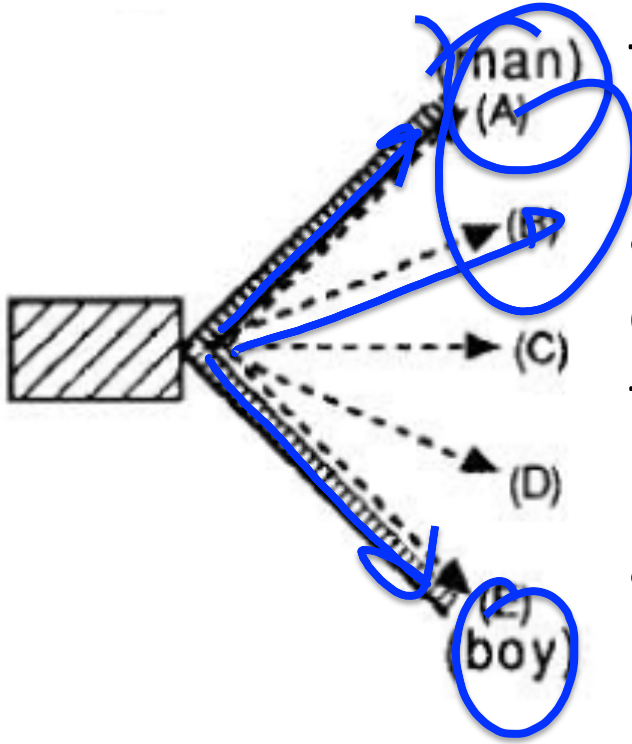
$\boldsymbol{F}_{net} = 0$



(*a*) (*b*) Free-body diagram for the foot pulley

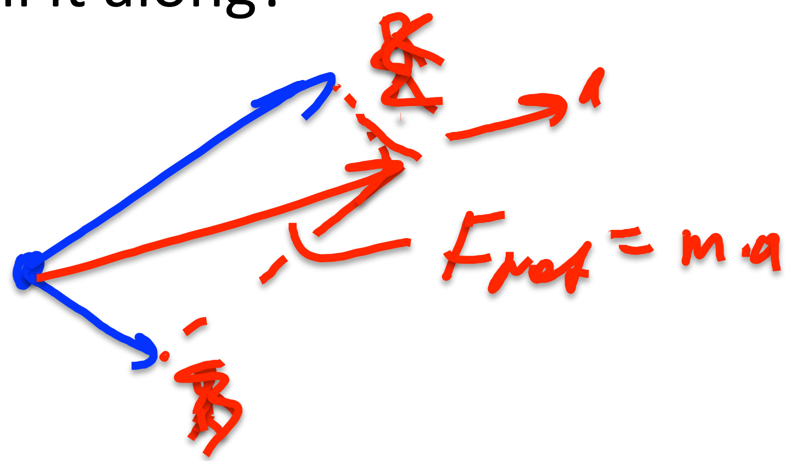
$$+T_1 \sin 35^\circ - T_2 \sin 35^\circ = 0$$

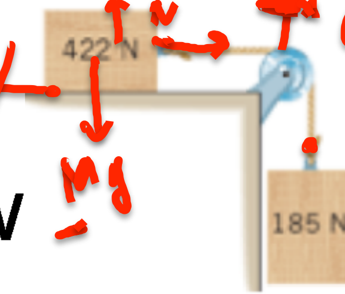
$$+T_1 \cos 35^\circ + T_2 \cos 35^\circ - F = 0$$



Two people, a large man and a boy, are pulling as hard as they can on two ropes attached to a crate as illustrated in the diagram to the left. Which of the indicated paths (A-E) would most likely correspond to the path of the crate as they pull it along?

$\vec{a} \upuparrows \vec{F}_{Net}$





(lab2)

Investigating

Newton's Second Law

When a net external force acts on an object of mass *m*, the acceleration that results is directly proportional to the net force and has a magnitude that is inversely proportional to the mass. The direction of the acceleration is the same as the direction of the net force.

$$\vec{\mathbf{a}} = \frac{\sum \vec{\mathbf{F}}}{m}$$

$$\boxed{\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}}$$

The direction of force and acceleration vectors can be taken into account by using *x* and *y* components.

$$\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$$

is equivalent to

$$\sum F_y = ma_y \qquad \sum F_x = ma_x$$