1. $f(x) : \mathbb{R} \to \mathbb{R}$ is continuous at x_0 if

   a) $\forall \epsilon > 0, \exists \delta > 0$ s.t. $\forall x, |x - x_0| < \delta \Rightarrow |f(x) - f(x_0)| < \epsilon$
   b) $\forall \epsilon > 0, \exists \delta > 0$ s.t. $x \in (x_0 - \delta, x_0 + \delta) \Rightarrow f(x) \in (f(x_0) - \epsilon, f(x_0) + \epsilon)$
   c) $\forall \epsilon > 0, \exists \delta > 0$ s.t. $(x_0 - \delta, x_0 + \delta) \subseteq f^{-1}(f(x_0) - \epsilon, f(x_0) + \epsilon)$
   d) All of the above
   e) More than one answer from a, b and c holds, but not all three

2. Does the following argument demonstrate that $\mathbb{R}_l$ is not contained in $\mathbb{R}$?

   Look at $0 \in [0, 1)$, which is a basis element of $\mathbb{R}_l$. For any basis element in $\mathbb{R}$, say (a,b), if $0 \in (a, b)$ then $a < 0$. Hence $\frac{a}{2} \in (a, b)$, but $\frac{a}{2} < 0$, and so $\frac{a}{2} \notin [0, 1)$. Thus $(a, b) \nsubseteq [0, 1)$, and so $\mathbb{R}_l$ is not contained in $\mathbb{R}$.

   a) Yes it does
   b) This argument does not demonstrate that, but there is an argument that does.
   c) It is not possible to demonstrate since $\mathbb{R}_l$ is contained in $\mathbb{R}$

3. Which of the following are continuous?

   a) If X has the discrete topology, then any function mapping X to any Y.
   b) $f : \mathbb{R} \to \mathbb{R}_l$ given by $f(x) = x$
   c) $f : \mathbb{R}_l \to \mathbb{R}$ given by $f(x) = x$
   d) All of the above
   e) More than one answer from a, b and c holds, but not all three

4. Which of the following are true about open sets?

   a) An open set is a set which is not closed
   b) If (X, τ) is a topology with a basis, then an open set $U \in \tau$ is a set so that for each $x \in U$, $\exists$ a basis element B_x so that $x \in B_x \subseteq U$. Since the arbitrary union of open basic sets is open, we can think of an open set as the union of all B_x, and in this way think of U as being made up of snapshots of basic opens.
   c) One of the great skills mathematicians develop is to break problems up into smaller pieces that are easier to work on. In topology we do the same thing - lots of times it is hard to prove something about a big space, and so we take a little snapshot of it and analyze things locally (via open sets).
   d) All of the above
   e) More than one answer from a, b and c holds, but not all three

5. Which of the following are true about closed sets.

   a) A closed set C is a set whose complement $X \setminus C$ is open
   b) The arbitrary union of closed sets is closed.
   c) The arbitrary intersection of closed sets is closed.
   d) Any of the above are possible
   e) More than one answer from a, b and c holds, but not all three

6. Which of the following are true about closed sets?

   a) In the lower limit topology on R, [a,b) is both open and closed.
   b) In the discrete topology on R, [a,b) is both open and closed.
   c) In the cofinite topology on R (the same as the Zariski topology on R), [a,b) is neither open nor closed.
   d) Any of the above are possible
   e) More than one answer from a, b and c holds, but not all three

7. Can an orange peel be flattened in a way that shows that an orange peel is homeomorphic to a plane?

   a) No - it must be cut or have far away areas glued together before stretching, violating continuity
   b) Yes

8. Which of the following are topologically equivalent to a donut?

   a) mug with one handle
   b) mug with two handles
   c) ball
   d) vest

9. Which of the following are Hausdorff?
   1. $\mathbb{R}^n$ with the standard topology.
   2. Any set with the discrete topology.
   3. The Sierpinski space.
   4. The natural numbers with the cofinite topology.
   5. Any space with a sequence that converges to two different points.
   6. Any metrizable space with the topology induced from the metric.

   a) all of the above
   b) all but 3
   c) all but 3 and 5
   d) Just 1, 2, and 6
   e) Just 1 and 2

10. Which are homeomorphic to $\mathbb{R}$ with the standard topology?

   a) $(-1, 1)$
   b) $[0, 1)$
   c) $[0, 1]$
   d) $\mathbb{R}_l$
   e) none of the above

11. Which of the following pairs are homeomorphic?
1. Sierpinski space $\sim \{0,1\}_{\text{discrete}}$?
2. $[1,2) \sim \{0\} \cup (1,2)$?

a) both pairs 1 and 2

b) just pair 1

c) just pair 2

d) neither pair

12. Which of the following are true regarding connected spaces?
1. A space is connected if there does not exist a separation of X
2. Every subspace of a connected space is connected
3. The arbitrary union of a family of connected subspaces is connected

a) Just 1

b) Just 1 and 2

c) Just 1 and 3

d) All are true

e) None are true

13. Which of the following are true regarding connected spaces?
1. The lower limit topology on $\mathbb{R}$ is not connected, but the standard topology on $\mathbb{R}$ is connected.
2. To prove that $[0,1]$ is connected, we assumed for contradiction that it is disconnected, and then arrive at a contradiction because the least upper bound of the set not containing 1 is not in either of the open sets separating $[0,1]$.
3. If $f : X \to Y$ is a continuous surjection and Y is connected, then X is connected.

a) Just 1

b) Just 1 and 2

c) Just 1 and 3

d) All are true

e) None are true