1. (12 points) Without using a calculator, evaluate the following indefinite integrals.

(a) \( \int (x^6 + 5x^3 + 13) \, dx \)

(b) \( \int \left( \frac{1}{5x^2} - \sqrt{x} \right) \, dx \)
2. (12 points) Without using a calculator, evaluate the following definite integrals.

(a) \( \int_2^5 \frac{1}{x} \, dx \)

(b) \( \int_1^2 (30x^2 - 4x) \, dx \)
3. (12 points) A town’s population has been increasing by $P'(t) = 2t + e^{0.1t}$ people per year, where $t$ represents the number of years since 1960. If the population in 1960 was $P(0) = 400$, then

(a) find a formula for $P(t)$, the population of this town $t$ years after 1960.

(b) find the population of this town in 2002.
4. (9 points) One of the ten choices below gives the value of the definite integral $\int_0^{12} f(x) \, dx$. Circle the correct choice.

\[ f(x) \]

(a) 0 \hspace{1cm} (b) 18 \hspace{1cm} (c) 36 \hspace{1cm} (d) 54 \hspace{1cm} (e) 72

(f) 90 \hspace{1cm} (g) 108 \hspace{1cm} (h) 126 \hspace{1cm} (i) 144 \hspace{1cm} (j) 162

5. (9 points) One of the ten choices below gives the value of the definite integral $\int_{-2}^{9} f(x) \, dx$. Circle the correct choice.

\[ f(x) \]

(a) -30 \hspace{1cm} (b) -24 \hspace{1cm} (c) -18 \hspace{1cm} (d) -12 \hspace{1cm} (e) -6

(f) 0 \hspace{1cm} (g) 6 \hspace{1cm} (h) 12 \hspace{1cm} (i) 18 \hspace{1cm} (j) 24
6. (9 points) The graphs of \( f(x) = x^2 - 9x + 27 \) and \( g(x) = 3x \) are sketched below and the area between the two curves is shaded in. Determine the exact area of this shaded region and circle the appropriate answer from the choices given.

(a) 24  
(b) 26  
(c) 28  
(d) 30  
(e) 32
(f) 34  
(g) 36  
(h) 38  
(i) 40  
(j) 42
7. (8 points) Which one of the following most clearly states the Fundamental Theorem of Calculus?

(a) Rate of change of a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (total change in that quantity) \( dt \)

(b) Rate of change of a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (total change in that quantity) \( dt \)

(c) Total change in a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (total change in that quantity) \( dt \)

(d) Total change in a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (rate of change of that quantity) \( dt \)

(e) Total change in a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (rate of change of that quantity) \( dt \)

(f) Total change in a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (rate of change of that quantity) \( dt \)

(g) Rate of change of a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (rate of change of that quantity) \( dt \)

(h) Rate of change of a quantity from \( t = a \) to \( t = b \) equals \( \int_a^b \) (rate of change of that quantity) \( dt \)

8. (8 points) Which one of the following most clearly states the Fundamental Theorem of Calculus?

(a) \( \int_a^b F(t) \, dt = F'(b) - F'(a) \)

(b) \( \int_a^b F(t) \, dt = F'(a) - F'(b) \)

(c) \( \int_a^b F(t) \, dt = F(a) - F(b) \)

(d) \( \int_a^b F(t) \, dt = F(b) - F(a) \)

(e) \( \int_a^b F'(t) \, dt = F'(a) - F'(b) \)

(f) \( \int_a^b F'(t) \, dt = F'(b) - F'(a) \)

(g) \( \int_a^b F'(t) \, dt = F(b) - F(a) \)

(h) \( \int_a^b F'(t) \, dt = F(a) - F(b) \)
9. (9 points) Due to a terrible storm, the water in a river is rising. The people in a nearby town are worried that flooding will occur. They have sandbags along both sides of the river which will stop the flooding as long as the total rise in the water-level is less than 15 inches. The rate at which the water is rising is decreasing until the storm finally stops 24 hours later, and is recorded every 6 hours in the table below.

<table>
<thead>
<tr>
<th># hours</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td># inches per hour</td>
<td>1.5</td>
<td>0.6</td>
<td>0.3</td>
<td>0.2</td>
<td>0</td>
</tr>
</tbody>
</table>

(a) By computing a left-hand Riemann sum, a right-hand Riemann sum, and then averaging these values, give three different estimates for the number of inches that the water-level of the river rises during this 24-hour period.

(b) Circle the statement which is most accurate for this 24-hour period. **Note:** You cannot obtain credit for this problem unless your estimates in part (a) are correct.

i. The town definitely floods.

ii. The town probably floods, but there is a slight chance that it does not flood.

iii. The town definitely does not flood.

iv. The town probably does not flood, but there is a slight chance that it does flood.
10. (12 points) Alice was standing in a room with a 13-foot ceiling. She is normally only 4 feet tall, but after drinking liquid from a very strange bottle, she started to grow at a rate of \( r(t) = \frac{t}{12} \) feet per second, where \( t \) represents the number of seconds since she first drank from the bottle. Will she bump her head on the ceiling during the first 15 seconds after drinking from the bottle? You need to fully justify your answer – a simple yes or no will not earn you any points!

Note: To find out your course grade, print your email address or phone number below, and I will contact you later this afternoon.

Contact Info: ____________________________________________