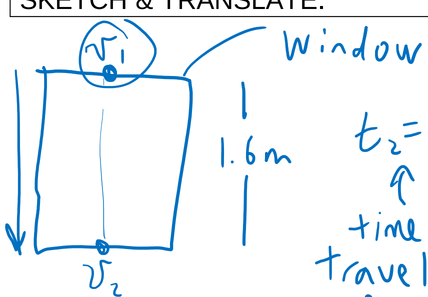
PHY131 F Fall 2020
Class 5

Today:

- Chapter 2 Kinematics: Motion in One Dimension
- Problem Solving Examples relevant to the Synchronous Midterm Assessment

Some people in a hotel are dropping water balloons from their open window onto the ground below. The balloons take 0.15 s to pass your 1.6-m-tall window. Where should security look for the raucous hotel guests?

SKETCH & TRANSLATE.



Define + = down

$t_2 = 0.15$ s ← time to travel height of window.

Find how far above top of window was balloon dropped?

SIMPLIFY & DIAGRAM

Assume initial drop was from rest.

→ Divide motion into 2 segments!

Seg. 1 Before balloon gets to top of my window.
$v_0 = 0$ = initial
v_1 = final
Need: y_1 distance traveled.
Don't care about t_1 time.

Seg. 2 v_1 = initial, (final of seg. 1)
$t_2 = 0.15$ s $y_2 = 1.6$ m.
Don't care about v_2 final speed.

Some people in a hotel are dropping water balloons from their open window onto the ground below. The balloons take 0.15 s to pass your 1.6-m-tall window. Where should security look for the raucous hotel guests?

REPRESENT MATHEMATICALLY

Seg. 1 Use Eq. 2.7, solve for v_1

$$2a(y_1 - y_0) = v_1^2 - v_0^2$$

$v_0 = 0$, set $y_0 = 0$, $a = g = 9.8\ m/s^2$

$$2gy_1 = v_1^2$$

$$v_1 = \sqrt{2gy_1}$$

Seg. 2 Use Eq. 2.6 solve for v_1

$$y_2 = v_1 t_2 + \tfrac{1}{2} g t_2^2$$

$$v_1 t_2 = y_2 - \tfrac{1}{2} g t_2^2$$

$$v_1 = \frac{y_2 - \frac{1}{2} g t_2^2}{t_2}$$

SOLVE & EVALUATE

Set $v_1 = v_1$

$$\sqrt{2gy_1} = \frac{y_2 - \frac{1}{2} g t_2^2}{t_2}$$

$$2gy_1 = \left[\frac{y_2 - \frac{1}{2} g t_2^2}{t_2}\right]^2$$

$$y_1 = \frac{1}{2g}\left[\frac{y_2 - \frac{1}{2} g t_2^2}{t_2}\right]^2$$

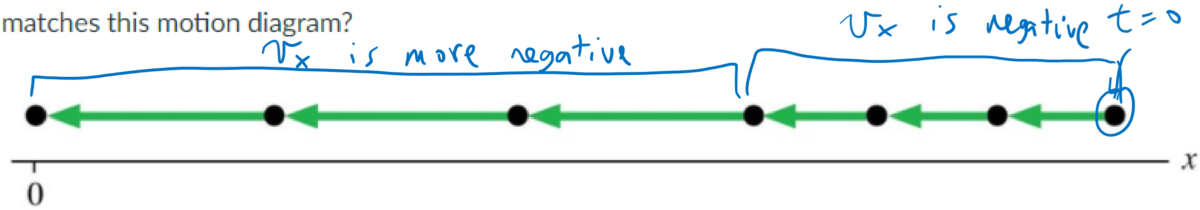
$$= \frac{1}{2(9.8)}\left[\frac{1.6 - \frac{1}{2}(9.8)0.15^2}{0.15}\right]^2$$

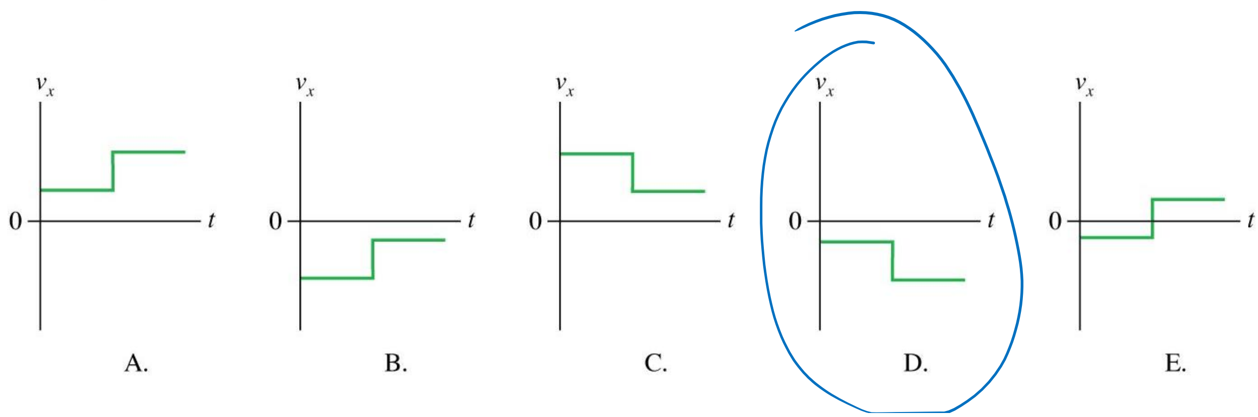
$y_1 = 5.03$ m. They should look 5 m above my room.

3

Poll

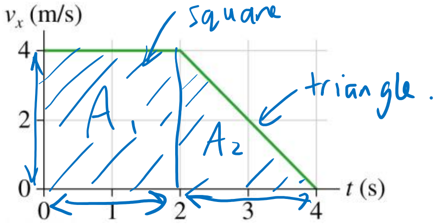
Here is a motion diagram of a car moving along a straight road. Which velocity-versus-time graph matches this motion diagram?





4

Here is the velocity graph of an object that is at the origin ($x = 0$ m) at $t = 0$ s. At t = 4.0 s, the object's position is



SKETCH & TRANSLATE.

At $t = 0$, $x_0 = 0$

v_x vs t graph is given.

SIMPLIFY & DIAGRAM

→ Area under v_x vs t graph gives change in position.
$\Delta x = (x - x_0)$

REPRESENT MATHEMATICALLY

$\Delta x = A_1 + A_2$
$= (l \times w) + (\frac{1}{2} b h)$
$= (2 s)(4 m/s) + \frac{1}{2}(2 s) 4 m/s$

SOLVE & EVALUATE

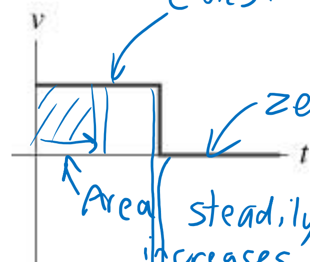
$\Delta x = 8 m + 4 m$
$= 12 m$. $x_0 = 0$

$x = 12 m$

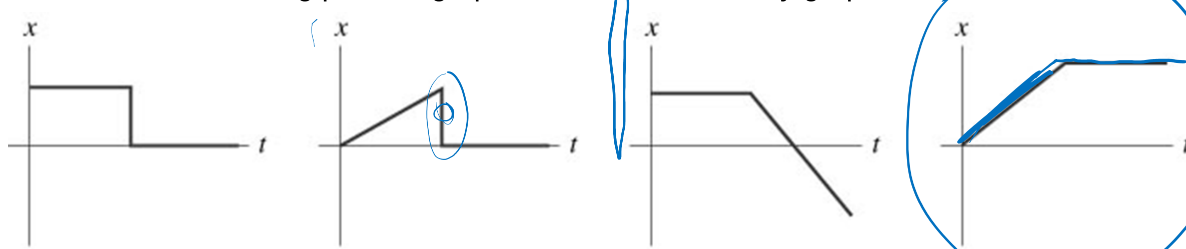
5

Poll

A graph of velocity versus time for a hockey puck shot into a goal appears as follows:



Which of the following position graphs matches the velocity graph?



A. B. C. D.

6

Shannon drives at a constant speed on the highway. She measures the time between passing successive km markers separated by exactly 1.000 x 10^3 m. If she measures a time of 48 seconds, what is her speed in km/h?

SKETCH & TRANSLATE.

Constant speed. $v = \frac{x}{t}$

$x = 1.000 \times 10^3$ m

$t = 48$ s.

REPRESENT MATHEMATICALLY

$$v = \frac{x\,[m]}{t\,[s]}\left(\frac{1\ km}{1000\ m}\right)\left(\frac{60\ s}{1\ min}\right)\left(\frac{60\ min}{1\ h}\right)$$

SIMPLIFY & DIAGRAM

$$v = \frac{x\,[m]}{t\,[s]}$$

Use: $1 = \frac{1\ km}{1000\ m}$ $1 = \frac{60\ s}{1\ m}$ $1 = \frac{60\ m}{1\ hr}$

SOLVE & EVALUATE

$$v = \frac{1000\ m}{48\ s} \times 60 \times 60 \div 1000$$

$$v = 75\ \frac{km}{h}$$

7

Poll

A Toyota Camry can accelerate from rest to 100 km/h in 6.5 s.

A Porsche 918 Spyder can accelerate from rest to 100 km/h in 2.6 s.

During the test, which car would drive the longer distance?

A The Camry

B The Porsche

C They would both travel the same distance

$$d = \frac{1}{2}at^2$$

$$v_{avg} = \frac{d}{t}$$

$$v_{avg} = \frac{v_0 + v_f}{2}$$

if a = constant.

let's assume a = constant (even though this may not be exactly true)

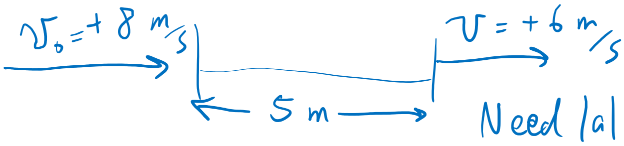
$$v_{avg} = \frac{0 + 100\ km/h}{2} = 50\ \frac{km}{h}$$

t is longer for Camry $\Rightarrow d$ is farther. for both.

8

A speed skater moving across frictionless ice at 8.0 m/s hits a 5.0-m wide patch of rough ice. She slows steadily, then continues on at 6.0 m/s. What is the magnitude of her acceleration on the rough ice? (Assume acceleration is constant on the rough patch.)

SKETCH & TRANSLATE.



Need |a| on rough patch.

Define + = to the right.

SIMPLIFY & DIAGRAM

Assume a is negative, and constant on rough patch.

REPRESENT MATHEMATICALLY

Known: v_0, v, $x - x_0$

Need: a

Don't care about time t.

Use 2.7, solve for a.

$$2a(x - x_0) = v^2 - v_0^2$$

$$a = \frac{v^2 - v_0^2}{2(x - x_0)}$$

SOLVE & EVALUATE

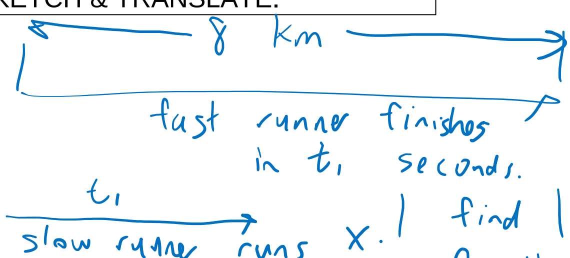
$$a = \frac{6^2 - 8^2}{2(5)} = -2.8 \text{ m/s}^2$$

$$|a| = 2.8 \text{ m/s}^2$$

← less than g, reasonable.

In an 8.00 km race, one runner runs at a steady 11.0 km/h, and another runs at 14.0 km/h. How far from the finish line is the slower runner when the faster runner finishes the race?

SKETCH & TRANSLATE.



find c where $x + c = 8$ km

SIMPLIFY & DIAGRAM

Constant speeds

$$v_{fast} = \frac{8 \text{ km}}{t_1} \qquad t_1 = \frac{8 \text{ km}}{14 \text{ km/hr}}.$$

REPRESENT MATHEMATICALLY

Slow runner.

$$v_{slow} = \frac{x}{t_1}$$

$$x = v_{slow} \cdot t_1$$

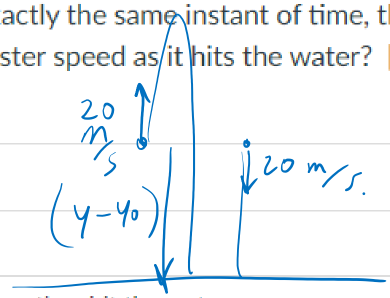
$$= \left(11 \frac{\text{km}}{\text{h}}\right) \cdot \frac{8 \text{ km}}{14 \text{ km/h}}$$

SOLVE & EVALUATE

$$c = 8 - x.$$

Poll

Heather and Jerry are standing on a bridge 50 m above a river. Heather throws a rock straight down with a speed of 20 m/s. Jerry, at exactly the same instant of time, throws a rock straight up with the same speed. Which rock has the faster speed as it hits the water? [Neglect air resistance.]



A The rock Heather threw.

B The rock Jerry threw.

C Both rocks will have the same speed as they hit the water.

v_0 Find v.
don't care about t.
Use Eq. 2.7
$2a(y-y_0) = v^2 - v_0^2$
$v^2 = v_0^2 + 2a(y-y_0)$
$(-20)^2 = (+20^2)$ same for both!
-9.8 same.

Before Class 6 on Wednesday

- Read the first 3 sections of chapter 3:
- 3.1 Force
- 3.2 Representing Forces with Vectors
- 3.3 How is Force Related to Motion?