1. A particle moves along the y–axis with velocity given by $v(t) = t\sin(t^2)$ for $t \geq 0$.
   (a) In which direction (up or down) is the particle moving at time $t = 1.5$? Why?
   (b) Find the acceleration of the particle at time $t = 1.5$. Is the velocity of the particle increasing at $t = 1.5$? Why or why not?
   (c) Given that $y(t)$ is the position of the particle at time t and that $y(0) = 3$, find $y(2)$.
   (d) Find the total distance traveled by the particle from $t = 0$ to $t = 2$.

(a) $v(1.5) = 1.5\sin(1.5^2) = 1.167$

Up, because $v(1.5) > 0$

1: answer and reason

(b) $a(t) = v'(t) = \sin t^2 + 2t^2\cos t^2$

$a(1.5) = v'(1.5) = -2.048$ or -2.049

No; v is decreasing at 1.5 because $v'(1.5) < 0$

2
- 1: $a(1.5)$
- 1: conclusion and reason

(c) $y(t) = \displaystyle\int v(t)\,dt$

$= \displaystyle\int t\sin t^2\,dt = -\frac{\cos t^2}{2} + C$

$y(0) = 3 = -\frac{1}{2} + C \implies C = \frac{7}{2}$

$y(t) = -\frac{1}{2}\cos t^2 + \frac{7}{2}$

$y(2) = -\frac{1}{2}\cos 4 + \frac{7}{2} = 3.826$ or 3.827

3
- 1: $y(t) = \displaystyle\int v(t)\,dt$
- 1: $y(t) = -\frac{1}{2}\cos t^2 + C$
- 1: $y(2)$

(d) distance $= \displaystyle\int_0^2 |v(t)|\,dt = 1.173$

or

$v(t) = t\sin t^2 = 0$

$t = 0$ or $t = \sqrt{\pi} \approx 1.772$

$y(0) = 3$; $y(\sqrt{\pi}) = 4$; $y(2) = 3.826$ or 3.827

$[y(\sqrt{\pi}) - y(0)] + [y(\sqrt{\pi}) - y(2)]$

$= 1.173$ or 1.174

3
- 1: limits of 0 and 2 on an integral of $v(t)$ or $|v(t)|$
  or
  uses $y(0)$ and $y(2)$ to compute distance
- 1: handles change of direction at student's turning point
- 1: answer
  0/1 if incorrect turning point