

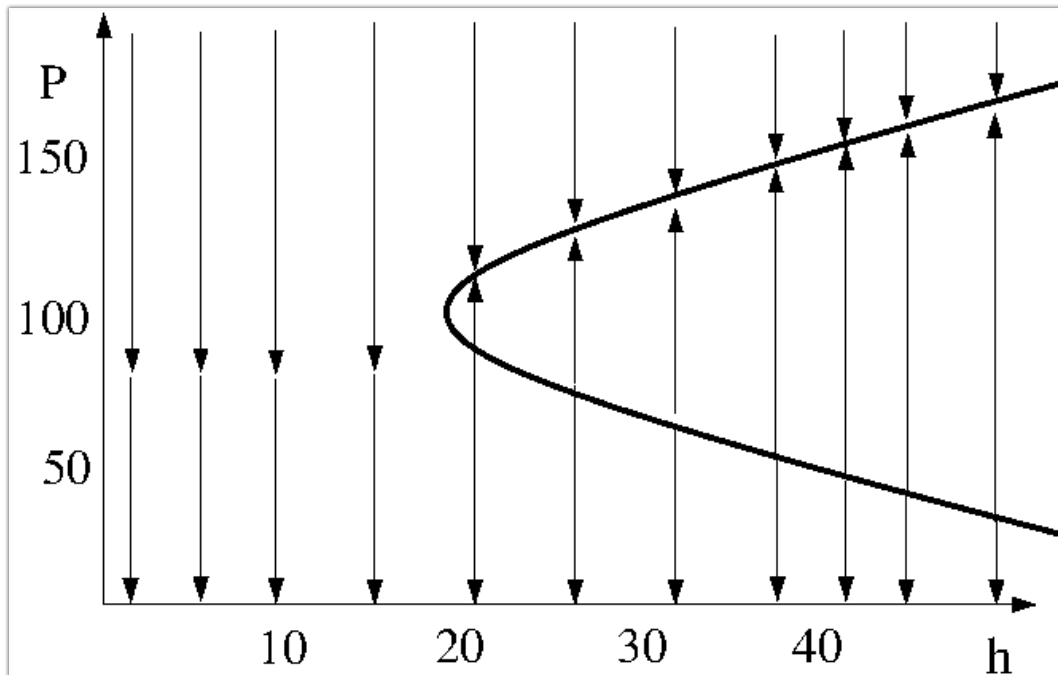
## Instructions

If the equations in this test do not display properly, please download the pdf version of the test [from this link](#). This file will show the equations correctly. Do not click on "Download Exam PDF", as this version will not have the equations displayed. We apologize for the inconvenience.

You may use any course materials, videos, websites, calculators, etc. for this test. Just don't ask another person for the answers or share your answers with other people. Please do not post questions about the test on the forum. If you have questions, please send them via email to [chaos@complexityexplorer.org](mailto:chaos@complexityexplorer.org). Thanks.

## Question 1

The bifurcation diagram for a differential equation is shown below



Suppose  $P=200$  and  $h = 30$ . What would happen to  $P$ ?

- $P$  would get larger and larger and grow without bound.
- $P$  would decrease to around 140.
- $P$  would decrease to around 70.
- $P$  would decrease to 0.

## Question 2

Refer again to the bifurcation diagram shown in Question 1. If  $P=100$  and  $h=10$ , what would happen to  $P$ ?

- $P$  would decrease to 0
- $P$  would remain constant
- $P$  would decrease to 20
- $P$  would get larger and larger and grow without bound.

## Question 3

Refer again to the bifurcation diagram shown in Question 1. Suppose  $P$  is 150 and  $h$  is 40. If  $h$  is decreased gradually from 40 to 35, what would happen to  $P$ ?

- $P$  would increase gradually
- $P$  would decrease gradually

- P would drop suddenly to 0
- P would increase suddenly

#### Question 4

Refer again to the bifurcation diagram shown in Question 1. Suppose P is 120 and h is 25. If h is decreased gradually from 25 to 15, what would happen?

- P would increase gradually
- P would decrease gradually
- P would drop suddenly to 0
- P would increase suddenly

#### Question 5

Consider the logistic differential equation:

$$\frac{dP}{dt} = 2P\left(1 - \frac{P}{200}\right)$$

In this equation, the growth rate is:

- 1
- 2
- 100
- 200

#### Question 6

Consider again the logistic differential equation given in Question 5. In this equation, the carrying capacity is

- 1
- 2
- 100
- 200

#### Question 7

Consider again the logistic differential equation given in Question 5. Which of the following statements best describes the phase line for this differential equation?

- There is an attracting fixed point at 0 and a repelling fixed point at 200
- There is a repelling fixed point at 0 and an attracting fixed point at 200
- There is a repelling fixed point at 20 and an attracting fixed point at 180
- There is a repelling fixed point at 100
- This dynamical system has no fixed points.

#### Question 8

Consider a differential equation of the form:

$$\frac{dP}{dt} = f(P)$$

where,  $f(P)$  is a continuous and smooth function. A solution to this equation is a function  $P(t)$ . Is it possible for  $P(t)$  to oscillate?

- Yes
- No

### Question 9

Consider an iterated function  $f(P)$ , where  $f(P)$  is a continuous and smooth function of  $P$ . Is it possible for orbits of this type of dynamical system to be periodic?

- Yes
- No