

1. Consider the population model

$$\frac{dP}{dt} = 0.3P \left(1 - \frac{P}{200}\right) \left(\frac{P}{50} - 1\right)$$

where P is the population at time t .

- (a) For which values of P is the population increasing?
 - (b) For which values of P is the population decreasing?
 - (c) For which values of P is the population in equilibrium? Determine whether each of these equilibrium values is stable or unstable.
 - (d) Sketch a rough graph of P given that: (i) $P(0) = 10$, (ii) $P(0) = 50$, (iii) $P(0) = 150$, (iv) $P(0) = 300$.
2. Find all equilibrium values for the following differential equation. There is no need to discuss whether or not these equilibrium values are stable.

$$\frac{dP}{dt} = 0.5(P - 4)(P + 3)(P^2 - 25)$$

3. Suppose y is a function of t which satisfies the differential equation below.

$$\frac{dy}{dt} = 0.25(y - 10)(20 - y)$$

Sketch plausible graphs for y as a function of t given each initial value below. Your graphs should clearly show if the y -values approach any particular values (i.e. horizontal asymptotes). You should draw all five graphs together on one set of coordinate axes.

- (a) $y(0) = 25$
- (b) $y(0) = 20$
- (c) $y(0) = 15$
- (d) $y(0) = 10$
- (e) $y(0) = 5$