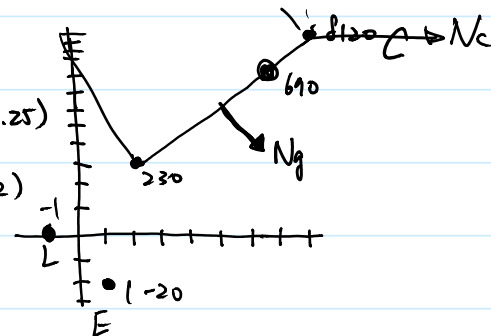Written homework #3

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1. normal at B is $\vec{N_B}$, since they are equal weight for both $\vec{N_F}$ and $\vec{N_G}$.

$\vec{N_B} = \dfrac{\vec{N_F} + \vec{N_G}}{2}$ (all the weight values will cancel out)

$\vec{N_f} = (-1, -1, 0)$ ⟶ $\vec{N_f} + \vec{N_g} = (0, -2, 0)$

$\vec{N_g} = (1, -1, 0)$

$\dfrac{\vec{N_f} + \vec{N_g}}{2} = \dfrac{(0, -2, 0)}{2} = (0, -1, 0)$ already norm

$\vec{N_B} = (0, -1, 0)$

2.

$\begin{pmatrix} k_a I_a = (0.5, 0.2, 0.5)(0.5, .1, 0.5) = (0.25, 0.02, .25) \\\\ k_d I_L = (0.3, 0.8, 0.2)(.9, 1, 1) = (.27, .8, .2) \\\\ k_s I_L = (.5, 1, 1)(.9, 1, 1) = (.45, 1, 1) \end{pmatrix}$

Use the rightmost vertex on each face ⟹ C

normal $\boxed{\hat{N_c}} = \dfrac{N_c}{\|N_c\|} = \dfrac{(0.9, 0.5, 0)}{\sqrt{.9^2 + .5^2}} = (0.874, 0.486, 0)$

$L - C = (-1, 0, 0) - (8, 12, 0) = (-9, -12, 0)$

$\boxed{\hat{L_c}} = \dfrac{L-C}{\|L-C\|} = \dfrac{(-9, -12, 0)}{\sqrt{9^2 + 12^2}} = (-0.6, -0.8, 0)$

$\boxed{\hat{N_c} \cdot \hat{L_c}} = (0.874 \cdot -0.6) + (0.486 \cdot -0.8) = \boxed{-0.9132}$ clamp to 0

$V = P_{eye} - P = E - C = (1, -2, 0) - (8, 12, 0) = (-7, -14, 0)$

$\boxed{\hat{V}} = \dfrac{V}{\|V\|} = \dfrac{(-7, -14, 0)}{\sqrt{7^2 + 14^2}} = (-0.447, -0.894, 0)$

$\boxed{R} = reflection = 2\vec{N_c}(\vec{N_c} \cdot \vec{L_c}) - \vec{L_c}$

$= 2(\ 0\ )(0.874, 0.486, 0) - (-0.6, -0.8, 0)$

$= (0.6, 0.8, 0)$

$\boxed{V \cdot R} = \langle -0.447, -0.894, 0 \rangle \cdot \langle 0.6, 0.8, 0 \rangle$

$= (-0.447)(0.6) + (-0.894)(0.8)$

$= -0.983 \not\geq 0$ clamp to 0

⟶ $\vec{N} \cdot \vec{L} = -0.9132 \not\geq 0$ the light is behind the surface. ⟶

$\llcorner_\bullet\vec{N}\cdot\vec{L} = -0.9132 \neq 0$ the light is behind the surface.

$I_{diffuse} = (0)(.27,.8,.2) = (0,0,0)$ the diffuse and specular are $\langle 0,0,0 \rangle$

$I_B = (0.25, .02\ 0.25)$ ⎫ So the only illumination is the

$I_D = (0.25, .02, 0.25)$ ⎬ ambinent.

$I_C = (0.25, .02, 0.25)$ ⎭

3. Gouraud

$\hat{N}_B = \dfrac{N_B}{\|N_B\|} = \dfrac{(0,-1,0)}{\sqrt{1^2}} = (0,-1,0)$

$L - B = (-1,0,0) - (2,3,0) = (-3,-3,0)$

$\hat{L}_B = \dfrac{L-B}{\|L-B\|} = \dfrac{(-3,-3,0)}{\sqrt{3^2+3^2}} = (-0.707, -0.707, 0)$

$\boxed{\hat{N}_B \cdot \hat{L}_B} = (0 \cdot -0.707) + (-1)(-0.707) + (0 \cdot 0) = 0.707 \geq 0$ ✓

$V_B = P_{eye} - P_B = E - B = (1,-2,0) - (2,3,0) = (-1,-5,0)$

$\hat{V}_B = \dfrac{E-B}{\|E-B\|} = \dfrac{(-1,-5,0)}{\sqrt{1^2+5^2}} = (-0.196, -0.981, 0)$

$R_B = 2\hat{N}_B(\hat{N}_B \cdot \hat{L}_B) - \hat{L}_B = 2(0.707)(0,-1,0) - (-0.707, -0.707, 0) = (0.707, -0.707, 0)$

$\boxed{\hat{V}_B \cdot R_B} = (-0.196)(0.707) + (-0.981)(-0.707) + 0 = 0.555 \geq 0$ ✓

$I_{diffuse} = (0.707)(.27, .8, .2) = (0.19, 0.566, 0.141)$

$I_{specular} = (0.555)^{10}(.45, 1, 1) = (0.001, 0.003, 0.003)$

$I_{amb} = (0.25, 0.02, 0.25)$

$I_B = (0.441, 0.589, 0.394)$

$I_C = (0.25, 0.02, 0.25)$

$I_D = \dfrac{1}{3}(0.441, 0.589, 0.394) + \dfrac{2}{3}(0.25, 0.02, 0.25)$

$= (0.314, 0.210, 0.298)$

4. Phong

Normal $\hat{N}_D = \dfrac{\hat{N}_B + \hat{N}_c}{\|N_B + Nc\|} = \dfrac{(0,-1,0) + (0.874, 0.486, 0)}{\|N_B + Nc\|}$

$\qquad = \dfrac{(0.874, -0.514, 0)}{\sqrt{.874^2 + .514^2}} = (0.862, -0.507, 0)$

$\hat{L}_D = \dfrac{L-D}{\|L-D\|} = \dfrac{(-1,0,0)-(6,9,0)}{\|L-D\|} = \dfrac{(-7,-9,0)}{\sqrt{7^2+9^2}} = (-0.614, -0.789, 0)$

$\hat{N} \cdot \hat{L} = (0.862)(-0.614) + (-0.507)(-0.789) + 0 = -0.129 \neq 0$

$\hat{V}_D = \dfrac{P_{eye}-D}{\|P_{eye}-D\|} = \dfrac{E-D}{\|E-D\|} = \dfrac{(1,-2,0)-(6,9,0)}{\|E-D\|} = \dfrac{(-5,-11,0)}{\sqrt{5^2+11^2}} = (-0.414, -0.910, 0)$

$R_D = 2\hat{N}(N \cdot L) - \hat{L}_D = 2(0)(0.862, -0.507, 0) - (-0.614, -0.789, 0)$

$\qquad = (0.614, 0.789, 0)$

$R_D \cdot \hat{V}_D = (0.614)(-0.414) + (0.789)(-0.910) + 0 = -0.853 \neq 0$

$I_{diffuse} = k_d I_L = (0.3, 0.8, 0.2)(.9, 1, 1)(0) = (0,0,0)$

$I_{specular} = k_s I_L = (.5, 1, 1)(.9, 1, 1)(0)^{10} = (0,0,0)$

Illumination for D is $I_{ambient} + I_{diffuse} + I_{specular} = (0.25, 0.02, 0.25)$