2. Observe that $|ab| = |a|\,|b|$.

4. Let E denote any even permutation and O any odd. Observe that $\phi(EE) = \phi(E) = 0 = 0 + 0 = \phi(E) + \phi(E)$. $\phi(EO) = \phi(O) = 1 = 0 + 1 = \phi(E) + \phi(O)$. The other cases are similar.

7. $(\sigma\phi)(g_1 g_2) = \sigma(\phi(g_1 g_2)) = \sigma(\phi(g_1)\phi(g_2)) = \sigma(\phi(g_1))\sigma(\phi(g_2)) = (\sigma\phi)(g_1)(\sigma\phi)(g_2)$. It follows from Theorem 10.3 that $|G/\text{Ker } \phi| = |H|$ and $|G/\text{Ker } \sigma\phi| = |K|$. Thus. $[\text{Ker } \sigma\phi : \text{Ker }] = |\text{Ker } \sigma\phi/\text{Ker } \phi| = |H|/|K|$.

14. Observe that $\phi(6 + 7) = \phi(1) = 3$ while $\phi(6) + \phi(7) = 8 + 1 = 9$.

19. Since $|\text{Ker } \phi|$ is not 1 and divides 17, ϕ is the trivial map.