

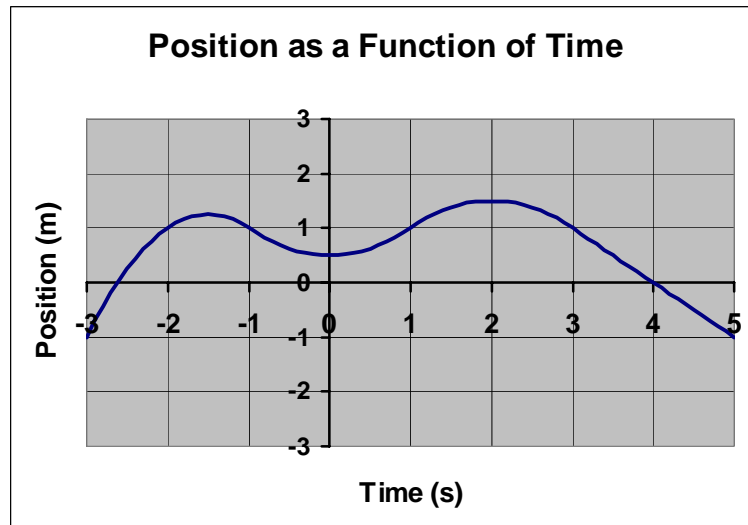
Quiz #2: Physics 201

NAME: SOLUTIONS

Do **YOUR OWN WORK** and **SHOW ALL OF IT!** (Continue on back, clearly labeled, if necessary)

This quiz does NOT require the use of a calculator. You may write answers as algebraic expressions (that is, write that $x = 33.7$ and $y = 108.4$, and that the answer is $(x/y) \text{ kg m/s}^2$). Trig functions and square roots may be left in that form if you do not know the results (that is $\sin 25^\circ$ or $\sqrt{30}$).

All answers **MUST** include appropriate **units and dimensions**.



1. The graph above shows a plot of the position (in meters) of a toy car as a function of time (in seconds) during an eight second period. Answer all of the questions below that you can using the information in the graph, **and always explain your reasoning**. If you think you need more information to answer a question, please explain what else you need to know.
 - a) When, if ever, during that eight second period was the velocity of the car zero? Indicate all times or time intervals between $t = -3 \text{ s}$ and $t = 5 \text{ s}$, and explain your reasoning.

At about $t = -1.5 \text{ s}$ and $t = 0.0 \text{ s}$ and $t = 2.0 \text{ s}$.
This is when the slope of the graph (or the slope of a tangent line) is zero.
 - b) When, if ever, during that eight second period was the velocity of the car positive? Indicate all times or time intervals between $t = -3 \text{ s}$ and $t = 5 \text{ s}$, and explain your reasoning.

During $[-3.0 \text{ s} \leq t < -1.5 \text{ s}]$ and $[0.0 \text{ s} < t < 2.0 \text{ s}]$
This is when the slope of the graph (or the slope of a tangent line) is positive.

See next page!

- c) When, if ever, during that eight second period was the velocity of the car constant? Indicate all times or time intervals between $t = -3 s$ and $t = 5 s$, and explain your reasoning.

During $[3.0 s < t \leq 5.0 s]$

This is when the graph is a straight line, so the slope of the graph is constant.

- d) When, if ever, was the acceleration of the car positive. List all times or time intervals between $t = -3 s$ and $t = 5 s$, and explain your reasoning.

During $[-1.0 s \leq t < +1.0 s]$

This is when the graph curves upward, so the slope of the graph is increasing.

- e) When, if ever, was the speed of the car increasing? List all times or time intervals between $t = -3 s$ and $t = 5 s$, and explain your reasoning.

During $[-1.5 s < -1.0 s]$ and $[0.0 s < t < 1.0 s]$ and $[2.0 s < t < 3.0 s]$

*This is when the slope of the graph is getting **farther from zero** (either + or -).*

- f) If you were to plot the *velocity* of the car using the same choice of coordinates that was used to make the position plot above, at what time(s) would the *velocity* be a maximum? (remember: $0 > -1$; “zero” is greater than “negative one”.) Explain your reasoning.

As far as we can tell, this is true at $t = -3.0 s$ (and there is a local maximum at $t = 1.0 s$). *This is when the slope of the graph is greatest.*

- g) Estimate the velocity of the car when $t = 1 s$. (Don't just guess! Show your work!)

There is some estimation and artistic judgement here, but if I draw a tangent line it appears to have a slope of $+1.0 m/s$.

- h) Estimate the average acceleration between times $t = 2 s$ and $t = 3 s$. (Show your work.)

One has to draw two tangent lines for this part, but they are easy. When $t = 2 s$ the graph is horizontal so the velocity is zero. When $t = 3 s$ the graph is beginning a long straight phase with a constant slope of $-1.0 m/s$. So the average acceleration is

$$\frac{(-1.0 m/s) - (0.0 m/s)}{3.0 s - 2.0 s} = -1.0 m/s^2$$

- i) Estimate the average acceleration between times $t = -2 s$ and $t = 3 s$. (Show your work.)

We get to reuse what we know about $t = 3 s$ (the slope is $-1.0 m/s$). When $t = -2 s$ the graph has a slope of $1.0 m/s$. So the average acceleration is

$$\frac{(-1.0 m/s) - (1.0 m/s)}{3.0 s - (-2.0 s)} = -0.4 m/s^2$$