Exercises for Alex Benton's lectures (2/2)

All work must be submitted by email no less than 48 hours before supervision.

1. Prove the Poincaré Formula.

2. **Curvature -** The *one-ring* of a vertex is the (usually ordered) set of vertices which lie exactly one edge away from a given vertex on a polyhedral surface. Given a vertex *V* with one-ring $\{v_0,\ldots,v_{n-1}\}$, give a formula for the discrete curvature of the surface at *V*.

3. Write an implementation of a ray / triangle intersection routine, using real code or pseudocode. Your method should return true if the ray hits the triangle, else false.
   a. Generalize your method for an arbitrary convex polygon.

4. **OpenGL**
   a. Describe the OpenGL rendering pipeline. Explain how the abstract rendering pipeline (local → world → camera → projected → screen) is expressed in OpenGL's concrete implementation.
   b. Explain Vertex Array Objects and Vertex Buffer Objects.

5. **Shaders**
   a. Describe the inputs, outputs, and usage of *vertex shaders*.
   b. Describe the inputs, outputs, and usage of *fragment shaders*.
   c. How do you read *texture data* in GLSL?
   d. Describe three possible uses for *tesselation shaders*.
   e. What is a *compute shader*?

6. **OpenGL and Shaders**
   The diffuse shaders given in lecture implement *flat shading*.
   a. Modify them to implement *Phong shading*.
   b. Modify them to add *specular highlights*.
      i. Several websites allow you to test out shader code "live" with WebGL. Use your favorite search engine to find one to test your results, or write your own WebGL layer (or adapt the sample code from lectures.) Please include screenshots.