Problem sheet for chapter 10: Light and material models

Problem 1:

Consider the following `three.js` code:

```
const spotlight = new THREE.SpotLight({
                    color:"rgb(0.5, 0.25, 0.75)"
                  });
spotlight.position.set(0, -1, Math.sqrt(3));
scene.add(spotlight);
const mat = new THREE.MeshPhongMaterial( {
              color: 0xff0000,
              specular: "rgb(0, 0.5, 1)",
              emissive: "rgb(0, 0, 1)",
              shininess: 2
            });
const obj = new THREE.Mesh(new THREE.
  PlaneGeometry(1,1), mat);
```

The plane `obj` is oriented such that it is located in the x-y plane.

(a) A perspective camera is configured as

```
camera.position.set(0,1, Math.sqrt(3));
camera.lookAt(0,0,0);
```

What is the color of the pixel at the origin as seen from this camera?

(b) What is the color of the pixel when the camera position is changed by the following code?

```
camera.position.set(0,Math.sqrt(3),1);
```

Hint: values of sine and cosine functions

$\cos(0)$	$\cos(\pi/6)$	$\cos(\pi/4)$	$\cos(\pi/3)$	$\cos(\pi/2)$
$\sin(\pi/2)$	$\sin(\pi/3)$	$\sin(\pi/4)$	$\sin(\pi/6)$	$\sin(0)$
1	$\sqrt{3}/2$	$\sqrt{2}/2$	$1/2$	0

Lösung:

The emissive component sets the blue channel to 1. The red channel is due to diffuse reflection and the green channel due to specular reflection.

(a) **Diffuse:** Using $\cos(\varphi) = \sqrt{3}/2$ yields

$$c_{\text{diff}} = (0.5, 0.25, 0.75) \cdot (1, 0, 0) \cdot \sqrt{3}/2 = (\sqrt{3}/4, 0, 0) \approx (0.43, 0, 0)$$

Specular: The shininess factor plays no role because $\theta = 0$.

$$c_{\text{spec}} = (0.5, 0.25, 0.75) \cdot (0, 0.5, 1) \cdot \sqrt{3}/2 = (0, \sqrt{3}/16, 3\sqrt{3}/8) \approx (0, 0.11, 0.65)$$

Adding c_{diff} and c_{spec} to the emissive component (and taking into account saturation) gives an overall color of $\approx (0.43, 0.11, 1)$ (Han Purple).

(b) Now we have $\theta = 30°$. Only the specular component changes which gets multiplied by (shininess $n = 2$):

$$\cos(\theta)^n = \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3}{4},$$

i.e.

$$c_{\text{spec}} = (0, 3\sqrt{3}/64, 9\sqrt{3}/32) \approx (0, 0.08, 0.49)$$

which gives an overall color of $\approx (0.43, 0.08, 1)$