1. (10 points) Consider sorting $n$ numbers stored in array $A$ by first finding the smallest element of $A$ and exchanging it with the number stored in $A[1]$. Then find the second smallest element of $A$, and exchange it with $A[2]$. Continue in this manner for the first $n-1$ elements of $A$. This algorithm, called SELECTION-SORT, is given below. Assume the input and output are as specified for the sorting problem on page 16 of our textbook.

SELECTION-SORT($A$):
1. $n = A$.length
2. for $j = 1$ to $n - 1$
3. smallest = $j$
4. for $i = j + 1$ to $n$
5. if $A[i] < A[\text{smallest}]$
6. smallest = $i$
7. exchange $A[j]$ with $A[\text{smallest}]

(a) (1 point) Give the line number of the basic operation in the algorithm

(b) (2 points) Why does the outer for loop of the algorithm need to run for only the first $n-1$ elements?

(c) (5 points) Are there best-case and worst-case asymptotic running times for SELECTION-SORT? If so, give the best-case and worst-case running times of the algorithm in $O$ and $\Omega$ notation. If not, give the worst-case running time in $\Theta$ notation. Explain your answer.
2. (4 points) Use the definitions of $O$, $\Theta$, and $\Omega$ to determine whether the following assertions are true or false. Briefly justify your answers.

a. $n^2(n + 1)/2 \in O(n^3)$

b. $n(n + 1)/2 \in O(n)$

c. $n(n + 1)/2 \in \Theta(n^3)$

d. $n(n + 1)/2 \in \Omega(n)$

3. (4 points) For each of the following functions, indicate the class $\Theta(g(n))$ the function belongs to. Show your work in simplifying these expressions to arrive at each answer.

a. $(n^2 + 1)^{10}$

b. $\sqrt{10n^2 + 7n + 3}$

c. $2^{n+1} + 3^{n-1}$

d. $\lceil \lg n \rceil$

4. (4 points) Answer Yes or No and provide a brief justification for each question below:

a. Is $2^{n+1} \in O(2^n)$?

b. Is $2^{2n} \in O(2^n)$?