7) **8pts** Draw all the (nonisomorphic) simple (no multiple edges or loops), undirected graphs having 4 vertices and 3 or fewer edges. Separate your graphs so it is possible to distinguish them. (grading: 2 points deducted for each mistake (extra, duplicate, or missing graph)).

![Graphs](image)

remark: This is similar to problem #4 on page 212, which was assigned as homework, and which we also worked in class.

8) **8pts** Consider a dominoes set in which each domino contains a pair of letters A,...,Z. Each pair of letters occurs exactly once. For example there is just one domino that contains an A and a B, and there is just one that contains two As. Is it possible to arrange all of the dominoes into one big circle? Explain. (The usual domino conventions apply -- when two dominoes touch, the touching letters must be the same). Hint: Think Eulerian!

Consider a complete graph with 26 nodes labelled with the letters A,...,Z. The arcs of this graph represent the dominoes, and an Eulerian cycle represents a way of arranging the dominoes in a circle. An Eulerian cycle exists if and only if every node has even degree. However, in this graph every node has odd degree (=27, double letters are represented by loops - actually it doesn't matter whether you draw the loops since they do not affect the existence or nonexistence of an Eulerian cycle). Hence there exists no Eulerian cycle and no way of arranging the dominoes in circle.

remark: This is #8a and 8b on page 238, which was assigned as homework. The solution is also on the class web site. The only difference is that instead of using dominoes based on six or seven numbers, this problem here uses dominoes based on 26 letters.