1. Does there exist a finite $T_1$ topological space that is not Hausdorff?

2. Let $\{(X_j, d_j)\}_j$ be a collection of metric spaces. Prove that the metric topology on $(\prod_j X_j; \sum_j 2^{-j} \frac{d_j}{1+d_j})$ is the same as the product of the metric topologies.

3. Prove that every separable metric space is second countable.

4. Problem 15 in Chapter 4 of Folland.

5. Problem 34 in Chapter 4 of Folland. (Let $X$ a set and $\{f_\alpha : X \to X_\alpha\}$ a collection of maps whose codomains are topological spaces. The weak topology on $X$ wrt $\{f_\alpha\}$ is the weakest topology for which each $f_\alpha$ is continuous.)

6. Problem 36 in Chapter 4 of Folland