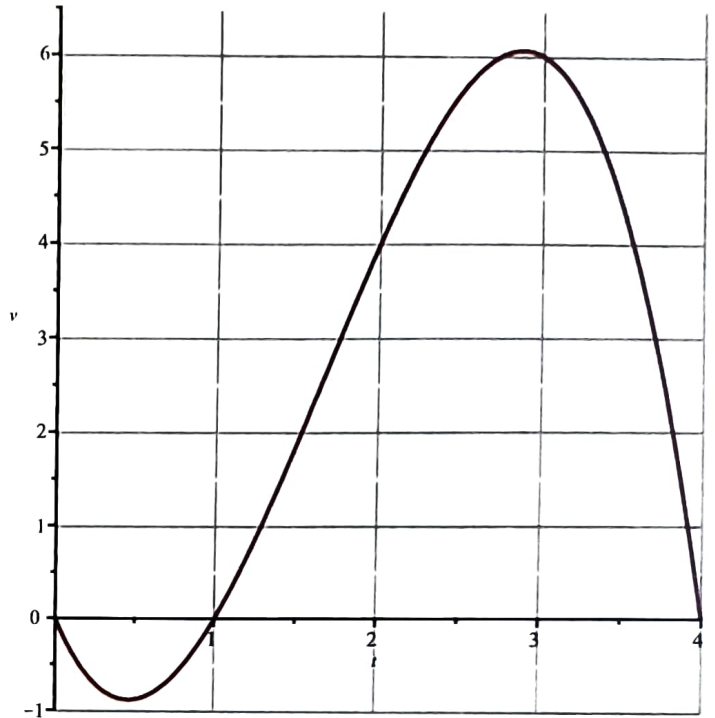


Show all work, including mental steps, in a clearly organized way that speaks for itself. Use proper mathematical notation, identifying expressions by their proper symbols (introducing them if necessary), and use EQUAL SIGNS and arrows when appropriate. Always SIMPLIFY expressions. BOX final short answers. LABEL parts of problem. Keep answers EXACT (but give decimal approximations for interpretation). INDICATE where technology is used and what type (Maple, GC).

Consider the velocity function $v(t) = -t^3 + 5t^2 - 4t$ on the interval $0 \leq t \leq 4$ whose graph is shown in the figure.

- Use Maple to find the 3 times (obvious in the graph) when the velocity is zero, (or factor this and use the quadratic formula). Over what interval is the displacement $s(t)$ increasing? Decreasing?
- Evaluate the exact total displacement over this time interval, showing your work step by step (power rule, etc), and give the numerical approximation to 3 decimal places.
- Evaluate the exact distance traveled by setting up the integrals and using technology to evaluate them, and its numerical approximation to 3 decimal places.
- How much distance was traveled while moving in the direction of the positive s axis? Give both the exact value and the numerical approximation to 3 decimal places.



► **solution**

a) $0 = v = -t^3 + 5t^2 - 4t = -t(t^2 - 5t + 4)$
 $t = 0$ $t = \frac{5 \pm \sqrt{25 - 4(4)}}{2} = \frac{5 \pm \sqrt{9}}{2} = \frac{5 \pm 3}{2} = 1, 4$
 so $t = 0, 1, 4$

$v > 0 : 1 < t < 4$ s is increasing

$v < 0 : 0 < t < 1$ s is decreasing

b) $\Delta s = \int_0^4 v dt = \int_0^4 -t^3 + 5t^2 - 4t dt = -\frac{t^4}{4} + \frac{5t^3}{3} - \frac{2t^2}{1} \Big|_0^4 = -4^3 + \frac{5 \cdot 4^3}{3} - 2 \cdot 4^2$
 $= -64 - 32 + \frac{5}{3} \cdot 64$ Maple $\boxed{32/3 \approx 10.667}$

c) $d = \int_0^4 |v| dt = -\int_0^1 -t^3 + 5t^2 - 4t dt + \int_1^4 -t^3 + 5t^2 - 4t dt$
 $= \frac{t^4}{4} - \frac{5t^3}{3} + 2t^2 \Big|_0^1 + \left(-\frac{t^4}{4} + \frac{5t^3}{3} - 2t^2 \right) \Big|_1^4 = \left(\frac{1}{4} - \frac{5}{3} + 2 \right) + \left(-\frac{4^4}{4} + \frac{5 \cdot 4^3}{3} - 2 \cdot 4^2 \right)$ Maple $\boxed{71/6 \approx 11.833}$
 Maple: $7/12 \approx 0.583$ Maple: $45/4$

$v \geq 0 :$

e) $\Delta s_{1 \rightarrow 4} = \int_1^4 v dt = \boxed{45/4 \approx 11.25}$

Summary (not requested):

