7.2 The constraint given by equation 7.5 is:

$$t_n \left(\mathbf{w}^T \boldsymbol{\phi}(\mathbf{x}_n) + b \right) \geq 1, \qquad n = 1, \dots, N$$

Replacing the 1 with γ, it becomes:

$$t_n \left(\mathbf{w}^T \boldsymbol{\phi}(\mathbf{x}_n) + b \right) \geq \gamma, \qquad n = 1, \dots, N$$

The modified Lagrangian function is given by:

$$L(\mathbf{w}, b, \mathbf{a}) = \frac{1}{2}||\mathbf{w}||^2 - \sum_{n=1}^{N} a_n \left\{ t_n(\mathbf{w}^T \boldsymbol{\phi}(\mathbf{x}_n) + b) - \gamma \right\}$$

Setting the derivatives of $L(\mathbf{w}, b, \mathbf{a})$ with respect to $\mathbf{w}$ and b equal to zero, we obtain the same conditions as 7.8 and 7.9, and the dual representation becomes:

$$\begin{aligned}
\tilde{L}(\mathbf{a}) &= \sum_{n=1}^{N} \gamma a_n - \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{N} a_n a_m t_n t_m k(\mathbf{x}_n, \mathbf{x}_m) \\
&= \gamma \sum_{n=1}^{N} a_n - \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{N} a_n a_m t_n t_m k(\mathbf{x}_n, \mathbf{x}_m) \\
\implies \frac{1}{\gamma^2} \tilde{L}(\mathbf{a}) &= \frac{1}{\gamma} \sum_{n=1}^{N} a_n - \frac{1}{2\gamma^2} \sum_{n=1}^{N} \sum_{m=1}^{N} a_n a_m t_n t_m k(\mathbf{x}_n, \mathbf{x}_m)
\end{aligned}$$

$$\implies \frac{1}{\gamma^2} \tilde{L}(\mathbf{a}) = \sum_{n=1}^{N} \left(\frac{a_n}{\gamma} \right) - \sum_{n=1}^{N} \sum_{m=1}^{N} \left(\frac{a_n}{\gamma} \right) \left(\frac{a_m}{\gamma} \right) t_n t_m k(\mathbf{x}_n, \mathbf{x}_m)$$

Since $a_n \geq 0 \, \forall n$, and $\gamma > 0$, we can simply write $a'_n = \dfrac{a_n}{\gamma}$.

$$\implies \frac{1}{\gamma^2} \tilde{L}(\mathbf{a'}) = \sum_{n=1}^{N} a'_n - \sum_{n=1}^{N} \sum_{m=1}^{N} a'_n a'_m t_n t_m k(\mathbf{x}_n, \mathbf{x}_m)$$

Maximizing $\dfrac{1}{\gamma^2} \tilde{L}(\mathbf{a'})$ results in simply maximizing $\tilde{L}(\mathbf{a'})$ since γ is a constant, and so in the dual representation, only the values of a_n get scaled.

Substituting this result into 7.8, we get:

$$\mathbf{w'} = \sum_{n=1}^{N} a'_n t_n \boldsymbol{\phi}(\mathbf{x}_n) = \sum_{n=1}^{N} \left(\frac{a_n}{\gamma}\right) t_n \boldsymbol{\phi}(\mathbf{x}_n) = \frac{\mathbf{w}}{\gamma}$$

Finally, substituting this result into equation 7.4 for the maximum margin hyperplane, we get:

$$t_n \left(\gamma \mathbf{w'}^T \boldsymbol{\phi}(\mathbf{x}_n) + b\right) = \gamma$$

$$\implies t_n \left(\mathbf{w'}^T \boldsymbol{\phi}(\mathbf{x}_n) + \frac{b}{\gamma}\right) = 1$$

$$\implies t_n \left(\mathbf{w'}^T \boldsymbol{\phi}(\mathbf{x}_n) + b'\right) = 1$$

where $b' = \dfrac{b}{\gamma}$.

As mentioned in the first paragraph of page 328, a simple rescaling of $\mathbf{w}$ and b gives us the same decision surface, so the solution remains unchanged.