1. Do not open this exam until you are told to do so.
2. Do not write your name anywhere on this exam.
3. This exam has 8 pages including this cover. There are 6 problems. Note that the problems are not of equal difficulty, so you may want to skip over and return to a problem on which you are stuck.
4. Do not separate the pages of this exam. If they do become separated, write your UMID on every page and point this out to your instructor when you hand in the exam.
5. Please read the instructions for each individual problem carefully. One of the skills being tested on this exam is your ability to interpret mathematical questions, so instructors will not answer questions about exam problems during the exam.
6. Show an appropriate amount of work (including appropriate explanation) for each problem so that graders can see not only your answer, but also how you obtained it. Include units in your answer where that is appropriate.
7. You may use a TI-84, TI-89, TI-Nspire or other approved calculator. However, you must show work for any calculation which we have learned how to do in this course.
8. If you use graphs or tables to find an answer, be sure to include an explanation and sketch of the graph, and to write out the entries of the table that you use.
9. Turn off all cell phones, pagers, and smartwatches, and remove all headphones.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Points</th>
<th>Score</th>
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<td>1</td>
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1. [10 points] Two cab companies, Ada Autos and Blue Cabs, operate in the same city. A passenger is trying to decide which to use.

- Let \( f(u) \) be the cost, in dollars, to get a ride of \( u \) miles from Ada Autos.
- Let \( g(u) \) be the cost, in dollars, to get a ride of \( u \) miles from Blue Cabs.

Graphs of these two functions are given at right. Note that \( f(u) \) is dashed and linear, while \( g(u) \) is solid.

a. [4 points] Find the slope of the line \( y = f(u) \), and give a practical interpretation of this value in the context of the problem.

Answer: Slope = _____________

Interpretation:

b. [3 points] If someone needs to travel 9 miles, which cab company will be less expensive? Explain how you know. *You may draw on the graph and refer to it in your explanation.*

Answer (circle one): Ada Autos  Blue Cabs

Explanation:

c. [3 points] If someone has $25 to pay for a ride, which cab company will take them farther for that price? Explain how you know. *You may draw on the graph and refer to it in your explanation.*

Answer (circle one): Ada Autos  Blue Cabs

Explanation:
2. [14 points] The population of moose in Michigan has increased in recent years. Let $M$ be the population of moose in Michigan $t$ years after 1985. Some values of $M$ are given below.

<table>
<thead>
<tr>
<th>$t$</th>
<th>1</th>
<th>12</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M$</td>
<td>47</td>
<td>139</td>
<td>347</td>
</tr>
</tbody>
</table>

For each of the following questions, show work to justify your answer.

a. [3 points] Could $M$ reasonably be modeled as a linear function $h(t)$? If so, find a formula for such a model. If not, explain why not.

Answer (circle one): Linear, with formula $h(t) = \underline{\underline{\underline{\underline{}}}\underline{}}$

Not linear (justify below)

b. [5 points] Find a formula for an exponential function $g(t) = ab^t$ that could reasonably model $M$ as a function of $t$. Interpret the meaning of your value of $a$ in the context of the problem.

Answer: $g(t) = \underline{\underline{\underline{\underline{}}}\underline{}}$

Meaning of $a$ value:
Recall: The population of moose in Michigan has increased in recent years. Let $M$ be the population of moose in Michigan $t$ years after 1985. Some values of $M$ are given below.

<table>
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<tr>
<th>$t$</th>
<th>1</th>
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<tbody>
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<td>47</td>
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<td>347</td>
</tr>
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</table>

For the following questions, you will need your answer to (b).

Please rewrite it here: $g(t) = \underline{\hspace{10cm}}$

For each of the following questions, show work to justify your answer.

**c.** [2 points] According to your model from (b), what was the moose population in Michigan in 1992?

**Answer:** $\underline{\hspace{10cm}}$

**d.** [4 points] According to your model from (b), in what year would the moose population in Michigan reach 600?

**Answer:** $\underline{\hspace{10cm}}$
3. [12 points] A baker is making chocolate chip cookies.

- Let \( f(t) \) be the number of cookies the baker can make in \( t \) minutes.
- Let \( g(C) \) be the number of chocolate chips in \( C \) cookies.
- Let \( h(C) \) be the amount of time, in minutes, it takes the baker to eat \( C \) cookies.

The functions \( g \) and \( h \) have inverses.

For each of the following, give a practical interpretation of the expression in the context of the problem, or explain why the expression does not make sense in this context.

a. [3 points] \( g(4) = 60 \)

b. [3 points] \( h^{-1}(2) = 5 \)

c. [3 points] \( g(f(80)) \)

d. [3 points] \( g(h^{-1}(5)) \)
4. [8 points] On the axes below, sketch a graph of a single function $f(t)$ satisfying all of the following requirements. Your graph should clearly show the properties listed below to receive full credit.

- The domain of $f(t)$ is $[-4, 1) \cup [2, 4]$.
- $f(t)$ has vertical intercept $(0, 3)$.
- $f(t)$ has only two zeroes, at $t = -2$ and $t = 4$.
- $f(t) > 0$ for $-4 < t < -2$.
- $f(t)$ has a constant rate of change for $-4 \leq t \leq -2$.
- $f(t)$ is concave down for $-2 \leq t \leq 0$.
- $f(t)$ is concave up and decreasing for $2 \leq t \leq 4$.
- The average rate of change of $f(t)$ between $t = 2$ and $t = 4$ is $-1.5$. 

```
\begin{tikzpicture}[domain=-4:4]
\draw[very thin,color=gray] (-4,-5) grid (4,5);
\draw[->] (-4,0) -- (4,0) node[right] {$t$};
\draw[->] (0,-5) -- (0,5) node[above] {$y$};
\draw (-4,3) -- (4,3) node[below] {$y$-axis}
    (-4,0) -- (4,0) node[right] {$x$-axis};
\end{tikzpicture}
```
5. [8 points] On the moon, an astronaut throws a rock up into the air, and notes the following:

- When the astronaut first throws the rock, it starts 1 meter above the ground.
- The rock returns to a height of 1 meter after 12.4 seconds.
- The rock hits the ground after 12.5 seconds.
- The astronaut knows that the height of the rock (in meters) is a quadratic function of the time $t$ (in seconds) after it is thrown.

What was the maximum height of the rock? Give an exact answer, and provide full justification, showing all of your work and reasoning.

Answer: ______________________________
6. [8 points] A video streaming company has decided to expand from the US to the world.

- The number of paid subscribers in the US is currently 20.4 million, and is increasing by 33% every four years.
- In the world (including the US), the company has 30.3 million paid subscribers, and this number is growing by 10% annually.

In how many years, if ever, will US subscribers make up 50% of all of the company’s subscribers? Give your answer both in exact form and rounded to the nearest hundredth, and justify your answer, showing all of your work.

Answer: ________________________________