

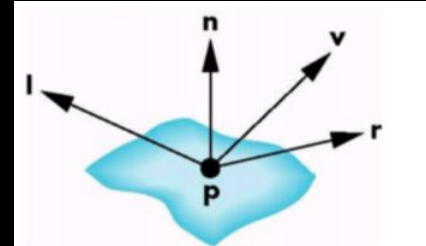
# HW3

2021 Introduction to Computer Graphics

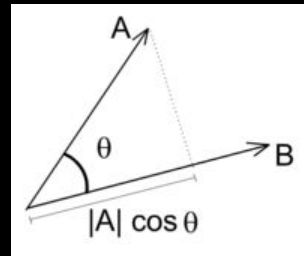
# How to determine light intensity

- We can simply use the included angle of the reflection and view vectors.

- $L$  is a vector towards the light source
- $V$  is a vector towards the camera position
- $R$  is a vector which is the reflection of  $L$
- $N$  is a vector which is the normal of the point  $P$

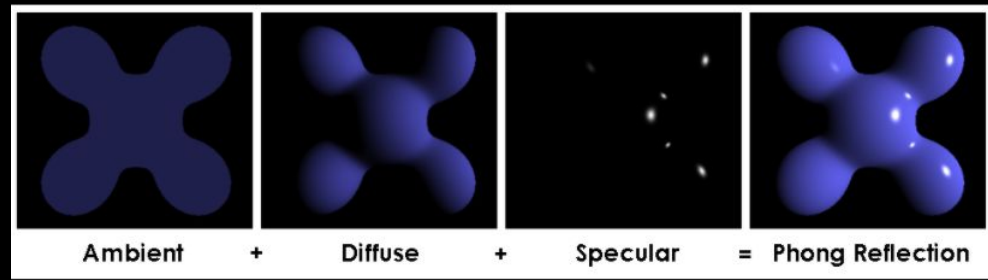


# How to determine light intensity



- If two vectors are unit vectors. Then we can get  $\cos\theta$  by doing dot products of the two vectors.  
$$A \cdot B = |A| |B| \cos \theta$$
- The smaller  $\theta$  is, the larger  $\cos \theta$  is. According to the Phong reflection model, we can determine the light intensity based on  $\cos \theta$ .
- If  $\cos \theta < 0$ ,  $\theta$  must be bigger than  $90^\circ$ . In this case, this position cannot be illuminated.

# Phong shading



**K** is the reflectivity of each component of the material

- Parameters of model material:

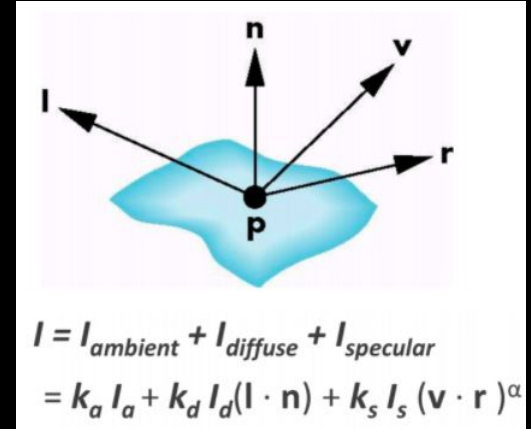
1. Ambient reflectivity ( $K_a$ ) : 1 1 1
2. Diffuse reflectivity ( $K_d$ ) : 1 1 1
3. Specular reflectivity ( $K_s$ ) : 1 1 1

**L** is the intensity of each component of the light.

- Parameters of light:

1. Ambient intensity ( $L_a$ ) : 0.2 0.2 0.2
2. Diffuse intensity ( $L_d$ ) : 0.8 0.8 0.8
3. Specular intensity ( $L_s$ ) : 0.5 0.5 0.5
4. gloss (Specular shininess factor) : 25

**$\alpha$**  is the glossiness of the material.



# Phong shading - pseudocode

```
void main()  
{  
    object_color = texture2D(Texture, texcoord);  
  
    ambient =  $L_a * K_a * \text{object\_color}$ ;  
    diffuse =  $L_d * K_d * \text{object\_color} * \text{dot}(L, N)$ ; // must > 0  
    specular =  $L_s * K_s * \text{pow}(\text{dot}(V, R), \text{gloss})$ ;  
  
    color = ambient + diffuse + specular;  
}
```



# Toon shading - pseudocode

```
void main()
```

```
{
```

```
    object_color = texture2D(Texture, texcoord);
```

Decide a level by calculating the included angles between the Light and normal vectors

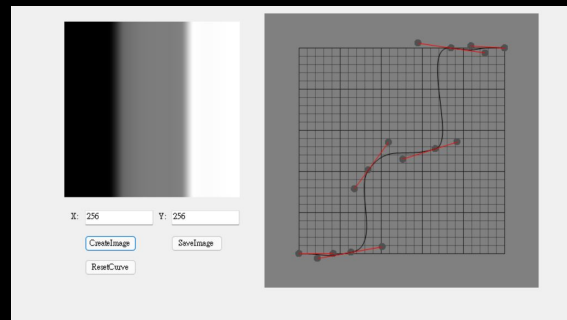
```
    if (level > 0.75) intensity = 0.8;
```

```
    else if (level > 0.30) intensity = 0.6;
```

```
    else intensity = 0.4;
```

```
    Color = Kd * object_color * intensity ;
```

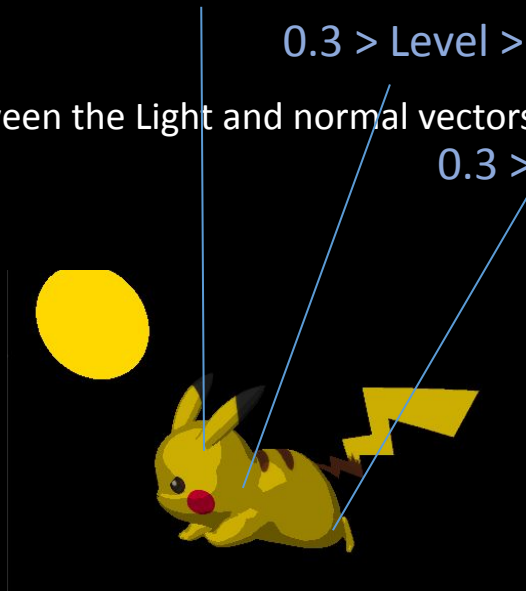
```
}
```



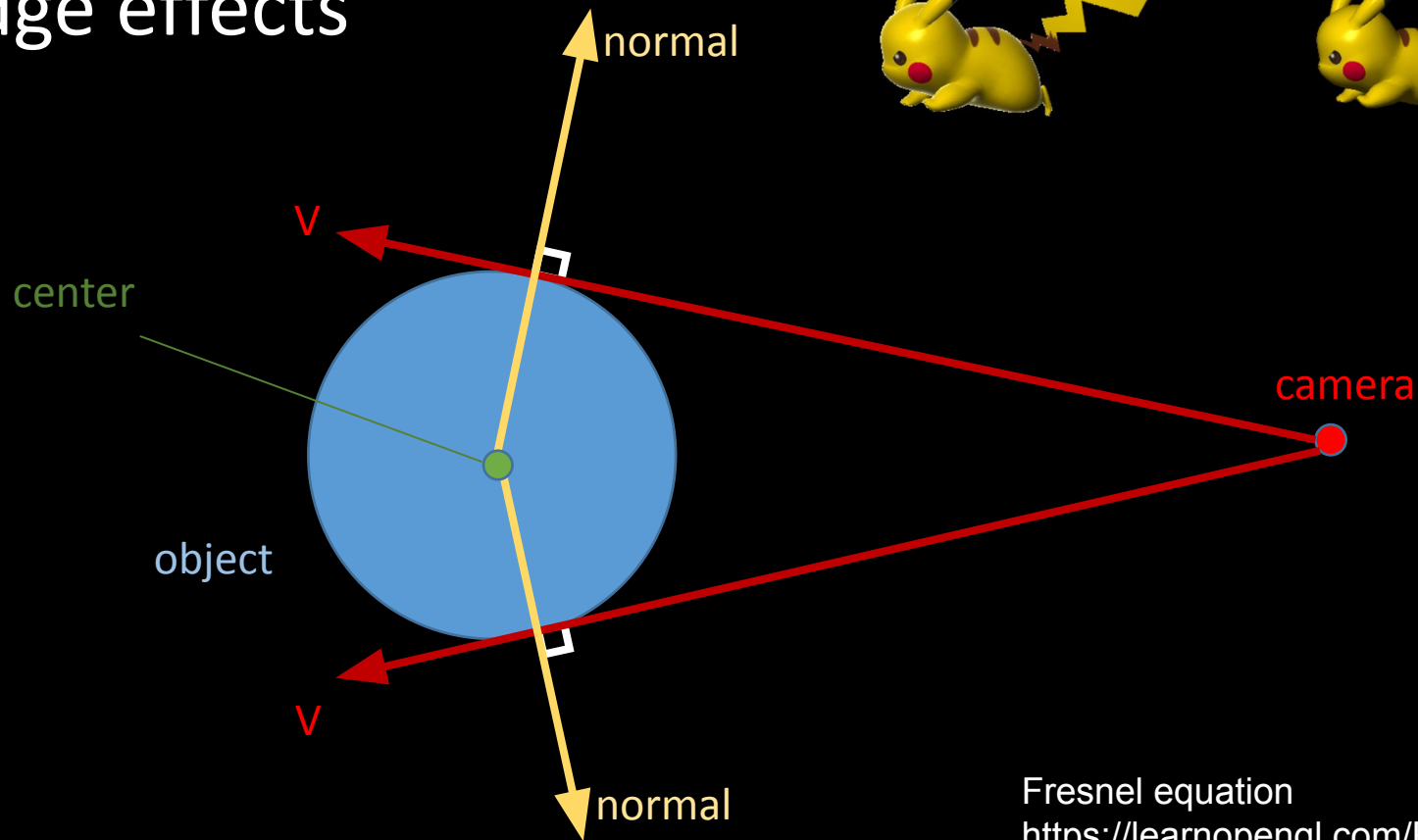
Level > 0.75

0.3 > Level > 0.75

0.3 > Level



# Edge effects

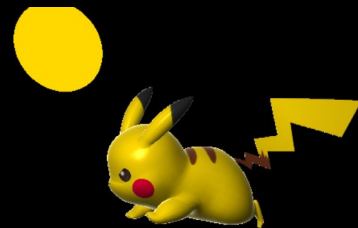


Fresnel equation  
<https://learnopengl.com/PBR/Theory>

# Homework 3

- Goal :

1. Phong shading
2. Toon shading
3. Phong shading + Edge effects & Toon shading + Edge effects



Phong shading



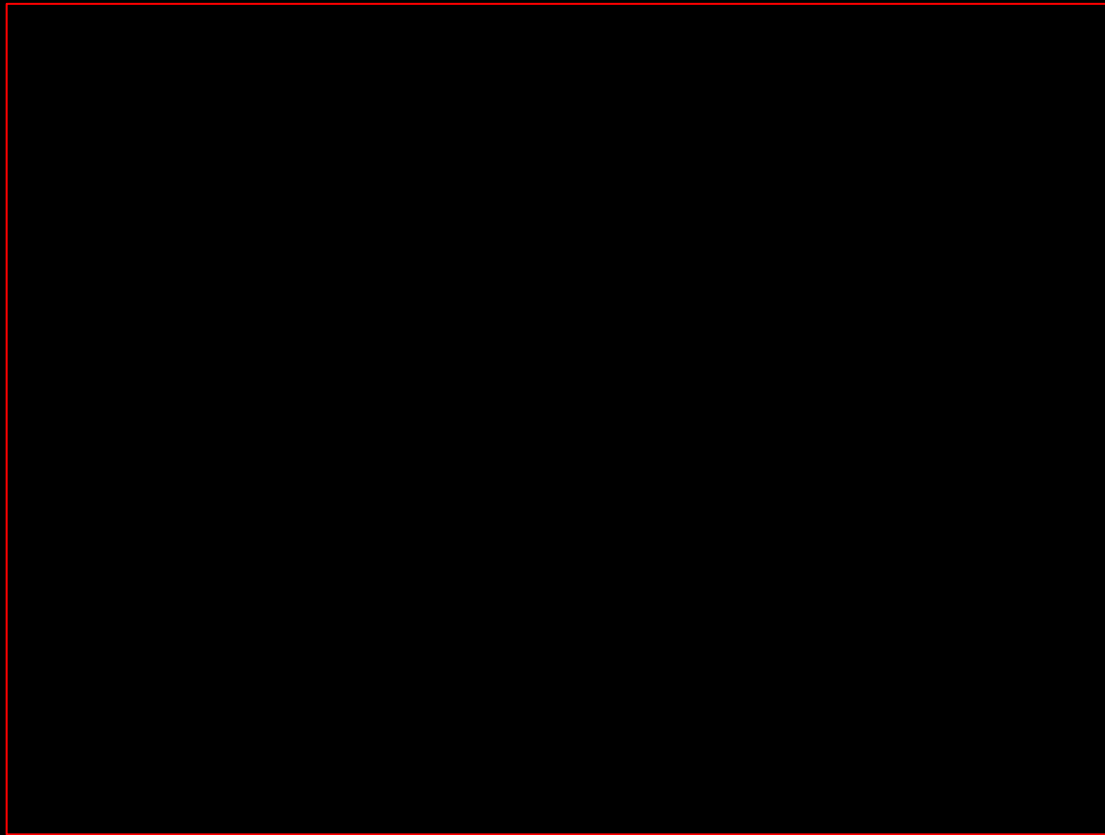
Toon shading



Edge effects



# Demo Video



# Homework 3 (配分)

1. create shaders and programs you need and can switch them correctly.(5%)
2. Pass all variable to shaders and trigger by Uniform(5%)
3. Implement **Phong shading** via shader (40%)
4. Implement **Toon shading** via shader(30%)
  - # at least define 3 levels.
5. Implement **Edge effects with Phong & Toon shading** via shader(10%)
  - # must clearly see the edge
  - # The color of the edge is not specified
6. Report (10%)

# Homework 3 (report)

- Please specify your name and student ID in the report.
- Explain how you implement the above shading/effects.  
(ex: how I get the vector  $L$ . I do  $\text{dot}(L, N)$  for what.....etc.)
- Describe the problems you met and how you solved them.

# Homework 3 (繳交規則)

1. DeadLine: 2022/ 1 / 10 23: 59:59
2. Penalty of 10% of the value of the assignment per late week.

If you submit your homework late, the score will be discounted.

submit between (1/11 - 1/17) : Your final score \* 0.9

submit between (1/18 - 1/23) : Your final score \* 0.8

# Restrictions !!

- Your GLSL version should `>= #version 330`
- Deprecated shader syntaxes are not allowed, e.g. `attribute`, `varying`
- You are only allowed to pass uniform data to shader using `glUniform*` series function
- Using built-in uniform variables in shader is forbidden!
  - (That is, you **cannot** use `gl_ModelViewMatrix` or `gl_NormalMatrix` ...etc)
  - The only `gl_XXX` term should be in your shader code is `gl_Position`.

# Restriction modification (12/22) : you can define variable in shader but don't hard code it  
(Ex. `"WorldLightPos"` = "particular" if in some situation)

# Upload Format

1. If your uploading format doesn't match our requirement, there will be penalty to your score. (-5%)
2. Please hand in the whole **project file** and **report** (.pdf) as **HW3\_<yourstudentID>.zip** to e3 platform.  
e.g. HW3\_0716XXX.zip

#project file要載下來就可以demo

# Reference

Learning OpenGL : <https://learnopengl.com/Lighting/Basic-Lighting>

E3 Forum : <https://e3.nycu.edu.tw/mod/forum/view.php?id=251401>

#tool

- GLSL language integration :

<https://marketplace.visualstudio.com/items?itemName=DanielScherzer.GLSL>