8.1

According to Michaelis-Menten's kinetics equations, at low concentrations of substrate, [S], the concentration is almost negligible in the denominator as KM >> [S], so the equation is essentially

V0=k3[ES]

Ks = k2/k1 = [S][E]/[ES]

[ES]=[Etol]-[E]

V0=K3[Etol][S]/(Ks+[S])

Rate of formation of ES = k1[E][S]

Rate of breakdown of ES = (k2 + k3) [ES]

k1[E][S]= (k2 + k3) [ES]

[ES]=[Etol]-[E]

Km=(k2+k3)/k1

V0 = Vmax [S]/(Km+[S])

At High substrate concentrations, [S] >> KM, and thus the term [S]/([S] + KM) becomes essentially one and the initial velocity approached Vmax, which resembles zero order reaction.

The Michaelis-Menten equation is:

V0=Vmax[S]/([S]+Km)

8.2

Python：

```
k1 = 100.0 / 60.0    # /μM/min
k2 = 600.0 / 60.0    # /min
k3 = 150.0 / 60.0    # /min

E0 = 1.0    # μM
S0 = 10.0    # μM
ES0 = 0.0    # μM
P0 = 0.0    # μM

t0 = 0.0    # min
tend = 20.0    # min
dt = 0.01    # min

def f(y, t):
    E, S, ES, P = y
```

```
    dEdt = -k1 * E * S + k2 * ES
    dSdt = -k1 * E * S + k2 * ES
    dESdt = k1 * E * S - k2 * ES - k3 * ES
    dPdt = k3 * ES
    return [dEdt, dSdt, dESdt, dPdt]

t = np.arange(t0, tend + dt, dt)
n = t.size
y = np.zeros((n, 4))
y[0, :] = [E0, S0, ES0, P0]

k1 = f(y[i, :], t[i])
k2 = f(y[i, :] + 0.5 * dt * k1, t[i] + 0.5 * dt)
k3 = f(y[i, :] + 0.5 * dt * k2, t[i] + 0.5 * dt)
k4 = f(y[i, :] + dt * k3, t[i] + dt)
y[i + 1, :] = y[i, :] + dt / 6.0 * (k1 + 2.0 * k2 + 2.0 * k3 + k4)

plt.plot(t, y[:, 0], label="E")
plt.plot(t, y[:, 1], label="S")
plt.plot(t, y[:, 2], label="ES")
plt.plot(t, y[:, 3], label="P")
plt.legend()
plt.xlabel("Time (min)")
plt.ylabel("Concentration (µM)")
plt.show()
```

8.3