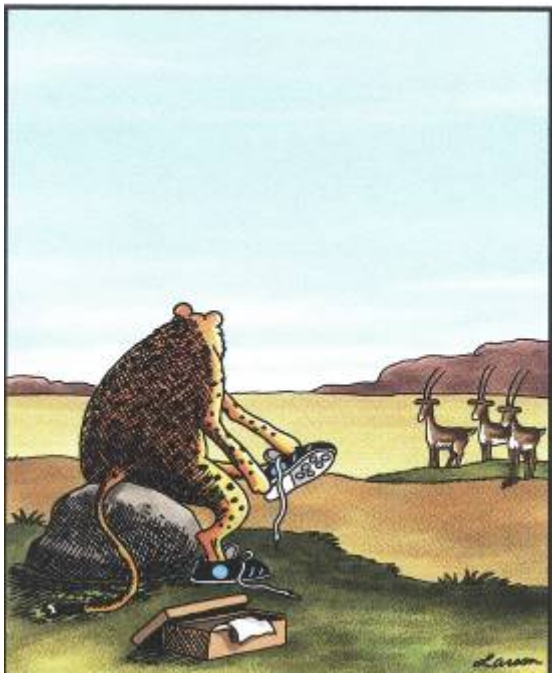
Physics Traditional1314 Williams

Sports Physics: Linear Motion

Chapters 1-2



Physics Linear Motion 4-atep template

(1) Draw a picture of what's going on	(4) Solve with units
(2) List knowns & unknowns	
(3) List formula to use	

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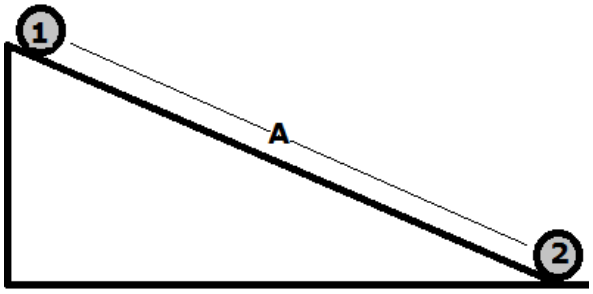
130828LinearMotionDefinitionsConceptCheck

1. You walk 400 m. Which is definitely true about your distance? (more than one may be true)
    a. Must be 400 m
    b. May be 400 m
    c. May be 0 m
2. You walk 400 m. Which is definitely true about your displacement? (more than one may be true)
    a. Must be 400 m
    b. May be 400 m
    c. May be 0 m
3. You circle a 400 m track in 80 sec. Which is definitely true about your average speed? (more than one may be true)
    a. Must be 0 m/s
    b. May be 0 m/s
    c. Cannot be 0 m/s
4. You circle a 400 m track in 80 sec. Which is definitely true about your average velocity? (more than one may be true)
    a. Must be 0 m/s
    b. May be 0 m/s
    c. Cannot be 0 m/s
5. You circle a 400 m track in 80 sec. At no time do you stop during this time. Which is definitely true about your instantaneous velocity at the half-way point around the track? (more than one may be true)
    a. Must be 0 m/s
    b. May be 0 m/s
    c. Cannot be 0 m/s
6. Your car is accelerating at +4 m/s^2. Positive forward motion is considered to the right and that is the direction of your acceleration. You are not given the direction of the car's motion. Which is definitely true about what's happening?
    a. Your speed is increasing
    b. Your speed may be decreasing
    c. Your velocity is increasing
    d. You must be pressing on the accelerator or going downhill or something like that to have positive acceleration
    e. Given the information, we cannot say that any of these are DEFINITELY true
7. Distance is to displacement like speed is to
    a. Distance
    b. Acceleration
    c. Velocity
    d. None of these make any sense
8. You move 10 miles east then 14 miles west in 1 hour. What is
    a. Your distance?
    b. Your displacement?
    c. Your average speed?
    d. Your average velocity?

130829TennisballrollingdownarampTracker

Tennis ball rolling down a ramp

Goal: Graph velocity of a tennis ball's motion and find important average and instantaneous values.

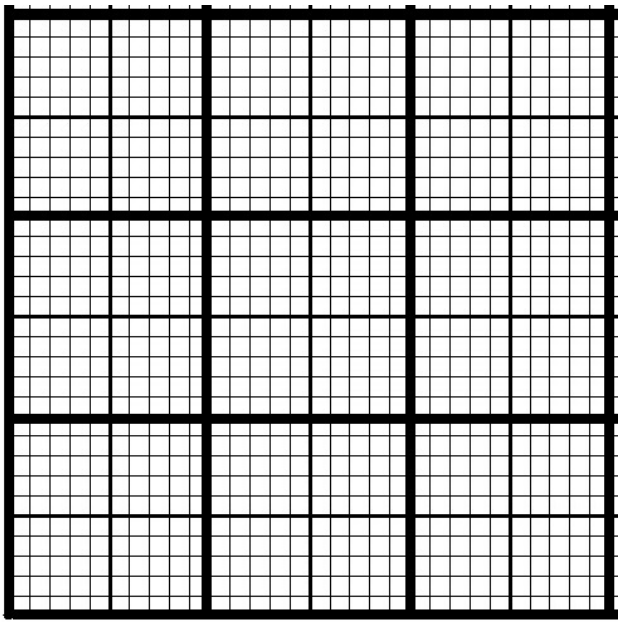


Method: With the tennis ball beginning from rest at the top of a wooden ramp (1), release a tennis ball and let it roll down a ramp until it reaches the floor. Then, let friction slow the ball down to a stop. Time how long it takes to roll from 1 to 2 (length A) and then from 2 to three (length B). Pick any reasonable angle to the ball doesn't roll too far.

Data:

	A
ΔX	
Δt	
V_{avg}	
a_{avg}	

Graph V vs t (hint: $V_1 = 0$, so what is V_{avg}?) →



1. How can you find the slope when the time is half over? What value is it?

2. How can you use area under the curve to find <u>when</u> the ball is half way down? Do it.

3. What would you do to identify the rate of acceleration? (read directly, slope, area?) What is a_{avg}?

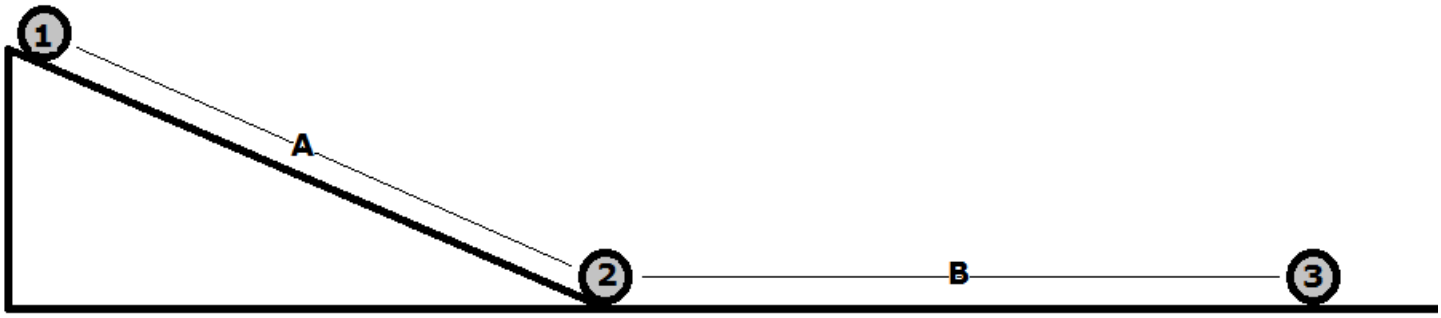
4. How fast is the ball going when its half way down the ramp? (which way: read directly, slope, area?)

If average speed is distance/time, then is that value the same as the average of the V_i and V_f?

130904Tennisballrollingdownaramp

Tennis ball rolling down a ramp

Goal: Graph velocity of a tennis ball's motion and find important average and instantaneous values.

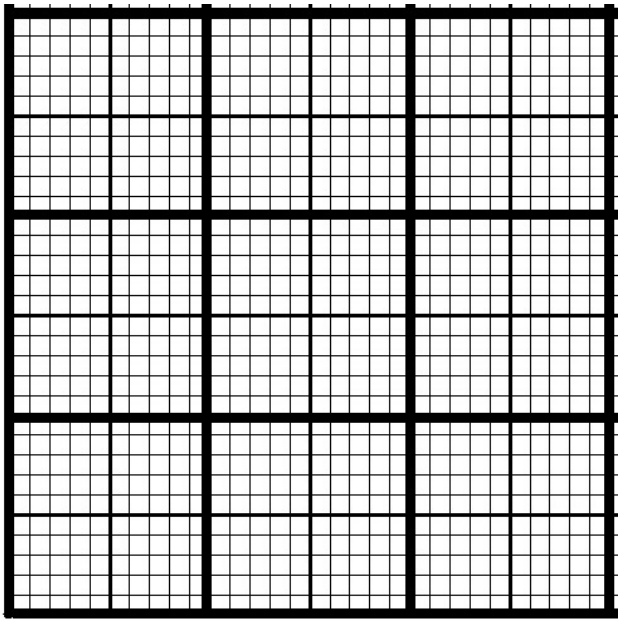


Method: With the tennis ball beginning from rest at the top of a wooden ramp (1), release a tennis ball and let it roll down a ramp until it reaches the floor. Then, let friction slow the ball down to a stop. Time how long it takes to roll from 1 to 2 (length A) and then from 2 to three (length B). Pick any reasonable angle to the ball doesn't roll too far.

Data:

	A	**B**	**Total (overall)**
ΔX			
Δt			
V_{avg}			
a_{avg}			

Graph V vs t (hint: $V_1 = 0$, $V_3 = 0$, V_2 is max speed)

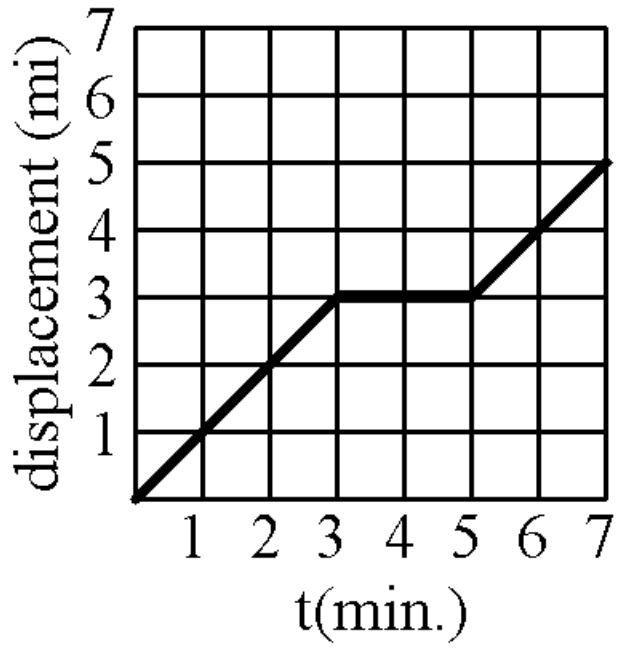


(Show your work!) Using slopes, area or the direct reading of values, and your cleverness, find

1. Distance from 1 to 2
2. Average acceleration from 2 to 3
3. Average acceleration from 1 to 3
4. Speed 1/2 way between 1 and 2
5. Speed 1/2 way between 2 and 3

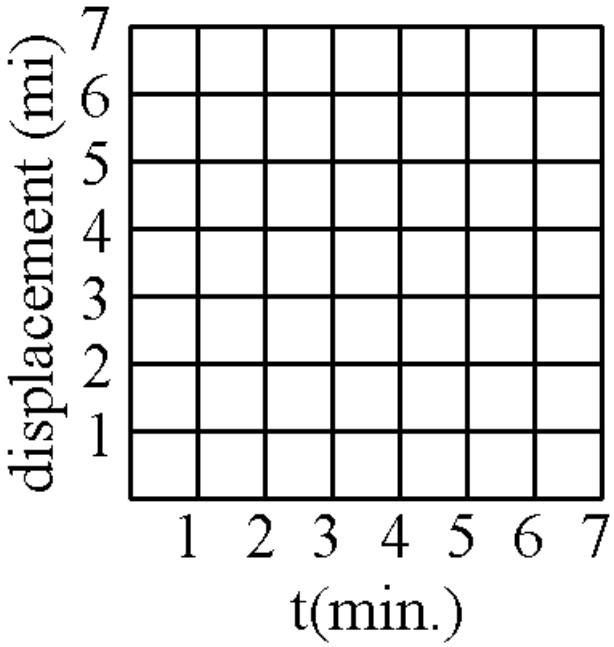
Example

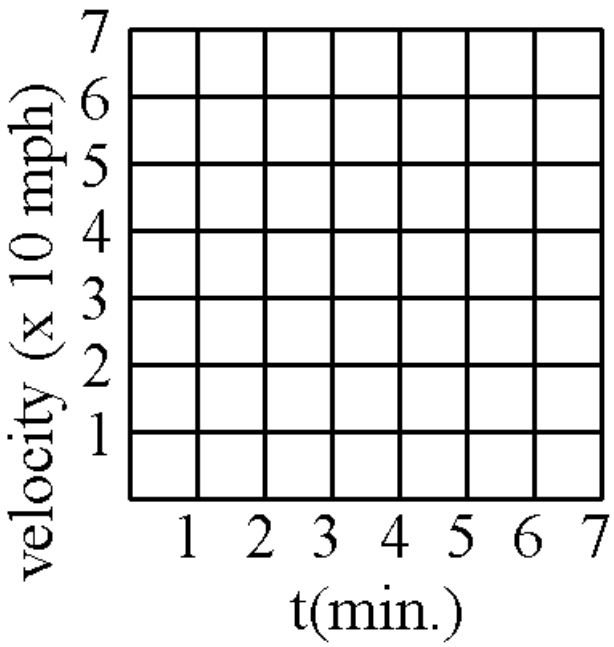
1. Melora and Sarah drive 60 mph (1 mile/min) for 3 min on the expressway. Then they stop at the Hinsdale oasis to clean off their windshield for 2 minutes before continuing on their trip.



Now YOUR turn

2. Omar and Palmer drive 30 mph (0.5 mi/min) to school a mile away. Then they stop for two minutes to drop off a physics assignment before continuing at 30 mph in the same direction for 2 minutes where they pull off to the side to help a lady change her car tire for one minute. Graph their displacement and velocity.





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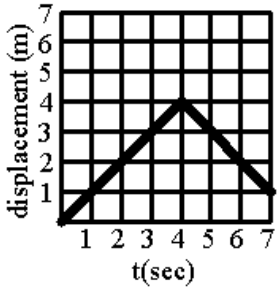

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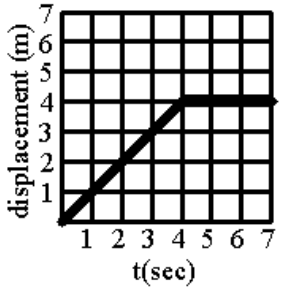

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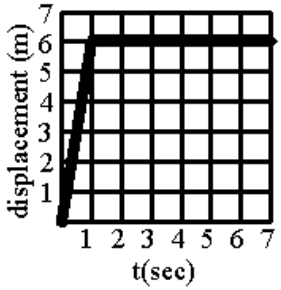

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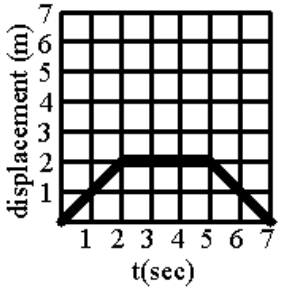

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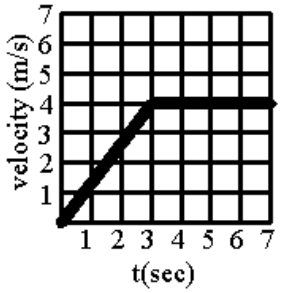

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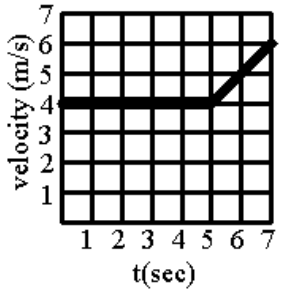

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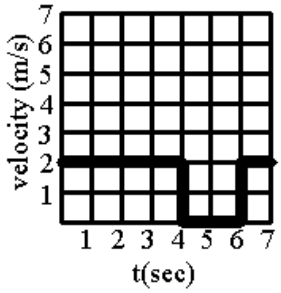

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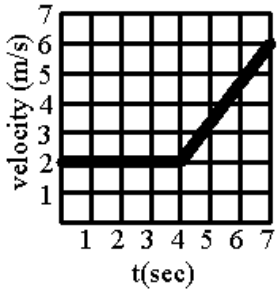

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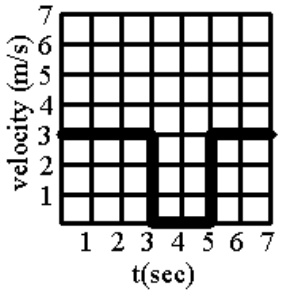

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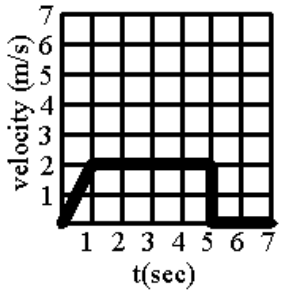

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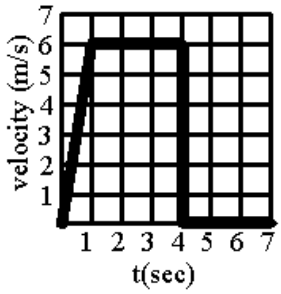

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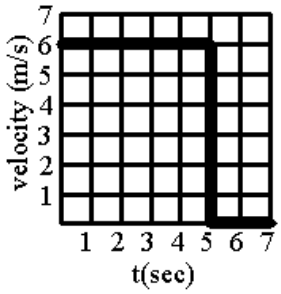

Match the story with the correct graph:

3. Jack runs full speed (6 m/s) for 1 sec. and then runs into a wall (tackling dummy) and stops suddenly.
4. Molly is jogging along at 4 m/s when she sees Emily and speeds up to catch up to her.
5. Sylwia is strolling along at 1 m/s when she grows weary and stops.
6. Whitney is walking along when she sees a butterfly and stops for a couple seconds to watch it.
7. Caitlin is skating along at 6 m/s. She turns her head to wave at a friend and 5 seconds later runs into a wall.
8. Emily and Alyssa are in a bumper car going forward. They spot Dave and ram into his bumper car which makes them go backwards.
9. Amer walks 2.0 m forward to throw away a piece of paper. Stops to throw it away and glance at the time. Then he walks back to his desk.
10. Ryan is walking along (2 m/s) and he notices Pat. He begins running fast to catch up to Pat.
11. Laura is speed-walking, but she has to wait a couple seconds so she can check the cross-walk
12. Spike begins at rest and then walks at a normal pace for 4 seconds before stopping.
13. Starting from rest, John begins to run down the court to play defense.
14. Andrew starts from rest and goes to a fast run for a few seconds before stopping suddenly.

Name:_____No:_____

Physics linear motion practice problems

$$v_{avg} = \frac{\Delta x}{\Delta t} \qquad v_{avg} = \frac{v_f + v_i}{2} \qquad a_{avg} = \frac{\Delta v}{\Delta t}$$

a = const. $v_f = v_i + at$ $x_f = x_i + v\,t$ $v_f^2 = v_i^2 + 2a(x_f - x_i)$

60 mph = 27 m/s;

Word problems

Easy

1. Superman is off to visit Lois Lane. He sees he's late and increases his flying speed. I know he defies the laws of physics anyway, but let's pretend, okay? If our lead-phobic super hero accelerates uniformly from 1200 m/s to 1600 m/s in 0.40 seconds, then what is his rate of acceleration?

2. Scoobie runs after a Scoobie Snack® placed by Daphne 60 m away. Scooby averages 9 m/s. How long until the snack is in his mouth?

3. Barney is walking with all his good friends. If he began walking away from Lucy 12 seconds ago at an average speed of 1.5 m/s and is now 25 m from Lucy, the how far from her was he when he began walking?

4. Charlie rolls a basketball down a ramp. If ball velocity increases from 3 m/s south to 24 m/s south in 7 seconds, then what is the acceleration?

5. Mary slept all during physics class in high school. She needs to know if her friend can jump across a pool. Her friend averages 9.0 m/s and can stay airborne for 0.80 seconds. I know we shouldn't feel sorry for Mary, but let's help her out anyway: How long of pool is the most her friend can possibly leap across?

Medium

6. Mike lets his bike roll down a hill beginning from rest and accelerating uniformly. If he rolls 125 m in 25 s, then what was his rate of acceleration?

7. A rabbit wakes up from a nap and begins chasing a turtle. If the rabbit runs at 6 m/s and the turtle runs at 0.5 m/s, then how long will it take our foolish bunny to catch the turtle if he has a 300 m lead?

8. According to an article in Business Week, the 2008 Corvette can go from zero to 60 mph in just 4.2 seconds. Assuming acceleration is uniform, then how much track length did it take to accomplish this?

Hard

9. Madisenis fast, so she plays a shallow center field. If she begins 50 m from the ball and can run 9.0 m/s then how deep can she catch a ball hit at 30 ms in line with her (headed over her head)?

10. A sled slides for 9 seconds down a 108 m hill accelerating constantly the whole time so as to reach a final speed of 20 m/s after being given a push to give it a small starting speed. How fast was the starting speed?

11. If a 2008 Corvette can go from zero to 60 mph in 4.2 seconds, how fast would it be going at the end of 100 m assuming acceleration is constant?

Sample multiple choice problems:

12. You buy and car and the odometer says it has 12,000 miles. What does your car odometer read?
    a. Speed
    b. Velocity
    c. Displacement
    d. Distance
13. You're pedaling your fancy bike and see the speedometer reads 10.5 mph. What does the speedometer reveal?
    a. Instantaneous velocity
    b. Instantaneous speed
    c. Average velocity
    d. Average acceleration
    e. Average distance
14. Which of the following is NOT a scalar?
    a. Speed
    b. Displacement
    c. Magnitude of acceleration
    d. They're all scalars!
15. What do you calculate when you find the slope of an acceleration-time graph?
    a. Velocity
    b. Acceleration
    c. Displacement
    d. Nothing meaningful
16. A horse (Mr. Ed) runs as fast as his poor little feet can carry him in a 1.5 mile complete circle around a track. What was Mr. Ed's displacement during the course of the race?
    a. 1.5 miles
    b. 0 miles
    c. 0.75 miles
    d. 3.0miles
    e. -1.5 miles
17. The correct setting for the blue tracker arrow scale is:
    a. 1.0 m
    b. 1.8 m
    c. Zero m
    d. The length of whatever object you know
    e. Trick question: you NEVER change the scale setting!
18. The difference between a scalar and a vector can best be summarized by which of the following?
    a. Vectors are always longer than scalars
    b. Vectors are the "rate of change" of scalars
    c. Scalars are the "rate of change" of vectors
    d. Scalars and vectors are the same
    e. Vectors include a direction
19. Which of the following is NOT an example of linear motion?
    a. Dropping a ball
    b. Rolling a bowling ball without any special spin
    c. Tom Brady throwing an interception (go Giants!)
    d. Passing a hockey puck flat across the ice

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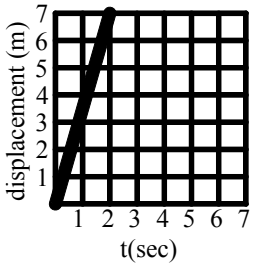

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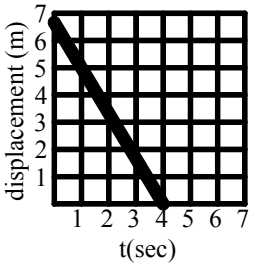

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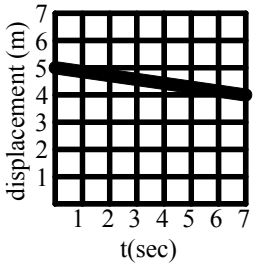

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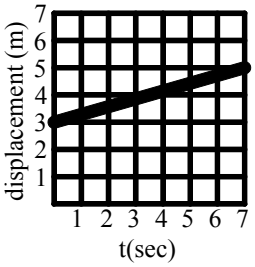

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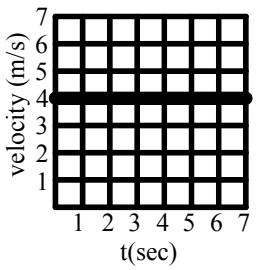

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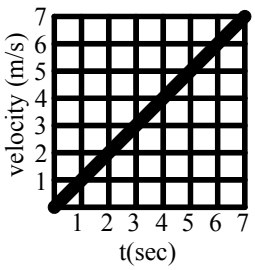

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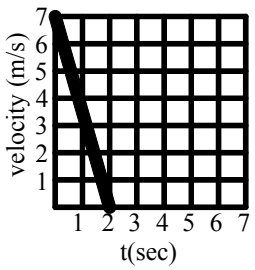

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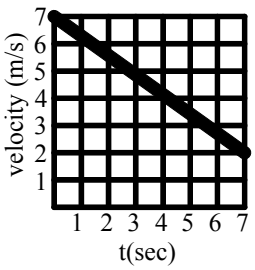
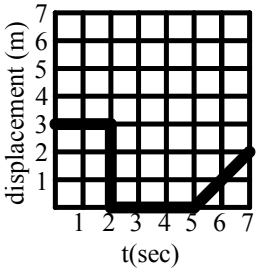


20. Which graph(s) represent constant (& non-zero) acceleration?
    a. 5
    b. 1,2,3,4,5
    c. 6,7,8,
    d. All of these
21. In which graph is the highest speed depicted?
    a. 1
    b. 5
    c. 7
    d. 6
    e. 6,7,8
22. Which graphs indicate backward motion?
    a. 2,3
    b. 7,8
    c. 2,3,7,8
    d. 5
23. Which graph shoes a constant speed of 0.28 m/s?
    a. 1
    b. 4
    c. 5
    d. 8

(1)



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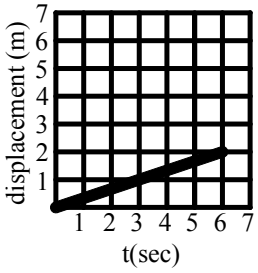

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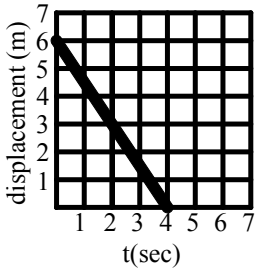

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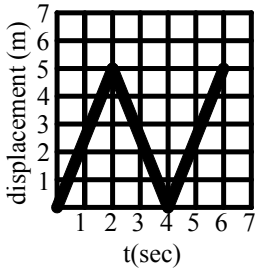

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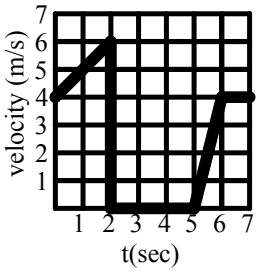

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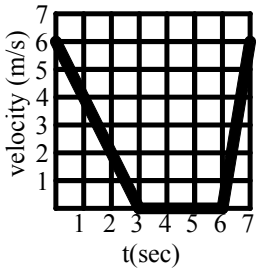

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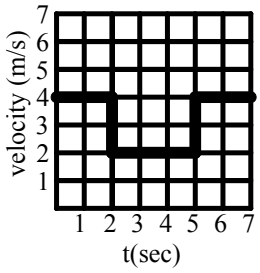

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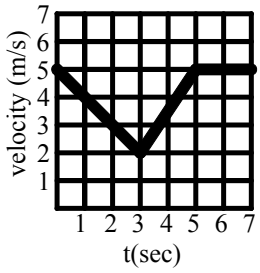
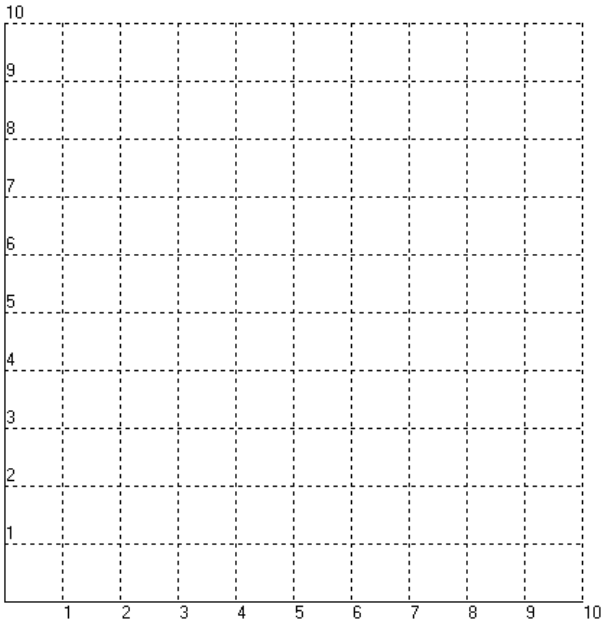
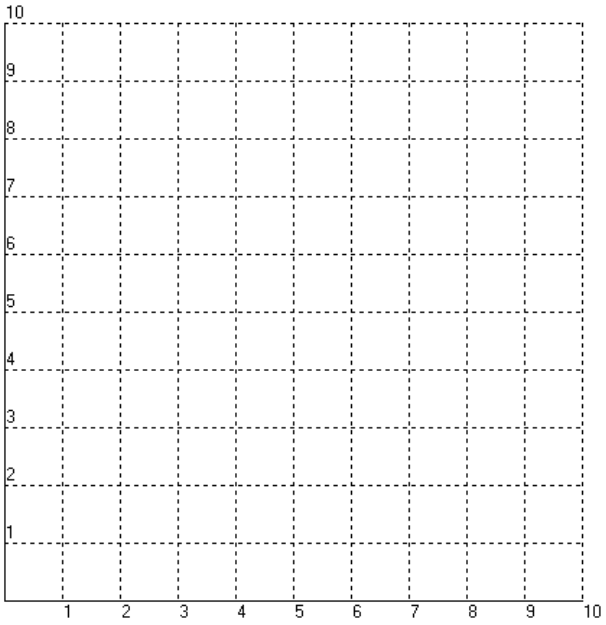


24. Which graph shows Sam jogging along and thinks a bee is there, so she speeds up for a couple seconds. Then she realizes it's only a mosquito, so she stops for a few seconds to kill it before returning to her jog.
    a. 1
    b. 4
    c. 5
    d. 6
    e. 7
25. Which graph shows Mark jogging slowing down to a walk to pant for a few seconds, then resumes his jog.
    a. 1
    b. 4
    c. 6
    d. 7
26. Which graph shows a student returning back to her desk?
    a. 2
    b. 3
    c. 4
    d. 7



27. Use the graph above to draw a mouse starting a x = 4 m from the cheese. He runs away from it for 2 seconds at 3 m/s because he sees spot, the cat. When he sees spot using the kitty litter he makes a mad dash for the cheese running toward to it at breakneck speed of 5 m/s. Draw the position graph above (labels count!)



28. Math man, strange math visitor from a strange math planets pays homage to HCHS physics by visiting physics class. He says "whoa dude, that's some righteous physics goin' on". He needs a velocity vs. time graph for a toy train accelerating at a constant -3 m/s^2 with an initial velocity of +9 m/s. Give him a good impression of earth by helping him out.

Unit 01 – Vocabulary and Equations – Linear Motion

Vocabulary:

nano (n)
micro (μ)
milli (m)
centi (c)
kilo (k)
mega (M)
giga (G)
tera (T)
SI (Système International d'units)
Δ
vector
scalar
position (x)
distance (Δx)
displacement (Δx)
speed (v)
velocity (v)
frame of reference
magnitude of acceleration (a)
acceleration (a)
instantaneous (velocity, acceleration)
average (velocity, acceleration) ($\bar{v}$, $\bar{a}$)
direct reading, slope, area under curve

Symbols:

Δ, x, v, t, Δx, Δv, Δt, a, f, i

Equations & constants:

You get these on test:

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t}$$

$\Delta x = v_0 \Delta t + \frac{1}{2} a t^2$

$v = v_0 + a \Delta t$ (v means v_f)

$v_f^2 = v_i^2 + 2a \Delta x$

60 mph = 27 m/s; 60 seconds = 1 min.; 60 min = 1hr.

Unit Objectives - Williams

1. I understand all the vocabulary & math of this unit and all demos, videos, equations, and class assignments.
2. I have memorized the assigned SI prefixes for the year; I know how to substitute these prefixes for numbers and vice-versa.
3. I know how to use the EE button on my calculator for problems involving exponential notation
4. I will use three significant digits or more in my answers this year to make sure my final answers are within 1% of correct value
5. I know how to use T-charts to convert between units
6. I can use concept of dimensional analysis to see if my answer units make sense
7. I understand the subtle differences between distance and displacement and other vector quantities compared to their scalar equivalents
8. I understand that all motion is relative and is measured from some frame of reference
9. I know what the three types of motion graphs are and the three ways to get information from them
10. I can see motion graphs and critically describe what they reveal and what they do not reveal
11. I know the difference between average and instantaneous values
12. I can apply one-dimensional motion equations to solve realistic problems
13. I can do "catch up" problems applying relative motions

DuPage ROE Objectives

101. I can distinguish between scalar and vector quantities.
102. I can differentiate between accelerated and constant velocity motion.
103. I can describe and analyze motion based on graphs, numeric data, words, and diagrams.
104. I can differentiate between speeding up, slowing down, and change in direction, based on the direction of velocity and acceleration.

Physics Calendar - Introduction & Linear Motion: 2013-14 (Williams) - Chapters 1-2 (10 days)

Bold and underlined means put in journal notes (for any problems: Show your work!)

Mod	Date	Plans	Homework
1	**Fr:08/23/13**	GOALS:Pix,class intro/GOALSs,groups MO! • Show assigned seats (test seats), Take class picture • will86.org website, show notes (video notes!) • Bold/Underlined → put in journal • Syllabus highlights, inflated pts (2x, test ~15 pts/day), journal, participation, activities/challenges, no book • Get to know each other to form 4 groups of six by Mo. • Show objectives and link to notes • Get to know each other to form 4 groups of six by Mo. (leaders, president)	• Get all class materials by Mo (calculator, journal, book, for pts?) • **(01-01)** Notes: prefixes, factor labeling, dimensional analysis (p. 23), 4-step method, SI units; preview HW**:2,4,5,6** • Notes Quiz Tu, 10 min after class start (10 pts)
2	**Mo:08/26/13**	GOALS:See how much physics you know at semester start • ROE pre-course (all period, test how much physics you know prior to the class)	•
3	**Tu:08/27/13**	GOALS:Pick groups/pres/leaders • Notes Quiz, 10 pts, 10 min. after bell (closed notes) • "Officialize" new groups (notice calendar!), sit there • Journal expectations (assignment #, show work, no spiral) • Go over quiz, Group HW Quiz (5 pts), start HW	• **(01-02)** Do p. 15: 1-5; p. 25: 2-5 • May do journal check tomorrow
4	**We:08/28/13**	GOALS:Intro vectors/scalars, 4-step method • Clickers assigned, do clix • Go over HW Quiz • **(01-03)** How to use calculator EE button (no quiz)**:3** • Demonstrate acceleration (def. ex dir OR speed) • Bring up all journals and grade group same time (5 pts)	• **(01-04)** Review p. 27: 10,11,13,14,29-36,38 • **(01-05)** Notes on linear motion: displacement & velocity (vectors vs. scalars), 4-step method or do at home**:7,8**
5	**Th:08/29/13 Meet the teachers 7p**	GOALS:accelerationvs velocity/speed • Notes quiz, go over THEN pkt 130828 sheet • Show time relationship: position, velocity, acceleration (each slope of other) • Start HW or preview next notes (HW)	• **(01-06)** p. 47: 1-6 • **(01-07)** Notes on accelerated motion**:14**
6	**Fr:08/30/13**	GOALS:Solidifyx,v,a with slopes & intro area • Notes quiz, go over • Intro graphing concept of area (accumulation) vs. slope (rate of change) & relationships of xva • Demo Tracker: **130829TennisballrollingdownarampTracker** • Group quiz sheet/start HW	• **(01-08)** p. 49: 1-5 • **(01-09)** Notes on three different graphs and three things to read from graphs**:9,10,11**
7	**Tu:09/03/13**	GOALS:Practice problems • Notes quiz, go over, Intro Moodle - do Moodle assignment • Reminder: ROE pre-test tomorrow (do your best, no points)	• **(01-10)** p. 55: 1-4 • Work on Moodle, due day before test! • **(01-11)** p. 58: 1-6
8	**We:09/04/13**	GOALS:Demonstratexva knowledge on a practical problem • Demonstrate ball on ramp (no more than 10 to 15 min, then on your own!) • Tennis ball rolling down a ramp (lab), due tomorrow at start of class (1 per group…or split up group if you want)	• **(01-12)** p. 59: 1-6 • Moodle due tomorrow!
9	**Th:09/05/13**	GOALS:Get ready for BIG test! • Go over first explanation paper; Collect lab, go over • Moodle hints/help • Remind that all questions based on objectives! • Anything class wants to do to prepare for test	• Study for test
10	**Fr:09/06/13**	• Test: Linear motion. Chapter 1, Chapter 2 sections 1-2	• Hug your parents...they love you!