1. (a) Here is one such partition: \{\{a, b\}, \{c, d\}, \{e, f\}, \{g, h\}\}.
   
   (b) Yes, every partition of a set determines an equivalence relation on the set.

2. (a) False. If \(A\) is not empty, then there is no function from \(A\) to the empty set.
   
   (b) False. The power set of the empty set is the set \(\{\emptyset\}\).
   
   (c) True, by definition.
   
   (d) True, by definition.
   
   (e) False. A relation is one-to-one if its inverse is well defined.
   
   (f) False. That is because the cardinality of \(\{1, 2, 3, 4\}\) is greater than the cardinality of \(\{a, b, c\}\).

3. (a) i. The relation is reflexive, i.e., \(x^2 \geq 0\) for all \(x \in \mathbb{R}\).
   
   ii. The relation is symmetric, i.e., if \(xy \geq 0\), then \(yx \geq 0\), for all \(x, y \in \mathbb{R}\).
   
   iii. The relation is transitive, i.e., if \(xy \geq 0\) and \(yz \geq 0\), then \(xz \geq 0\), for all \(x, y, z \in \mathbb{R}\).
   
   iv. The relation is not anti-symmetric. If \(xy \geq 0\), then it is not true that \(yx \not\geq 0\).
   
   (b) \(R\) is an equivalence relation, because it is reflexive, symmetric, and transitive.
   
   (c) \(R\) is not a partial order, because it is not anti-symmetric.
   
   (d) \(R\) is not a total order, because it is not a partial order.

4. Arrange the pairs of integers in rows and columns so that the pair \((i, j)\) is in row \(i\) and column \(j\). Then trace out the successive diagonals from the left edge upwards to the right to the top edge. The pairs are listed in the order in which they appear on these diagonals:

\[
(0, 0), (1, 0), (0, 1), (2, 0), (1, 1), (0, 2), \ldots.
\]

Another description of the same sequence is to begin with \((1, 1)\). Then define the successor of \((i, j)\) to be

\[
\text{Successor of } (i, j) = \begin{cases} 
(i - 1, j + 1), & \text{if } i > 0; \\
(i + j + 1, 0), & \text{if } i = 0.
\end{cases}
\]

5. Suppose that the set is countable. Then the paths may be listed \(p_0, p_1, p_2, \ldots\).
Create a new path \(p\) as follows: if the \(i\)-th branch on path \(p_i\) is \(L\), then the \(i\)-th branch of path \(p\) is \(R\), and vice versa. Then \(p\) is a path through the tree, but it does not equal any of the listed paths, because for any \(i\), \(p\) differs from \(p_i\) in the \(i\)-th position. This is a contradiction. Therefore, the set of all such paths is uncountable.
6. (a) Add loops at each vertex:

(b) Make every arrow two-way:

(c) Complete all possible triangles:

7. Cut the string up into block containing exactly two 1s and ending with a 1. The pattern for such a block is $0^*10^*1$. To repeat this pattern, use the Kleene star: $(0^*10^*1)^*$. Finally, to allow for trailing 0s, add $0^*$ on the end. The result is $(0^*10^*1)^*0^*$. 