

# Introduction to Dynamical Systems and Chaos (Winter, 2015)

## 6.9 Test » Unit 6 Test

---

### Instructions 1

You may use any course materials, videos, websites, calculators, etc. for this test. Just don't ask another person for the answers or 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.

I have embedded equations as image files instead of relying on the external equation renderer that has been giving us trouble the last few weeks. The equations don't look as nice, but they should be much more reliable.

---

### Question 2

For the cubic equation there is a period-five window around  $r=6.064$ . There is a bifurcation from period five to period 10 at approximately what value?

- 6.065
  - 6.067
  - 6.069
  - 6.071
  - 6.073
- 

### Question 3

A dynamical system undergoes a bifurcation from period one to period two at  $r=7$ . The system undergoes a bifurcation from period two to period four at  $r=9$ , and there is a bifurcation from period four to period eight at  $r=9.43$ . What is  $\Delta_1$  for this system?

- 1
  - 2
  - 3
  - 7
  - 9
- 

### Question 4

For the dynamical system described in Question 2, what is  $\Delta_2$ ?

- 0.214
- 0.43
- 0.5
- 0.75
- 1.0

---

**Question 5**

For the dynamical system described in Question 2, what is  $\delta_1$  ?

- 4.11
  - 4.30
  - 4.65
  - 4.669
  - 4.72
- 

**Question 6**

Suppose a dynamical system undergoes a bifurcation from period three to period six at  $r=10$  and a bifurcation from period six to twelve. At approximately what  $r$  value would you expect to see a bifurcation from period twelve to period twenty-four?

- 16.000
  - 16.071
  - 16.142
  - 17.000
  - 19.669
- 

**Question 7**

For the dynamical system described in Question 5, at approximately what  $r$  value would you expect to see a bifurcation from period twelve to period twenty-four?

- 16.300
  - 16.600
  - 17.071
  - 18.214
  - 20.669
- 

**Question 8**

Suppose an electronic circuit undergoes a period-doubling transition to chaos. The first bifurcation, from period one to period two, is to occur when the voltage is 5V. A bifurcation from period two to period four occurs at a voltage of 8V. At approximately what voltage would you expect to see the next bifurcation, from period four to period eight?

- 8.214
- 8.456
- 8.5
- 8.470
- 8.643

---

**Question 9**

Your answer to Question 7 is an approximation because

- A. There is experimental uncertainty in the exact value of the voltages.
  - B. The ratio 4.669 only is exact for large periods
  - C. Both A and B.
- 

**Question 10**

A function with a single quadratic maximum that maps an interval to itself undergoes the period-doubling route to chaos. Which of the following statements must be true about this dynamical system.

- A. The transition to chaos occurs at  $r=3.57$
- B. The quantity  $\frac{\Delta_1}{\Delta_2}$  is exactly equal to 4.669
- C. Its bifurcation diagram is identical to the logistic equation's bifurcation diagram.
- D. None of the above.