$$A^{a_1} \times A^{a_2} \times \cdots \times A^{a_n} = \begin{cases} A^{a_1} & A^{a_2} & \cdots & A^{a_n} \\ F(f \circ_{a_1, \dots, a_n}(g_1, \dots, g_n)) \downarrow & & & \downarrow F(f) \\ A & & & & \downarrow F(f) \end{cases}$$