

Overview of Mathematical Processes Covered



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Transforming Numerical Methods Education for STEM Undergraduates



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- Go to <http://nm.MathForCollege.com>
- Click on Introduction to Numerical Methods



Mathematical Processes

- Nonlinear Equations ✓
- Simultaneous Linear Equations ✓
- Curve Fitting ✓
 - Interpolation
 - Regression
- Differentiation ✓
- Integration ✓
- Ordinary Differential Equations ✓
- Other Advanced Mathematical Procedures:
 - Partial Differential Equations
 - Optimization
 - Fast Fourier Transforms



Nonlinear Equations

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$ax^3 + bx^2 + cx + d = 0$$

$$ax^4 + bx^3 + cx^2 + dx + e = 0$$

$$\tan x = x$$

Nonlinear Equations

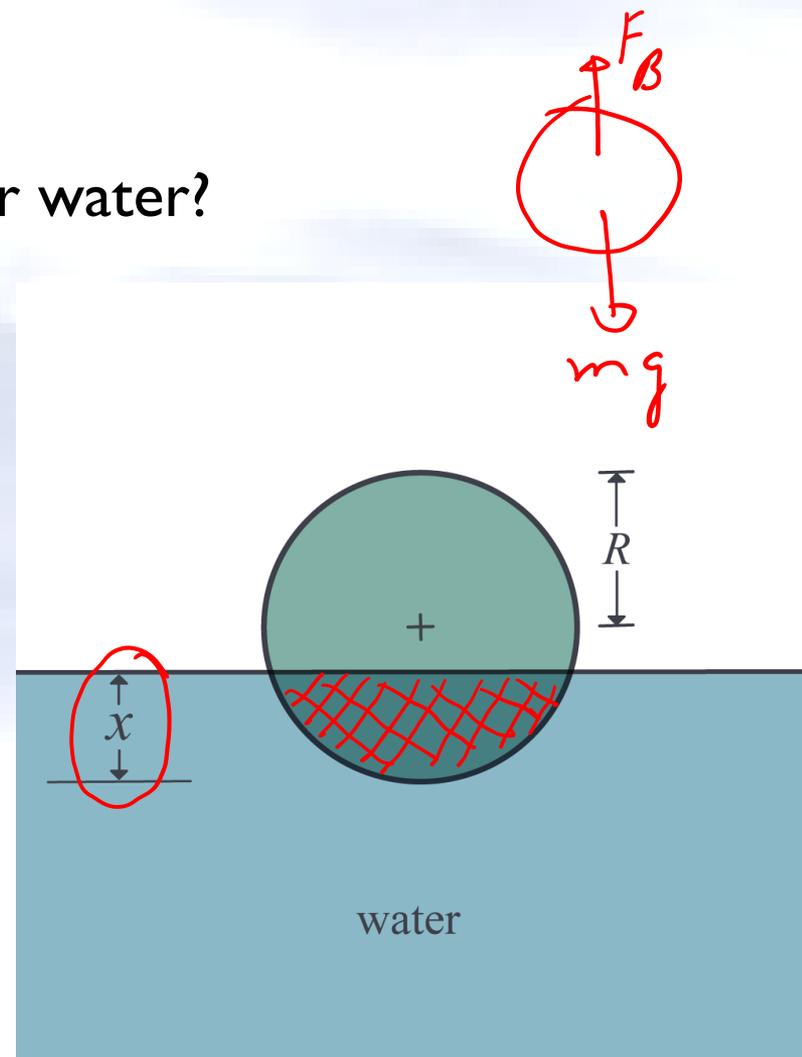
How much of the floating ball is under water?

Radius=0.055 m ✓

Specific Gravity=0.6 ✓

$$x^3 - 0.165x^2 + 3.993 \times 10^{-4} = 0$$

x is in (m)



Simultaneous Linear Equations

Find the velocity profile, given

Time (s)	5	8	12
Vel (m/s)	106	177	600

$$v(t) = at^2 + bt + c, 5 \leq t \leq 12$$

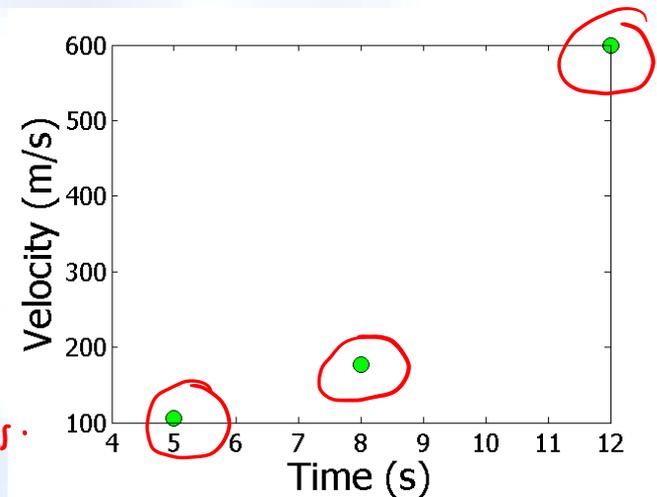
Three simultaneous linear equations

$$a(5^2) + b(5) + c = 106$$

$$a(8^2) + b(8) + c = 177$$

$$a(12^2) + b(12) + c = 600$$

3 eqns
3 unknowns.

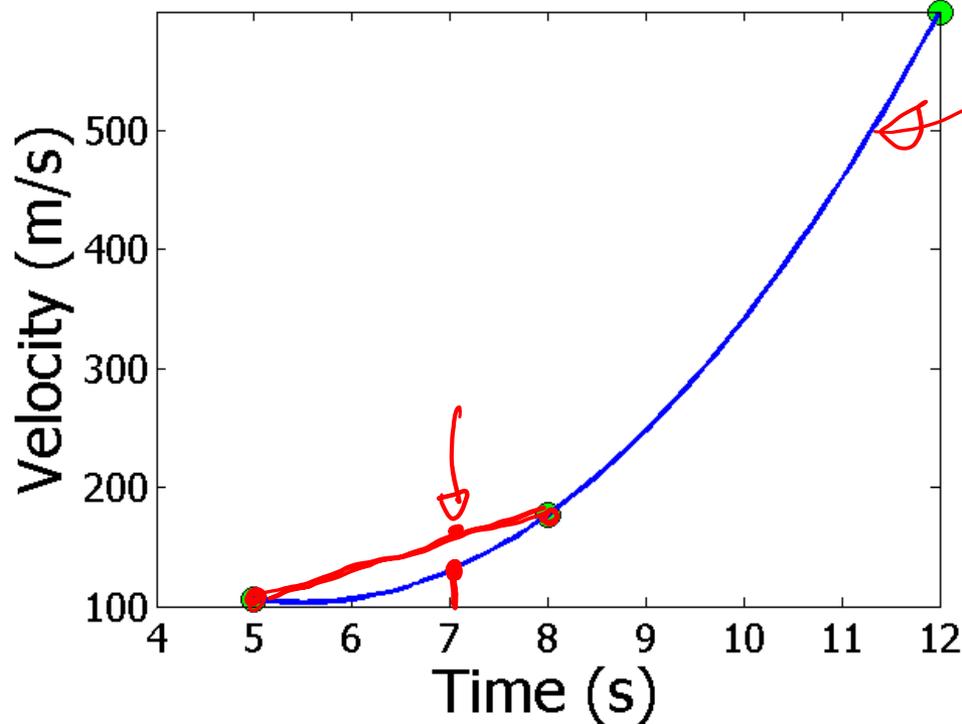


Interpolation

What is the velocity of the rocket at $t=7$ seconds?

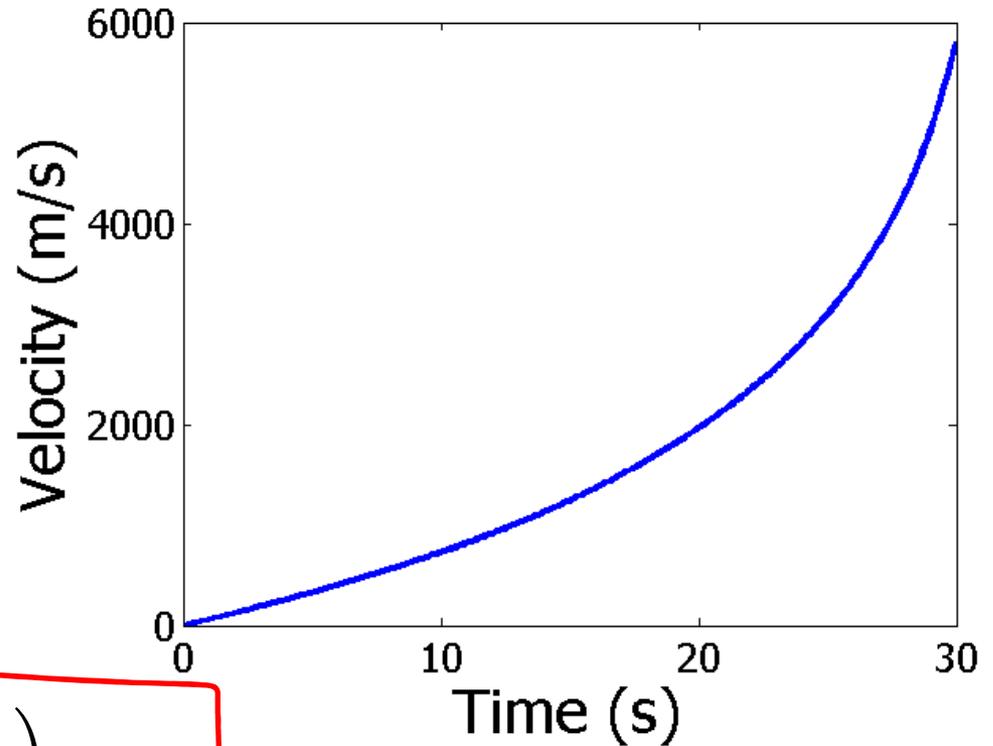
Time (s)	5 ✓	8 ✓	12 ✓
Vel (m/s)	106	177	600

$a t^2 + b t + c$
 $5 \leq t \leq 12$



Differentiation

What is the acceleration at $t=7$ seconds?



$$v(t) = 2200 \ln\left(\frac{16 \times 10^4}{16 \times 10^4 - 5000t}\right) - 9.8t$$

$$a = \frac{dv}{dt}$$



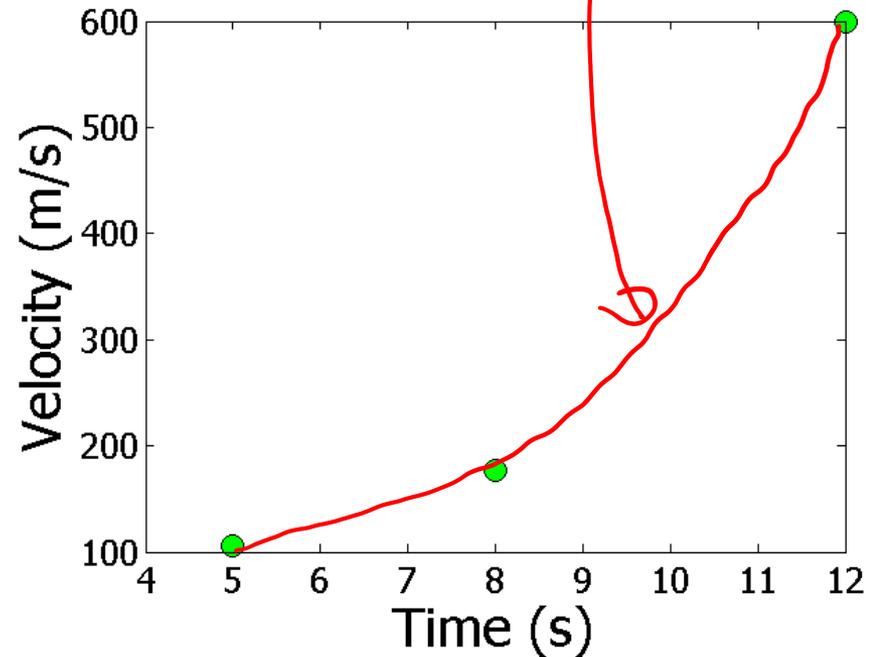
Differentiation

What is the acceleration at $t=7$ seconds?

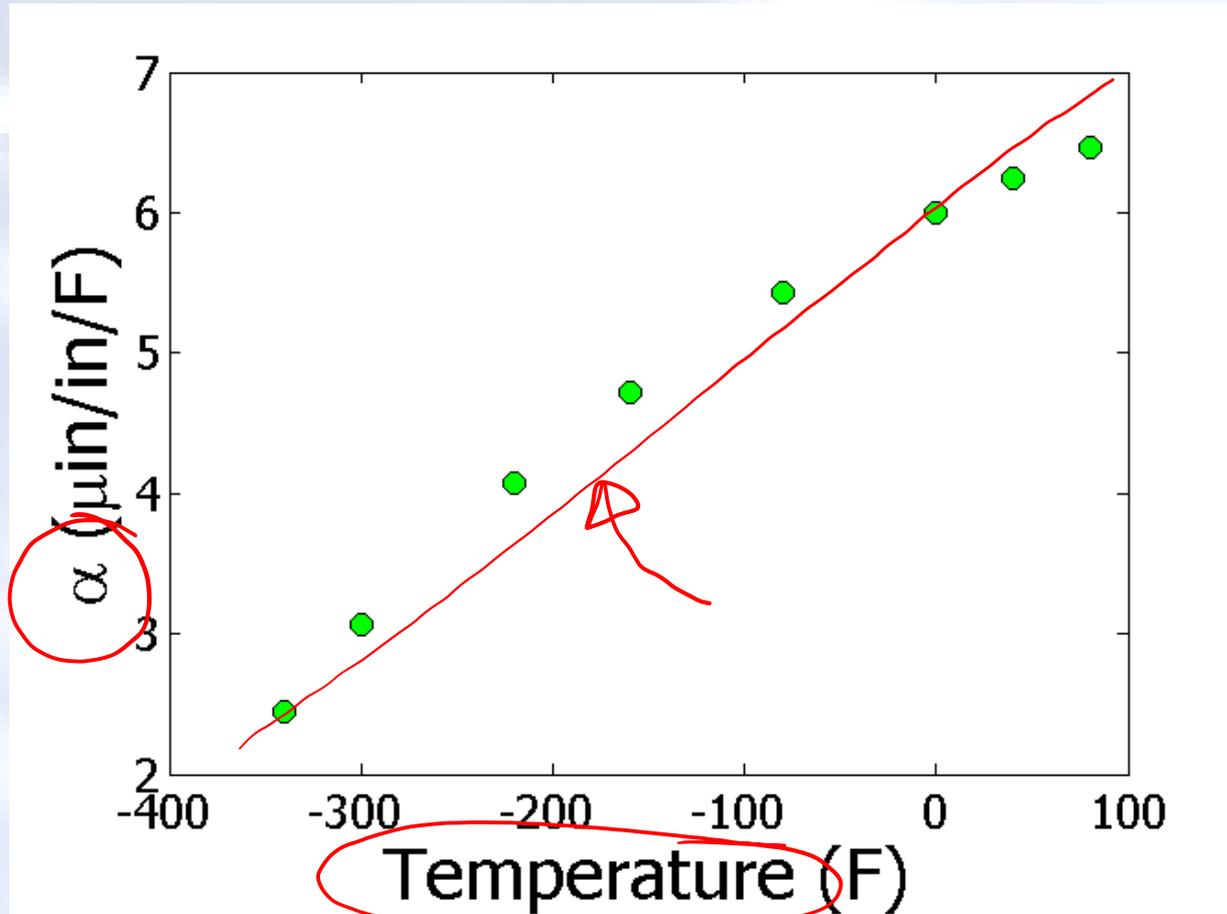
Time (s)	5 ✓	8 ✓	12 ✓
Vel (m/s)	106	177	600



$$a = \frac{dv}{dt}$$



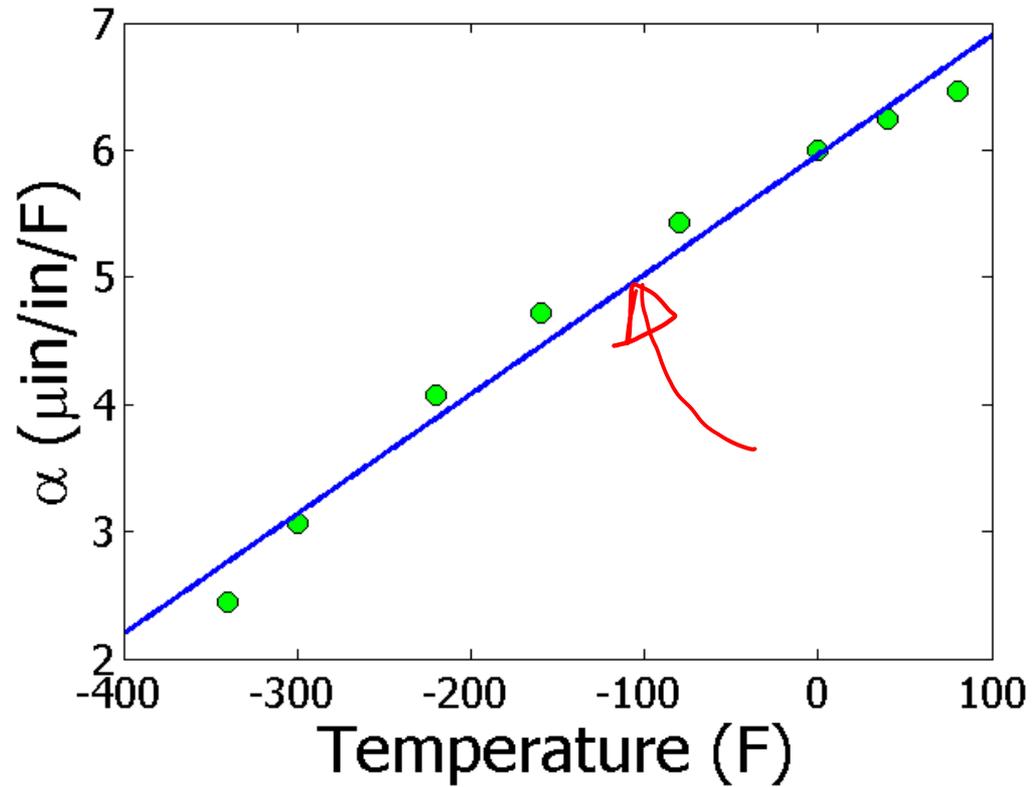
Regression



Thermal expansion coefficient data for cast steel



Regression – Linear

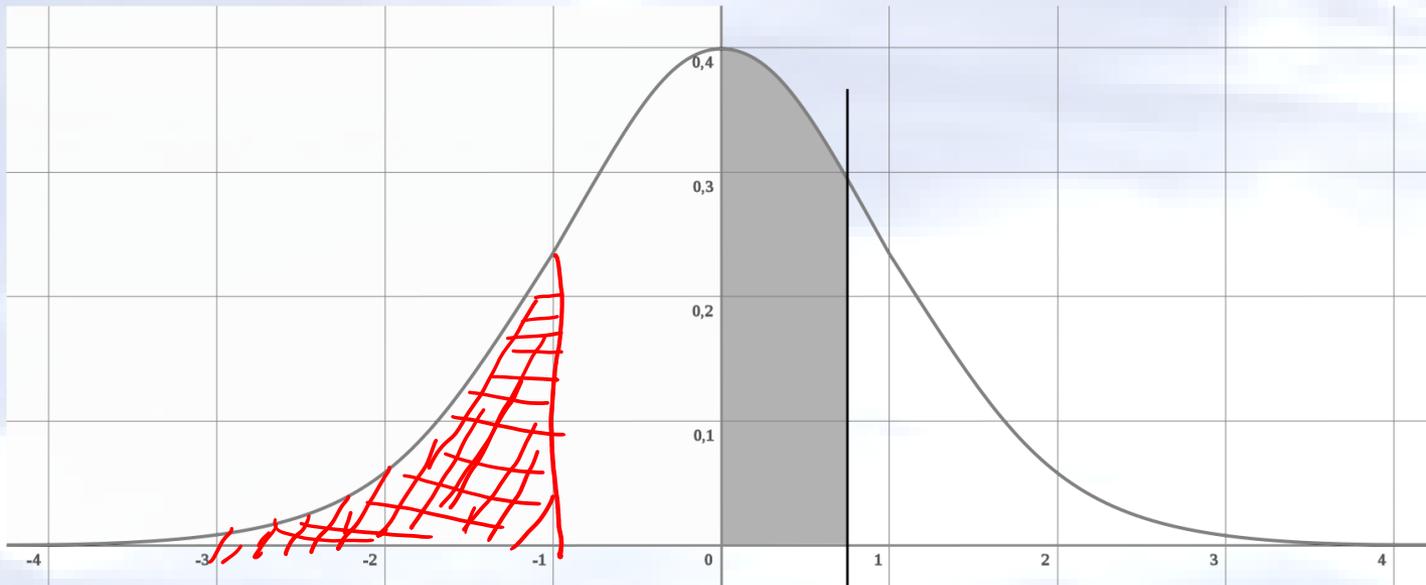


Integration

$$\Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-t^2/2} dt$$

$$x = 0$$

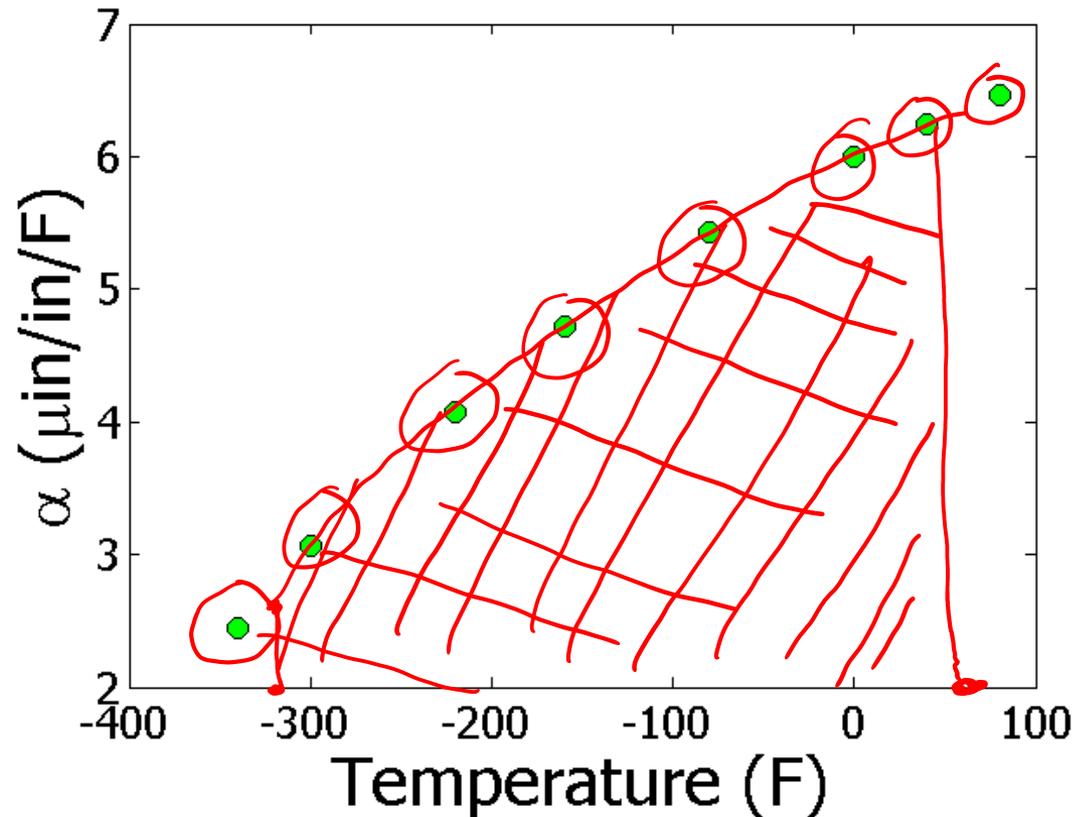
$$x \rightarrow \infty$$



Integration

Finding the diametric contraction in a steel shaft when dipped in liquid nitrogen.

$$\Delta D = D \int_{T_{room}}^{T_{fluid}} \alpha dT$$



Ordinary Differential Equations

How long does it take a trunnion to cool down?



$$mc \frac{d\theta}{dt} = -hA(\theta - \theta_a), \theta(0) = \theta_{room}$$

$c(\theta)$ $h(\theta)$



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