Why are the logarithmic properties true?

1. Complete the blanks and boxes to show $\log_b QR = \log_b Q + \log_b R$
   a. Let $\log_b Q = x$.
   b. Write the equation in 1a in exponential form: ____________
   c. Let $\log_b R = y$.
   d. Write the equation in 1c in exponential form: ____________
   e $QR = b^x \cdot \square$ if we substitute the results from 1b and 1d.
   f. $QR = b^{\square}$ by properties of exponents. (Hint: See the first rule in the second blue box on page 139 of your text.)
   g. Now write the equation in 1f in logarithmic form: $(QR) = b^{\square}$ means $\log_{\bigcirc} \square = \square$
   h. Eliminate x and y in the equation in 1g by substituting the equations in 1a and 1c:

   ____

2. Complete the blanks and boxes to show $\log_b Q^k = k \cdot \log_b Q$
   a. Let $\log_b Q = x$.
   b. Write the equation in 2a in exponential form: ____________
   c. $Q^k = (\square)^k$ if we substitute 2b.
   d. $Q^k = b^{\square}$ by properties of exponents. (Hint: See third rule in the second blue box on page 139 of your text.)
   e. Now write the equation in 2d in logarithmic form: $(Q^k) = b^{\square}$ means $\log_{\bigcirc} \square = \square$
   f. Eliminate x in the equation in 2e by substituting the equation in 2a:

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3. Complete the boxes to show $\log_b \frac{Q}{R} = \log_b Q - \log_b R$

Since $\frac{1}{R} = R^{\square}$, we have $\log_b \frac{Q}{R} = \log_b (Q \cdot \square)$

$= \log_b (Q \cdot R^{\square})$

$=$ ____________________ using the property in 1h above.

$=$ ____________________ using the property in 2f above.