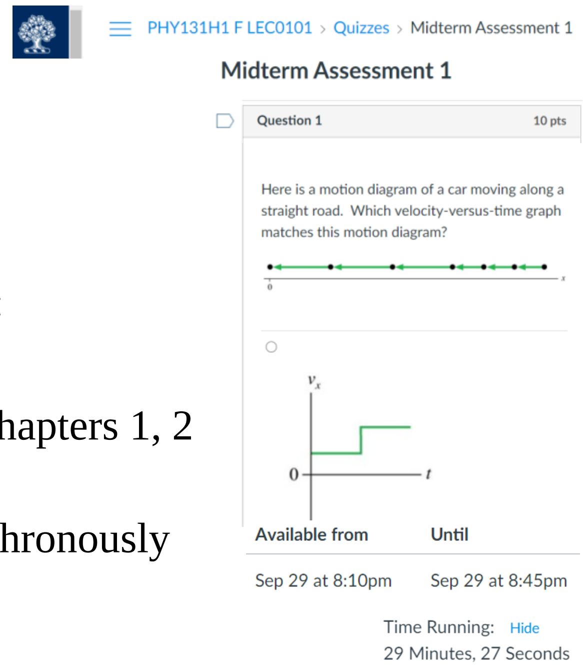
PHY131 F Fall 2020
Class 8



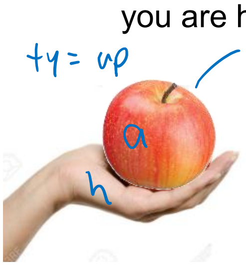
Today:

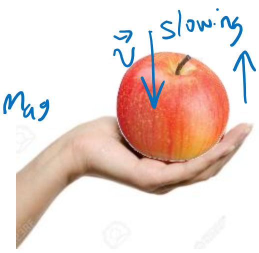
- Finishing Chapter 3
- Review and Practice Problems
- Tomorrow: Midterm Assessment #1:
  - 30 minutes
  - 10 multiple choice questions on Chapters 1, 2 and 3.
  - the whole class does the quiz synchronously in real-time!

Poll

Last day at the end of class I asked:

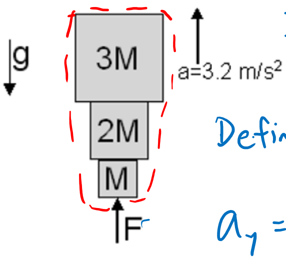
- "After having been thrown upward, a 100-g apple falls back into your hand and you catch it. While you are catching it, the force that you exert on the apple is
  A. more than
  B. less than
  C. the same as
- the force that you exert on the apple when you are holding it at rest."





Example

Three blocks are being accelerated upward at 3.2 m/s[2] by a force $\vec{F}$ applied to the bottom block as shown in the diagram. The mass of the bottom block is 7.0 kg, the mass of the middle block is 14 kg, and that of the top block is 21 kg.
(a) Find the magnitude of *F*.



SKETCH & TRANS

Define system = all 3 blocks.

Define +y ↑

$a_y = +3.2\ m/s^2$

$M_{sys} = 7 + 14 + 21 = 42\ kg. = m_s$

Need F. ↑ external force on system.

SIMP & DIAG

- There is gravity
- Internal forces don't go on force diagram.

↑F, ↓$m_s g$

REP. MATH Newton's 2nd Law

$$a_y = \frac{\Sigma F_y}{m_s} = \frac{F - m_s g}{m_s}$$

Solve for F $m_s a_y = F - m_s g$

$$F = m_s a_y + m_s g = m_s(a_y + g)$$

SOLVE & EVAL $F = 42(3.2 + 9.8)$

$$F = 546\ N$$

More than weight, 412 N

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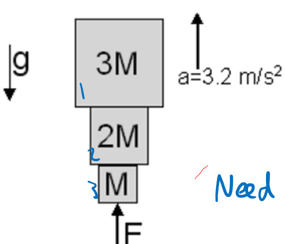
Example

Three blocks are being accelerated upward at 3.2 m/s[2] by a force $\vec{F}$ applied to the bottom block as shown in the diagram. The mass of the bottom block is 7.0 kg, the mass of the middle block is 14 kg, and that of the top block is 21 kg.
(b) What is the magnitude of the normal force that the top block exerts on the middle block?

SKETCH & TRANS.



Set 1 = Top
2 = Middle
3 = Bottom

Need $|F_{1 on 2}|$.

By Newton's 3rd Law: $|F_{1 on 2}| = |F_{2 on 1}|$

Since there is only one pushing force on 1, it's easiest to consider it as the system

Set "system" = block 1, $m_1 = 21\ kg$.

SIMP & DIAG

↑$F_{2 on 1}$, ↓$F_{g on 1} = m_1 g$

REP. MATH Newton's 2nd Law:

$$a_y = \frac{\Sigma F_y}{m_1} = \frac{F_{2 on 1} - m_1 g}{m_1}$$

Solve for $F_{2 on 1}$: $m_1 a_y = F_{2 on 1} - m_1 g$

$$|F_{1 on 2}| = |F_{2 on 1}| = m_1(a_y + g)$$

SOLVE & EVAL $= 21(9.8 + 3.2)$

$$|F_{1 on 2}| = 273\ N$$

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Demonstration

- Have you ever seen a professor gain 30 pounds before your very eyes?

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Self-adjusting forces

- The force of gravity, $F_g = mg$, has an equation for it which gives the correct magnitude. But not all kinds of force have handy equations like these.
- Normal force and Tension are self-adjusting forces: ***there are no equations for these!!***
- **Normal force** is whatever is needed to keep the object from crashing through the surface.
- **Tension** is whatever is needed to keep the string or rope from breaking.
- In these cases, you must draw a free-body diagram and figure out by using equilibrium and Newton's 2^{nd} law what the needed force is.

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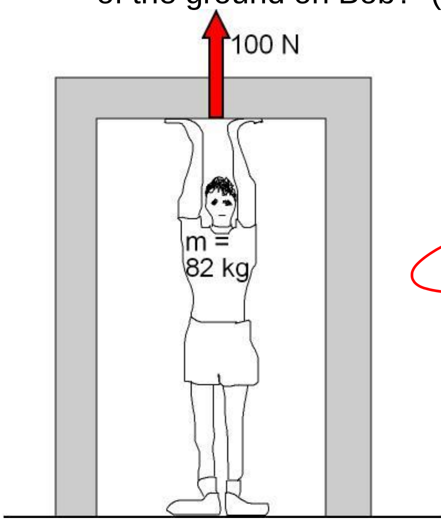
Poll Question

Bob stands under a low concrete arch, and presses upwards on it with a force of 100 N. Bob's mass is 82 kg. He is in equilibrium. What is the total **normal force** of the ground on Bob? (Note that 82 × 9.8 = 800.)



A. 800 N, upward
B. 800 N, downward
C. 900 N, upward
D. 700 N, upward
E. 900 N, downward

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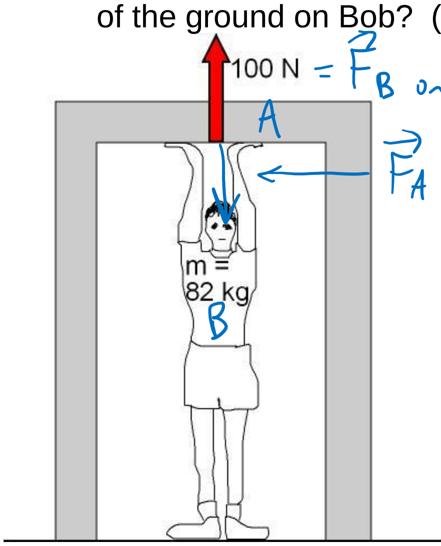
Poll Question

Bob stands under a low concrete arch, and presses upwards on it with a force of 100 N. Bob's mass is 82 kg. He is in equilibrium. What is the total **normal force** of the ground on Bob? (Note that 82 × 9.8 = 800.)



100 N = $\vec{F}_{B\ on\ A}$

A

B

$\vec{F}_{A\ on\ B}$ = 100 N, Down

Define system = Bob.

F_{Normal}

$\vec{F}_{A\ on\ B}$

$M_B g$

Define +y = up.

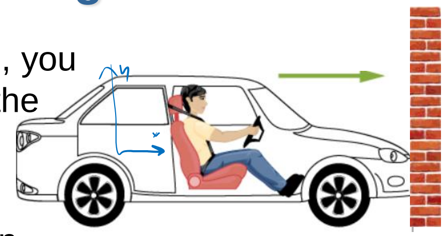
$\vec{a} = 0$, $\Sigma\vec{F} = 0 = F_{Normal} - M_B g - 100\,N$ (800 N)

Solve for F_{normal}

$F_{normal} = 800 + 100 = 900\,N$

Fictitious Forces and Airbags

• If you are riding in a car that makes a sudden stop, you may feel as if a force “throws” you **forward** toward the windshield.



• There really is no such force!

•Some books (not Etkina) describe the experience in terms of what are called **fictitious forces**.

• These are not real, but they help describe motion *in a noninertial reference frame.*

• Etkina avoids fictitious forces by doing all the calculations in inertial frames (better).

• In this case, the external force on the passenger is **backward**.

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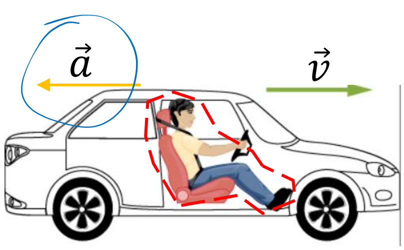
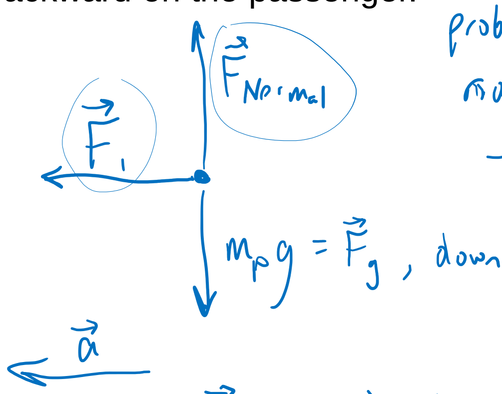
• Using the inertial reference frame of the Earth, this is how we draw the force diagram in this course.

• Note there are no forward forces on the passenger.

• The airbag will push backward on the passenger.





$\vec{F}_1$ is probably a normal force, → air-bag pushes passenger backwards.

$\Sigma\vec{F}$ is to the left.

- Define “system” = passenger (also the driver in this case)
- Speed is decreasing
- Acceleration is in opposite direction of velocity.

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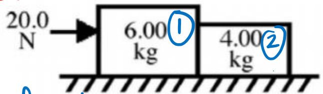
A 6.00-kg block is in contact with a 4.00-kg block on a horizontal frictionless surface as shown in the figure. The 6.00-kg block is being pushed by a horizontal 20.0-N force as shown. What is the magnitude of the force that the 4.00-kg block exerts on the 6.00-kg block?



A. 4.00 N
B. 6.00 N
C. 8.00 N
D. 10.0 N
E. 20.0 N

SKETCH & TRANSLATE.

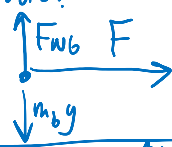
No friction.
Set +x = to the right
$\vec{F} = +20$ N $m_1 = 6$ kg
$m_2 = 4$ kg
Need $|F_{2 \text{ on } 1}|$
By Newton's 3rd Law $|F_{2 \text{ on } 1}| = |F_{1 \text{ on } 2}|$

SIMPLIFY & DIAGRAM

Strategy: Use System = both, solve for a_y.
Then use sys. = m_2, solve for $|F_{1 \text{ on } 2}|$

REPRESENT MATHEMATICALLY

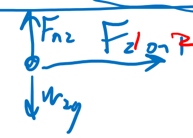
Syst. = both:



$\Sigma F_x = m_b a_x = F$

$a_x = \frac{F}{m_1 + m_2}$

Sys = m_2



$\Sigma F_x = m_2 a_x = F_{1 \text{ on } 2} = m_2 \left(\frac{F}{m_1 + m_2} \right)$

by Newton's 3rd Law

SOLVE & EVALUATE

$|F_{2 \text{ on } 1}| = 4 \left(\frac{20}{4+6} \right) = 8$ N

3 sig. digs.

$|F_{2 \text{ on } 1}| = 8.00$ N

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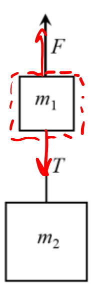
Two masses, m_1 and m_2, are joined by a string. An upward pulling force of magnitude F is applied directly to m_1. As a result, both blocks accelerate upward with acceleration magnitude a. While accelerating, the tension in the string has a magnitude of T. If F = 36 N, a = 2.2 m/s^2, and T = 24 N, what mass of m_1?

A. 1.0 kg
B. 1.5 kg
C. 2.0 kg
D. 2.5 kg
E. 3.0 kg

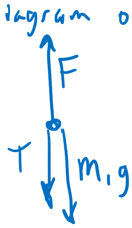


SKETCH & TRANSLATE.

Define system = m_1
Define +y = up

SIMPLIFY & DIAGRAM

Force diagram of m_1



REPRESENT MATHEMATICALLY

Newton's 2nd Law:

$a_y = \frac{\Sigma F_y}{m_1} = \frac{F - T - m_1 g}{m_1}$

Solve for m_1

$m_1 a_y = F - T - m_1 g$

$m_1 a_y + m_1 g = F - T$

$m_1 (a_y + g) = F - T$

SOLVE & EVALUATE

$m_1 = \frac{F - T}{a_y + g} = \frac{36 - 24}{2.2 + 9.8}$

$m_1 = 1$ 2 sig. digs.

$m_1 = 1.0$ kg

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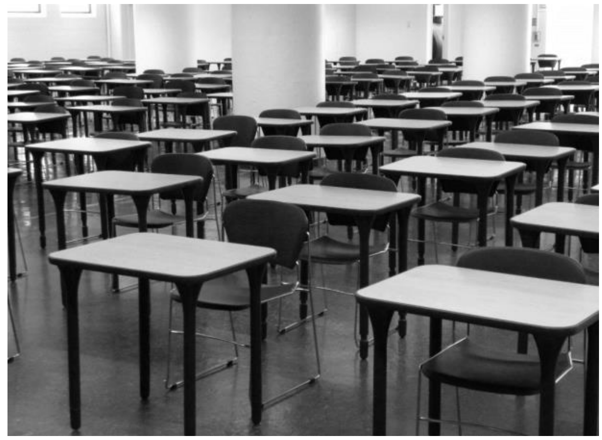
Midterms in Non-Global Pandemic Times

- Midterm Assessments in this course are normally done in person, on paper.
- We book huge rooms in the Exam Centre at 255 McCaul St. It's quiet for 2 hours.
- Calculators and one aid-sheet are allowed.
- Phones and backpacks must be stored at the edges of the room.
- Many invigilators circulate in the room.
- Every student must show photo-ID to an invigilator and sign a signature sheet.



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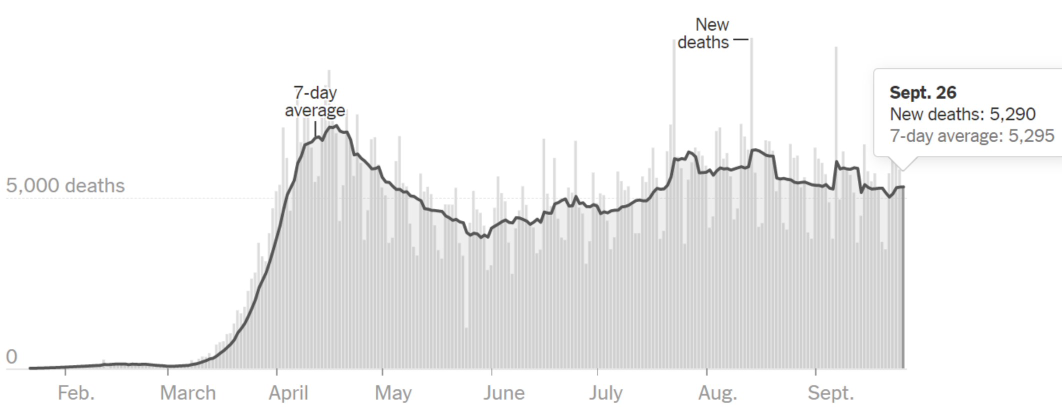
This pandemic rages on…

New reported deaths by day across the world



Physical distancing is helping to slow the local spread of COVID-19.
By avoiding gatherings, wearing masks, and reducing non-essential travel and trips out of our homes we are helping.
The pandemic would be **far worse** if we did not do this.

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Fall 2020 (during COVID-19 pandemic) Midterm Assessment #1

- Each online half-hour assessement is worth between 10% and 12.5% of your mark in this course.
- The lowest of five assessment scores will be dropped.
- The assessment will become available on Quercus to start at 8:10pm tomorrow evening, Toronto time (ie 32 hours from right now)
- If you are registered for the alternate sitting, then you do the whole thing exactly 2 hours later.
- If you miss the assessment, you get a zero.

Fall 2020 (during COVID-19 pandemic) Midterm Assessment #1

- The assessment is "open book"; allowed aids include the course notes, videos, and google-searches for static web-pages.
- You must work on the assessment **individually**.
- No group work or chats with other students are allowed during the assessment.

Fall 2020 (during COVID-19 pandemic)
Midterm Assessment #1

- Once you start there will be a 30-minute timer
- The assessment ends when your personal 30-minute timer elapses, or 8:45pm, whichever comes *first*.
- You will see one question at a time, in a random order.
- You must submit each answer by clicking Next in order to see the next question; you will **not** have the ability to go back change any answer after it has been submitted.
- After completing all 10 questions you must click Submit Quiz before the time has ended.

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Fall 2020 (during COVID-19 pandemic)
Midterm Assessment #1

- There are 3 conceptual questions and 7 numerical questions.
- You **will** need a calculator, or Excel or something to do these. You should have pencil and paper ready for rough work.
- All questions are Multiple Choice, marked automatically.
- The average time per question is 3 minutes, but numerical questions will likely take longer than conceptual, so do not linger long on the conceptual questions.
- Material will cover mostly questions and problems from Chapters 2 and 3 from Etkina. Chapter 1 is also important, but not heavily emphasized in this assessment.

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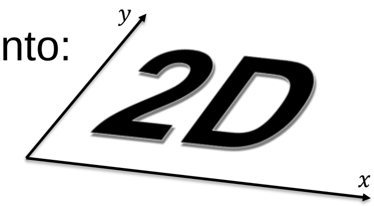
Before Class 9 on Wednesday

- On Wednesday we go into:



- Please read:
- 4.1 Two-Dimensional Vectors, Force Vector Components
- 4.2 Newton's Second Law in 2D
- Something to think about:
- “If you are driving at a constant speed around a large, circular track, are you accelerating?”

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