Q3 (c):

Suppose that $d_0 > 0$, $P = (\overbrace{0, 0, \cdots, 0}^{p})^T$ and $Q = (\overbrace{d_0, 0, \cdots, 0}^{p})^T$ then making a simplifying assumption that error is multivariate normal, we get:

$$P^m = P + \varepsilon \qquad \varepsilon \sim N_p(0, I) \qquad \varepsilon = (\varepsilon_i)_{i=1,p}$$
$$Q^m = Q + \eta \qquad \eta \sim N_p(0, I) \qquad \eta = (\eta_i)_{i=1,p}$$

The points P^m and Q^m have "measurement error."

$$\begin{aligned}
\mathbb{E}[d(P^m, Q^m)^2] &= \mathbb{E}[\|Q^m - P^m\|^2] \\
&= \mathbb{E}[\|Q + \eta - (P - \varepsilon)\|^2] \\
&= \mathbb{E}[(d_0 + \eta_1 - \varepsilon_1)^2 + (\eta_2 - \varepsilon_2)^2 + \cdots + (\eta_p - \varepsilon_p)^2] \\
&= \mathbb{E}[d_0^2 + d_0(\eta_1 - \varepsilon_1) + (\eta_1 - \varepsilon_1)^2 + \cdots + (\eta_p - \varepsilon_p)^2] \\
&= d_0^2 + \mathbb{E}[(\eta_1 - \varepsilon_1)^2 + \cdots (\eta_p - \varepsilon_p)^2] \\
&= d_0^2 + Var(\eta_1 - \varepsilon_1) + Var(\eta_2 - \varepsilon_2) + \cdots + Var(\eta_p - \varepsilon_p) \\
&> d_0^2
\end{aligned}$$

Also notice that if we assume $(\eta_i - \varepsilon_i) = N(0, c)$ for $i = 1, \cdots, p$ then

$$\begin{aligned}
\mathbb{E}[d(P^m, Q^m)^2] &= d_0^2 + \sqrt{c}\,\mathbb{E}[X] \qquad X \sim \chi^2_p \\
&= d_0^2 + \sqrt{c}\,p. \qquad \text{As } \mathbb{E}[X] = p.
\end{aligned}$$