Problem 1.

(a) Use Equation 10.132 to determine the mass of the W, in terms of $v = \frac{\mu}{\lambda}$ and $q = g_w\sqrt{\frac{\hbar c}{4\pi}}$. Thus, confirm Equation (12.1)
(b) Use Problem 10.21 and Equation 10.130 to determine the vertex factor for the coupling of the Higgs to a quark or lepton.
(c) Use Equation 10.136 to determine the vertex factors for the couplings hWW, hZZ, and hhh.

Solution
(a) $m_A = 2\sqrt{\pi}(\frac{q\mu}{\lambda c^2})$ (10.132)
To get a mass term from a lagrangian, we expand L in powers of ϕ and pick out the term proportional to ϕ^2. (second order in the field).
$L = \frac{1}{2}(\partial_\mu\phi)(\partial^\mu\phi) + \frac{1}{2}\mu^2\phi^2 - \frac{1}{4}\lambda^2\phi^4$ (10.108)
And we can assume that $L = T - U(10.109)$
and $U(\phi) = -\frac{1}{2}\mu^2\phi^2 + \frac{1}{4}\lambda^2\phi^4$ (10.110)
$\phi = \frac{\mu}{\lambda}$ (10.111) we assume this as a ground state.
Now, starts from (10.132), $m_A = 2\sqrt{\pi}(\frac{q\mu}{\lambda c^2})$,
This is the mass term for a free gauge field lagrangian(10.131) and was derived from the lagrangian of the spontaneously broken continuous symmetry(chapter 10.8).
$m_A = 2\sqrt{\pi}(\frac{g_w\sqrt{\hbar c/4\pi v}}{c^2})$
$\frac{m_A c^2}{g_w} = 2\sqrt{\pi\hbar c/4\pi} = \frac{1}{2}\sqrt{\hbar c}v \rightarrow \sqrt{\hbar c}v = \frac{2m_A c^2}{g_w} = 246\ GeV$
the vertex factor is $2iM_m^2 c^2 g^{\mu\nu}/\hbar^2 v$: one higs + 2 Ws or 2 Zs.

Problem 2.
(a) Calculate the decay rate for h $\rightarrow f + \bar{f}$ (where f is a quark or lepton), in the MSM.

$$\left[\ Answer : \frac{\alpha_w}{8\hbar}m_h c^2(\frac{2m_f}{M_W})^2\left[1 - (\frac{2m_f}{m_h})^2\right]^{3/2}\ \right]$$

(b) If $m_h = 120\ GeV/c^2$, what are the branching ratios $\Gamma(b\bar{b})/\Gamma(c\bar{c})$ and $\Gamma(b\bar{b})/\Gamma(\tau^+\tau^-)$? [Include a factor of 3, for color, in the case of quarks.]