**3.17** 3.77 gives us the equation for the evidence function:

$$p(\mathbf{t}|\alpha,\beta) = \int p(\mathbf{t}|\mathbf{w},\beta)\, p(\mathbf{w}|\alpha)\, d\mathbf{w}$$

From 3.11 and 3.12, we can see that:

$$p(\mathbf{t}|\mathbf{w},\beta) = \beta^{N/2} \left(\frac{1}{(2\pi)}\right)^{N/2} \exp\{-\beta E_D(\mathbf{w})\}$$
$$= \left(\frac{\beta}{2\pi}\right)^{N/2} \exp\{-\beta E_D(\mathbf{w})\}$$

From 3.52, we can see that:

$$p(\mathbf{w}|\alpha)\, d\mathbf{w} = \mathcal{N}(\mathbf{w}|\mathbf{0}, \alpha^{-1}\mathbf{I})$$

$$= \frac{1}{(2\pi)^{D/2}|\alpha^{-1}\mathbf{I}|^{1/2}} \exp\left\{-\frac{1}{2}(\mathbf{w}-\mathbf{0})^T(\alpha^{-1}\mathbf{I})^{-1}(\mathbf{w}-\mathbf{0})\right\}$$

$$= \frac{1}{(2\pi)^{D/2}(\alpha^{-D})^{1/2}} \exp\left\{-\frac{1}{2}(\mathbf{w}-\mathbf{0})^T(\alpha^{-1}\mathbf{I})^{-1}(\mathbf{w}-\mathbf{0})\right\}$$

$$= \frac{\alpha^{D/2}}{(2\pi)^{D/2}} \exp\left\{-\frac{\alpha}{2}\mathbf{w}^T\mathbf{w}\right\}$$

$$= \left(\frac{\alpha}{2\pi}\right)^{D/2} \exp\left\{-\alpha E_{\mathbf{w}}(\mathbf{w})\right\}$$

Substituting in the equation for the evidence function, we get:

$$p(\mathbf{t}|\alpha,\beta) = \int \left(\frac{\beta}{2\pi}\right)^{N/2} \exp\{-\beta E_D(\mathbf{w})\} \left(\frac{\alpha}{2\pi}\right)^{D/2} \exp\left\{-\alpha E_{\mathbf{w}}(\mathbf{w})\right\}\, d\mathbf{w}$$

$$= \left(\frac{\beta}{2\pi}\right)^{N/2} \left(\frac{\alpha}{2\pi}\right)^{D/2} \int \exp\{-(\beta E_D(\mathbf{w}) + \alpha E_{\mathbf{w}}(\mathbf{w}))\}\, d\mathbf{w}$$

$$= \left(\frac{\beta}{2\pi}\right)^{N/2} \left(\frac{\alpha}{2\pi}\right)^{D/2} \int \exp\{-E(\mathbf{w})\}\, d\mathbf{w}$$

which is the same as 3.78.