44. [D1.4.2] $H = \lambda q^r p^s$ (1.4.15) $\Rightarrow$

$$\dot{q} = \frac{\partial H}{\partial p} = \lambda s q^r p^{s-1}, \quad \dot{p} = -\frac{\partial H}{\partial q} = -\lambda r q^{r-1} p^s.$$

(1.4.16) (1.4.17)

Equations (1.4.18) and (1.4.19) are derived in the text.

Rewrite $\dot{q} = \lambda s \left(\frac{H}{\lambda}\right)^{\frac{s-1}{s}} q^{r/s}$ (1.4.19) as

$$\frac{dq}{dt} = \lambda s \left(\frac{H}{\lambda}\right)^{\frac{s-1}{s}} q^{r/s} \Rightarrow \frac{dq}{q^{r/s}} = \lambda s \left(\frac{H}{\lambda}\right)^{\frac{s-1}{s}} dt \Rightarrow$$

$$\boxed{\int_{q^i}^{q^f} \frac{dq}{q^{r/s}} = \lambda s \left(\frac{H}{\lambda}\right)^{\frac{s-1}{s}} (t^f - t^i).} \quad \star$$

If $r \neq s$, $\int_{q^i}^{q^f} \frac{dq}{q^{r/s}} = \int_{q^i}^{q^f} dq\, q^{-r/s}$

$$= \frac{1}{-r/s+1} q^{-r/s+1} \Big|_{q^i}^{q^f} = \frac{1}{1-r/s} \left[(q^f)^{1-r/s} - (q^i)^{1-r/s} \right]$$

$$= \frac{1}{1-r/s} \left[(q^f)^{\frac{s-r}{s}} - (q^i)^{\frac{s-r}{s}} \right]. \text{ Thus, we have}$$

$$\left[(q^f)^{\frac{s-r}{s}} - (q^i)^{\frac{s-r}{s}} \right] = (1 - \tfrac{r}{s}) \lambda s \left(\frac{H}{\lambda}\right)^{\frac{s-1}{s}} (t^f - t^i) \Rightarrow$$