```python
import numpy as np

S0 = 100.0
sigma = 0.40
rate = 0.03
T = 1.0
ns = 360
dt = T / ns
nt  = 20000

dW = np.random.randn(ns, nt)

drift = (rate - 0.5 * sigma**2) * dt
diffusion = sigma * np.sqrt(dt) * dW

log_increments = drift + diffusion
log_paths = np.cumsum(log_increments, axis=0)
log_paths = np.vstack([np.zeros((1, nt)), log_paths])
paths = S0 * np.exp(log_paths)
event_occurred = np.zeros(nt, dtype=bool)

for j in range(nt):
    path_j = paths[:, j]
    below_90_indices = np.where(path_j < 90)[0]
    if len(below_90_indices) > 0:
        first_below_90 = below_90_indices[0]
        if np.any(path_j[first_below_90+1:] > 110):
            event_occurred[j] = True

prob_event = np.mean(event_occurred)
print(f"p = {prob_event:.4f}")
```