Physics 20 - Lesson 5
Acceleration Graph Analysis– Answer Key

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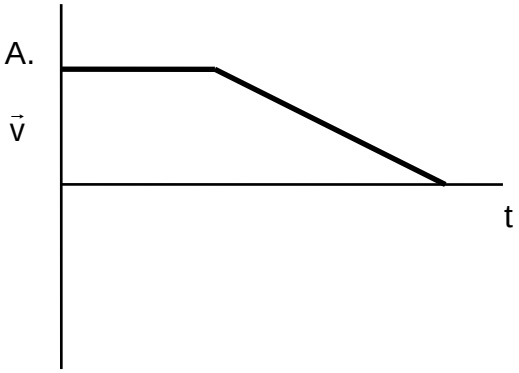
1. For each of the following graphs, <u>describe</u> the motion involved and then <u>sketch</u> the missing graph.

A.



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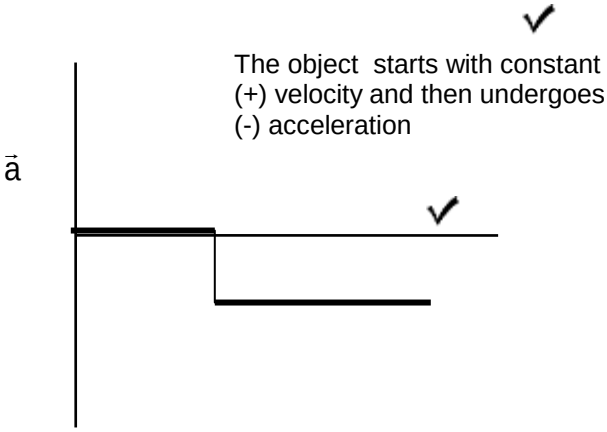
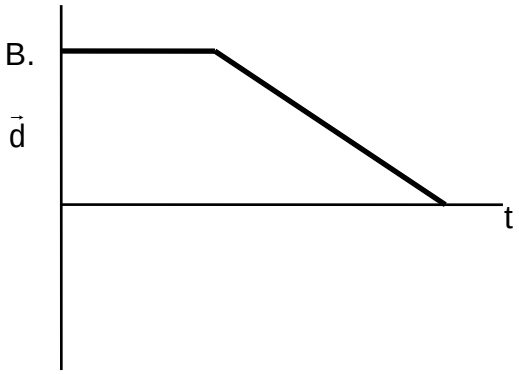


The object starts with constant (+) velocity and then undergoes (-) acceleration

B.



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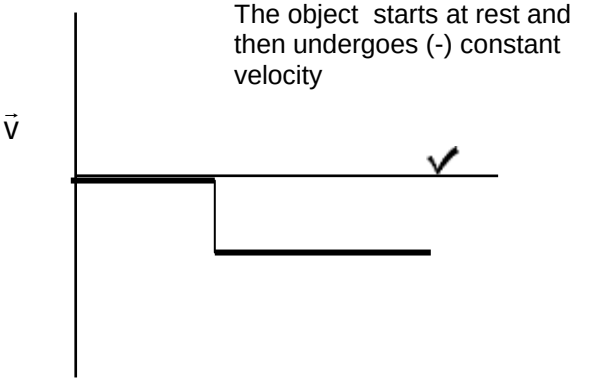
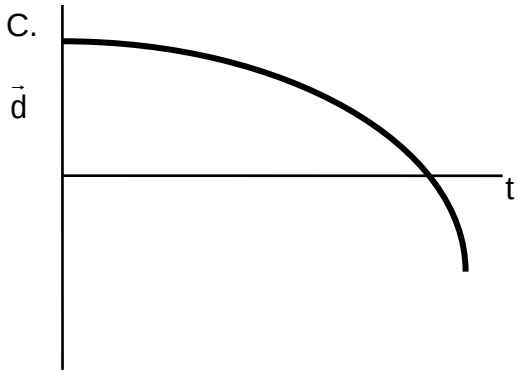


The object starts at rest and then undergoes (-) constant velocity

C.



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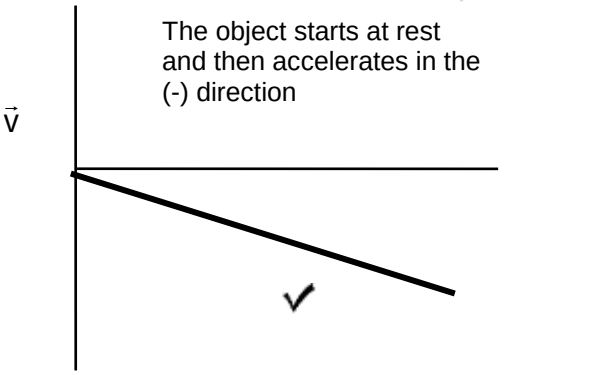
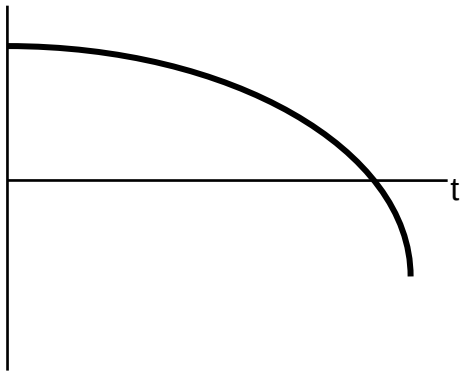


The object starts at rest and then accelerates in the (-) direction

D.



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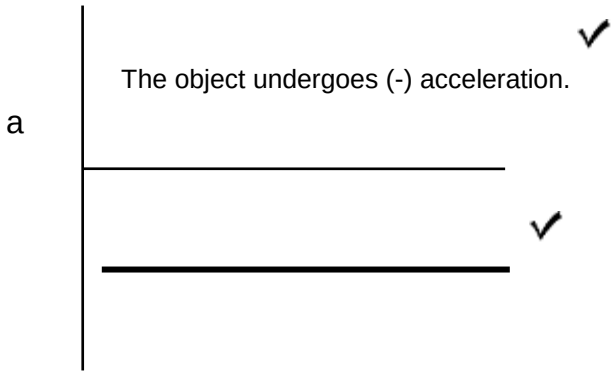
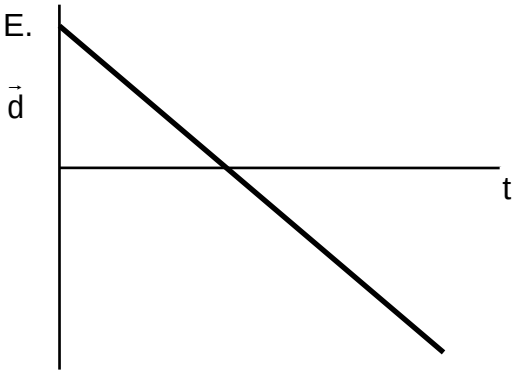


The object undergoes (-) acceleration. ✓

✓

E.



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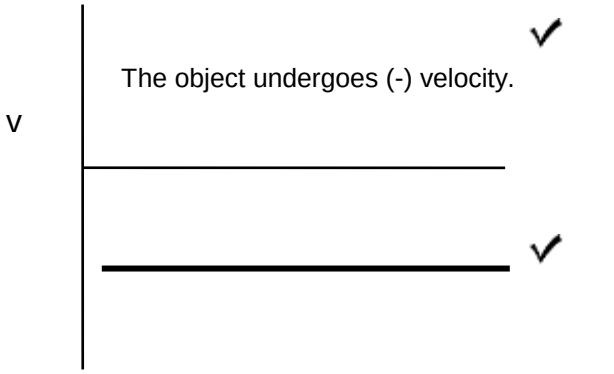
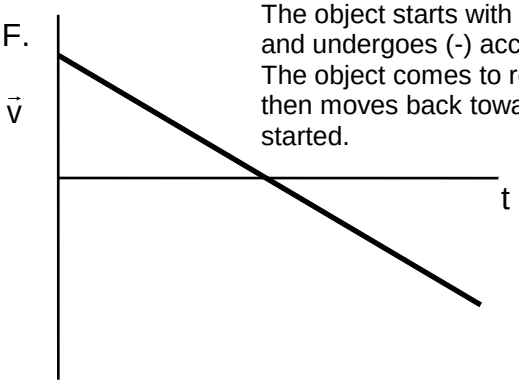


The object undergoes (-) velocity. ✓

✓

F.



The object starts with (+) velocity and undergoes (-) acceleration. The object comes to rest and then moves back toward where it started.

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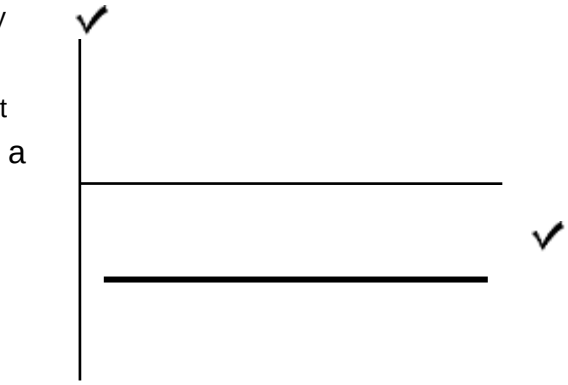
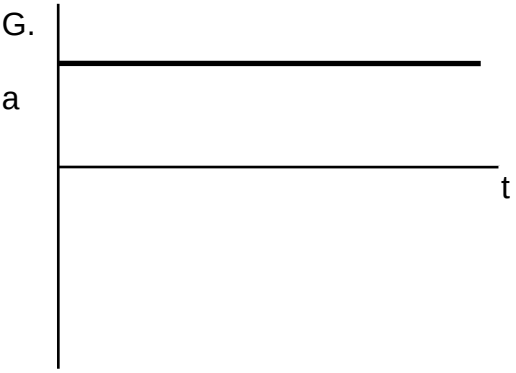


✓

✓

G.



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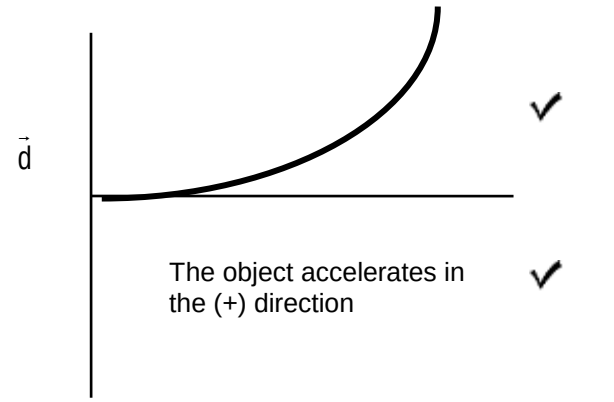

✓

The object accelerates in the (+) direction ✓

2. Consider the following position–time graph.

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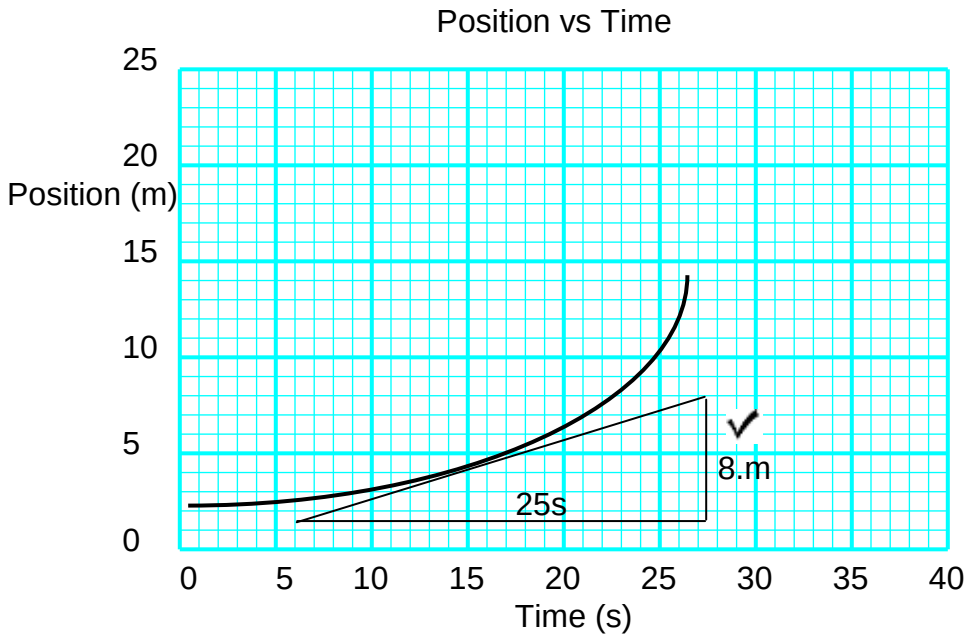

A. What is the instantaneous velocity at 15 s? (~ +0.34 m/s)

Velocity=slope of tangent line $slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{+8.5m}{25s} = \boxed{0.34\,^{m}/_{s}}$

B. How far would the object travel from 5 s to 20 s? (4.1 m)

off the graph

$\Delta d_{total} = \Delta d_2 - \Delta d_1 = 6m - 1.9m = \boxed{4.1m}$

C. What was the average speed at 25 s? (0.32 m/s)

off the graph

$\Delta d = \Delta d_2 - \Delta d_1 = 10.5m - 2.5m = 8m$

$v_{avg} = \frac{\Delta d}{\Delta t} = \frac{8m}{25s} = 0.32\,^{m}/_{s}$

3. The following is a graph for an object moving north.

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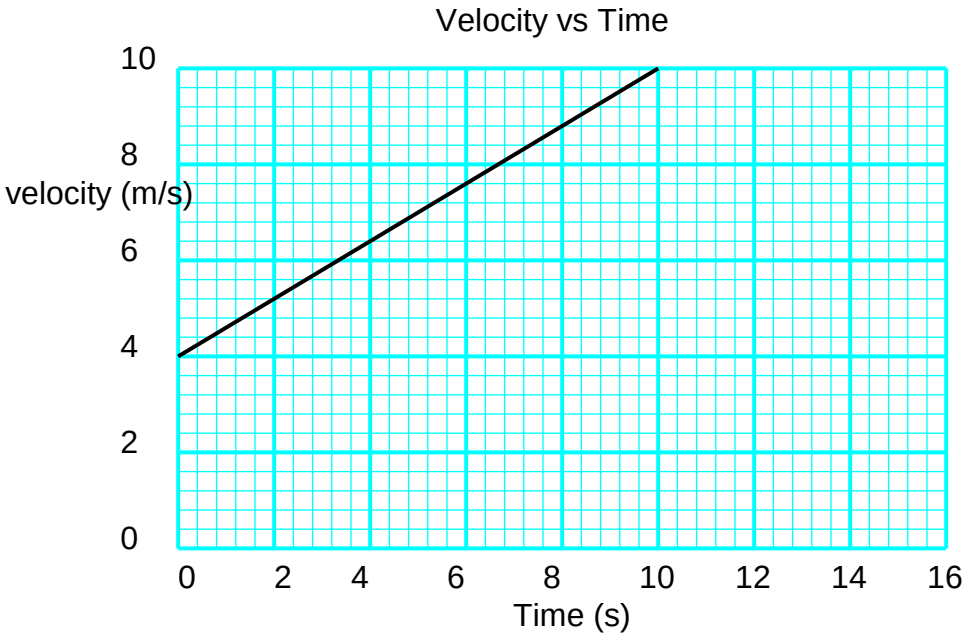

A. What is the acceleration of the object? (+0.60 m/s^2)

Acceleration=slope of v-t graph $slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10\,m/s - 4\,m/s}{10s - 0s} = \frac{+6\,m/s}{10s} = \boxed{+0.6\,m/s^2}$

B. What is the displacement from 0 to 10 s? (+70 m)

$$\vec{d} = \vec{d}_{tri} + \vec{d}_{rec}$$

$$\vec{d} = \frac{\Delta\vec{v}_{0-10}\Delta t}{2} + \vec{v}_{0-10}\Delta t$$

$$\vec{d} = \frac{+6.0\,m/s\,(10s)}{2} + (4.0\,m/s)(10s)$$

$$\vec{d} = +70m$$

4. Given the following velocity – time graph.

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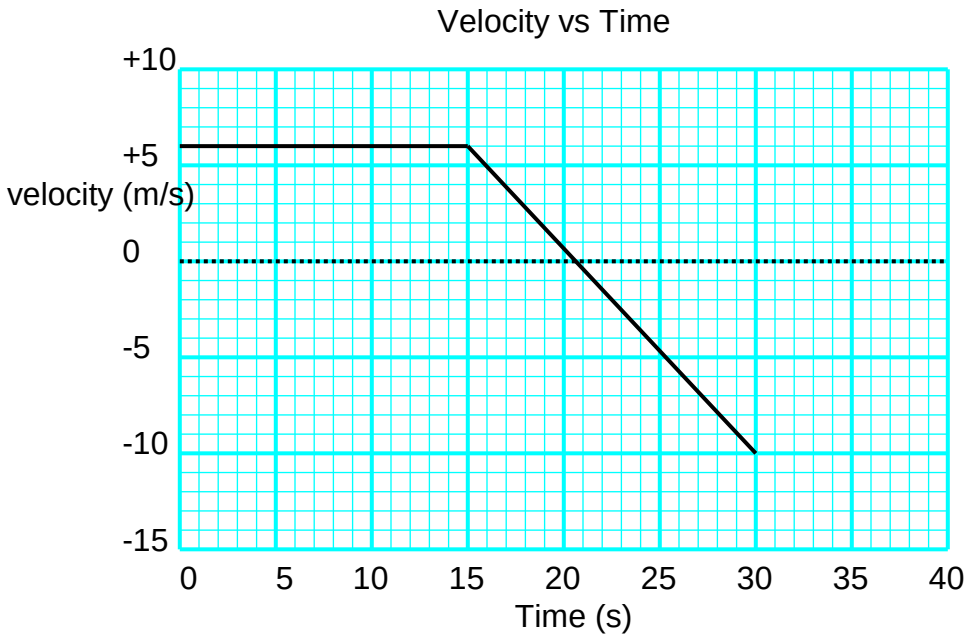


A. What was the acceleration at 5 s and at 20 s? (0, -1.07 m/s^2)

$$\vec{a}_1 = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{6\,{}^{m}\!/_{s} - 6\,{}^{m}\!/_{s}}{15s} \quad \vec{a} = 0\,{}^{m}\!/_{s^2}$$

$$\vec{a}_1 = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{-10\,{}^{m}\!/_{s} - 6\,{}^{m}\!/_{s}}{15s} \quad \vec{a} = -1.07\,{}^{m}\!/_{s^2}$$

B. What is the displacement from 0 to 30 s? (+60 m)

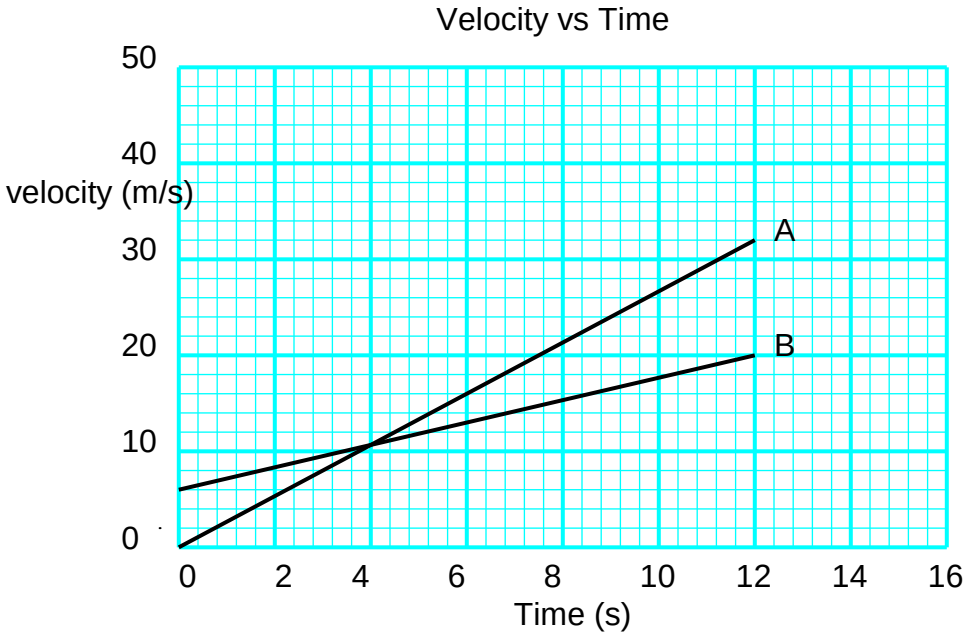
$$\vec{d} = \vec{d}_{0-15} + \vec{d}_{15-20.7} + \vec{d}_{20.7-30}$$

$$\vec{d} = \vec{v}_{0-15}\Delta t + \frac{\Delta\vec{v}_{15-20.7}\Delta t}{2} + \frac{\Delta\vec{v}_{20.7-30}\Delta t}{2}$$

$$\vec{d} = (6.0\,{}^{m}\!/_{s})(15s) + \frac{+6.0\,{}^{m}\!/_{s}\,(5.7s)}{2} + \frac{(-10\,{}^{m}\!/_{s})(9.3s)}{2}$$

$$\vec{d} = +60m$$

5. The following graph shows the motion of two objects traveling east.



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A. How much faster is object A traveling at 8 s than object B? (6.0 m/s)

$at\ 8s$

$v_a = 21\,m/s$

$v_b = 15\,m/s$

$21\,m/s - 15\,m/s = \boxed{6.0\,m/s}$

B. What is the acceleration of each object? (+2.2 m/s^2, +1.2 m/s^2)

$$\vec{a}_A = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{32\,m/s - 0\,m/s}{12s} \qquad \boxed{\vec{a}_A = +2.7\,m/s^2}$$

$$\vec{a}_B = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{20\,m/s - 6\,m/s}{12s} \qquad \boxed{\vec{a}_B = +1.2\,m/s^2}$$

C. From 0 to 12 s, which object travelled the furthest? (A)

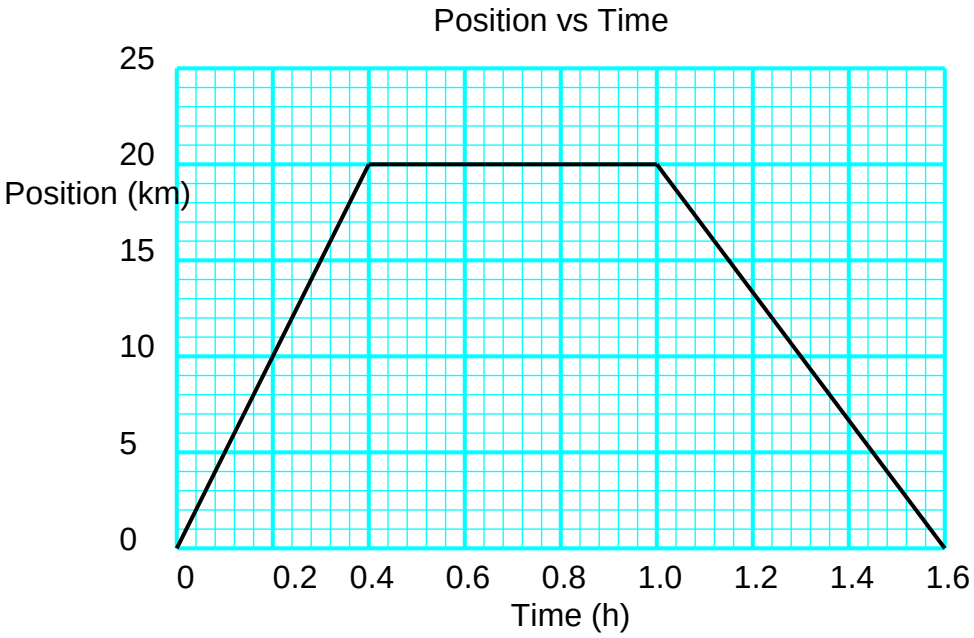
$$\vec{d}_A = \frac{\vec{v}_{12}}{2}\Delta t = \frac{0 + 32\,m/s}{2}(12s) = 192m$$

$$\vec{d}_B = \vec{v}_0 \Delta t + \frac{\vec{v}_{12} - \vec{v}_0}{2}\Delta t = 6\,m/s\,(12s) + \frac{20\,m/s - 6\,m/s}{2}(12s) = 156\,m$$

6. Using the graph of the motion of a car travelling in a straight line, determine each of the following.

a. the velocity of the car in each interval. (+50 km/h, 0, -33 km/h)

b. the final displacement of the car. (0)



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a)

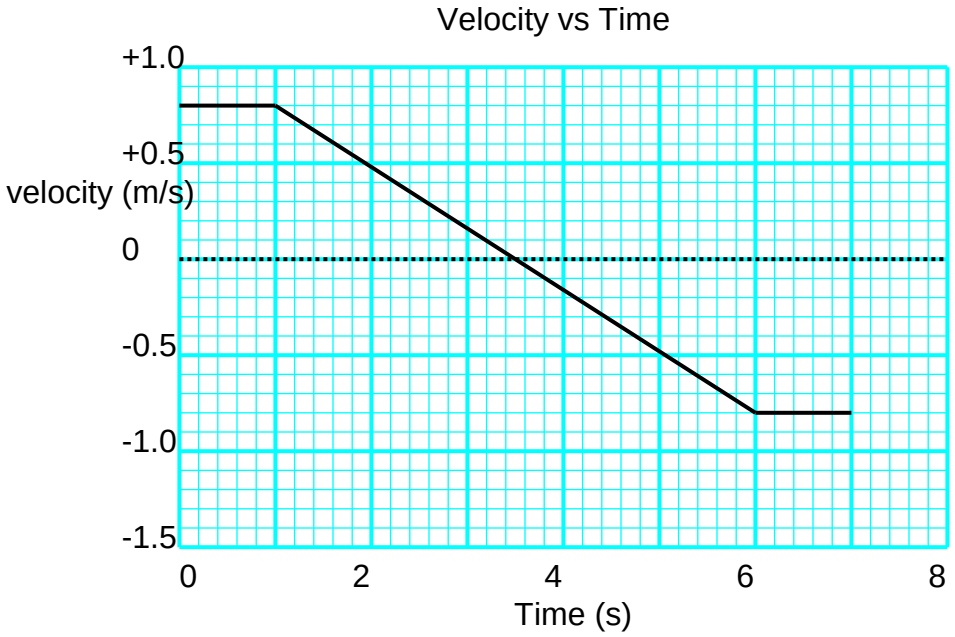
$$\vec{v}_a = \frac{\Delta \vec{d}}{\Delta t} = \frac{+20km}{0.4h} = +50\,{}^{km}/_{h}$$

$$\vec{v}_b = \frac{\Delta \vec{d}}{\Delta t} = \frac{0km}{0.6h} = 0$$

$$\vec{v}_a = \frac{\Delta \vec{d}}{\Delta t} = \frac{-20km}{0.6h} = -33\,{}^{km}/_{h}$$

b) The car has returned to its point of origin $\therefore\ \vec{d} = 0$

7. A ball rolls along the floor, up an inclined plane, and then back down the plane and across the floor again. The graph below represents this motion.
   a. At what time is the ball at its highest point?
   b. What is its maximum displacement up the ramp? (1.0 m)
   c. What was the acceleration when the ball was (i) rolling up the ramp, (ii) rolling down the ramp, and (iii) when the ball was instantaneously at rest at the top of the ramp?



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a) The ball is at its highest point when its velocity is zero (t= approx. 3.5s) ✓

b) $\vec{d}_A = \frac{b \times h}{2} = \frac{0.8\,{}^{m}\!/\!_{s} \times 2.5s}{2} = 1.0\,m$ ✓ ✓

c) $\vec{a}_1 = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{-0.8\,{}^{m}\!/\!_{s} - 0.8\,{}^{m}\!/\!_{s}}{6s - 1s}$ ✓ $\vec{a} = -0.32\,{}^{m}\!/\!_{s^2}$ ✓ ✓

At all times while the ball was on the ramp, its acceleration was a <u>constant</u> -0.32m/s^2