Name:______________________________ ID:______________________________

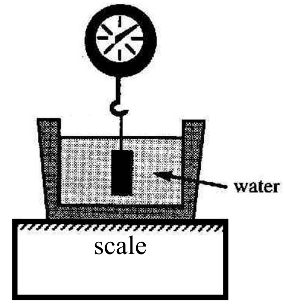
Physics 202

Final Exam

3/17/2025

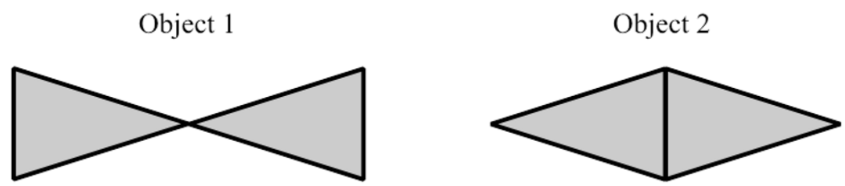
Collaboration is not allowed. Allowed on your desk are: ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating graphing scientific calculator, a page of scratch paper, writing utensils, and the exam. You will have 110 minutes to complete this exam.

For questions 1 through 9 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **12** correct answers in this section and only the first **12** filled in answers will be graded. There is no partial credit.



1. A steel block hanging from a scale is slowly lowered into a vat of water that rests on another scale. Consider the time when the block is being lowered and is partially submerged. Which of the following statements are true regarding this situation.
   - □ (a) The reading on the top scale will be getting **smaller** while the bottom scale will **stay the same value**.
   - □ (b) The reading on the top scale will be getting **larger** while the bottom scale **remains the same value**.
   - □ (c) The reading on the top scale will be getting **smaller** while the reading on the bottom scale gets **larger**.
   - □ (d) The reading on the top scale will be getting **larger** while the reading on the bottom scale gets **smaller**.
   - □ (e) The height of the water in the vat will **lower**.
   - □ (f) The pressure from the vat pushing on the bottom scale will remain a **constant**.
   - □ (g) After the block is fully submerged, but still not touching the bottom of the vat, the readings on both scales will remain **constant**.

Prompt for questions below: The two objects shown below have the same length L and the same total mass m. Both are made out of solid, uniform pieces of metal.

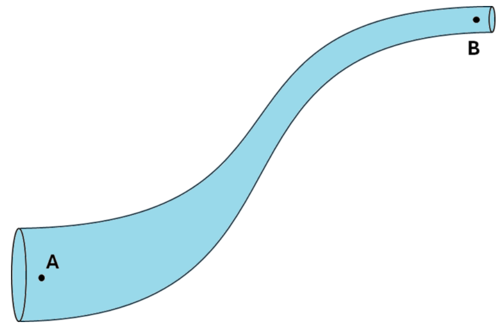


2. Is the center of mass position of Object 2 to the left of, to the right of, or at the same place as the center of mass position of Object 1?
   - □ (a) to the left of
   - □ (b) to the right of
   - □ (c) at the same place

3. For an axis of rotation passing vertically through the center of each object: Is the moment of inertia of Object 2 greater than, less than, or equal to the moment of inertia of Object 1?
   - □ (a) greater than
   - □ (b) less than
   - □ (c) equal to

4. You hear a loud shout from your friend at **80 dB**. If you move four times as far away from your friend, how loud is the shout?
   - □ (a) 20 dB
   - □ (b) 68 dB
   - □ (c) 74 dB
   - □ (d) 76 dB
   - □ (e) 92 dB

5. Water flows through a rigid pipe as shown. Which of the following statements **must be** true?
   □ (a) the water is flowing **faster** at point A than at point B
   □ (b) the water is flowing **the same speed** at points A and B
   □ (c) the water is flowing **slower** at point A than at point B
   □ (d) the pressure at point A is **higher** than the pressure at point B
   □ (e) the pressure at point A is **lower** than the pressure at point B
   □ (f) the pressure at point A is **the same** as the pressure at point B

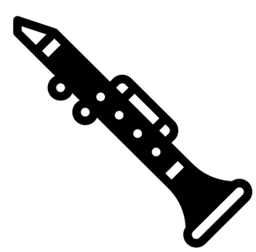


6. Sitting on the cosmic dock of the bay, you observe some radiation left over from the big bang that has a wavelength of **2.50 mm**. What is the period of this radiation? Note: the speed of the wave is the speed of light **$3x10^8$ m/s**.
   □ (a) $1.20x10^8$ s
   □ (b) $2.39x10^6$ s
   □ (c) $2.50x10^{-3}$ s
   □ (d) $4.24x10^{-9}$ s
   □ (e) $1.20x10^{-12}$ s
   □ (f) $8.33x10^{-12}$ s

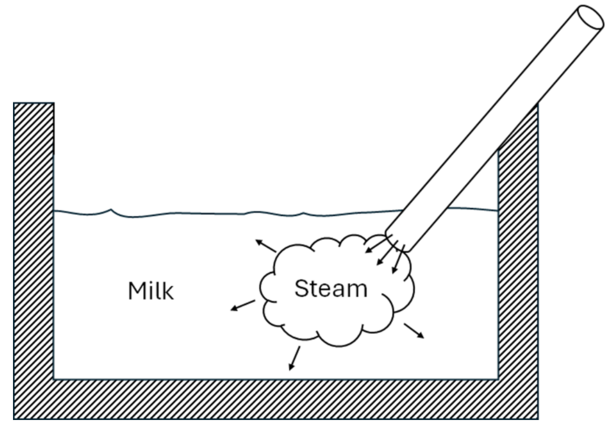
7. You have a square drum with side length **0.3 m** that absorbs a total of **0.27 J** of energy from a sound wave over **15 s**. What is the numerical value of the intensity of the wave in the SI units?
   □ (a) 0.1
   □ (b) 0.2
   □ (c) 0.3
   □ (d) 0.4
   □ (e) 0.5
   □ (f) 0.6

8. What are the units for your answer to the previous question?
   □ (a) J
   □ (b) W
   □ (c) W/m
   □ (d) W/m^2
   □ (e) dB

9. A clarinet is an instrument where players blow air through a tube open on both ends. Which of the following actions would **increase** the frequency heard by this instrument?
   □ (a) Increase the length of the clarinet.
   □ (b) Decrease the length of the clarinet.
   □ (c) Increase the temperature of the air in the room the instrument is playing.
   □ (d) Decrease the temperature of the air in the room the instrument is playing.
   □ (e) Close one of the ends of the clarinet



10. (6 points) Water vapor (steam) at approximately 100° C is pumped through a metal tube such that it exits the tube with some speed. The tube is then placed into a partially insulated (the top is open to the environment) container of room temperature (20° C) milk. The water vapor (steam) mixes with the milk and reaches an equilibrium temperature of 60° C. Assume the system in question contains the milk, liquid water, and water vapor in the container.
    Discuss the role that Conduction, Convection, and Radiation each do or do not play in the system during the time it is reaching an equilibrium temperature of 60° C. In your answer, please consider heat transfers into, out of, and within the system.



Conduction

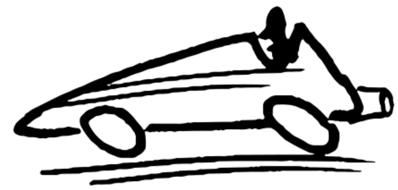
Convection

Radiation

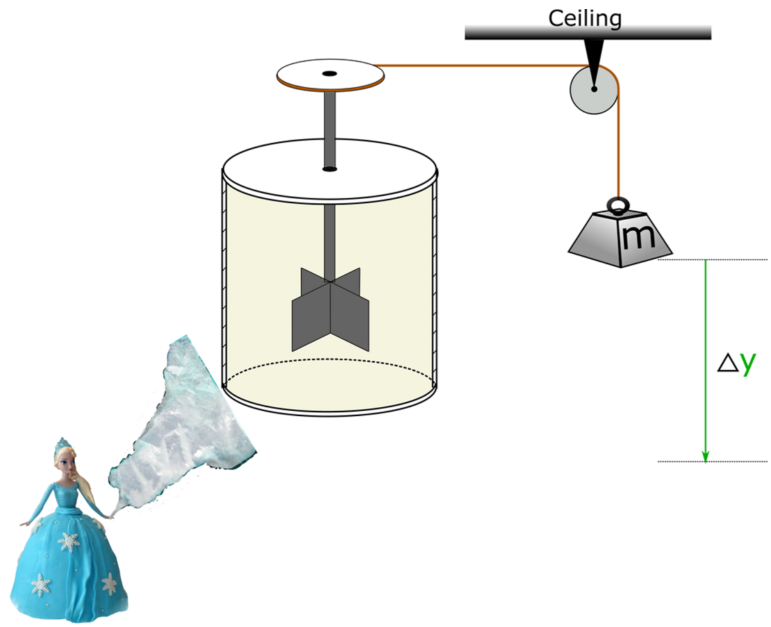
11. (6 points) Your friend is riding a bicycle with initial velocity to the left. At $t = 0$, your friend applies the brakes, causing them to slow down without slipping. Sketch and label a qualitatively accurate extended free-body diagram for the system of your friend + bicycle system during the time they are slowing down.

12. (5 points) A racecar has a horn that normally produces sound at **5000 Hz**. You are stationary and hear the horn sound at **4000 Hz** while the racecar is moving relative to you.

(a) Is the racecar moving towards you or away from you? Explain.
(b) How fast is the racecar moving?

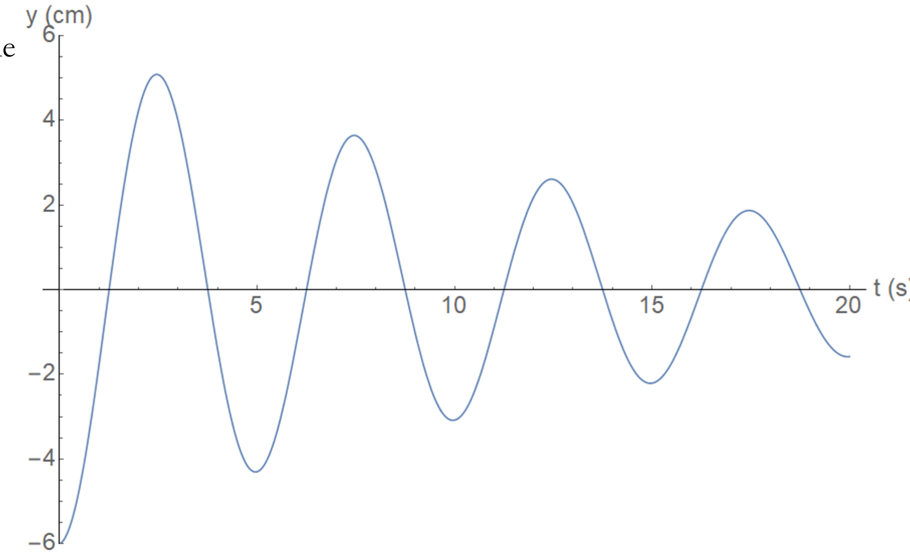


13. (10 points) Consider the system explored during lecture. A mass connected to some pulleys falls downward, causing a paddle wheel to spin inside a sealed jar filled with an ideal gas at room temperature. The jar is close enough to a bunch of ice that the gas in the jar maintains a constant temperature.
   (a) Is the change in thermal energy of the gas during this process positive, negative, or zero? Explain.
   (b) Where ultimately does the energy to spin the paddle wheel come from?
   (c) Is the work done on the gas positive, negative, or zero? Explain.
   (d) Is the heat transfer to the gas positive, negative, or zero? Explain.
   (e) Does the average speed of the air molecules in the gas increase, decrease, or stay the same during this process? Explain.



14. (12 points) You tie a small apple to a vertical spring and allow it to bounce up and down, creating the graph below of the apple's position vs. time.

(a) Is this an example of simple harmonic motion, damped harmonic motion, or non-harmonic motion?



(b) Write an equation to describe the displacement of the apple as a function of time. You should specify any and all values or constants that you include in your equation.

(c) At what time, in seconds, does the apple achieve its greatest speed during the time plotted? Explain your reasoning.

(d) Suppose you were to replace the spring with a new spring that has a larger spring constant. Give a qualitative description of how you expect the graph of the apple's position vs. time to be different.