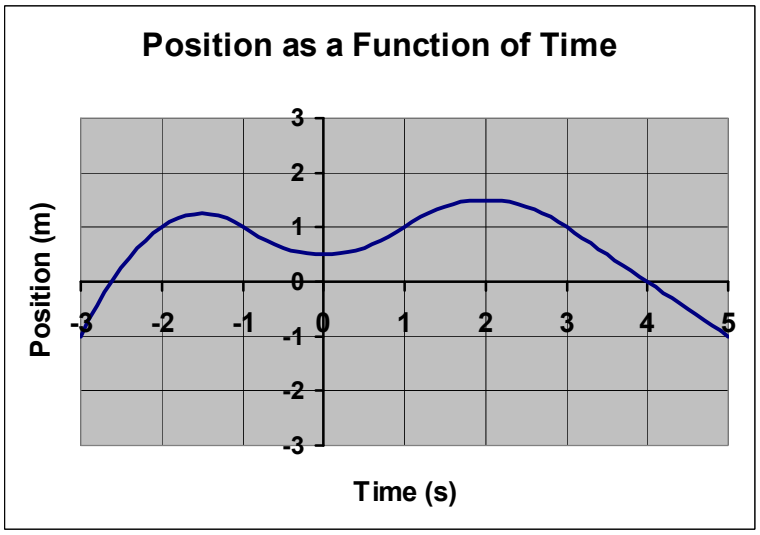
Quiz #2: Physics 221

NAME: _SOLUTIONS____

Do **YOUR OWN WORK** and **SHOW ALL OF IT!**

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 $t = -3\ s$ *and* $t = 5\ s$, and explain your reasoning.

   At about $t = -1.5\ s$ and $t = 0.0\ s$ and $t = 2.0\ s$.
   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 $t = -3\ s$ *and* $t = 5\ s$, and explain your reasoning.

   During $[-3.0\ s \le t < -1.5\ s]$ and $[0.0\ s < t < 2.0\ s]$
   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 $\left[3.0\ s < t \le 5.0\ s\right]$

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 $\left[-1.0\ s \le t < +1.0\ s\right]$

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 $\left[2.0\ s < t < 3.0\ s\right]$

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) Estmate 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

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

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

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