12.6.1 Given $r = a(1-\cos\theta)$ and $\mathrm{d}\theta/\mathrm{d}t = 3$:

$$\begin{aligned}
\dot\theta &= 3;\\
\ddot\theta &= 0;\\
\dot r &= a\sin\theta\,\dot\theta = 3a\sin\theta;\\
\ddot r &= 3a\cos\theta\,\dot\theta = 9a\cos\theta;\\
v_r &= \dot r = 3a\sin\theta;\\
v_\theta &= r\dot\theta = 3a(1-\cos\theta);\\
a_r &= \ddot r - r\dot\theta^2 = 9a(2\cos\theta-1);\\
a_\theta &= r\ddot\theta + 2\dot r\dot\theta = 18a\sin\theta.
\end{aligned}$$

In other words,

$$\mathbf{v} = 3a\sin\theta\,\mathbf{u}_r + 3a(1-\cos\theta)\mathbf{u}_\theta,$$

and

$$\mathbf{a} = 9a(2\cos\theta-1)\mathbf{u}_r + 18a\sin\theta\,\mathbf{u}_\theta.$$

12.6.3 Given $r = \mathrm{e}^{a\theta}$ and $\mathrm{d}\theta/\mathrm{d}t = 2$:

$$\begin{aligned}
\dot\theta &= 2;\\
\ddot\theta &= 0;\\
\dot r &= a\mathrm{e}^{a\theta}\dot\theta = 2a\mathrm{e}^{a\theta};\\
\ddot r &= 2a^2\mathrm{e}^{a\theta}\dot\theta = 4a^2\mathrm{e}^{a\theta};\\
v_r &= \dot r = 2a\mathrm{e}^{a\theta};\\
v_\theta &= r\dot\theta = 2\mathrm{e}^{a\theta};\\
a_r &= \ddot r - r\dot\theta^2 = 4\mathrm{e}^{a\theta}(a^2-1);\\
a_\theta &= r\ddot\theta + 2\dot r\dot\theta = 8a\mathrm{e}^{a\theta}.
\end{aligned}$$

In other words,

$$\mathbf{v} = 2a\mathrm{e}^{a\theta}\mathbf{u}_r + 2\mathrm{e}^{a\theta}\mathbf{u}_\theta,$$

and

$$\mathbf{a} = 4\mathrm{e}^{a\theta}(a^2-1)\mathbf{u}_r + 8a\mathrm{e}^{a\theta}\mathbf{u}_\theta.$$

12.6.5 Given $r = 2\cos 4t$ and $\theta = 2t$:

$$\begin{aligned}
\dot\theta &= 2;\\
\ddot\theta &= 0;\\
\dot r &= -8\sin 4t;\\
\ddot r &= -32\cos 4t;\\
v_r &= \dot r = -8\sin 4t;\\
v_\theta &= r\dot\theta = 4\cos 4t;\\
a_r &= \ddot r - r\dot\theta^2 = -40\cos 4t;\\
a_\theta &= r\ddot\theta + 2\dot r\dot\theta = -32\sin 4t.
\end{aligned}$$

In other words,

$$\mathbf{v} = -8\sin 4t\,\mathbf{u}_r + 4\cos 4t\,\mathbf{u}_\theta,$$

and

$$\mathbf{a} = -40\cos 4t\,\mathbf{u}_r - 32\sin 4t\,\mathbf{u}_\theta.$$