

CALCULUS BC
WORKSHEET 2 ON PARTICLE MOTION

Work these on **notebook paper**. Use your calculator, and give decimal answers correct to three decimal places. Write your justifications in a sentence.

1. A particle moves along a horizontal line so that its position at any time $t \geq 0$ is given by $s(t) = -t^3 + 7t^2 - 14t + 8$, where s is measured in meters and t in seconds.
- Find the instantaneous velocity at any time t and when $t = 2$.
 - Find the acceleration of the particle at any time t and when $t = 2$.
 - When is the particle at rest? When is moving to the right? To the left? Justify your answers.
 - Find the displacement of the particle during the first two seconds?
 - Find the total distance traveled by the particle during the first two seconds?
 - Are the answers to (d) and (e) the same? Explain.
 - When is the particle speeding up? Slowing down? Justify your answers.

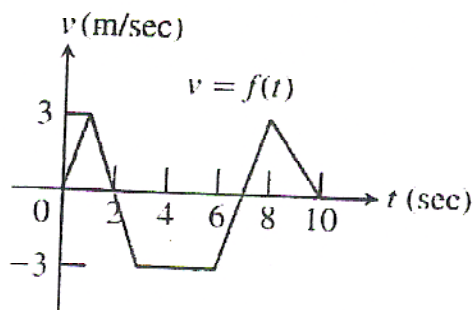
2. The position of a particle at time t seconds, $t \geq 0$, is given by $s(t) = t^2 - \sin t$, $0 \leq t \leq 3$, where t is measured in seconds and s is measured in meters. Find the particle's acceleration each time the velocity is zero.

3. A particle's velocity at time t seconds, $t \geq 0$, is given by $v(t) = \cos(t^2) + t$, $0 \leq t \leq 4$, where t is measured in seconds and v is measured in meters/second. Find the velocity of the particle each time the acceleration is zero.

4. A particle moves along the x -axis so that at any time $t > 0$, its velocity is given by $v(t) = \ln(1 + 2^t)$. Find the acceleration of the particle when $t = 3$.

5. The figure on the right shows the velocity of a particle moving along a vertical line.

- When is the particle moving up? moving down? at rest? Justify your answers.
- When is the particle moving at a constant speed?
- Graph the particle's speed for $0 \leq t \leq 10$.
- Graph the particle's acceleration for $0 < t < 10$.



TURN->>>

6. (2004) A particle moves along the y -axis so that its velocity at time $t \geq 0$ is given by

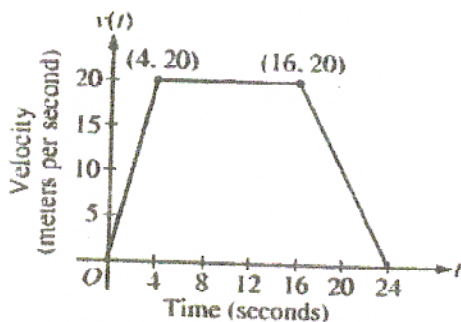
$$v(t) = 1 - \tan^{-1}(e^t).$$

- Find the acceleration of the particle at time $t = 2$.
- Is the speed of the particle increasing or decreasing at time $t = 2$? Give a reason for your answer.
- Find the time $t \geq 0$ at which the particle reaches its highest point. Justify your answer.

7. (2005) A car is traveling on a straight road.

For $0 \leq t \leq 24$ seconds, the car's velocity $v(t)$,

in meters per second, is modeled by the piecewise-linear function defined by the graph on the right.



- For each of $v'(4)$ and $v'(20)$, find the value or explain why it does not exist. Indicate units of measure.
- Let $a(t)$ be the car's acceleration at time t , in meters per second per second. For $0 < t < 24$, write a piecewise-defined function for $a(t)$.
- Find the average rate of change of v over the interval $8 \leq t \leq 20$. Does the Mean Value Theorem guarantee a value of c , for $8 < c < 20$, such that $v'(c)$ is equal to this average rate of change? Why or why not?