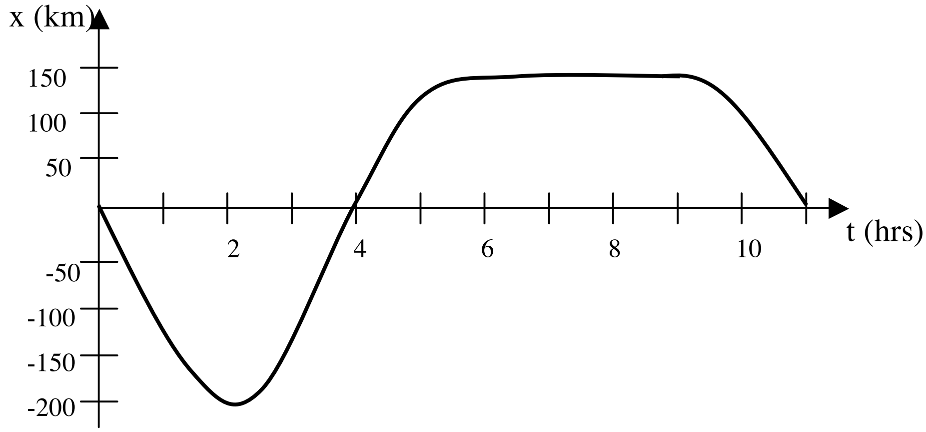
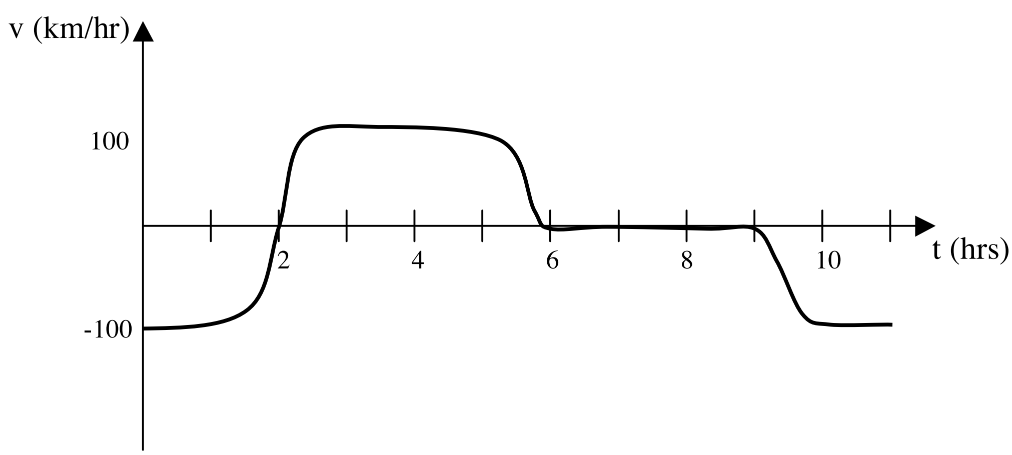
1. (a) Avg. speed = distance traveled/time = (1/4 mile)/(2 min) = 1 mile/8 minutes × (60 min / 1 hr) = 7.5 mph.
   (b) Displacement = distance from starting point = zero.
   (c) Avg. velocity = displacement / time = zero.

2.



(a) Speed is zero when position curve has zero slope: At t = 2 hrs, and from t = 6 hrs to t = 9 hrs.
(b) (i) from 0 to 6 hrs
$\bar{v} = \Delta x / \Delta t$ = (150 km – 0 km) / 2 hrs = 75 km/hr
(ii) from 2 to 4 hrs
$\bar{v} = \Delta x / \Delta t$ = (0 km – (–200 km)) / 2 hrs = +100 km/hr
(iii) from 4 to 11 hrs
$\bar{v} = \Delta x / \Delta t$ = (0 km – 0 km) / 3 hrs = 0 km/hr
(c) Avg. speed = distance traveled / time elapsed = (200 km + 350 km + 150 km) / 11 hrs ≈ 64 km/hr.
(d) At any instant of time, the velocity is the slope of the position curve:



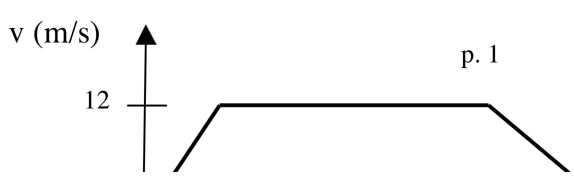
3. First we convert the speed given into SI units:

$$62\ \text{mph} \times \left(\frac{0.45\ \text{m/s}}{1\ \text{mph}}\right) = 27.9\ \text{m/s}$$

Then we use the definition of average acceleration:

$$a_{\text{av}} = \frac{\Delta v}{\Delta t} = \frac{27.9\ \text{m/s} - 0}{4.1\ \text{s}} = 6.8\ \text{m/s}^2$$

4. Here's the velocity-time graph you were given:



(a) A possible description of this motion is: "I was stopped at a traffic light in my car. The light turned green and I sped up to about 25 mph, drove a few blocks and then stopped at another red light. Then I had to wait for that light to change."

(b) Using the definition of average acceleration:

$$a_{\text{av}} = \frac{\Delta v}{\Delta t} = \frac{12 \text{ m/s} - 0}{6 \text{ s}} = 2 \text{ m/s}^2$$

(c) For the entire time interval, there is no change in velocity (the object begins and ends at rest). Therefore the average acceleration is **zero**.

5. (a) At all of these times, Smoky is in free-fall (i.e., the only force acting on him is the force of gravity). Therefore, his acceleration at all of the times is g downward, or about 10 m/s^2 downward.

(b) At the maximum height, we know that v = 0. Taking $x_0 = 0$ and up to be the positive direction, we have

$$\begin{aligned} v^2 &= v_0^2 + 2a(x - x_0) \\ 0 &= (4)^2 + 2(-10)(x - 0) \\ \Rightarrow x &= \frac{16}{20} = \frac{4}{5} m \end{aligned}$$

Coordinate system!

So at his highest point, he is 0.8 meters above his starting point, or 1.8 meters above the ground.

(c) From the highest point to the ground will be 1.8 m, since the ground is 1 m below the starting point. Therefore we need the speed of something that drops from a height of 1.8 m to the ground:

$$\begin{aligned} v^2 &= v_0^2 + 2a(x - x_0) \\ v^2 &= 0 + 2(-10)(0 - 1.8) \\ \Rightarrow v &= -6 \text{ m/s (downward)} \end{aligned}$$

Additional Questions

1) This is not possible. If the average speed is zero, then the total distance traveled is zero, in which case the displacement (and therefore the average velocity) is certainly also zero.

2) No. The only way that an object can have zero average speed is if its total distance traveled is zero, which represents an object that never moved at all.

3) The jet had the greater average speed, since it covers more distance per unit time. Since the average velocity is determined by the displacement (i.e. the final distance from the starting point), we need to know where the planes landed in order to answer that question.