Key

Name:_______________

Date:_______________

Graphing Displacement/Distance and Time

Graphs can be used to represent motion. A displacement versus time graph has time on the x-axis and displacement on the y-axis.

Recall:

$$slope = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$$

However, in the case of a displacement vs. time graph, y = displacement and x = time, so

$$slope = \frac{d_2 - d_1}{t_2 - t_1} = \text{velocity / speed}$$

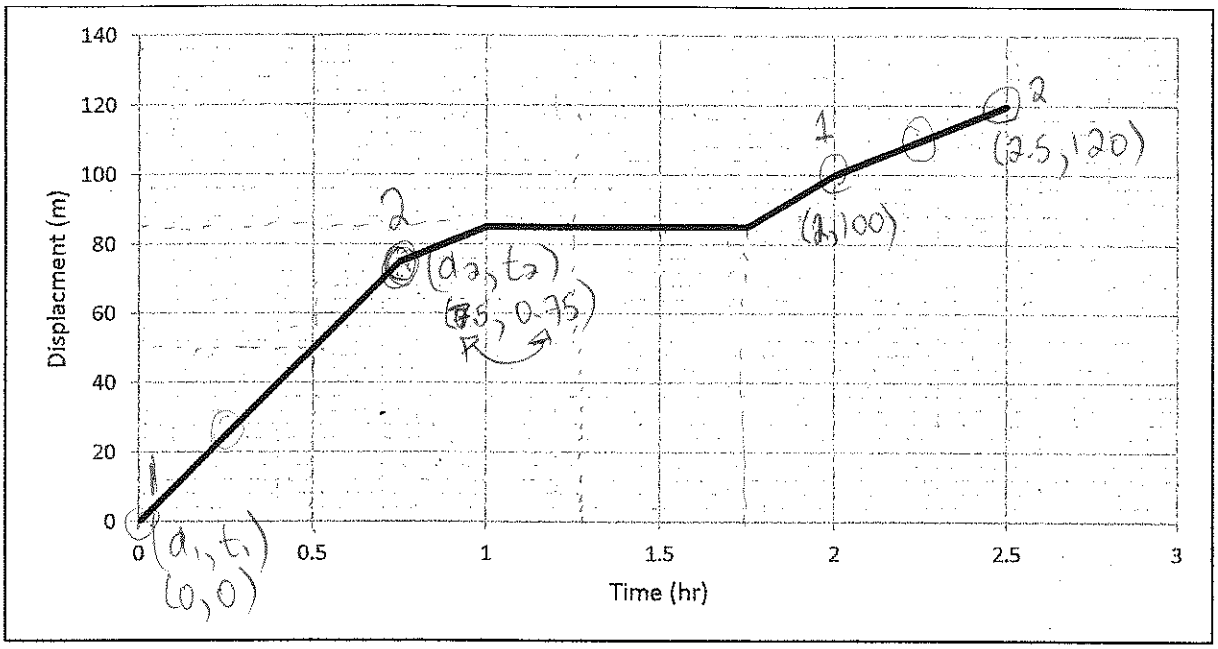
Does this look familiar?

Conclusion:

slope of distance/displacement vs. time graph is the speed/velocity

Slope	Velocity	Meaning
positive /	positive	moving in the positive direction
negative \	negative	moving in the negative direction
zero —	stationary/ zero	not moving

Example 1: The displacement versus time of a car



Calculate:

$f(x)$

1. The displacement travelled between t = 0.5hr and t = 1.25hr $d(t)$

   $\Delta d = d_2 - d_1 = d(1.25) - d(0.5)$
   $= 85 - 50 = 35\,m$

2. The average velocity over the first 1.75hr

   $\vec{v}_{avg} = \frac{\Delta \vec{d}}{\Delta t} = \frac{d_f - d_i}{t_f - t_i} = \frac{85 - 0}{1.75 - 0} = 48.57$
   48.6 m/hr

3. The velocity the car is travelling at t = 0.25hr and t = 2.25hr

   @ t = 0.25hr
   $\frac{d_2 - d_i}{t_2 - t_1} = \frac{75}{0.75} = 100\ \frac{m}{hr}$

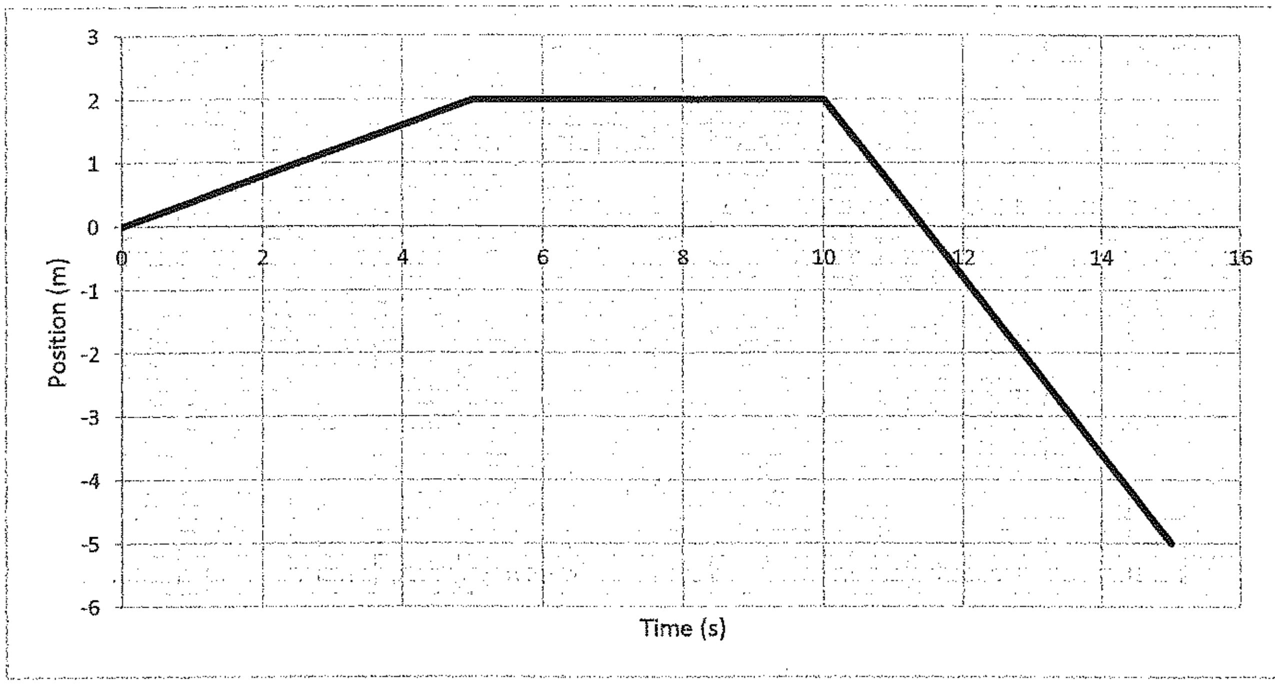
   @ t = 2.25hr
   $\frac{120 - 100}{2.5 - 2} = 40\ m/hr$

   $\frac{d_2 - d_1}{t_2 - t_1} = \frac{120 - 100}{2.5 - 2} = 40\ \frac{m}{hr}$

4. In words, write a description of the car's movement over the 2.5hr interval in terms of velocity, time, and displacement.

   Car begins @ the origin @ t=0 hr. It travels in the +ve direction ~~at~~ @ a constant velocity until t=0.75hr at which points it slows down. At t=1hr the car stops ~~for~~ until t=1.75 hr. It then continue travels in the positive direction ~~for~~ until t=2hr at which point it speeds up. It contin until ~~until~~ t=2.5hr

Example 2: The position versus time of a jogger.



1. Calculate the displacement between:
   a. t = 0s and t = 5s

   $\Delta d = d_2 - d_1 = 2 - 0 = \boxed{2m}$ (direction is +)

   d @ t=0s ⇒ 0m

   d @ t=5s ⇒ 2m

   b. t = 5s and t = 10s

   $\Delta d = d_2 - d_1 = 2 - 2 = \boxed{0m}$ (direction is +)

   @ t=5s ⇒ 2m

   @ t=10s ⇒ 2m

   c. t = 10s and t = 15s

   $\Delta d = d_2 - d_1 = -5 - 2 = \boxed{-7m}$ (direction is −)

   @ t=10s ⇒ 2m

   @ t=15s ⇒ −5m

   d. t = 0s and t = 15s

   $\Delta d = d_2 - d_1 = -5 - 0 = \boxed{-5m}$ (direction is −)

   @ t=15s ⇒ −5m

   @ t=0s ⇒ 0m

remember: d_1 = point on left, d_2 = point on right, $d_2 - d_1 = d_f - d_i$ (final) (initial)

50

2. At what time(s) is the jogger at the origin?

   when d = 0 : $\boxed{t = 0s, \sim 11.5s}$

   ↑ estimation

3. Calculate the velocity at:

$\vec{v} = \frac{d_2 - d_1}{t_2 - t_1}$

a. t = 2s velocity remains constant from t=0s to t=5s (straight line) point 1 = (0,0) point 2 = (5,2)

so $\vec{v} = \frac{2-0}{5-0} = 0.4$ m/s

↳ @ t=2s, the velocity is +0.4 m/s

b. t = 8s velocity constant from t=5s to t=10s point 1 = (5,2) point 2 = (10,2)

$\vec{v} = \frac{2-2}{10-5} = 0$ m/s

↳ @ t=8s, the velocity is 0 m/s

c. t = 12s velocity remains constant from t=10s to t=15s point 1 = (10,2) point 2 (15,-5)

$\vec{v} = \frac{-5-2}{15-10} = \frac{-7}{5} = -1.4$ m/s

↳ @ t=12s, the velocity is -1.4 m/s

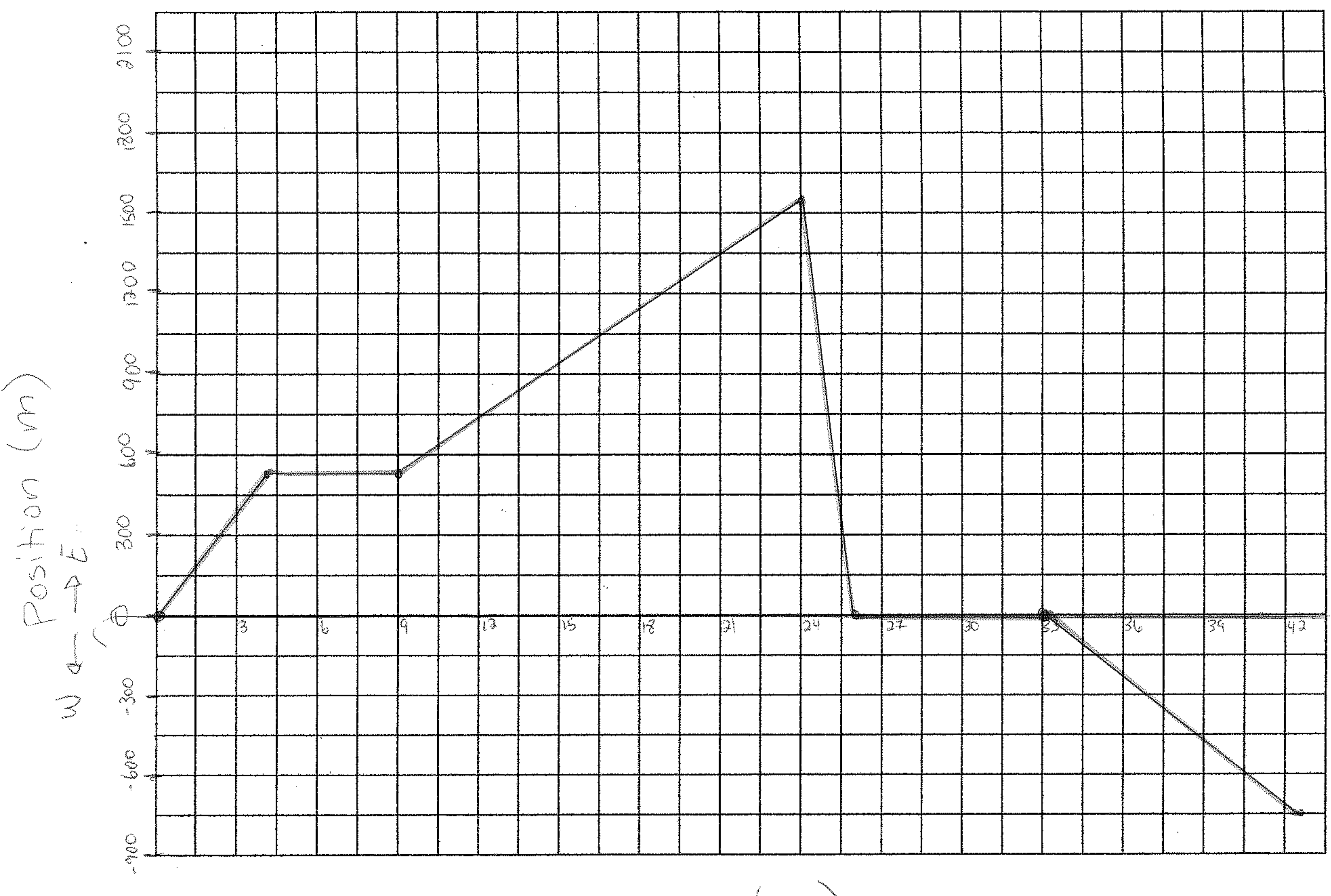
4. In words, describe the motion of the jogger in terms of position, time, and velocity.

Jogger begins @ the origin @ t=0s. They begin jogging in the positive direction @ 0.4 m/s. At t=5s, they stop and remain at rest until t=10s. At this point they turn around, jog in the negative direction @ -1.4 m/s, past the origin until t=15s.

Example 3: Graph the following situation

You leave your house at t = 0min. You realize you are running late and run the 500 m [E] to your bus stop in 4 min. Unfortunately, you weren't quite fast enough. Just as you reach the bus stop your bus pulls away, leaving you behind. You stand at the bus stop dumbfounded at your bad luck for 5 min until you pull yourself together and continue walking [E]. After 15 minutes of walking you realize you left your lunch at home. At this point, you are already 1550m away from your house. Luckily, your buddy drives by and offers you a ride home. This ride only takes 2 minutes and you're back where you started. At this point, you forget why you left you house in the first place, or why you ever leave your house. You ponder existential questions for 7 minutes, at which point you decide to see a movie. You look up screen times and are happy to discover the new action/rom com/horror/animated film you wanted to see is playing in 10 min. You walk to the movie theatre located 750m [W] from your house and arrive just in time to watch the trailers. Another perfect day.

Calculate your velocity during each time interval.



Position (m)
W ← → E
2100
1800
1500
1200
900
600
300
0
-300
-600
-900
3
6
9
12
15
18
21
24
27
30
33
36
39
42
time (min)