**Worksheet 4 – Part 6: Answer the following questions:**

**a) What is the difference between Phong shading and Phong lighting (the Phong reflection model)?**

Phong is real looking light model that describes how the light is reflected on surfaces and consist of three parts: ambient, diffuse, and specular lighting. For each 3D point on the object’s surface Phong illumination model returns a real number which is the associated light intensity.

Phong shading is a technique that computes a shaded surface based on the color and illumination model (e.g., Phong reflection model) at each pixel. Concrete, surface normals at the polygon's points are used to compute a surface normal for each pixel, which in turn creates a more accurate RGB value for each pixel.

The Phong reflection model is just an illumination model, meanwhile, Phong shading evaluates an illumination model at every pixel resulting in colored pixels.

**b) What is the difference between flat shading, Gouraud shading, and Phong shading? List pros and cons of each.**

* Flat shading is the most simple and efficient way to specify a color for an object. A single color is defined for face. The main idea behind this model is that uses only one surface normal per polygon. The color itself is uniform on that polygon.
  + - Pros: it’s fast, only one computation per polygon is needed
    - Cons: gives low polygon models a faceted look
* Gouraud shading is a per-vertex color computation. What this means is that the vertex shader must determine a color for each vertex and pass the color as an out variable to the fragment shader. Since this color is passed to the fragment shader as an in varying variable, it is interpolated across the fragments thus giving the smooth shading.
  + - Pros: has a problem with specular reflections and can introduce anomalies known as Mach bands
    - Cons: removes the discontinuity which exists in flat shading model
* In Phong shading, unlike Gouraud shading, which interpolates colors across polygons, a normal vector is linearly interpolated across the surface of the polygon from the polygon's vertex normals. The surface normal is interpolated and normalized at each pixel and then used in a reflection model, e.g., the Phong reflection model, to obtain the final pixel color.
  + - Pros: gives more accurate results, displays more realistic highlights on a surface and reduces the Mach band effect
    - Cons: is more computationally expensive than Gouraud shading since the reflection model must be computed at each pixel instead of at each vertex

**c) What is the difference between a directional light and a point light?**

* A point light is a light source with a specific position somewhere in a world that illuminates in all directions. It is present in most 3D applications where light sources are simulated only to illuminate an area close to them and not the entire scene. Therefore, the objects closer to the sources will be lighter and the rest darker.
* You can think of the directional light as the light coming from the Sun, an infinite light. All the light rays are parallel. The computations required for directional lights are considerably less than other types of light source because the angle at which any ray is approaching an object is always the same

**d) Does the eye position influence the shading of an object in any way?**

Since lighting depends heavily on the angles, it can influence the shading of an object. To do per-pixel lighting, certain data that is available in the vertex shader must be passed to the fragment shader in varying variables. This includes, for example, either object coordinates or eye coordinates for the surface point.

**e) What is the effect of setting the specular term to (0,0,0)?**

Specular highlights will not appear.

**f) What is the effect of increasing the shininess exponent (𝛼𝛼)?**

The more the shininess coefficient is increased, the smaller the highlight becomes. This is happening because the object manages to reflect the light progressively better instead of scattering it.

**g) In what coordinate space did you compute the lighting?**

The light is computed in the eye space.