Problem 1

When there is light, the V_1 will decrease and V_2 will increase. V_1 and V_2 always add up to the voltage of the battery (roughly). The transistor roughly acts as a variable resistor since there is light, its resistance will increase (reflected as the increase in the V_2).

Problem 2

$$V_2 = 0.06V, V_1 = 8.70V$$

the $R_{\mathrm{DS}}^{(\mathrm{dark})} = \frac{0.06\mathrm{V}}{8.70\mathrm{V}} \cdot 1\mathrm{k}\Omega = 0.00690\mathrm{k}\Omega$

Problem 3

$$V_2 = 8.55\mathrm{V}, V_1 = 0.06\mathrm{V}$$

the $R_{\mathrm{DS}}^{(\mathrm{light})} = \frac{8.55\mathrm{V}}{0.06\mathrm{V}} \cdot 1\mathrm{k}\Omega = 142.5\mathrm{k}\Omega$