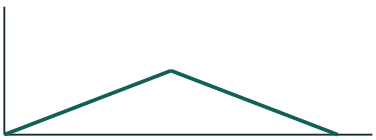
Protecting a sensor

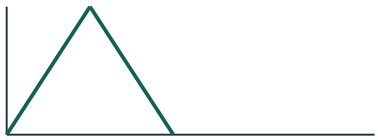
Suggested time for the entire exam: 35–50 min; adjust to local conditions.

Name _____ **Date** _____

A sensor cart hits two prototype stops in separate trials. It approaches each stop with the same momentum and comes to rest. Model each force pulse as triangular. Stop X gives a peak of 150 N over 0.12 s. Stop Y gives a peak of 300 N over 0.06 s. Use magnitudes.



X 0.12 s / 150 N



Y 0.06 s / 300 N

1. Which quantity is the area under each force-time pulse?

- ○ A Speed
- ○ B Impulse
- ○ C Power
- ○ D Pressure

2. If damage occurs above 200 N, which design meets that constraint in this trial?

- ○ A X only
- ○ B Both
- ○ C Neither
- ○ D Y only

3. Calculate both impulses. Explain how the sensor can experience different peak forces while undergoing the same change in momentum.

Powering the light

Use the stimulus and your course knowledge.

Name _____ **Date** _____

Two lamps each operate at 6.0 V. Lamp A draws 0.40 A and provides a measured useful light output of 0.48 W. Lamp B draws 0.25 A and provides 0.45 W of useful light. Use P = VI and efficiency = useful output / input.

4. Which is the electrical input power for lamp B?

- ○ A 6.25 W
- ○ B 24 W
- ○ C 1.50 W
- ○ D 0.45 W

5. What extra measurement is needed to estimate total input energy for one use at constant power?

- ○ A Color of the lamp housing
- ○ B Ambient light level alone
- ○ C Length of the power cord alone
- ○ D Time switched on

6. Which lamp is more efficient under these conditions? Compare both numerical efficiencies and explain why light output alone is insufficient.

Signals on a string

Use the stimulus and your course knowledge.

Name _____ **Date** _____

A wave travels along a uniform string at 24 m/s. A driver runs at 6 Hz and then 8 Hz while string tension and mass per length stay constant. Use $v = f\lambda$.

7. What is the wavelength at 6 Hz?

- ○ A 0.25 m
- ○ B 144 m
- ○ C 4 m
- ○ D 18 m

8. Which change would most directly increase amplitude without changing frequency in an ideal linear model?

- ○ A Increase the driver’s displacement per oscillation
- ○ B Shorten the time for each cycle
- ○ C Relabel the vertical axis in different units
- ○ D Double the number of oscillations per second

9. Predict the new wavelength and describe the cause of the change using the spacing between crests.

Lens on an inspection stand

Use the stimulus and your course knowledge.

Name _____ **Date** _____

A converging thin lens has focal length 12 cm. A 3 cm object stands 36 cm from the lens. Use $1/f = 1/d_o + 1/d_i$ and magnification magnitude = absolute value of d_i/d_o. A real object beyond the focal point can form a real image.

10. Where is the sharp image?

- ○ A 12 cm on the object side
- ○ B 18 cm from the lens on the opposite side
- ○ C 36 cm on the opposite side
- ○ D 48 cm on the object side

11. Which observation most directly confirms the image is real?

- ○ A The object reflects light.
- ○ B The image looks smaller than the object.
- ○ C The lens is made from transparent material.
- ○ D A screen placed at its location captures a focused image.

12. Find the image height and describe its orientation. Explain what a pair of principal rays from the object tip would show.