1\. (1) $(e^x \sin^{-1}x)' = e^x \sin^{-1}x + e^x \frac{1}{\sqrt{1-x^2}}$

(2) $\left(\cos^{-1}(\boxed{\ln x + e^{-x^2}}) - e^{\boxed{\sin^{-1}x}}\right)'$

$= -\frac{1}{\sqrt{1-(\ln x + e^{-x^2})^2}} \cdot \left(\frac{1}{x} + e^{-x^2} \cdot (-2x)\right)$

$- e^{\sin^{-1}x} \cdot \frac{1}{\sqrt{1-x^2}}$.

(3) $\left((\sin x + 2x)^{\tan x}\right)'$

$= \left(e^{\ln (\sin x + 2x)^{\tan x}}\right)'$

$= \left(e^{\boxed{\tan x \ln (\boxed{\sin x + 2x})}}\right)'$

$= e^{\tan x \ln (\sin x + 2x)} \cdot \left(\sec^2 x \ln (\sin x + 2x)\right.$

$\left. + \tan x \cdot \frac{1}{\sin x + 2x} \cdot (\cos x + 2)\right)$

(4) $\left((x^2+1)^{x \sin x}\right)'$

$= \left(e^{\ln (x^2+1)^{x \sin x}}\right)'$

$$= \left(e^{\boxed{x \sin x \ln(x^2+1)}} \right)'$$

$$= e^{x \sin x \ln(\boxed{x^2+1})} \cdot \Big(\sin x \cdot \ln(x^2+1)$$

$$+ x \ln(x^2+1) \cdot \cos x + x \sin x \cdot \frac{1}{x^2+1} \cdot 2x \Big)$$

(5) $(e^{3x})^{(31)} = e^{3x} \cdot 3^{31}$

$$(e^{3x})' = e^{3x} \cdot 3$$

$$(e^{3x})'' = e^{3x} \cdot 3^2$$

(6) $(e^{-x^2})'''$

$$(e^{\boxed{-x^2}})' = e^{-x^2} \cdot (-2x)$$

$$(e^{-x^2})'' = e^{-x^2} \cdot (-2x) \cdot (-2x) + e^{-x^2} \cdot (-2)$$

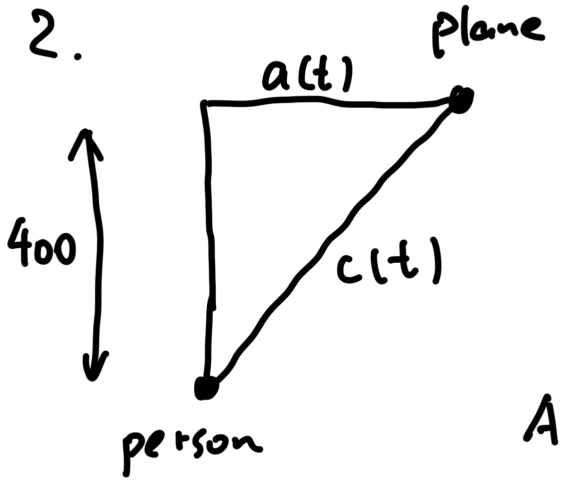
$$= e^{-x^2} (4x^2 - 2)$$

$$(e^{-x^2})''' = e^{-x^2} \cdot (-2x)(4x^2 - 2) + e^{-x^2} \cdot 8x$$

$$= e^{-x^2} (-8x^3 + 12x).$$

"Hermite polynomial"

2.



$$\boxed{a(t)}^2 + 400^2 = c(t)^2$$

$$2a(t) \cdot a'(t) = 2c(t) \cdot c'(t)$$

At t_0, $c(t_0) = 500$, $a'(t_0) = 150$

$\hookrightarrow$ $a(t_0)^2 + 400^2 = 500^2$

$a(t_0) = 300$

$$2 \times 300 \times 150 = 2 \times 500\, c'(t_0)$$

$$\Rightarrow c'(t_0) = 90$$

3. $V(t) = \frac{4}{3}\pi\, r(t)^3$ $\qquad$ $S(t) = 4\pi\, r(t)^2$

$V'(t) = \frac{4}{3}\pi \cdot 3r(t)^2 \cdot r'(t)$ $\qquad$ $S'(t) = 4\pi \cdot 2r(t) \cdot r'(t)$

$V'(t_0) = \boxed{4\pi \cdot \frac{10}{4\pi} \cdot \frac{-2}{8\pi \cdot \sqrt{\frac{10}{4\pi}}}}$

$S(t_0) = 10$ $\qquad$ $S'(t_0) = -2$

$\hookrightarrow$ $10 = 4\pi r(t_0)^2$

$r(t_0) = \sqrt{\frac{10}{4\pi}}$

$\Rightarrow$ $-2 = 8\pi \cdot \sqrt{\frac{10}{4\pi}} \cdot r'(t_0)$

$$r'(t_0) = \frac{-2}{8\pi \cdot \sqrt{\frac{10}{4\pi}}}$$