

$$\textcircled{1} \quad y = 7x^{-2} - 3x^{1/2}$$

$$y' = -14x^{-3} - \frac{3}{2}x^{-1/2}$$

$$y'|_{x=1} = -14 - \frac{3}{2}$$

$$= -\frac{31}{2}$$

$$m_{\text{tan}} = -\frac{31}{2} \Rightarrow m_{\text{normal}} = \frac{-1}{m_{\text{tan}}} = \frac{2}{31}$$

$$x=1 \Rightarrow y = 7(1)^{-2} - 3\sqrt{1} = 4$$

$$\left. \begin{array}{l} x_1 = 1 \\ y_1 = 4 \\ m = \frac{2}{31} \end{array} \right\} \rightarrow$$

$$y - y_1 = m(x - x_1)$$

$$y - 4 = \frac{2}{31}(x - 1)$$

Multiply by 31: $31y - 124 = 2(x - 1)$

$$31y - 124 = 2x - 2$$

$$-2x + 31y - 122 = 0$$

or $2x - 31y + 122 = 0$

②

$$\underbrace{2x^5 - 19x^2 + 3}_{f(x)} = 0$$

$$f'(x) = 10x^4 - 38x$$

x_n	$f(x_n)$ $= 2x^5 - 19x^2 + 3$	$f'(x_n)$ $= 10x^4 - 38x$	x_{n+1}
2	-9	84	2.1071

$$x_1 \approx 2.11$$

③

$$x = 27t^{-2} + 1, \quad y = 7t^2 + 2t$$

$$v_x = -54t^{-3}, \quad v_y = 14t + 2$$

$$\text{At } t=3: v_x = -2, \quad v_y = 44$$

$$\text{speed } v = \sqrt{(-2)^2 + 44^2} \approx 44.0 \text{ m/s}$$

$$\begin{aligned} \text{direction } \theta &= \tan^{-1}\left(\frac{v_y}{v_x}\right) (+180^\circ?) \\ &= \tan^{-1}\left(\frac{44}{-2}\right) + 180^\circ \\ &\approx 92.6^\circ \end{aligned}$$

Add 180° when $v_x < 0$

④

1) Equation

$$P = \frac{k}{V} \quad (k: \text{constant})$$

$$P = kV^{-1}$$

$$\begin{aligned} \frac{dV}{dt} &= 20.0 \frac{\text{cm}^3}{\text{min}} \\ \frac{dP}{dt} &= ? \\ V &= 800 \text{ cm}^3 \end{aligned}$$

2) Take $\frac{d}{dt}$:

$$\frac{dP}{dt} = \frac{dP}{dV} \frac{dV}{dt}$$

$$\frac{dP}{dt} = -kV^{-2} \frac{dV}{dt}$$

3) Missing value: k

$$\begin{aligned} V=600 \quad \uparrow \rightarrow P &= \frac{k}{V} \\ P=200 \quad \downarrow \end{aligned} \quad \begin{aligned} 200 &= \frac{k}{600} \\ 120,000 &= k \end{aligned}$$

4) Solve

$$\frac{dP}{dt} = -120,000 V^{-2} \frac{dV}{dt}$$

Sub $\frac{dV}{dt} = 20.0, V = 800$:

$$\frac{dP}{dt} = -120,000 (800)^{-2} (20.0)$$

$$\frac{dP}{dt} = -3.75 \frac{\text{kPa}}{\text{min}}$$

$$(5) \quad f(x) = -x^3 + 9x^2 - 24x + 5$$

$$f'(x) = -3x^2 + 18x - 24$$

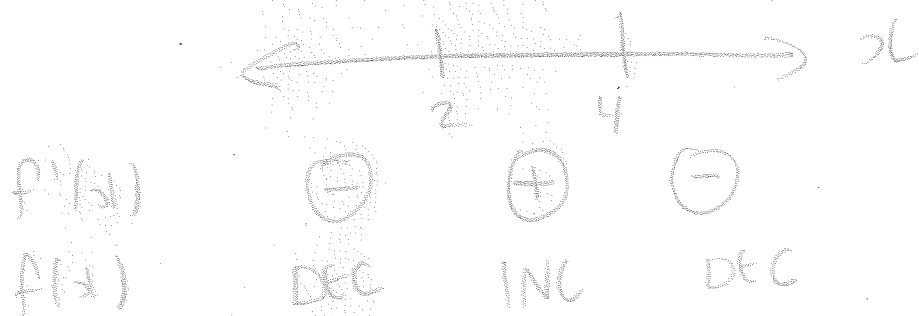
$$\text{Set } f'(x) = 0 :$$

$$0 = -3x^2 + 18x - 24$$

$$0 = -3(x^2 - 6x + 8)$$

$$0 = -3(x-2)(x-4)$$

$$x = 2, 4$$



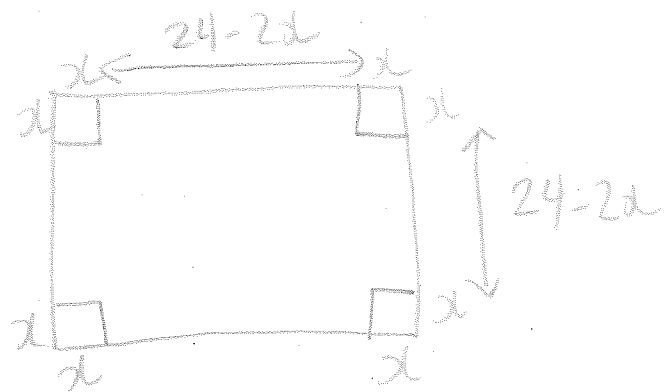
$f(x)$ is decreasing for:

$$-\infty < x < 2 \quad \text{or} \quad 4 < x < \infty$$

$$x < 2 \quad \text{or} \quad 4 < x$$

} both acceptable

6



1) Maximize $V = lwh$
 $V = (24-2x)^2 x$

2) V is a single-variable function ✓

3) Set $V' = 0$

$$V' = (24-2x)^2 (1) + x [2(24-2x)(-2)]$$

$$V' = (24-2x) [24-2x - 4x]$$

$$V' = (24-2x) (24-6x)$$

Set $V' = 0$:

$$0 = (24-2x) (24-6x)$$

$$\begin{aligned} \downarrow \\ 24-2x &= 0 \\ 24 &= 2x \\ x &= 12 \end{aligned}$$

$$\begin{aligned} \downarrow \\ 24-6x &= 0 \\ 24 &= 6x \\ x &= 4 \end{aligned}$$

THIS LEADS TO
MINIMUM VOLUME
BECAUSE $V(12) = 0$

THIS LEADS TO
MAXIMUM VOLUME

4) Answer
The height that maximizes the box's volume is 4 cm.

⑦

$$f = 12x^3$$

$$\frac{df}{dx} = 36x^2$$

$$df = 36x^2 dx$$

$$\frac{df}{f} = \frac{36x^2 dx}{12x^3}$$

$$= \frac{3dx}{x}$$

$$= 3 \left(\frac{dx}{x} \right)$$

$$= 3 (0.07)$$

$$= 0.21$$