Random Walks

Let $e_1, e_2, \ldots$ be a sequence of iid r.v. with mean 0 and variance σ_e^2. Then the series $\{Y_t : t = 1, 2, \ldots\}$ is constructed as follows:

$$Y_1 = e_1$$
$$Y_2 = e_1 + e_2$$
$$\vdots$$
$$Y_t = e_1 + e_2 + \ldots + e_t$$

That we can rewrite as

$$\boxed{Y_t = Y_{t-1} + e_t}$$

Then $\underline{E[Y_t]} = E[e_1] + E[e_2] + \ldots + E[e_t]$
$= 0 + 0 + \ldots + 0 = \underline{0}$

and $\underline{var(Y_t)} = var(e_1 + e_2 + \ldots + e_t)$
$= var(e_1) + var(e_2) + \ldots + var(e_t)$
$= \sigma_e^2 + \sigma_e^2 + \ldots + \sigma_e^2$
$= \underline{t\sigma_e^2}$

Reference: Time Series Analysis With Applications in R; Cryer, Chan; 2008.