1. Antidifferentiating $f''(t) = \sin t$ gives

$$f'(t) = -\cos t + C.$$

The condition $f'(0) = 1$ gives
$$-1 + C = 1,$$

i.e. $C = 2$. Now antidifferentiating one more time gives

$$f(t) = -\sin t + Ct + D = -\sin t + 2t + D.$$

The condition $f(0) = 0$ gives
$$-0 + 2 \cdot 0 + D = 0,$$

i.e. $D = 0$. Therefore
$$f(t) = -\sin t + 2t.$$

2. $(a)\ 2$ $(b)\ \frac{9\pi}{2}$