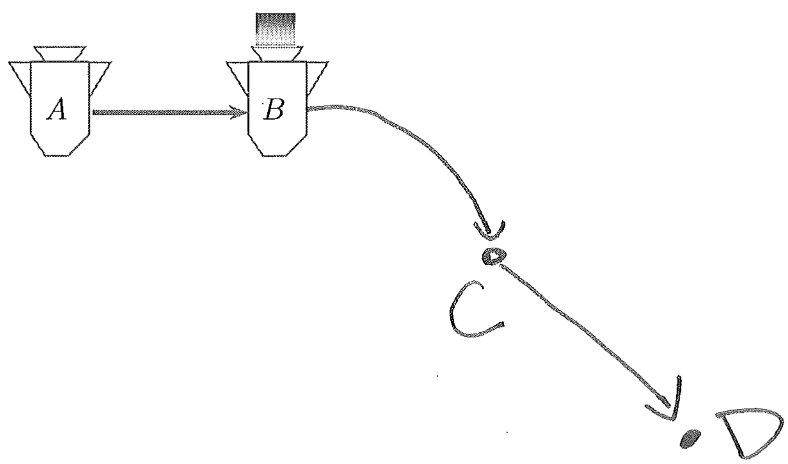
Chapter 4, Sections 4.2-4.7

4.6 - Newton's Second Law

(1.) A spaceship is floating sideways from point A to B in the middle of outer space. At B the spaceship turns on it's engines for $5\,s$ and moves to point C. At C the engines are again turned off and the spaceship floats to point D. Fill in the trajectory of the spaceship from points B to C and then from C to D.



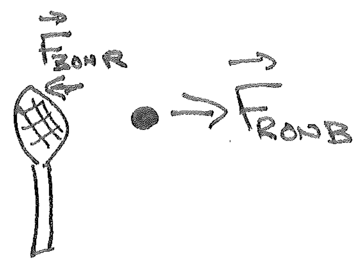
Explanation: FROM A to B, there's NO FORCE ON spaceship ⇒ UNIFORM MOTION FROM A to B, hence the straight LINE. At B, the engines EXERT A FORCE (THRUST) IN THE y-DIRECTION. So SPACESHIP Accelerates IN y but NOT x ⇒ Continues moving WITH Constant speed IN x, Accelerates IN y ⇒ CURVED MOTION. AT C when ENGINES TURNED OFF, WE go BACK to UNIFORM ⇒ STRAIGHT-LINE MOTION. But Now we HAVE both x AND y MOTION ⇒ STRAIGHT-LINE DOWN AND to the Right.

4.8 - Newton's Third Law

(1.) Each of the following situations has two or more interacting objects. Draw a picture similar to Figure 4.31 of the textbook where you

- Show the interacting objects with a small gap separating them.
- Draw the force vectors of *ALL* action/reaction pairs.
- Label the force vectors, using a notation like $\vec{\mathbf{F}}_{A \text{ on } B}$ and $\vec{\mathbf{F}}_{B \text{ on } A}$.

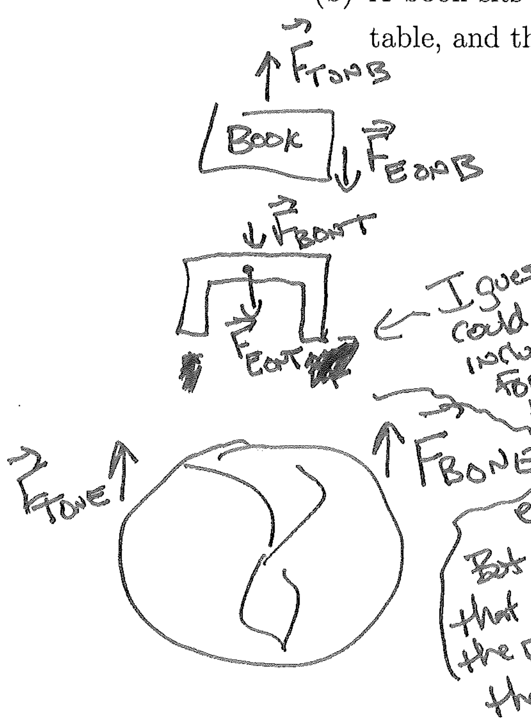
(a) A tennis racket hits a tennis ball. The interacting objects are the racket and the ball.



B on R = Ball on Racket

R on B = Racket on Ball

(b) A book sits on a table. The interacting objects are the book, the table, and the earth.



T = Table, B = Book, E = Earth

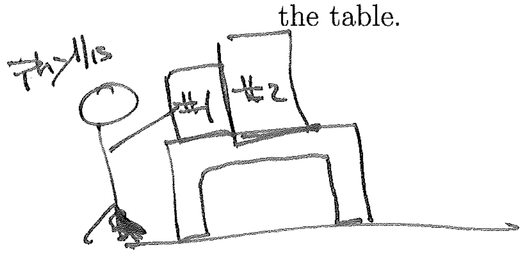
I guess we could also include normal force on table as coming from the earth too. But let's say that comes from the floor of the house

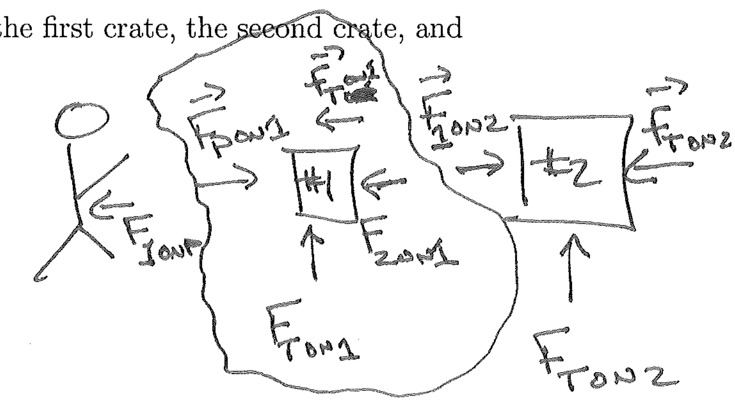
$\vec F_{E on B}$ = Weight of Book

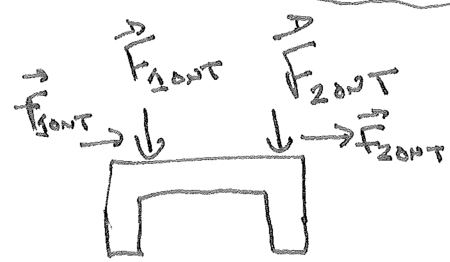
$\vec F_{E on T}$ = Table's Weight

$\vec F_{T on B}$ = Normal Force

(c) Phyllis pushes two crates, which are sitting side-by-side, across a rough table by applying a horizontal force to the first crate. The interacting objects are Phyllis, the first crate, the second crate, and the table.







$F_{T\,on\,1}$ and $F_{T\,on\,2}$ would typically be called normal forces

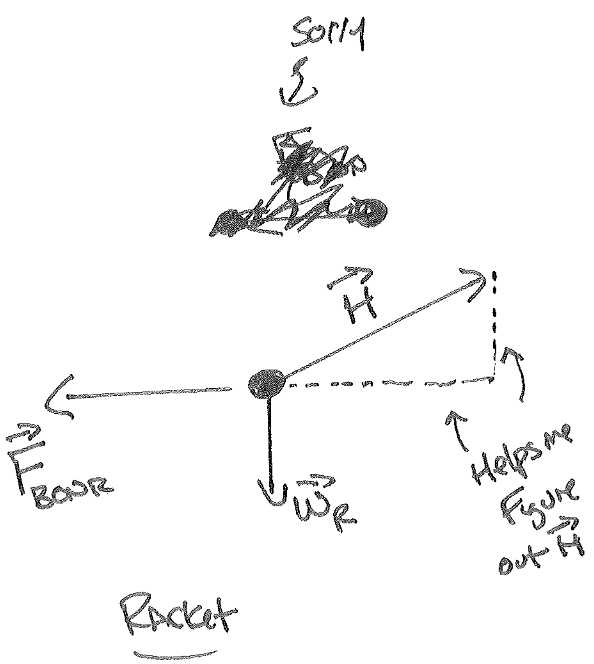
Ran out of names, so $\vec{f}_{T\,on\,1}$ = frictional force on 1 from table

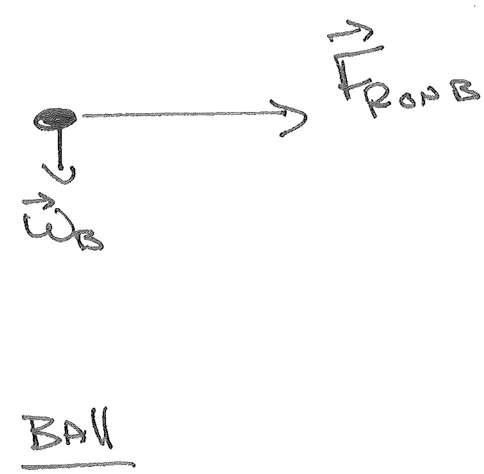
$\vec{f}_{T\,on}$ = frictional force on 2 from table

(2.) For the following situations, identify the forces and then draw the free-body diagrams for the requested objects. For most of these you will need to determine appropriate additional forces. Please include an explanation of your group's choices.

(a) A tennis racket hits a tennis ball. Draw the racket's and the ball's free-body diagrams. You may assume that the racket is not accelerating.

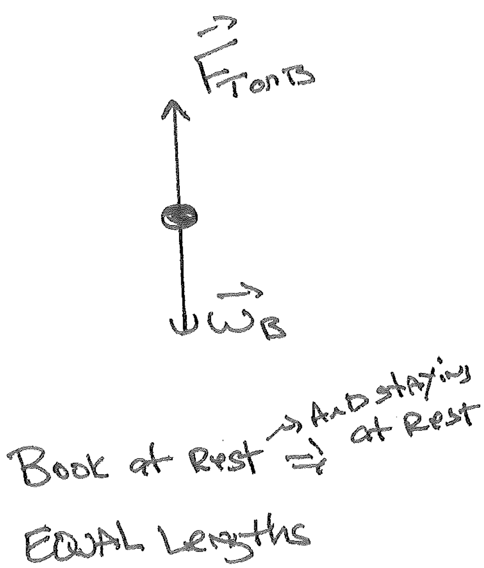
<table>
<tr><td>Forces on Racket:
$\vec{F}_{B on R}$, $\vec{W}_R$ ← weight
$\vec{H}$ ← Holding Force</td><td>Forces on Ball:
$\vec{F}_{R on B}$, $\vec{W}_B$ ← weight of BALL.</td></tr>
<tr><td colspan="2">Explanation:
RAcket Must have a third Force to Keep it from Accelerating
$\vec{H}$ Must Make vector sum on Racket equal to zero.
Ball is Accelerating, so just THE two "obvious" Forces</td></tr>
</table>

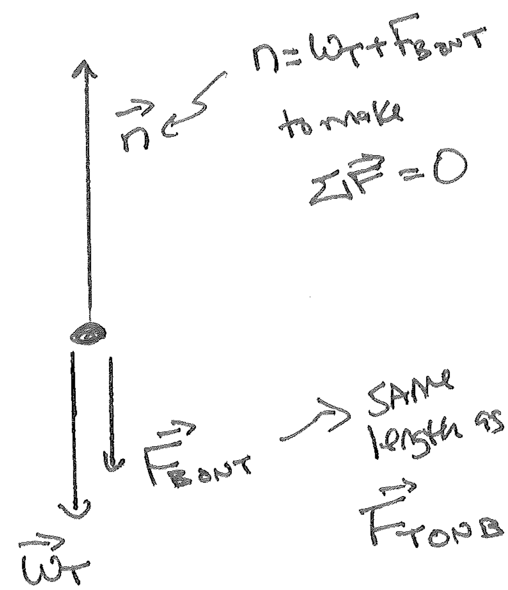




(b) A book sits on a table. Draw the book's and table's free-body diagrams.

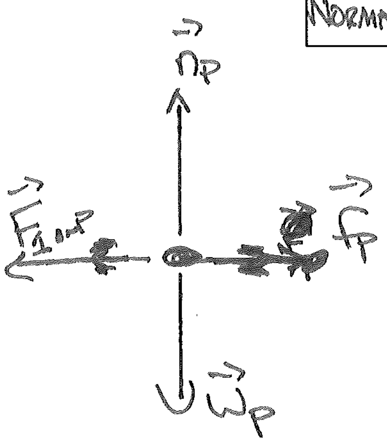
<table>
<tr><td>Forces on Book: $\vec{F}_{T\,on\,B}$
$\vec{W}_B$ ← weight</td><td>Forces on Table: $\vec{F}_{B\,on\,T}$
$\vec{W}_T$, $\vec{n}$ ← upwards normal</td></tr>
<tr><td colspan="2">Explanation:
TABLE NEEDS AN UPWARDS FORCE FROM FLOOR to KEEP IT FROM FALLING DOWN, SO CALL THIS A NORMAL FORCE.</td></tr>
</table>



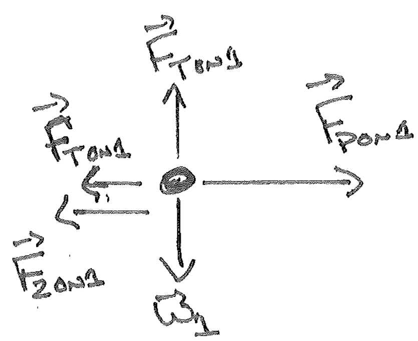


(c) Phyllis pushes two crates, which are sitting side-by-side, across a rough table by applying a horizontal force to the first crate. Draw Phyllis's, the first crate's, the second crate's, and the table's free-body diagrams. Assume the crates are accelerating while Phyllis and the table are not.

Forces on Phyllis: $\vec{F}_{1 on P}$, $\vec{\omega}_P$, $\vec{n}_P$, $\vec{f}_P$ ← static friction on Phyllis, to right	Forces on first crate: $\vec{F}_{P on 1}$, $\vec{\omega}_1$, $\vec{F}_{T on 1}$, $\vec{f}_{T on 1}$, $\vec{F}_{2 on 1}$
Forces on second crate: $\vec{\omega}_2$, $\vec{F}_{T on 2}$, $\vec{f}_{T on 2}$, $\vec{F}_{1 on 2}$	Forces on table: $\vec{F}_{1 on T}$, $\vec{F}_{2 on T}$, $\vec{f}_{1 on T}$, $\vec{f}_{2 on T}$, $\vec{\omega}_T$, $\vec{n}_T$, $\vec{f}_T$ ($\vec{n}_T$ = normal, up, from floor; $\vec{f}_T$ = friction, left, from floor)
Explanation: Phyllis not accelerating ⇒ $\Sigma\vec{F}=0$, so she needs a force to right to cancel $\vec{F}_{1 on P}$ ⇒ static friction and an upwards normal force to cancel gravity. Table also needs frictional force & normal force from floor to keep from accelerating.	



Phyllis



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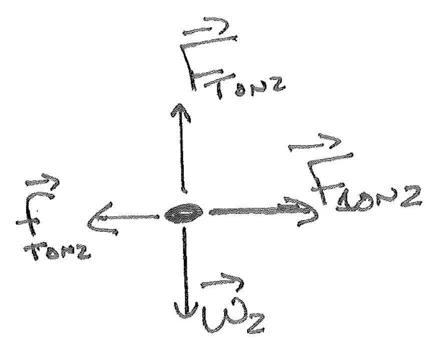

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