

### Answers to WS3

1. a.  $\frac{dP}{dt} = -0.05P + 8$   
b. equilibrium value at  $P_{eq} = 160$ ; stable  
c. If it starts below equilibrium the population will increase towards equilibrium; if it starts above, the population will decrease towards equilibrium.

2. a.  $\frac{dQ}{dt} = -0.06Q$ .  
b. 24.3 mg  
c. 38.4 hrs.

3. a.  $\Delta P = 0.02P - 12$   
b. 600 million; unstable equilibrium  
c. and d. will decrease to extinction

4. a.  $\frac{dT}{dt} = k(T - T_s)$   
b.  $\frac{dT}{dt} = -0.1(T - 20)$   
c.  $T = 20 + 70e^{-0.1t}$   
d.  $45.8^\circ \text{C}$   
e.  $t = \frac{\ln(0.5)}{-0.1} = 6.9$  minutes

5. a. equilibrium value: 16; stable  
b.  $P = \frac{2e^{-0.5t} + 8}{0.5} = 16 + 4e^{-0.5t}$  (answer may be given in either form)  
c. in the long term the value of  $P$  decreases towards equilibrium (16).  
d.  $P = \frac{8 - 3e^{-0.5t}}{0.5} = 16 - 3e^{-0.5t}$  (answer may be given in either form)  
in the long run the value of  $P$  increases towards equilibrium.