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Problem Set 4.

1. Prove that the pushout of a cofibration is a cofibration.
I.e., if

$$\begin{array}{ccc} A & \longrightarrow & B \\ {\scriptstyle f}\big\downarrow & & \big\downarrow{\scriptstyle g} \\ X & \longrightarrow & Y \end{array}$$

is a pushout square, where f is a cofibration, then g is a cofibration.

2. Show that a <u>weak</u> homotopy equivalence $f: X \to Y$ induces isomorphisms $f_*: H_*(X,G) \cong H_*(Y,G)$ and $f^*: H^*(Y,G) \cong H^*(X,G)$ for all coefficients G.

3. Show that if $S^a \to S^b \to S^c$ is a fibration sequence of spheres, then there are lots of restrictions on a, b, c. For example, use the fact that $S^b \to S^c$ cannot be nullhomotopic.

4. Find an example of a space that does not have the homotopy type of a CW complex. See Hatcher exercise 4.1.10.

5. (Hatcher 4.1.13).

6. (Hatcher 4.1.14).

7. (Hatcher 4.2.7). Use the fact that $\pi_n(X,x)$ is a $\mathbb{Z}[\pi_1(X,x)]$-module, as described at the beginning of Section 4.1 and in exercise 4.1.4.