

**LARSON—MATH 255—CLASSROOM WORKSHEET 28**  
**Graphs & Problems**

1. (a) Start the Chrome browser.
- (b) Go to `http://cocalc.com`
- (c) Login using **your VCU email address** .
- (d) Click on our class Project.
- (e) Click “New”, then “Worksheets”, then call it **c28**.
- (f) For each problem number, label it in the Sage cell where the work is. So for Problem 2, the first line of the cell should be `#Problem 2`.

### Graphs & Graph Theory

A **graph** is a mathematical object consisting of *dots* and *lines* (also called *vertices* and *edges*). The *order* of a graph is the number of vertices it has. The *size* of a graph is the number of edges it has. We can create our own graph using the `Graph()` constructor, and the `add_vertex()` and `add_edge()` methods.

2. Try the following Sage Interact which shows some famous graphs and uses a *dictionary*:

```
@interact
def i_graph(graph=selector(["icosahedron", "dodecahedron",
    "tetrahedron", "octahedron"],
    label="Select a graph", default="tetrahedron")):
    dict={"icosahedron":graphs.IcosahedralGraph(),
        "dodecahedron":graphs.DodecahedralGraph(),
        "tetrahedron":graphs.TetrahedralGraph(),
        "octahedron":graphs.OctahedralGraph()}

    g=dict[graph]
    order = g.order()
    size=g.size()
    print("The {} has {} vertices and {} edges".format(graph,order,size))
    g.show()
```

3. Let's get acquainted with paths, cycles, stars, and complete graphs. Try:

```
@interact
def i_graph(graph=selector(["path", "cycle", "star", "complete"],
    label="Select a graph", default="path"),order=slider(3,20,1,3)):
    dict={"path":graphs.PathGraph(order),
        "cycle":graphs.CycleGraph(order),
        "star":graphs.StarGraph(order),
        "complete":graphs.CompleteGraph(order)}

    g=dict[graph]
    order = g.order()
    size=g.size()
    print("This graph has {} vertices and {} edges".format(graph,order,size))
    g.show()
```

### Problems

4. **Ramanujan!** 2, 9, 16, etc. can be written (uniquely) as the sum of 2 cubes ( $1^3 + 1^3$ ,  $1^3 + 2^3$ ,  $2^3 + 2^3$ , etc.). Find the smallest integer which can be written as the sum of 2 cubes in 2 different ways.
5. **Challenge.** Try the problem at <http://projecteuler.net/problem=8>. How will you get that number into your program??? Do not type it in by hand.

### Getting your classwork recorded

When you are done, before you leave class...

- Click the “Make pdf” (Adobe symbol) icon and make a pdf of this worksheet. (If Cocalc hangs, click the printer icon, then “Open”, then print or make a pdf using your browser).
- Send me an email with an informative header like “Math 255—c28 worksheet attached” (so that it will be properly recorded).
- Remember to attach today's classroom worksheet!