### Instructions:

Do not open this examination until the proctor tells you to begin.

1. When the proctor tells you to begin, **write your name and section number at the top of every page.** This is essential since this exam booklet will be separated for grading.

2. Do your work for each problem on the page for that problem. You might find it convenient to either do your scratch work on the back of the page before starting to write out your answer or to continue your answer on the back. **If part of your answer is on the back, be sure to check the box on the bottom of the page so the grader knows to look on the back!**

3. On all the problems except the multiple choices questions in problem 1 or where it says *not to explain*, your answers will be evaluated at least in part on how you got them. If explanations are requested, more than half the credit of the problem will be given for the explanation. **LITTLE OR NO CREDIT MAY BE EARNED FOR ANSWERS THAT DO NOT SHOW HOW YOU GOT THEM.** Partial credit will be granted for correct steps shown, even if the final answer is wrong.

4. Write clearly and logically so we can understand what you are doing and can give you as much partial credit as you deserve. We cannot give credit for what you are thinking — only for what you show on your paper.

5. All estimations should be done to the appropriate number of significant figures.

6. At the end of the exam, write and sign the honor pledge in the space below: “I pledge on my honor that I have not given or received any unauthorized assistance on this examination.”

---

<table>
<thead>
<tr>
<th>#1:</th>
<th>#2:</th>
<th>#3:</th>
<th>#4:</th>
<th>#5:</th>
<th>Total</th>
</tr>
</thead>
</table>

***Good Luck***
1. (30 points) A pulse moving down an elastic string is photographed at time \( t = 0 \) and the picture looks like the figure shown at the right. At this instant, the pulse is moving to the left as indicated by the arrow. A bit to the left of the pulse is a small bead attached to the string.

As a function of time, indicate which of the graphs below could serve as graphs for the variables listed if the scales were appropriate. (Note that the arrows on the axes mark the positive direction of the axes that pass through the origin of the coordinates on the graph.) If none are correct write “N”.

1.1. The y-displacement of the bead.

1.2. The x-displacement of the bead.

1.3. The y-velocity of the bead.

1.4. The x-velocity of the bead.

1.5. The y-acceleration of the bead.

1.6. The net force on the bead.
2. (20 points)
A.) (10 pts) In the figure at the right is shown a small object and eyes representing two viewers. Would the two viewers agree where they thought the object appeared to be?

Yes ____  No ____

Explain why you think so in words and illustrate with a ray diagram.

B.) (10 pts) A pulse is observed to travel down a spring at a speed of 4 m/s. The spring weighs 0.5 kg and is stretched to a length of 2 m. What is its tension?
3. (15 points) In tutorial, you used a converging (convex) lens to project a real image of a brightly lit window (or door, if downstairs) on a sheet of paper. From an estimate of the distances involved, estimate the focal length of the lens you were using. Be sure to clearly state your assumptions, since grading on this problem will be mostly based on your reasoning, not on your answer.
4. (10 points) In our discussion of waves on springs, we did “the wave” in class, with people jumping up from their seats one after the other. Was this analogy of any use in helping us make sense of what was happening when a pulse moves on an elastic spring? If your answer is yes, explain why you think so and give one example of a concept, principle, or issue concerning wave motion that is clarified by the analogy. If your answer is no, discuss what the lecturer was trying to do with the analogy and explain why it did not help you.
5. (25 points) While waiting for the Queens’ banquet to be served, Alice picked up a soup spoon and looked at her reflection in the spoon’s back. The bowl of the spoon was a good approximation to a piece of a sphere of radius 15 cm.

(a) If she held her face so that her nose was 30 cm from the spoon:  (Be sure to show your work.)

1. Where did the image of her nose appear to be? (quantitative) (5 pts)  

2. Was it a real or virtual image? Explain why you think so. (5 pts)  

3. If her nose was 5 cm long, how large was the image of her nose? (5 pts)  

(b) If you did not do so as part of the previous question, carefully draw a ray diagram illustrating your conclusions. (10 pts)