Q-1)

$$\pi_\theta(s,a) = p(a|s,\theta) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(a-\mu(s,\theta))^2}{2\sigma^2}\right)$$

where $\mu(s,\theta) = \phi(s)^T\theta$

$$\nabla_\theta \log \pi_\theta(s,a) = \nabla_\theta \log \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(a-\mu(s,\theta))^2}{2\sigma^2}\right)$$

$$= \nabla_\theta \log\left(\frac{1}{\sigma\sqrt{2\pi}}\right) + \nabla_\theta\left(-\frac{(a-\mu(s,a))^2}{2\sigma^2}\right)$$

$$= 0 - \nabla_\theta\left[\frac{(a-\phi(s)^T\theta)^2}{2\sigma^2}\right]$$

$$= \frac{1}{2\sigma^2}\left\{2(a-\phi(s)^T\theta)\cdot\phi(s)\right\}$$

$$= \frac{(a-\phi(s)^T\theta)\cdot\phi(s)}{\sigma^2}$$