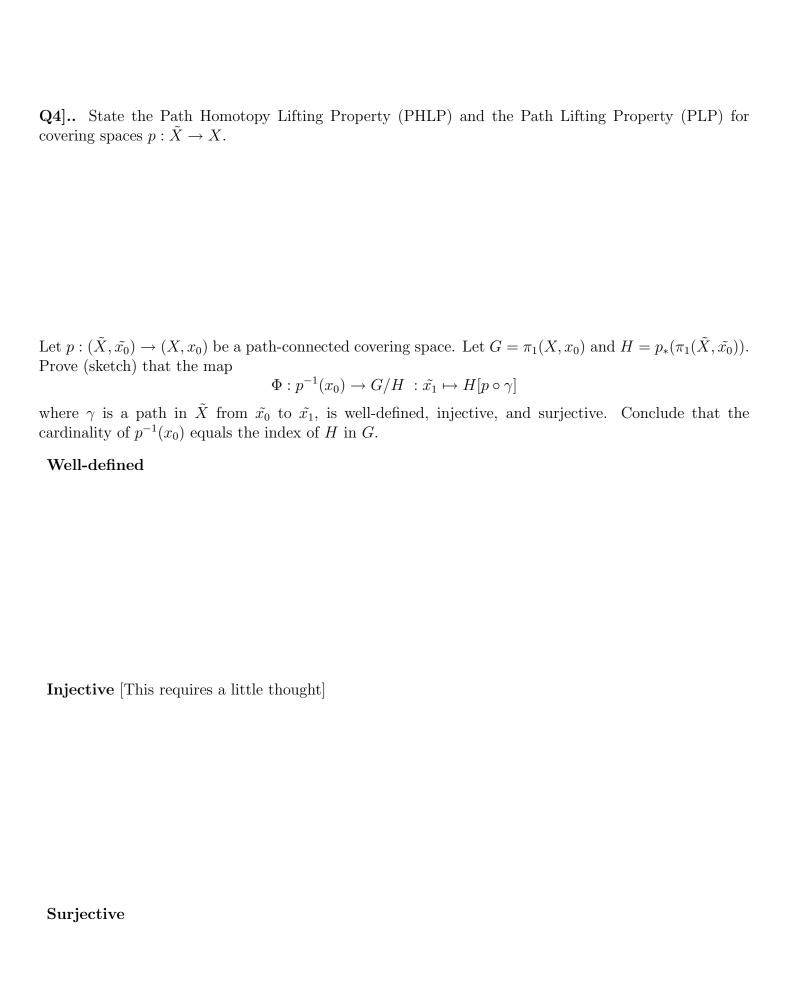
Math 5863-001	Final Examination Friday, May 9, 2003, 8:00 Answer as many questions as y	
Q1] Write down a Wirti	nger presentation for $\pi_1(S^3 \setminus Fi)$	g-8 knot).
Determine (showing your	work) the abelianization of $\pi_1(S)$	$7^3 \setminus \text{Fig-8 knot}$).
	exist a retraction from the space he Fig-8 knot) to the boundary	the X (which is defined to be S^3 minus an open torus of X .

Q2].. Use covering spaces (as in the proof of the Kurosh theorem) to give a complete description of the kernel of the homomorphism

$$\psi : \langle a \, | \, a^2 \rangle * \langle b \, | \, b^3 \rangle \to \text{Perm}(\{1, 2, 3\}) : a \mapsto (12), : b \mapsto (123)$$

Q3].. Here are two infinite regular covering spaces of the bouquet of two circles. Determine the automorphism group in each case. [Say how the automorphisms act on the covering spaces, and say why you have listed all of the automorphisms in each case]



Q5].. By constructing a covering space of the bouquet of two circles, give a detailed description of the subgroup H of the free group $F_{\{a,b\}}$ which is generated as follows:

$$\langle\,aba,\,baa,\,abba\bar{b},\,b\bar{a}\bar{b}a\,\rangle$$

- Determine the index of H in $F_{\{a,b\}}$.
- Is H free (if so describe a free basis for H)?
- Is H normal in $F_{\{a,b\}}$?
- Check whether $a^3b^3 \in H$.