Solution to Practice Problem of the Day #05:

Part (a) –

- We start with Resistor R_a. We see by inspection that the **voltage source** V_2 applies directly across this resistor, so the voltage drop V_a across R_a must be V_2. This means that by **Ohm's Law:** $V_a = R_a I_a$ the current through this resistor is given by:

$$I_a = \frac{V_a}{R_a}$$

$$\boxed{I_a = \frac{V_2}{R_a}}$$

- Next, we look at Resistor R_b. We see that moving from one side of the resistor to the other side of the resistor requires going through two **voltage sources** V_2 and V_3 we go through each in he "forward" (enter negative, leave positive) direction. So the total voltage drop across R_b must be $V_b = V_2 + V_3$ and therefore the current is given by **Ohm's Law** as:

$$I_b = \frac{V_b}{R_b}$$

$$\boxed{I_b = \frac{V_2 + V_3}{R_b}}$$

- We see that the **voltage source** V_1 is applied across both of these resistors together. In other words, the **voltage drop** from the "top" of R_c to the "bottom" of R_d must be V_1. The total voltage drop is just the sum of the two drops:

$$V_1 = V_c + V_d$$

Applying **Ohm's Law:**

$$V_1 = I_c R_c + I_d R_d$$

Resistors R_c and R_d are **in series** and this means that the current through each of these two is the same: $I_c = I_d$. Therefore:

$$V_1 = I_c R_c + I_c R_d$$

Solving for I_c:

$$V_1 = I_c(R_c + R_d)$$

$$\boxed{I_c = I_d = \frac{V_1}{R_c + R_d}}$$

Equivalently, we could note that the equivalent resistance of R_c and R_d in series is given by: $R_{equiv} = R_c + R_d$ so therefore:

$$V_1 = I_{equiv} R_{equiv}$$

$$I_{equiv} = \frac{V_1}{R_{equiv}}$$

$$\boxed{I_c = I_d = I_{equiv} = \frac{V_1}{R_c + R_d}}$$

Part (b):

- Closing the switch has **no impact** on the fact that the voltage source V_2 is still applied across resistor R_a. Nor does it impact the fact that voltage $V_2 + V_3$ is applied across R_b. So the value for these current **remain unchanged:**

$$\boxed{\mathcal{I}_a = \frac{V_2}{R_a}}$$

$$\boxed{\mathcal{I}_b = \frac{V_2 + V_3}{R_b}}$$

- We see that with the switch closed, the voltage across R_c is now V_1. So we simply apply **Ohm's Law**:

$$\mathcal{I}_c = \frac{V_c}{R_c}$$

$$\boxed{\mathcal{I}_c = \frac{V_1}{R_c}}$$

- We see that with the switch closed, the voltage drop across R_d must be zero. (There is an unbroken conducting line from the "top" of R_d to the "bottom" of R_d.) So again we simply apply **Ohm's Law**:

$$\mathcal{I}_d = \frac{V_d}{R_d}$$

$$\mathcal{I}_d = \frac{0}{R_d}$$

$$\boxed{\mathcal{I}_d = 0}$$