1. $f(x) = x^3 - ax$

$f'(x) = 3x^2 - a$ (poly, so dom $f' = \mathbb{R}$)

$f'(x) = 0 \Rightarrow 3x^2 - a = 0$

$\Rightarrow 3x^2 = a$

$\Rightarrow x^2 = \frac{a}{3}$

$\Rightarrow \boxed{x = \pm\sqrt{\frac{a}{3}}}$

$x = \pm 2 \Rightarrow \pm 2 = \pm\sqrt{\frac{a}{3}}$

$\Rightarrow \boxed{a = 12}$

2. $g(x) = x^5 - 5x^4 + 35$

$g'(x) = 5x^4 - 20x^3$

$= 5 \cdot x^3 \cdot (x - 4)$

$g'(x) = 0 \Rightarrow x = 0, 4$

$g''(x) = 20x^3 - 60x^2$

$g''(0) = 0 \Rightarrow$ 2nd der. test in incl.

$g''(4) = 20 \cdot 4^3 - 60 \cdot 4^2$

$= 4^2 (20 \cdot 4 - 60)$

$= 4^2 \cdot 20 \cdot (4-3) > 0$

$\therefore$ 2^{nd} der. test $\Rightarrow$ $\boxed{\text{local min at } 4}$

$g''(x) = 0 \Rightarrow 20x^3 - 60x^2 = 0$

$\Rightarrow 20x^2(x-3) = 0$

$\Rightarrow x = 0, 3$

$\underline{-1 < 0 < 1:}$

$g''(-1) = 20(-1)^2(-1-3) < 0$

$g''(1) = 20 \cdot 1^2 \cdot (1-3) < 0$

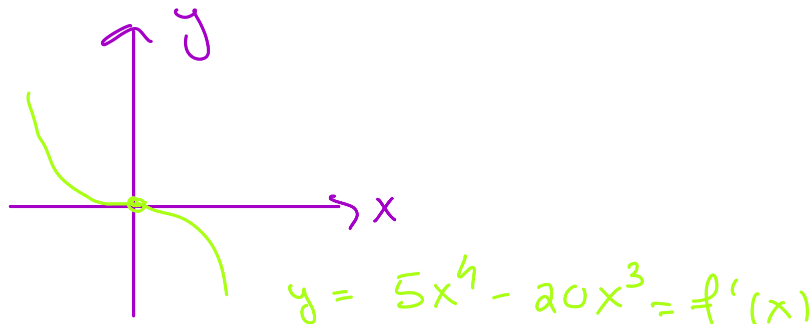
$\boxed{\therefore 0 \text{ not inf. pt.}}$

$\underline{2 < 3 < 4:}$ $g''(2) = 20 \cdot 2^2 \cdot (2-3) < 0$

$g''(4) = 20 \cdot 4^2 (4-3) > 0$

$\boxed{\therefore 3 \text{ is inf pt.}}$

We use 1^{st} der. test to see if 0 is a local extrema:



f' changes pos. to neg. at $0 \Rightarrow$

by 1^{st} der. test, $\boxed{0 \text{ is local max.}}$

3. $f(t) = \dfrac{t}{t^2+1}$

$$f'(t) = \frac{1 \cdot (t^2+1) - t(2t)}{(t^2+1)^2}$$

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

$$f'(t) = 0 \longleftrightarrow 1 - t^2 = 0 \longleftrightarrow t = \pm 1$$

$$f''(t) = \frac{2t(t^2-3)}{(t^2+1)^3}$$

$$f''(1) = \frac{2 \cdot 1 \cdot (1-3)}{2^3} < 0 \Rightarrow \boxed{1 \text{ local max}}$$

$$f''(-1) = \frac{2 \cdot (-1)(-1-3)}{2^3} > 0 \Rightarrow \boxed{-1 \text{ local min}}$$

4. $\int \left(t^3 - \frac{t^2}{2} - t\right) dt =$

$\int t^3\, dt - \frac{1}{2}\int t^2\, dt - \int t\, dt =$

$\frac{1}{4}t^4 - \frac{1}{2}\cdot\frac{1}{3}t^3 - \frac{1}{2}t^2 + C =$

$$\boxed{\frac{1}{4}t^4 - \frac{1}{6}t^3 - \frac{1}{2}t^2 + C}$$

5. $\int (\sqrt{z})^3 dz = \int z^{\frac{3}{2}}\, dz$

$$= \frac{1}{\left(\frac{3}{2}\right)} z^{\frac{3}{2}+1} + C$$

$$\boxed{= \frac{2}{3} z^{\frac{5}{2}} + C}$$

6. $\int \left(\frac{1}{x} + \frac{1}{x^2} + \frac{1}{x^3}\right) dx =$

$\int \frac{1}{x}\, dx + \int \frac{1}{x^2}\, dx + \int \frac{1}{x^3}\, dx =$

$$\boxed{\ln|x| - x^{-1} - \frac{1}{2}x^{-2} + C}$$

7. $\int_1^4 \frac{1}{\sqrt{x}}\,dx = \int_1^4 x^{-\frac{1}{2}}\,dx$

$= 2\sqrt{x}\,\Big|_{x=1}^{x=4} = 2\sqrt{4} - 2\sqrt{1}$

$= 4 - 2 = \boxed{2}.$