Lesson 1.15. Displacement & Average Velocity   Date: _____   Period: _____

Now that you have some practice drawing **blue arrows**, **green arrows**, and **red arrows** on position graphs, you are ready to use them to answer more complex questions about the motion of objects. Colored arrows can be a powerful tool to help you solve those (:o) dreaded physics word problems (:o). The way you draw them together on a graph depends upon the information given and the questions asked. Consider the following three examples:

1) A buggy passed 7.0 tiles, south of the reference point when the student placed the first washer, then traveled a total of 12.0 tiles, northward during the next 4 beats. Please determine the buggy's final position **and** its average velocity during this time interval.

2) A buggy passed by 8.0 tiles, south of the reference point after traveling for 5 beats at a velocity of 2.0 tiles/beat, southward. Determine its initial position **and** its total displacement during this time interval.

3) A buggy passed 7.0 tiles, south of the reference point when a student placed the first washer. If it then traveled with an average velocity of 3 tiles per beat, northward, how long did it take to reach position 11.0 tiles, north **and** what was its total displacement during the time interval?
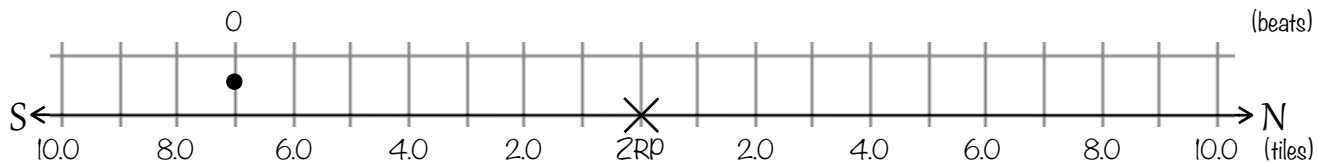
Please fill the empty cells in the data table below. This will help you to organize your thinking about each question.

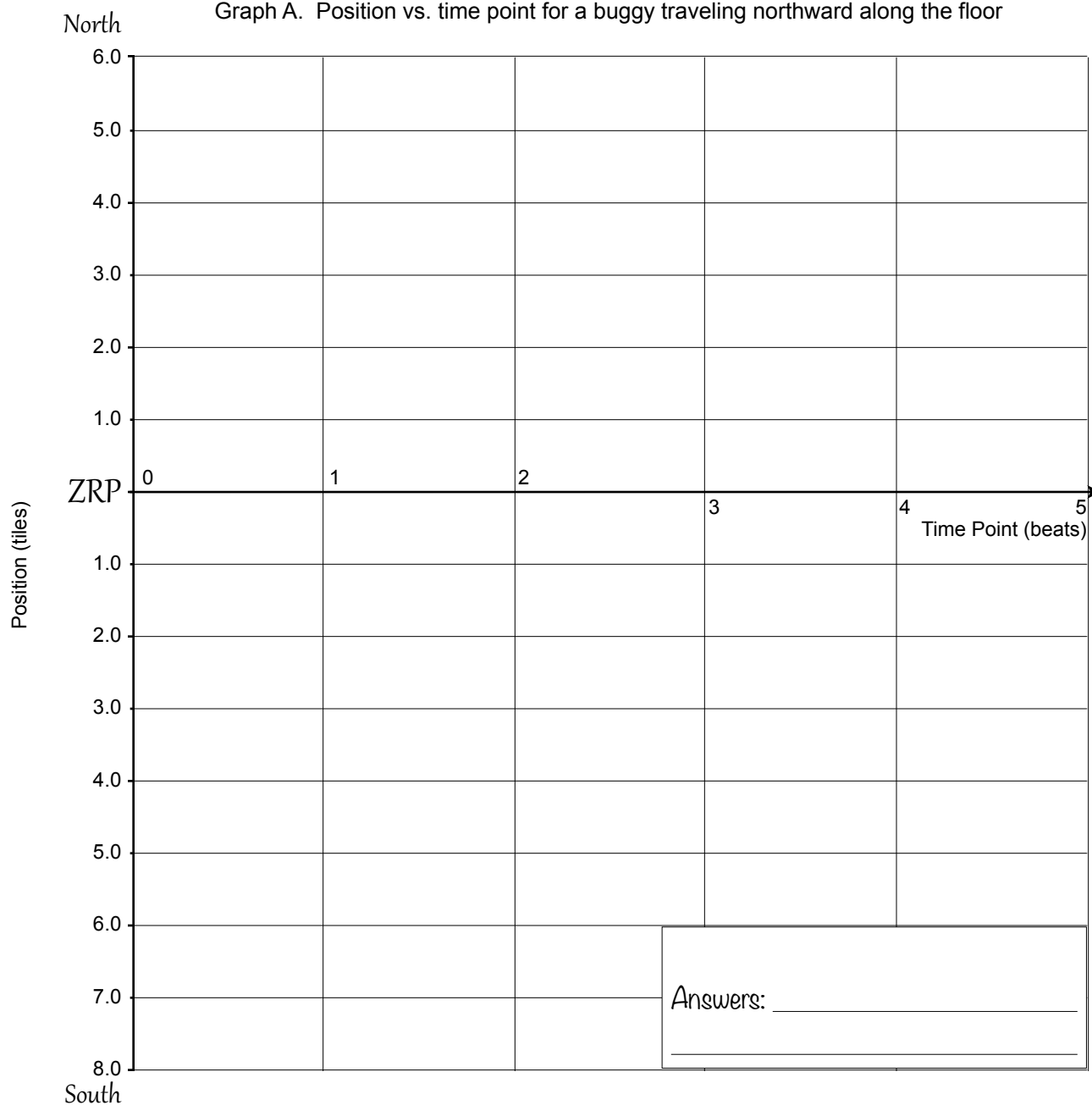|	Question 1	Question 2	Question 3
Initial position	7.0 tiles, south	?	7.0 tiles, south
Final position			
Time interval			
Total Displacement			
Average Velocity			

❖ Here are some helpful strategies:
  ❖ Starting with what you know, draw the story in a logical order.
  ❖ **Blue arrows** always start at the time point axis.
  ❖ **Green arrows** are always drawn at the *beginning* of the time interval, and always start at the point of the *initial* blue arrow.
  ❖ **Red arrows** are always drawn at the *beginning* of each time interval of 1 count, and always start at the point of a blue arrow (or stubby).
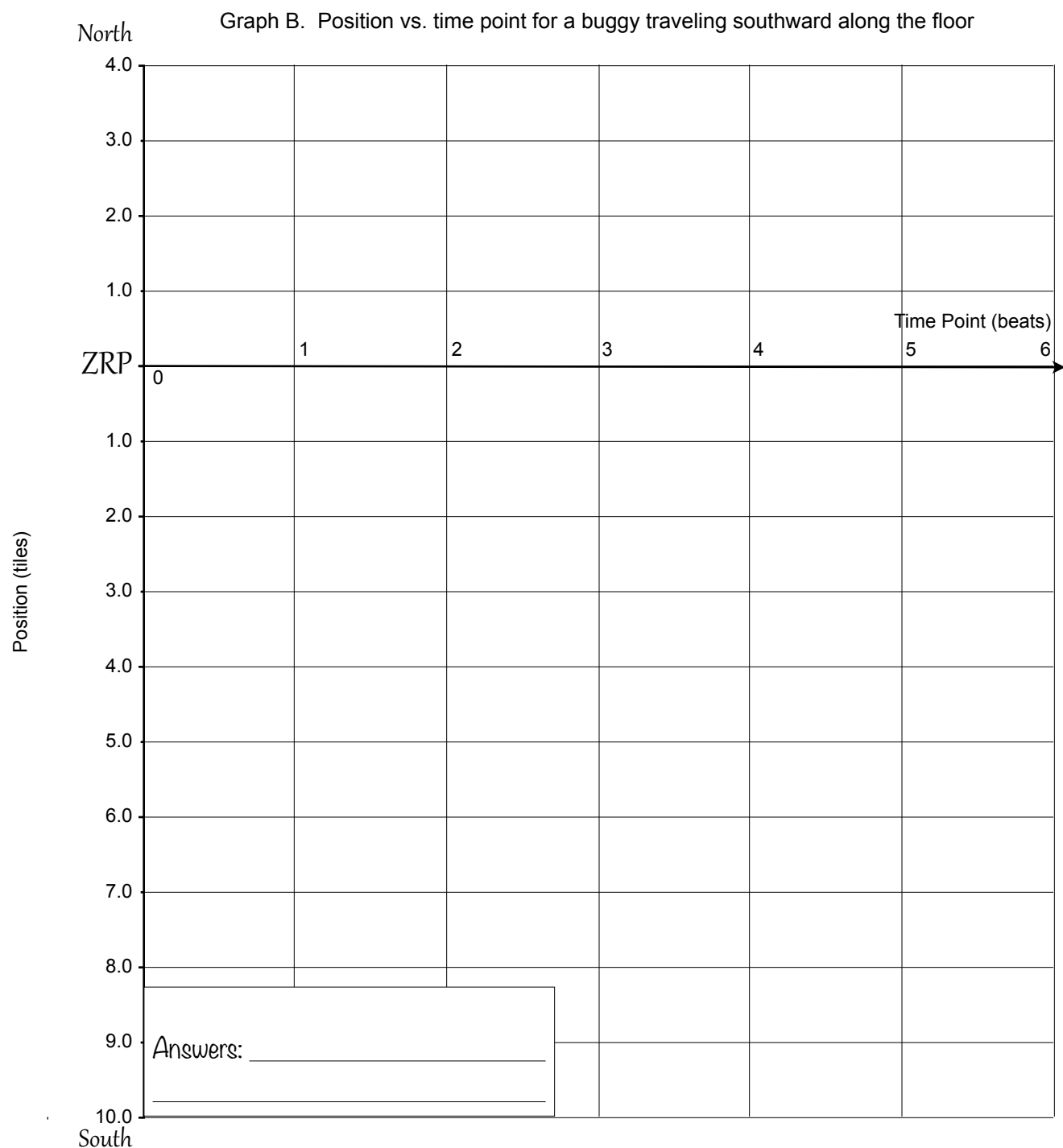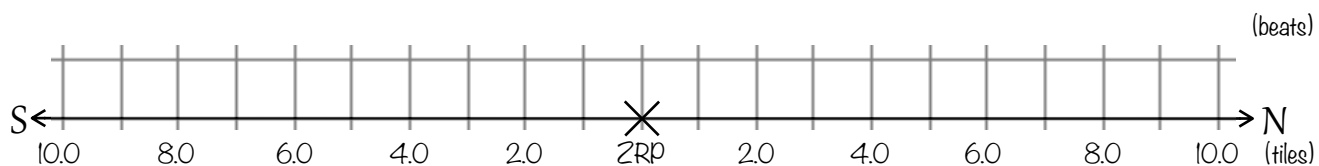
*A buggy passed 7.0 tiles, south of the reference point when a student placed the first washer, then traveled a total of 12.0 tiles, northward during the next4 beats. Please determine the buggy's final position **and** its average velocity during this time interval.*

0   (beats)

S← | | | | | | | | | X | | | | | | | | →N
    10.0   8.0   6.0   4.0   2.0   ZRP   2.0   4.0   6.0   8.0   10.0 (tiles)

Graph A. Position vs. time point for a buggy traveling northward along the floor

North

| | 0 | 1 | 2 | 3 | 4 | 5 |

Position (tiles)

6.0
5.0
4.0
3.0
2.0
1.0
ZRP   0   1   2
                              3   4   5
                                  Time Point (beats)
1.0
2.0
3.0
4.0
5.0
6.0
7.0   Answers: _____
                  _____
8.0

South

*A buggy passed by position 8.0 tiles, south of the reference point after traveling for 5 beats at an average velocity of 2.0 tiles/beat, southward. Determine its initial position **and** its total displacement during this time interval.*

(beats)

S ← | | | | | | | | | | X | | | | | | | | | | → N
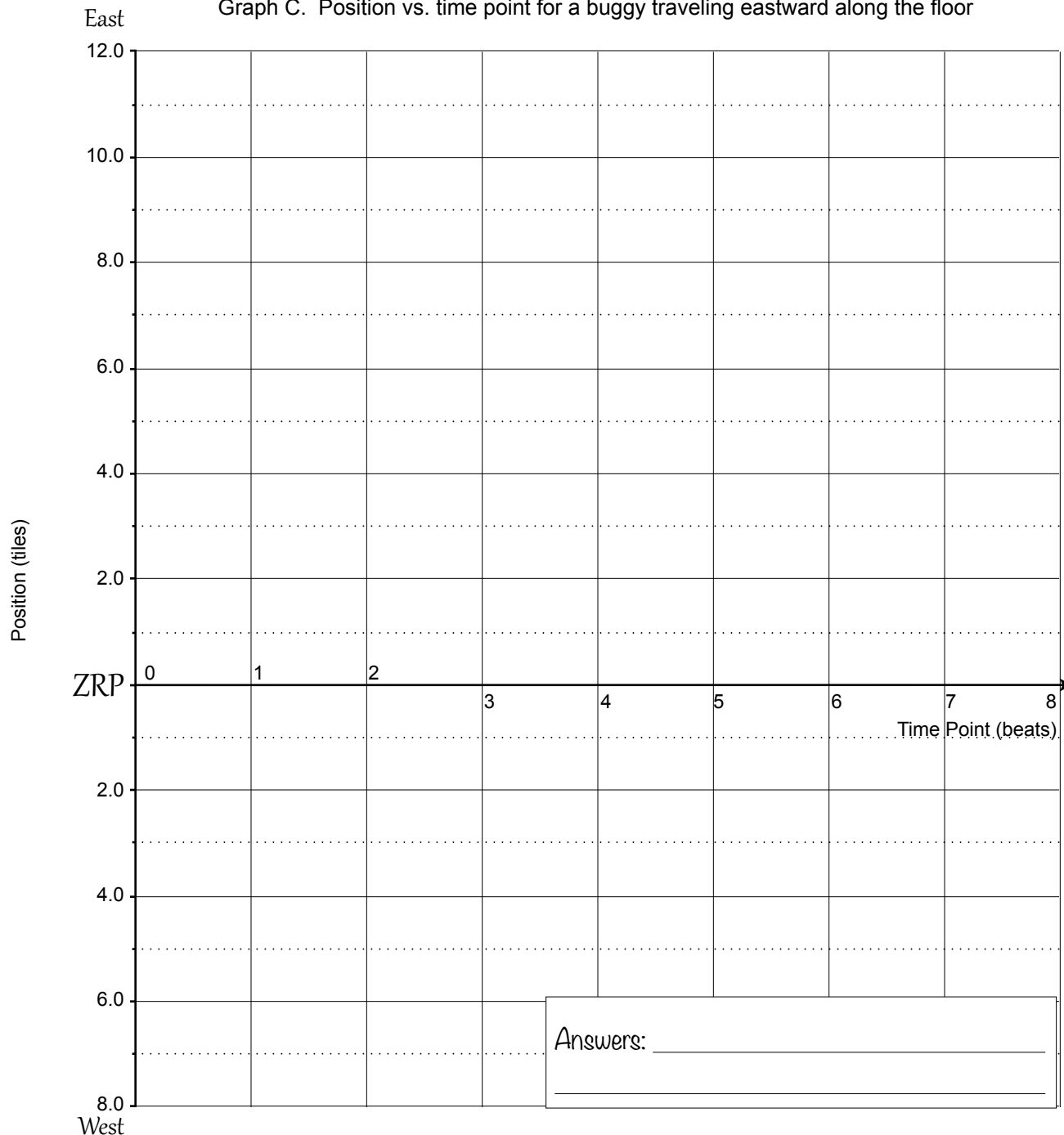10.0   8.0   6.0   4.0   2.0   ZRP   2.0   4.0   6.0   8.0   10.0   (tiles)

Graph B. Position vs. time point for a buggy traveling southward along the floor

North

Position (tiles)

				Time Point (beats)
4.0					
3.0					
2.0					
1.0					
ZRP 0	1	2	3	4	5 6
1.0					
2.0					
3.0					
4.0					
5.0					
6.0					
7.0					
8.0					
9.0	Answers: _____				
	_____				
10.0					

South

*A buggy passed 7.0 tiles, west of the reference point when a student placed the first washer. If it then traveled with an average velocity of 3 tiles per beat, eastward, how long did it take to reach position 11.0 tiles, east **and** what was its total displacement during the time interval?*

(beats)

W ← 8.0   6.0   4.0   2.0   ZRP   2.0   4.0   6.0   8.0   10.0   12.0 → E (tiles)

Graph C. Position vs. time point for a buggy traveling eastward along the floor

East

Position (tiles)

12.0

10.0

8.0

6.0

4.0

2.0

ZRP   0   1   2
                                3   4   5   6   7   8
                                        Time Point (beats)

2.0

4.0

6.0

Answers: _____

8.0

West

Name: _____

HW 1.15. Displacement & Average Velocity

Date: _____   Period: _____

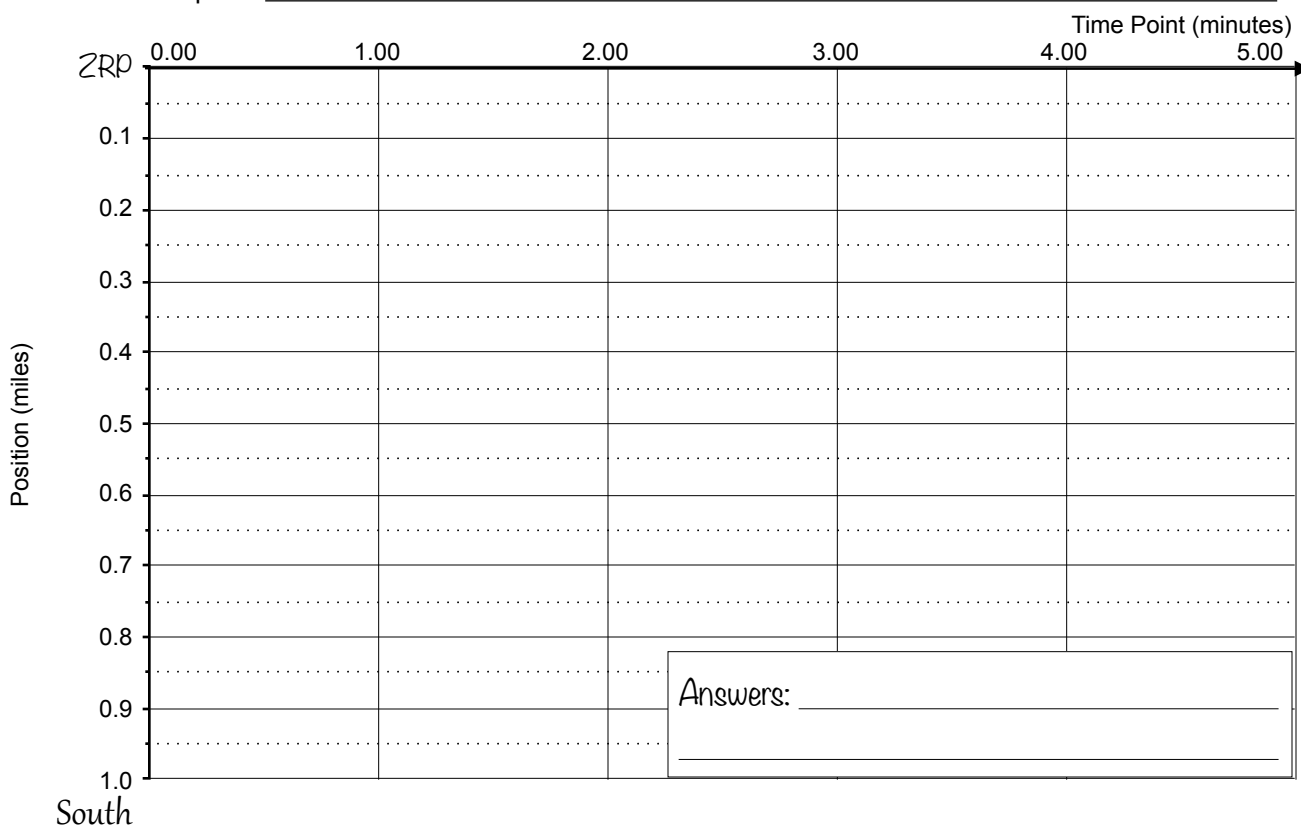*It's the annual Bring Your Tractor to School Day and the parade of tractors has just begun along Scottsville Road. Eager physics students are there, taking time point and position measurements. They set the ZRP at the corner of Scottsville Road and Cypress Wood Lane, where you must turn to come to school. The students begin counting when the lead tractor reaches the middle of the intersection of Scottsville Road and Plano Road, about 1.0 mile south of the ZRP. If the tractors travel at an average of 0.25 miles/minute, then how long does it take the lead tractor to reach the ZRP **and** what was its total displacement during this time interval?*

❖ Here are some helpful strategies:

  ❖ Starting with what you know, draw the story in a logical order.

  ❖ **Blue arrows** always start at the time point axis.

  ❖ **Green arrows** are always drawn at the *beginning* of the time interval, and always start at the point of the *initial* blue arrow.

  ❖ **Red arrows** are always drawn at the *beginning* of each time interval of 1 count, and always start at the point of a blue arrow (or stubby).

(minutes)

S ← 1.00   0.90   0.80   0.70   0.60   0.50   0.40   0.30   0.20   0.10   ZRP → N (miles)

Graph 1. _____

Time Point (minutes)

ZRP   0.00   1.00   2.00   3.00   4.00   5.00

Position (miles)

0.1

0.2

0.3

0.4

0.5

0.6

0.7

0.8

0.9

1.0

South

Answers: _____
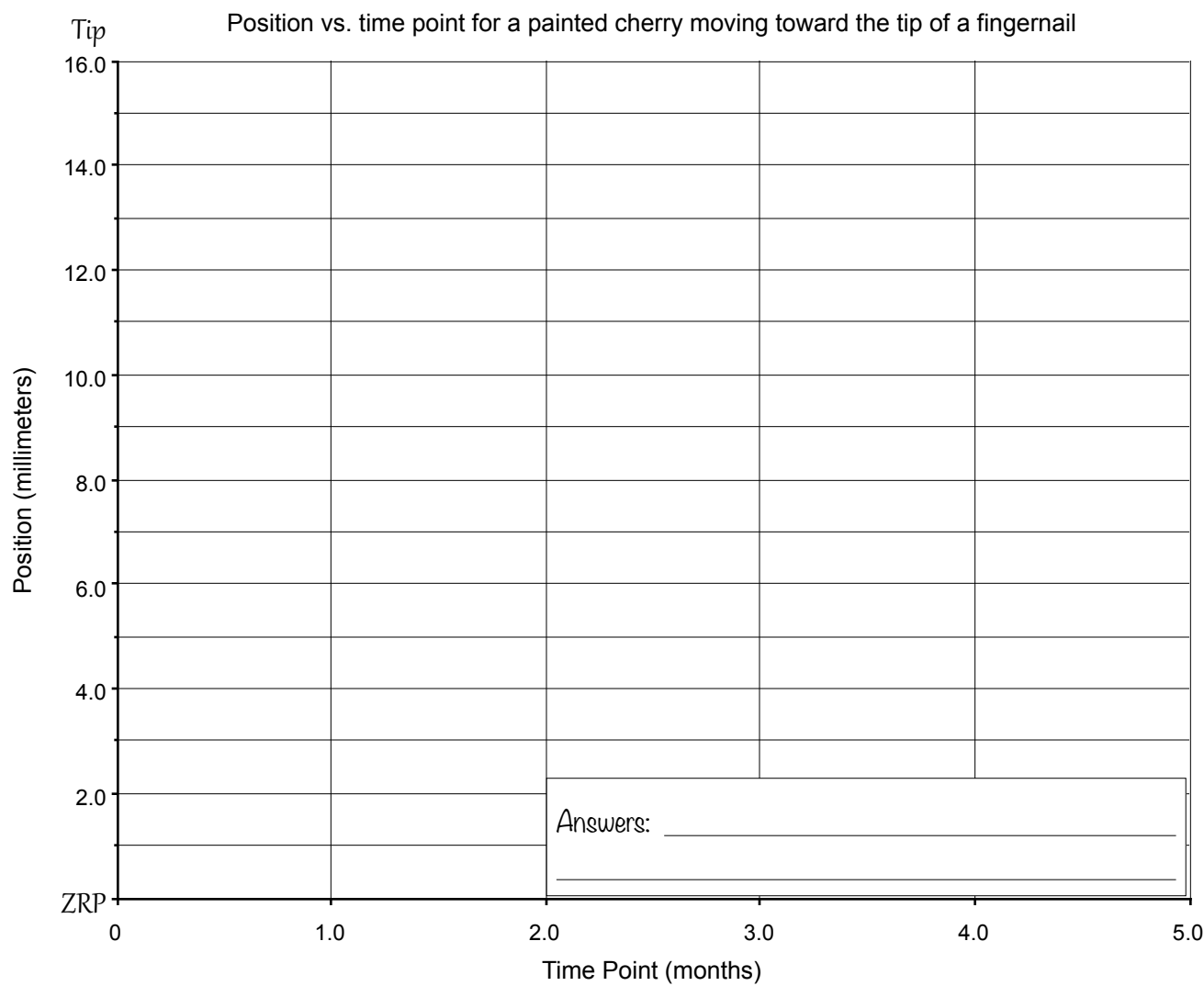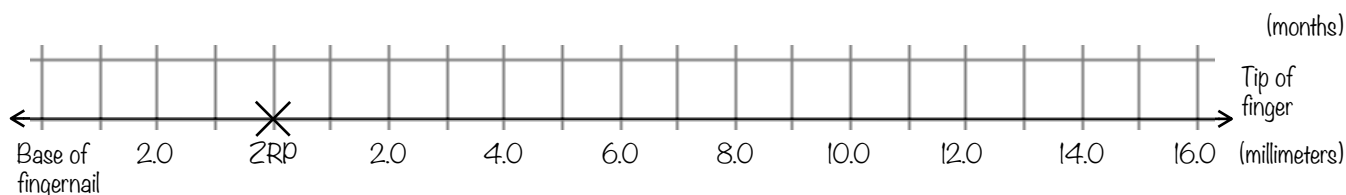
_____

Ug Lee's girlfriend, Ida Noe, treated herself to a "cupcake fingernail" manicure. Afterwards, she observed that, as her fingernails grew, a painted red cherry on top of the cupcake moved slowly toward her fingertip.[1,2]

*Suppose her fingernails grow at an average of 3.0 mm per month: this would be the average velocity of a painted cherry as it moves toward her fingertip. Let a point in the middle of the base of her fingernail be the reference point, and take the direction toward the fingertip as positive. She has managed not to break her fingernail for 4.0 months and the cherry is now 14.0 mm away from the reference point, toward the tip of her finger. Determine the initial position of the cherry **and** its total displacement during the past 4 months.*
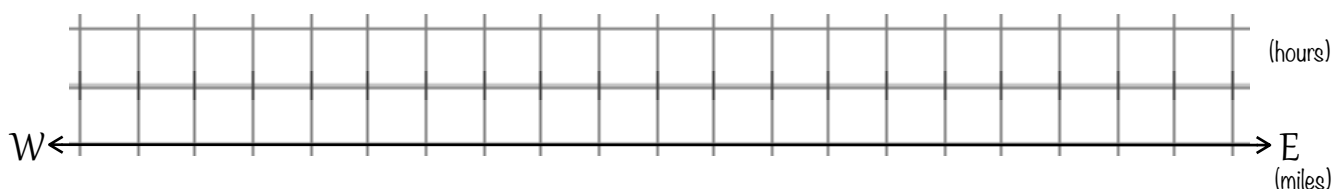
Here's the cherry she tracked as her fingernail grew.

(months)

Tip of finger

Base of fingernail   2.0   ZRP   2.0   4.0   6.0   8.0   10.0   12.0   14.0   16.0   (millimeters)

Position vs. time point for a painted cherry moving toward the tip of a fingernail

Tip

Position (millimeters)

16.0

14.0

12.0

10.0

8.0

6.0

4.0

2.0

ZRP

Answers: _____

_____

0   1.0   2.0   3.0   4.0   5.0

Time Point (months)

[1] <http://health.howstuffworks.com/skin-care/nail-care/health/how-fast-do-nails-grow.htm> October 10, 2014
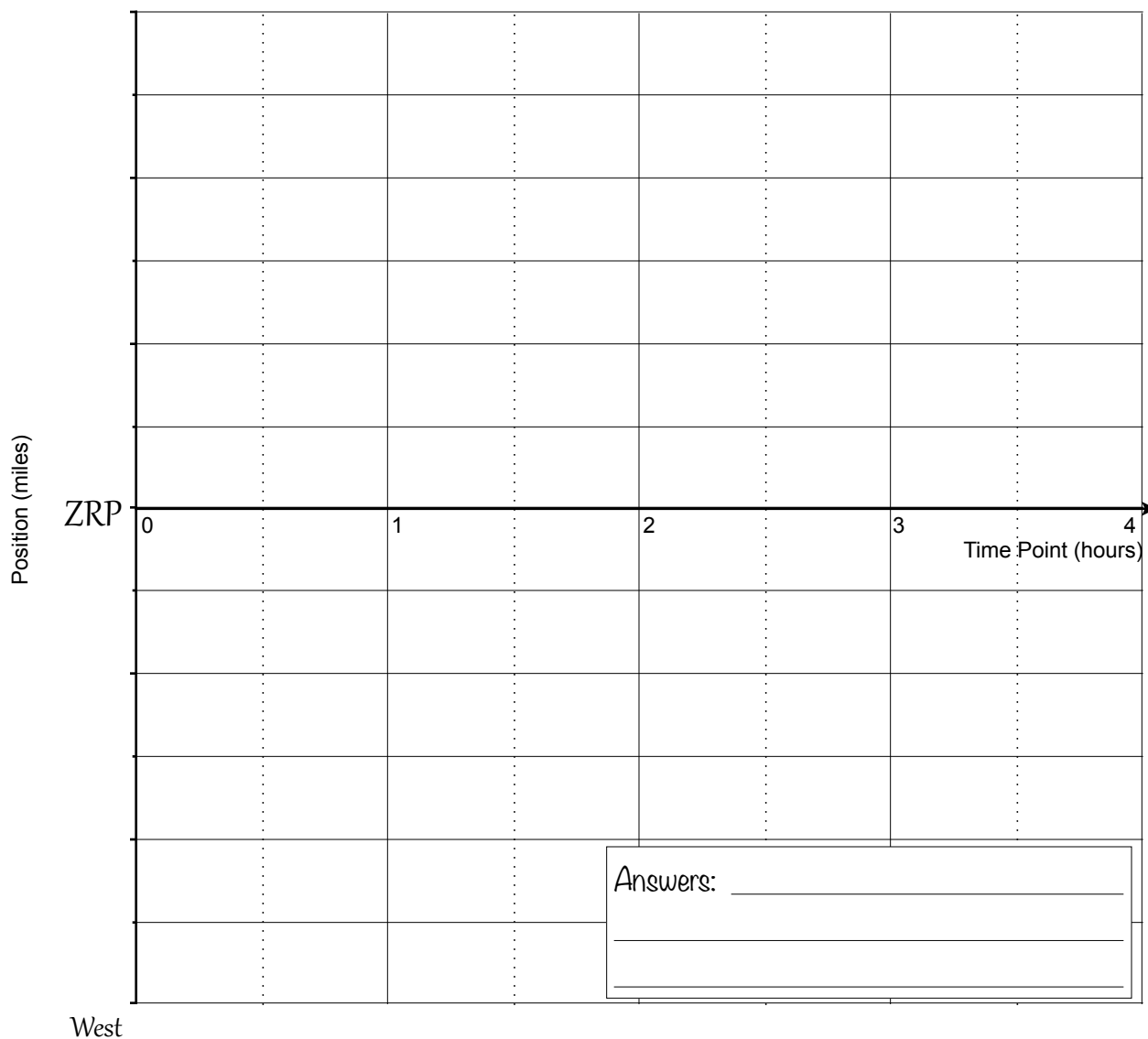
[2] <http://thecupcakeblog.com/cupcake-fingernails/> October 10, 2014

Name: _____

Scenario 1.15a. A Rendez-vous

Date: _____ Period: _____

*Prince Charming and Princess Lovelylocks have planned a rendez-vous to study for their physics test. This is an example of young people making a wise choice. Prince starts 50 miles, west of Princess. He rides his bicycle at 15 mph, eastward toward the secret meeting place. Princess rides her bicycle at 10 mph, westward toward the secret meeting place. Please determine when and where they meet **and** the displacement of each from his (or her) own starting position.*

(hours)

W ← ———————————————————————————————→ E
(miles)

East

Position vs. time point for students making a wise choice to study for their physics test

Position (miles)

ZRP

| 0 | 1 | 2 | 3 | 4 |

Time Point (hours)

Answers: _____

_____

_____

West

Name: _____

Scenario 1.15b. A Police Chase

Date: _____   Period: _____

*A bank robber flees the scene of his latest escapade, heading northward along the freeway at 90 mph. (If you've just robbed a bank, are you going to obey the speed limit?) The highway patrolman gives chase, traveling at an average of 120 mph, northward, but beginning 60 miles behind (south of) the bank robber. Please determine where and when the patrolman will catch the robber **and** the displacement of each from his (or her) own starting position.*

(hours)

S ⟵   ⟶ N
(miles)

Position vs. time point for a good guy catching a bad guy

North

Position (miles)

Answers: _____

_____

_____

South