Compute the arc length of the curve C with parametrization $\vec{r}(t) = \langle t, \frac{t^2}{4} - \frac{\ln(t)}{2}, 6 \rangle$, $1 \leq t \leq 3$.

$$\text{arclength of } C = \int_1^3 \|\vec{r}\,'(t)\|\, dt$$

$$\vec{r}\,'(t) = \langle 1, \frac{t}{2} - \frac{1}{2t}, 0 \rangle$$

$$\|\vec{r}\,'(t)\| = \sqrt{1^2 + \left(\frac{t}{2} - \frac{1}{2t}\right)^2 + 0^2}$$

$$= \sqrt{1 + \frac{t^2}{4} - \cancel{2}\left(\frac{\cancel{t}}{\cancel{2}}\right)\left(\frac{1}{\cancel{2t}}\right) + \frac{1}{4t^2}}$$

$$= \sqrt{1 + \frac{t^2}{4} - \frac{1}{2} + \frac{1}{4t^2}}$$

$$= \sqrt{\frac{1}{2} + \frac{t^2}{4} + \frac{1}{4t^2}}$$

$$= \sqrt{\frac{2t^2 + t^4 + 1}{4t^2}}$$

$u = t^2$

$u^2 + 2u + 1$

$= (u+1)^2$

$$
\begin{aligned}
&= \sqrt{\frac{t^4+2t^2+1}{4t^2}} \\
&= \sqrt{\frac{(t^2+1)^2}{(2t)^2}} \\
&= \sqrt{\left(\frac{t^2+1}{2t}\right)^2}
\end{aligned}
$$

$$
\|\vec{r}\,'(t)\| = \frac{t^2+1}{2t} = \frac{t^2}{2t} + \frac{1}{2t} = \frac{t}{2} + \frac{1}{2}\cdot\frac{1}{t}
$$

$$
\begin{aligned}
\int_1^3 \left(\frac{t}{2} + \frac{1}{2}\cdot\frac{1}{t}\right)dt &= \left[\frac{t^2}{4} + \frac{1}{2}\ln t\right]_1^3 \\
&= \frac{3^2}{4} + \frac{1}{2}\ln(3) - \left(\frac{1^2}{4} + \frac{1}{2}\underbrace{\ln(1)}_{0}\right) \\
&= \frac{9}{4} + \frac{1}{2}\ln(3) - \frac{1}{4} \\
&= \boxed{2 + \frac{1}{2}\ln(3)}
\end{aligned}
$$