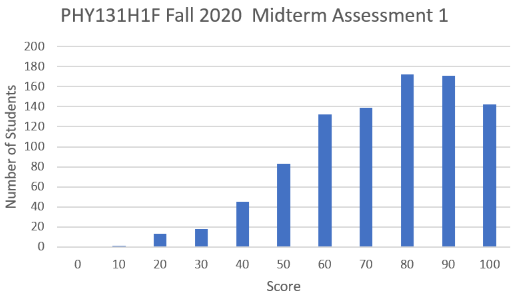
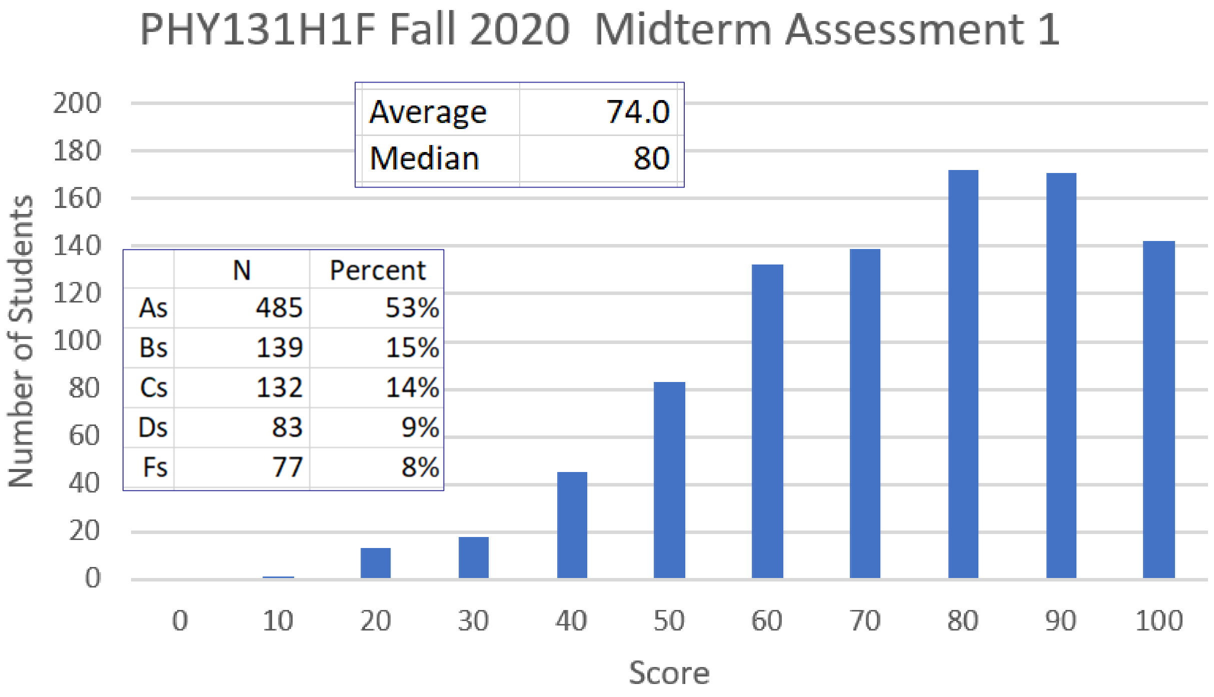


PHY131 F Fall 2020
Class 9

Today:

- Reviewing Last Night’s Assessment
- 4.1 Two-Dimensional Vectors, Force Vector Components
- 4.2 Newton's Second Law in 2D



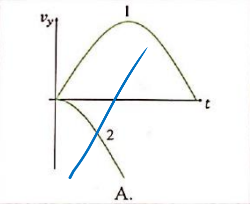
Average	74.0
Median	80

	N	Percent
As	485	53%
Bs	139	15%
Cs	132	14%
Ds	83	9%
Fs	77	8%

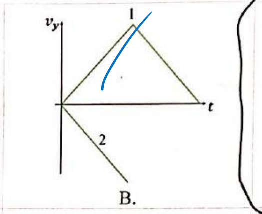
Midterm 1 Assessment

(t = 0)

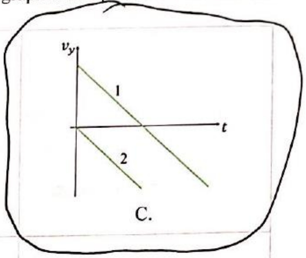
1. Angry Bird 1 is thrown straight up into the air, and, at the same instant, Angry Bird 2 is released from rest and allowed to fall. Define +y to be up. Both birds start at the same y-position. Which y-component of velocity-versus-time graph best represents the motion of the two birds?



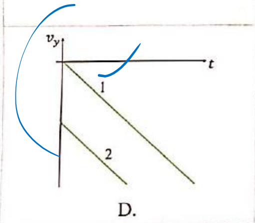
A.



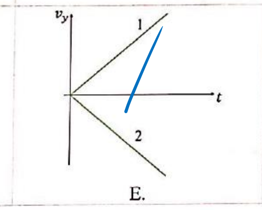
B.



C.



D.



E.

$v_1 = 0$

$\vec{v}_{10}$

$\vec{v}_1$ negative

$v_{20} = 0$

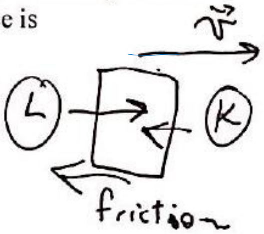
$a_y = -9.8 \, m/s^2$ ← slope

v_2 negative

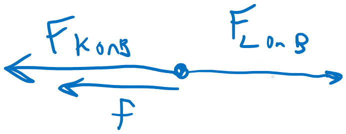
Midterm 1 Assessment

2. Lillian is pushing a box across the floor towards the front of the room. At the same time, Kevin is trying to stop the box by pushing it in the opposite direction. There is friction between the box and the floor. If the box is moving at a constant velocity toward the front of the room, then the magnitude of Lillian's pushing force is

[✓ A.] greater than the magnitude of Kevin's force.
B. equal to the magnitude of Kevin's force.
C. less than the magnitude of Kevin's force.



zero acceleration.



$$\Sigma F_{\cancel{net}} = F_L - f - F_K = 0$$

$$F_L = F_K + f > F_K.$$

Midterm 1 Assessment

3. Your car won't start, so you are pushing it. You apply a horizontal force of 300 N to the car, but it doesn't move. What is the other force in the interaction pair (governed by Newton's third law) of the 300 N force you exert?
   - A. The frictional force exerted on the car by the road
   - [✓ B.] The force exerted on you by the car
   - C. The frictional force exerted on you by the road
   - D. The normal force exerted on you by the road
   - E. The normal force exerted on the car by the road

1 = you.

2 = car

$F_{1on2} = 300\ N$

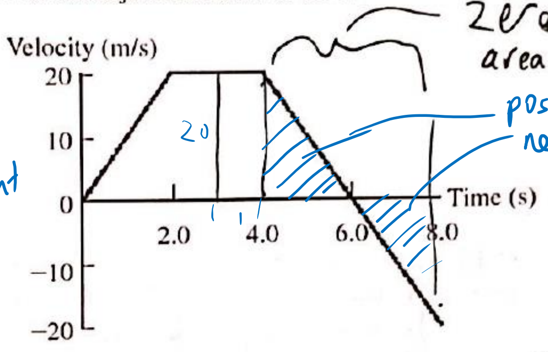
Newton's 3rd Law $F_{1on2} = F_{2on1}$

force of car on you

Midterm 1 Assessment

4. An object moves along the x-axis, and its velocity versus time graph is shown. What is the displacement of the object from 3.0 s to 8.0 s?

area under v vs t plot gives displacement



zero area here

positive

negative

sum to zero.

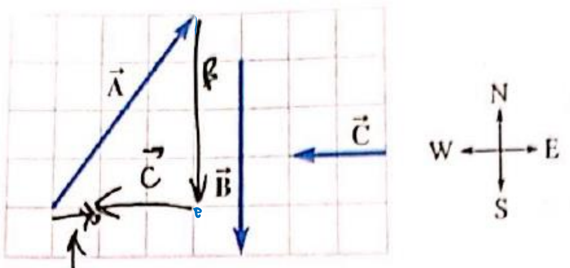
- A. zero
- [✓ B.] 20 m
- C. 40 m
- D. 60 m
- E. 80 m

$$x = l \times w = (1\ s)(20\ m/s)$$

$$= 20\ m$$

Midterm 1 Assessment

5. Three forces are shown in the drawing. What is the magnitude of the vector sum of forces $\vec{A} + \vec{B} + \vec{C}$ if each gird square is 1.0 N on a side?



sum = 1.0 N

$\Sigma F = \longrightarrow$

[✓ A.] 1.0 N
B. 2.0 N
C. 2.8 N
D. 5.7 N
E. 11 N

Midterm 1 Assessment

3/4 of distance

6. You walked three quarters of the way to school at a speed of 1.3 m/s, and you ran the final quarter at a speed of 2.7 m/s. What was your average speed?

A. 1.3 m/s
[✓ B.] 1.5 m/s
C. 1.7 m/s
D. 2.0 m/s
E. 2.7 m/s

$v = \frac{d}{t} \Rightarrow t = \frac{d}{v}$

$t_w = \frac{0.75\, d}{1.3}$

$t_r = \frac{0.25\, d}{2.7}$

$$\boxed{v_{avg} = \frac{d}{t_w + t_r}} = \frac{1}{0.75/1.3 + 0.25/2.7} = \frac{1}{0.5769 + 0.09259}$$

$= 1.49 \frac{m}{s}$

d's cancel

Midterm 1 Assessment

7. A juggler throws a bowling pin straight up with an initial speed of 7.75 m/s. How much time elapses until the bowling pin returns to the juggler's hand?

[✓ A.] 1.58 s
B. 1.94 s
C. 2.03 s
D. 2.41 s
E. 2.91 s

Final speed = Initial Speed, but velocity is in opposite direction.

$\Delta v_y = a_y t$

$v_2 - v_1 = -gt$

$v_1 \uparrow \quad \downarrow \boxed{v_2 = -v_1}$

$t = \frac{v_1 - v_2}{g} = \frac{2v_1}{g}$

$v_1 - v_2 = v_1 - (-v_1) = 2v_1$

$t = \frac{2(7.75)}{9.8} = 1.582$ s

Midterm 1 Assessment

Freefall.

8. It is the future, ~~and~~ it you have just landed on a distant planet called Planet X. You release a ball of mass m = 0.100 kg from rest from a height of 10.0 m and measure that it takes 3.40 s for it to reach the ground. There is no air on Planet X, so you can neglect air resistance. What is the magnitude of the gravitational force of Planet X on the ball?

A. 0.142 N
[✓ B.] 0.173 N
C. 0.323 N
D. 0.453 N
E. 0.694 N

$\downarrow \Sigma F = mg$

$v_0 = 0$

$d = 10$

$t = 3.4$

$x = \cancel{x_0}^0 + \cancel{v_0 t}^0 + \frac{1}{2}at^2$

$d = \frac{1}{2}at^2 \qquad a = \frac{2d}{t^2}$

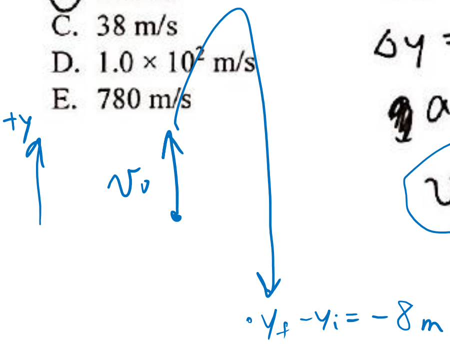
$\Sigma F = F_g = m \cdot a = \frac{2dm}{t^2} = \frac{2(10)(0.1)}{3.4^2}$

$F = 0.17301$ N

Midterm 1 Assessment

9. A rock is tossed straight up with an initial speed of 25 m/s. When it returns, it falls into a deep hole. The bottom of the hole is 8.0 m below the initial position of the rock. What is the rock's speed just before it hits the bottom of the hole?

A. 24 m/s
[✓ B.] 28 m/s
C. 38 m/s
D. 1.0×10^2 m/s
E. 780 m/s



$v_0 = 25$ m/s

$\Delta y = -8$ m

$a_y = -9.8$

$\boxed{v = ?}$

$a_y \downarrow$

$\boxed{2a\Delta y = v_0^2 - v^2}$

$v = \sqrt{v_0^2 + 2g\Delta y}$

$= \sqrt{25^2 + 2(9.8)(8)}$

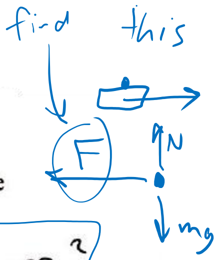
$= \sqrt{625 + 156.8}$

$v = 27.96$ m/s

Midterm 1 Assessment

10. A cart of mass 500 kg is rolling with a speed of 5 m/s on a railway track. There is very little friction between the tracks and the cart. You apply a constant force on the cart in the direction opposite to its velocity. From the moment you start applying the force, the cart moves a distance of 30 m before coming to a stop. What was the approximate magnitude of the force you applied?

A. 2 N
B. 20 N
[✓ C.] 200 N
D. 2000 N
E. 20,000 N



$\boxed{\Sigma F = ma} = F$

$\boxed{2a\Delta x = v^2 - v_0^2}$

$v = 0$

$v_0 = 5$ m/s

$a = ?$

$\Delta x = 30$

$a = \frac{v_0^2}{2\Delta x}$

$F = \frac{m v_0^2}{2\Delta x} = \frac{500(5)^2}{2(30)}$

$F = 208.3$ N.

≈ 200 N.

4.2 Newton's Second Law in Component Form

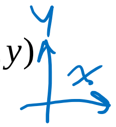
Force Diagram of Object S. 3 external things are exerting forces on S.

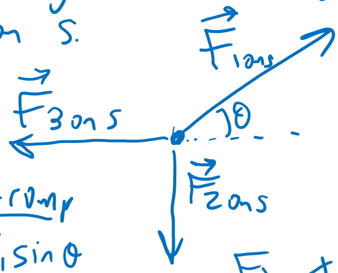
Newton's second law in 2-D becomes:

$$a_{Sx} = \frac{F_{1\text{ on S}x} + F_{2\text{ on S}x} + F_{3\text{ on S}x} + \cdots}{m_S} \qquad (4.2x)$$

$$a_{Sy} = \frac{F_{1\text{ on S}y} + F_{2\text{ on S}y} + F_{3\text{ on S}y} + \cdots}{m_S} \qquad (4.2y)$$

Define:

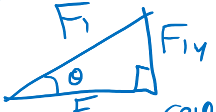




$$a_{sx} = \frac{F_1 \cos\theta - F_3}{m}$$

$$a_{sy} = \frac{F_1 \sin\theta - F_2}{m}$$

	x-comp.	y-comp
$\vec{F}_{1 on S}$	$F_1 \cos\theta$	$F_1 \sin\theta$
$\vec{F}_{2 on S}$	0	$-F_2$
$\vec{F}_{3 on S}$	$-F_3$	0
$\Sigma \vec{F}$	$F_1 \cos\theta - F_3$	$F_1 \sin\theta - F_2$



$\sin\theta = \frac{F_{1y}}{F_1}$ $\cos\theta = \frac{F_{1x}}{F_1}$

Poll Question

- A string is attached to the rear-view mirror of a car. A ball is hanging on the other end of the string. The car is accelerating to the left in this diagram. Which of the following lists gives all of the forces directly acting on the ball?

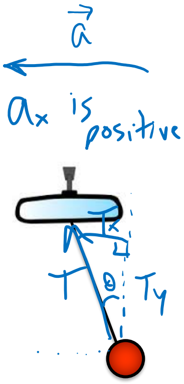
A. Tension

B. Tension, gravity, and a drag ~~force~~ from the air

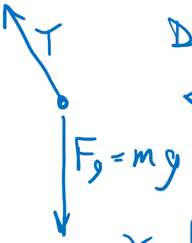
[✓ C. Tension and gravity]

D. Tension, gravity, and a fictitious force to the right

We don't use these in this course.



Inside the car, there is very little wind. (Windows are closed).



Define

$\sin\theta = \frac{T_x}{T}$

$\cos\theta = \frac{T_y}{T}$

	x	y
T	$T \sin\theta$	$T \cos\theta$
F_g	0	$-mg$

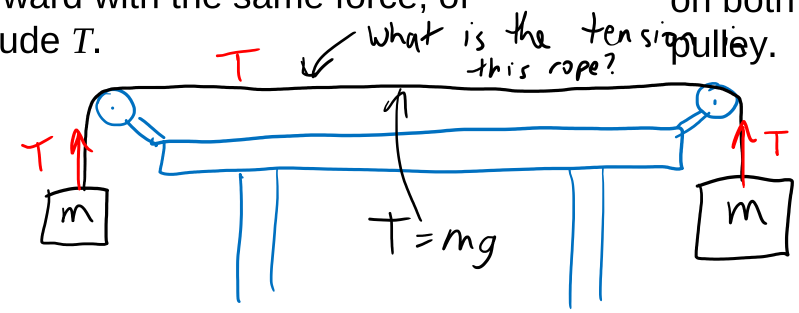
$a_x = \frac{T \sin\theta}{m}$

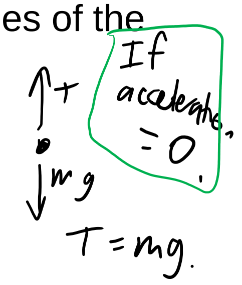
$a_y = 0$

$0 = \frac{T\cos\theta - mg}{m}$

Ropes and Pulleys

- The tension in a taught string or rope is a positive scalar number, *T*, in Newtons.
- If we can neglect the mass of the string compared to the other objects in the problem, each end of the string pulls inward with the same force, of magnitude *T*.
- If the string is wrapped over a frictionless pulley, and we can neglect the mass of the pulley, then the string has the same tension *T* on both sides of the pulley.





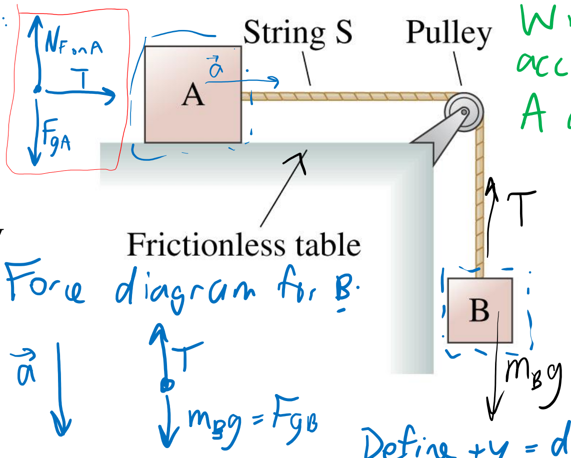
Poll Question

In the figure to the right, is the tension in the string greater than, less than, or equal to the force of gravity on block B?

A. Equal to

B. Greater than

[✓ C. Less than]



Will system accelarte? Yes

A accelerates to the right.

B accelerates downword.

Define +y = down.

a_y is positive.

$\Sigma F = F_{gB} - T$

$$a_y = \frac{\Sigma F_y}{m_B} = \frac{F_{gB} - T}{m_B}$$

$$m_B a_y = F_{gB} - T$$

$$T = F_{gB} - m_B a_y < F_{gB}$$

Before Class 10 on Friday

- Please read:
- 4.3 Friction
- 4.4 Solving Dynamics Problems in 2D
- Watch for a Ch.4 Practice Quiz which will be due Oct.6!

Something to consider:

Does friction always slow things down?

ANSWER: No!

Static friction between your feet and the floor is what allows you to walk! Walking certainly involves speeding up, and this would not be possible if the floor were frictionless or covered in marbles!