Question 2 (10 points) Broadcast Algorithms

1. YES.
The Atomic Broadcast algorithm satisfies validity, agreement, and integrity in the given system model. What remains is to show that the FIFO order property is satisfied. Assume that process $p$ invokes $FBcast(m_1)$ and then later $FBcast(m_2)$. Since the communication channels are FIFO, the sequencer will receive $m_1$ before $m_2$, and so it will give $m_1$ a lower sequence number than $m_2$. Thus, every process will deliver $m_1$ before $m_2$.

2. YES (under the assumption that the only messages that are sent are broadcast messages)
As stated above, validity, agreement, and integrity are satisfied. Suppose $CBcast(m_1)$ happens before $CBcast(m_2)$. Then: If the same process broadcast $m_1$ and $m_2$, all processes deliver $m_1$ before $m_2$ by the argument for part 1. If different processes $p$ and $q$ broadcast $m_1$ and $m_2$, respectively, then $q$ must have delivered $m_1$ before it broadcast $m_2$. Since messaging is reliable and all processes are correct, eventually all processes will deliver $m_2$. By the total order property, all processes will deliver $m_1$ before $m_2$.

The answer NO is also correct under the assumption that a causal relationship between $ABcast(m_1)$ and $ABcast(m_2)$ is established by a non-broadcast message. In this case, if $p$ broadcasts $m_1$, then $p$ sends a message to $q$, and finally $q$ broadcasts $m_2$, the sequencer could receive $m_2$ before $m_1$ and give it a lower sequence number.

Question 3 (10 points)

1. A larger replication factor $K$ means that there are more copies of the data object, and thus the data is more likely to survive catastrophic failures (where the object could be lost). A larger value of $K$ also means there are more available copies, since it is less likely that all replicas will be unavailable simultaneously. In Amazon Dynamo, specifically, a larger value of $K$ means that it is more likely that a get request will access some copy of the data (e.g., a recent shopping cart), rather than send the request to a site that does not have a copy of the object (empty shopping cart). (there are other correct answers)

2. Selecting $W > R$ means that a client needs to contact more sites to execute a write than to execute a read operation. This configuration is beneficial in a system where reads are more common than writes; in this case, the reads can be balanced among the replicas. The configuration is also beneficial in a system where reads must be fast. An example could be Submitty, where grades are not updated very often, but students log in frequently to check their grades.