Question: How can we investigate and measure the inside of an object or its structure if we cannot take it apart?
Examples of Material Failures

Silver Bridge Disaster video: https://www.youtube.com/watch?v=dGQfUWvP0II
BINDT – Bridges and NDT video: https://www.youtube.com/watch?v=WVLT01V5Cq4
Online research topics > discussion > posters

- Organize into small groups
- Research the definitions and any graphics/illustrations for these 10 topics
- Share research with the class
- Each group makes poster about one topic

1. voltage
2. inductance
3. current
4. magnetic fields (dipolar nature and their lines)
5. eddy current
6. conductors
7. excitation
8. nondestructive evaluation (NDE)
9. finite element method (FEM)
10. Ohm’s law
This B-52 bomber from the 1950s is still in use.
Eddy current testing method

- A nondestructive evaluation method
- Widely used for crack detection
- Cracks cause very large local conductivity changes

Mechanical fasteners (rivets) on airplane
Eddy current testing method

A = Coil in the air
B = Coil over defective specimen
C = Coil over defect-free specimen
Nondestructive testing results

Rivet with no defects

Rivet with defect
Maxwell’s equations

\[ \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \]

\( \Leftrightarrow \) Faraday’s law
Time-varying magnetic field creates electric field, and vice versa

\[ \nabla \times \mathbf{H} = \mathbf{j} + \frac{\partial \mathbf{D}}{\partial t} \]

\( \Leftrightarrow \) Ampere’s law
Electric current creates circular magnetic fields

\[ \nabla \cdot \mathbf{D} = \rho \]

\( \Leftrightarrow \) Gauss’ law
Electric charges create electric flux

\[ \nabla \cdot \mathbf{B} = 0 \]

\( \Leftrightarrow \) Gauss’ law for magnetism
No magnetic charges