1d motion problem set answers

1. Two people drive their cars from Piscataway, New Jersey, to Perkasie, Pennsylvania, about 35 miles east, leaving at the same time and using the same route. The first driver travels at a constant speed the whole trip. The second driver stops for a while for doughnuts and coffee in Lambertville. They arrive in Perkasie at the same time. Do the cars have the same average velocity? Explain.

$\bar{V} = \frac{\Delta x}{t}$

displacement and time are the same for both, so the average velocity is the same for both.

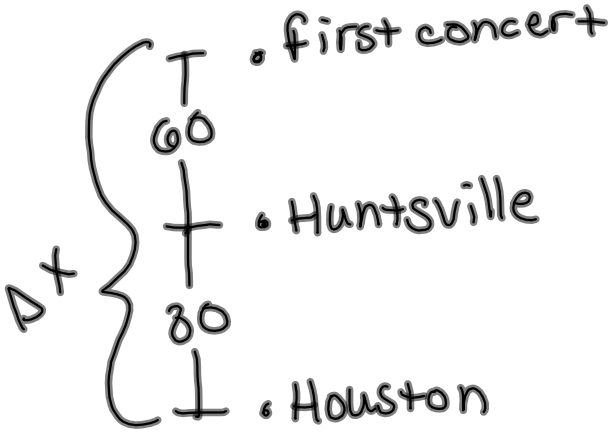
YES

2. Can a car with negative velocity move faster than a car with positive velocity? Explain.

YES

negative velocity means it is traveling in the negative direction. You could travel faster in the negative direction.

3. The Psychic Squishy Sounds band is on tour in Texas and now is resting in Houston. They traveled 60.0 miles due south from their first concert to Huntsville. If Huntsville is 80.0 miles due north of Houston, what is their displacement from the first concert to Houston? Use the convention that north is positive, and south is negative.



$\Delta x = -60 + -80$

$\Delta x = -140$ mi

4. To estimate the distance you are from a lightning strike, you can count the number of seconds between seeing the flash and hearing the associated thunderclap. For this purpose, you can consider the speed of light to be infinite (it arrives instantly). Sound travels at about 343 m/s in air at typical surface conditions. How many kilometers away is a lightning strike for every second you count between the flash and the thunder?

$V = 343\ m/s \quad t = 1 \quad \Delta x = ?$

$V = \frac{\Delta x}{t} \quad \Delta x = Vt = (343\ m/s)(1\ s)$

$\Delta x = 343\ m$ now convert to km

$\boxed{\Delta x = .343\ km}$

5. Light travels at a constant speed of 3.0×10^8 m/s in a vacuum. (a) It takes light about 1.3 seconds to travel from the Earth to the Moon. Estimate the distance of the Moon from the Earth's surface, in meters. (b) The astronomical unit (abbreviated AU) is equal to the distance between the Earth and the Sun. One AU is about 1.5×10^{11} m. If the Sun suddenly ceased to emit light, how many minutes would elapse until the Earth went dark?

$V = 3.0\times10^8\ m/s \quad t = 1.3\ s$

a) $\Delta x = ? \quad \Delta x = Vt = (3.0\times10^8)(1.3)$

$\boxed{\Delta x = 3.9\times10^8\ m}$

b) $\Delta x = 1.5\times10^{11}\ m \quad V = 3.0\times10^8\ m/s \quad t = ?$

$\Delta x = Vt$

$1.5\times10^{11} = 3.0\times10^8(t)$

$t = \frac{1.5\times10^{11}}{3\times10^8} = 500\ s$ now convert to min

$t = 500\ s\left(\frac{1\ min}{60\ s}\right) = \boxed{8\frac{1}{3}\ min}$

6. You made a journey, and your displacement was +95.0 km. Your initial velocity was +167 km/h and your final velocity was −26.0 km/h. The journey took 43.0 minutes. What was your average velocity in kilometers per hour?

unnecessary info.

$\bar{V} = \frac{\Delta x}{t} = \frac{95.0\ km}{43.0\ min}\left(\frac{60\ min}{1\ hr}\right) = 132.558$

converting to km/hr

$\boxed{\bar{V} = 133\ km/hr}$

7. The first controlled, sustained flight in a heavier-than-air craft was made by Orville Wright on December 17, 1903. The plane took off at the end of a rail that was 60 feet long, and landed 12 seconds later, 180 feet away from the beginning of the rail. Assume the rail was essentially at the same height as the ground. (a) Calculate the average velocity of the plane in feet per second while it was in the air. (b) What is the average velocity in kilometers per hour?

$t = 12\,s$

$\Delta x = 180 - 60 = 120\,ft$

$$\bar{V} = \frac{\Delta x}{t} = \frac{120\,ft}{12\,s} = \boxed{10\,ft/s}$$

8. A sailboat is moving across the water at 3.0 m/s. A gust of wind fills its sails and it accelerates at a constant 2.0 m/s^2. At the same instant, a motorboat at rest starts its engines and accelerates at 4.0 m/s^2. After 3.0 seconds have elapsed, find the velocity of (a) the sailboat, and (b) the motorboat.

$$V_f = V_0 + at$$

a) $V_0 = 3.0\,m/s \quad a = 2\,m/s^2 \quad t = 3s$

$$V_f = 3 + 2(3) = \boxed{9.0\,m/s = V_{sail}}$$

b) $V_0 = 0 \quad a = 4\,m/s^2 \quad t = 3.0s$

$$V_f = 0 + 4(3) = \boxed{12\,m/s = V_{motor}}$$

9. A rail gun uses electromagnetic energy to accelerate objects quickly over a short distance. In an experiment, a 2.00 kg projectile remains on the rails of the gun for only 2.10e−2 s, but in that time it goes from rest to a velocity of 4.00×10^3 m/s. What is the average acceleration of the projectile?

$t = 2.10 \times 10^{-2}\,s$

$V_0 = 0$

$V_f = 4.00 \times 10^3\,m/s$

$a = ?$

$$V_f = V_0 + at$$

$$\frac{4 \times 10^3 = 0 + a(2.1 \times 10^{-2})}{2.1 \times 10^{-2}}$$

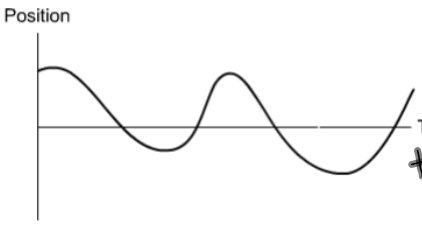
$$\boxed{a = 1.90 \times 10^5\,m/s^2}$$

10. A particle's initial velocity is −24.0 m/s. Its final velocity, 3.12 seconds later, is −14.0 m/s. What was its average acceleration?

$$\bar{a} = \frac{\Delta v}{t} = \frac{v_f - v_i}{t} = \frac{-14 - -24}{3.12} = \frac{10}{3.12} = \boxed{3.21\ m/s^2}$$

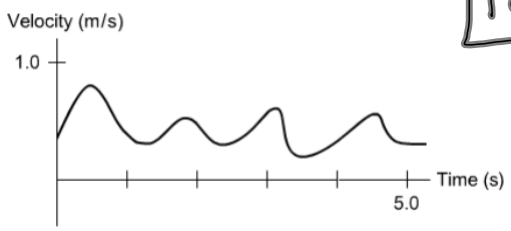
$v_i = -24$
$v_f = -14$
$t = 3.12$

11. The position versus time graph for a man trapped on an island is shown. Is he traveling at a constant velocity? Explain.



No. In a pos. v time graph velocity is the slope. This graph is curved which means the slope is changing, which means the velocity is changing.

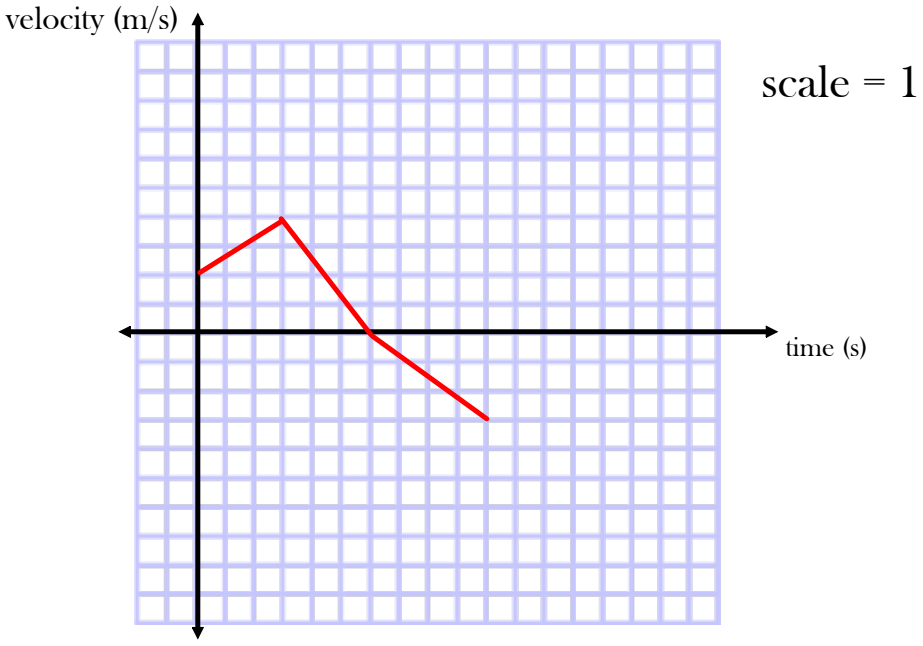
12. The velocity of a butterfly is shown. For the entire time interval, is the displacement of the butterfly positive, negative, or zero? Explain.



Positive. In a velocity vs. time graph, Displacement is the area under the curve. This area is always above the x-axis so it is positive.

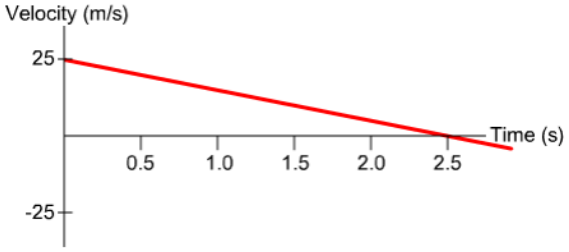
You can also think about it in another way. Velocity is always positive, so displacement must be positive.

13. A penguin swimming through the icy Antarctic waters accelerates from 2.0 m/s to 4.0 m/s over a period of 4.0 seconds, then slows down to a stop over a period of 3.0 seconds and reverses direction, accelerating to 3.0 m/s in the opposite direction over a period of 4.0 seconds. Assume the penguin's acceleration was constant over each of the three time periods, and that it started out traveling in the positive direction. Draw the penguin's velocity versus time graph.



14. An eagle is soaring in a straight line from $t = 0$ s to $t = 10$ s. Over that time interval, her average velocity is always greater than or equal to her instantaneous velocity. If her initial velocity is 5.0 m/s, draw two different possible velocity versus time graphs for the eagle.

15. A clown is shot straight up out of a cannon. The graph of his velocity versus time is shown. Determine the clown's vertical displacement from the instant he is shot out of the cannon at 0.0 seconds until when he reaches zero velocity at 2.5 seconds.



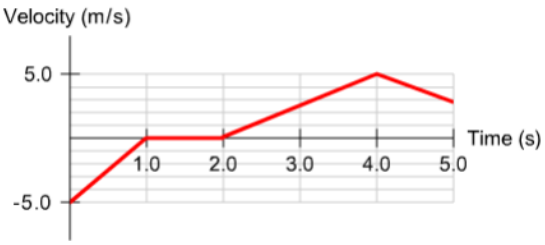
Displacement = area under curve = area of triangle

$\Delta x = .5bh = (.5)(2.5s)(25m/s) = 31.25$ m

$\Delta x = 31$ m

16. The velocity versus time graph for a pizza delivery driver who is frantically trying to deliver a pizza is shown. (a) During what time interval is he traveling at a constant velocity? (b) During what time interval is his acceleration 5.0 m/s^2? (c) During what time is his acceleration negative?

acceleration = slope



(a) from t=1s to t=2s
(b) from t=0s to t=1s
(c) from t=4s to t=5s