INSTRUCTIONS
Begin each problem in the space provided on the examination sheets. If additional space is required, use the yellow paper provided to you.

Work on one side of each sheet only, with only one problem on a sheet.

Each problem is worth 20 points.

Please remember that for you to obtain maximum credit for a problem, it must be clearly presented, i.e.

- the coordinate system must be clearly identified.
- where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- units must be clearly stated as part of the answer.
- you must carefully delineate vector and scalar quantities.

If the solution does not follow a logical thought process, it will be assumed in error.

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Please circle your instructor’s name and section:

<table>
<thead>
<tr>
<th>Nauman</th>
<th>Nauman</th>
<th>Cook</th>
<th>Murphy</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30-10:20</td>
<td>11:30-12:20</td>
<td>2:30-3:20</td>
<td>9:00-10:15</td>
</tr>
</tbody>
</table>

Problem 1 ________
Problem 2 ________
Problem 3 ________
Total ____________
1. Please provide your answers in the spaces provided.

1a. (5 points) Please determine the centroid in the y-direction \( \bar{y} \) for the region under the curve given by the equation: 
\[
y = \frac{bx^3}{a^4}.
\]
The area under the curve is given as \( A = \frac{ab}{4} \). Please write your response in the box provided.

Answer 1a:
\[
\bar{y} = \frac{b}{4} \text{ units}
\]
1b. (5 points) Please determine the centroid in the x-direction, $\bar{x}$, for the shape below. Please put your response in the box provided.

Answer 1b:

$\bar{x} =$ meters
1c. (5 points) A 100-lb weight is just held in place by a 15-lb tension in the direction shown. The 15-lb tension makes a 30º angle with the horizontal axis. Please determine the static coefficient of friction, \( \mu_s \), required to maintain equilibrium and place your response in the box provided.

Answer 1c:

\[ \mu_{\text{static}} = \]
1d. (5 points) A 100-lb load is applied at the point shown is used to keep the gate shut. The gate has a width of one foot (1.00') out of the page and a pin joint at point A. Determine the maximum height, $h$, that the water can fill in order to prevent the gate from opening to within three significant digits. The specific weight of water is $\gamma_{\text{water}} = 62.4 \text{ lb/ft}^3$.

Answer 1d:

$$h = \text{ feet}$$
2. Please provide your answers in the spaces provided.

**Important:** Write all answers in these boxes

*No partial credit for this section, and no credit will be given for answers in other locations!*

**Hint:** These questions are designed to be simple, most requiring only one or two short equations. If you find yourself writing pages of equations you are almost certainly on the wrong track.

---

2a. The box shown here is about to slide down a ramp of ice due to its own weight.

![Figure for Problem 2a.](image)

What is the coefficient of friction between the ice and the box?
Refer the figure to the right for problems 2b and 2c:

2b. For P = 25 N, which of the following best describes the values of \( \mu_s \) for which the box will slip?

- A) 0 < \( \mu_s \) < 0.1
- B) 0 < \( \mu_s \) < 0.2
- C) 0 < \( \mu_s \) < 0.3
- D) 0 < \( \mu_s \) < 0.4
- E) 0 < \( \mu_s \) < 0.5
- F) all of the above
- G) none of the above

2c. If P > 33.3 N, which of the following best describes the values of \( \mu_s \) for which the box will tip?

- A) 0 < \( \mu_s \) < 0.15
- B) 0.15 < \( \mu_s \) < 0.25
- C) 0.25 < \( \mu_s \) < 0.30
- D) 0.30 < \( \mu_s \) < 0.35
- E) 0.35 < \( \mu_s \) < 0.5
- F) all of the above
- G) none of the above
2d. The box at right is about to slip. Selected forces are provided. If the normal and friction forces acting on the above box were summed to obtain a single resultant force \((R = N + f)\), what would be the direction of \(R\) measured clockwise from the vertical (see diagram in box)?

\[ P_1 = 200 \text{ N}; \quad P_2 = 120 \text{ N}; \quad mg = 75 \text{ N} \]
\[ N = 273.86 \text{ N} \]

2e. Similar problem, different parameters and angle (see fig. at right). The coefficient of friction between the block and ramp is 0.3. For what value of \(P_1\) will the block begin to slip? Use the coordinate system of the figure.

*Hint: notice that the friction force required to prevent slip is independent of \(P_1\) and is provided below.*

\[ f = 1965 \text{ lbs}; \quad P_1 = ? \text{ lbs} \]
\[ P_2 = 1500 \text{ lbs}; \quad mg = 1800 \text{ lbs} \]
Name
3. An airplane wing is fixed to the fuselage with a pin joint at point A and a support strut, BC. The distributed load is given below. It is 30 lbs./in. near the fuselage, 8 lbs./in. near the wing tip and decreases linearly.

3a. What is the total force generated by the distributed load? (3 points)
3b. Draw a free body diagram of the wing. (7 points)

3c. Calculate the magnitude of the force in the support strut BC. (5 points)
3d. Determine the reactions at point A. Write the total force at point A as a vector. (5 points)
Name