

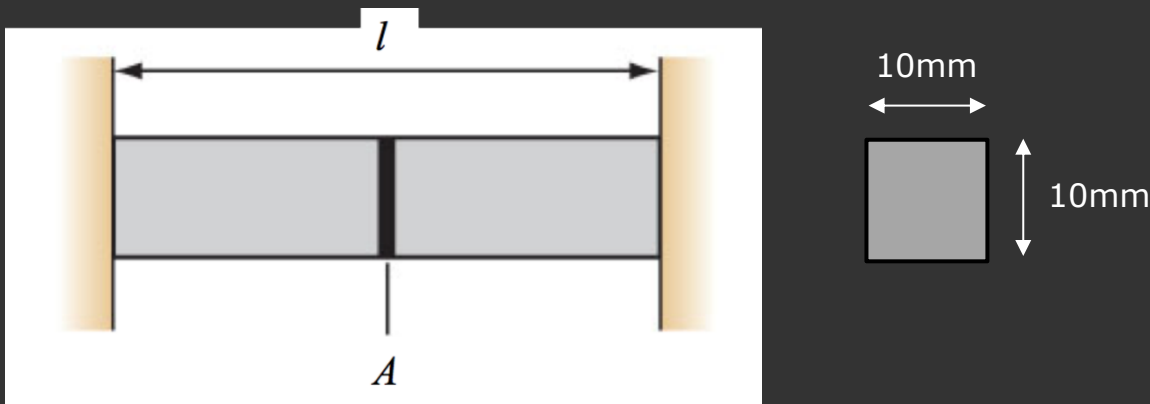
A close-up photograph of a complex engine component, likely a turbine or compressor section, painted in a vibrant blue and polished silver. The image shows various mechanical parts, including a large blue spherical cap with a central bolt, and a black curved duct. The background is a clear blue sky.

# Mechanics of Solids

## Thermal Stress and Strain Worked Example 1

# Worked Example

- The aluminium bar shown is increased in temperature from an initial value of 20°C to 40°C. Calculate the stress in the bar.



Assume  $\alpha = 23 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$  and  $E = 70 \text{ GPa}$

# Resistive Heating of a Bar

- Recalling:

$$\delta l_{total} = \frac{FL}{AE} + l\alpha\Delta T = 0$$

- Cancelling through  $l$  and rearranging for the reaction force,  $F$ , gives:

$$F = -AE\alpha\Delta T$$

- And we can determine the stress using:

$$\sigma = \frac{F}{A} = -E\alpha\Delta T$$

# Resistive Heating of a Bar

- Inserting the values for this problem:

$$\sigma = \frac{F}{A} = -E\alpha\Delta T$$

$$= -70 \times 10^9 \times 23 \times 10^{-6} \times 20$$

$$= -32.2 \times 10^6 \text{ Pa} = -32.2 \text{ MPa}$$