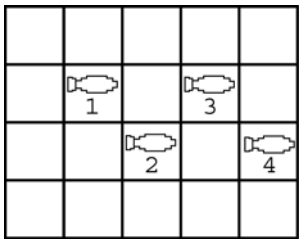
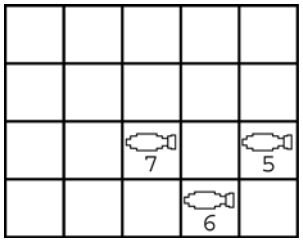
3. This question involves reasoning about the code from the Marine Biology Simulation case study. A copy of the code is provided as part of this exam.

   Consider defining a new type of fish called `ZigZagFish`, which moves in a zigzag pattern. The first time a `ZigZagFish` moves, it will move to the location forward and to the right if that cell is empty. This is illustrated in the figure below as the move from position 1 to position 2. In each subsequent move, the `ZigZagFish` will attempt to move to the forward diagonal location on the side opposite its previous move (the second move will be to the left forward diagonal, the third move will be to the right forward diagonal, and so on). When the `ZigZagFish` has successfully moved, its direction does not change. If the `ZigZagFish` is unable to move, it stays in the same location but reverses its direction. After reversing its direction, the next time the `ZigZagFish` moves, it will attempt to move in the same diagonal direction as it tried before reversing. The diagrams below show the path followed by a single `ZigZagFish` object as a result of multiple moves.



   Now consider what happens when the `ZigZagFish` attempts to move forward diagonally to the left from position 4. This move is blocked, and consequently the `ZigZagFish` stays in the same location but reverses its direction. This is illustrated as position 5 in the diagram below. From position 5, the `ZigZagFish` moves forward diagonally to the left, and from position 6, it moves forward diagonally to the right to position 7.



Copyright © 2005 by College Entrance Examination Board. All rights reserved.
Visit apcentral.collegeboard.com (for AP professionals) and www.collegeboard.com/apstudents (for AP students and parents).

The `ZigZagFish` class is defined by extending the `Fish` class and overriding the `move` and `nextLocation` methods. Because a `ZigZagFish` alternates its pattern of movement, a private instance variable `willZigRight` keeps track of the direction of the next movement.

The partial declaration for class `ZigZagFish` is shown below.

```
public class ZigZagFish extends Fish
{
  private boolean willZigRight;
    // true indicates the next move should be forward to the right
    // false indicates the next move should be forward to the left


  public ZigZagFish(Environment env, Location loc)
  {
    super(env, loc);
    willZigRight = true; // direction of the next move
  }


  // returns the forward diagonal cell to the left or right of this fish
  // (depending on willZigRight) if that cell is empty;
  // otherwise, returns this fish's current location
  // postcondition: the state of this ZigZagFish is unchanged
  protected Location nextLocation()
  {  /* to be implemented in part (a) */  }


  // moves this ZigZagFish diagonally (as specified in nextLocation) if
  // possible; otherwise, reverses direction without moving;
  // after a diagonal move, willZigRight is updated
  protected void move()
  {  /* to be implemented in part (b) */  }


  // other constructors, generateChild, and other methods not shown
}
```

Copyright © 2005 by College Entrance Examination Board. All rights reserved.
Visit apcentral.collegeboard.com (for AP professionals) and www.collegeboard.com/apstudents (for AP students and parents).