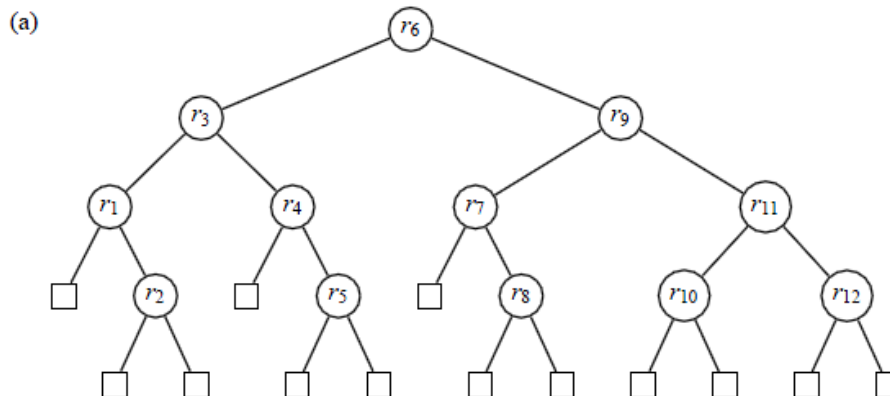


### Exercise

Suppose a **Binary Search Tree** contains 12 nodes, named  $\{r_1, r_2, r_3, \dots, r_{11}, r_{12}\}$ .

- (a) Draw the tree. Indicate which node is the root node. Include external nodes in your diagram.
- (b) What are the ancestors of node  $r_5$
- (c) List the nodes that are at level 2.
- (d) What is the maximum number of comparisons a computer would need to make to find a record in this tree?
- (e) Explain the purpose of the external nodes.

### Solutions



- (b) The ancestors of  $r_5$  are  $r_6$ ,  $r_3$  and  $r_4$ .
- (c) The nodes at level 2 are  $r_1$ ,  $r_4$ ,  $r_7$  and  $r_{11}$
- (d) The maximum number of comparisons that the computer would need to make to match any existing record in a binary tree is  $\lceil \log_2 n \rceil$ , where  $n$  is the number of nodes in the tree. In this case it would be  $\lceil \log_2 12 \rceil = 4$
- (e) The external nodes (*leaf* nodes) indicate that there are no further records on that particular path. *i.e.* if you are at an external node whose value is not the same as the record you are looking up, then there is no matching record in the tree. They also allow for the insertion of new records at those points.