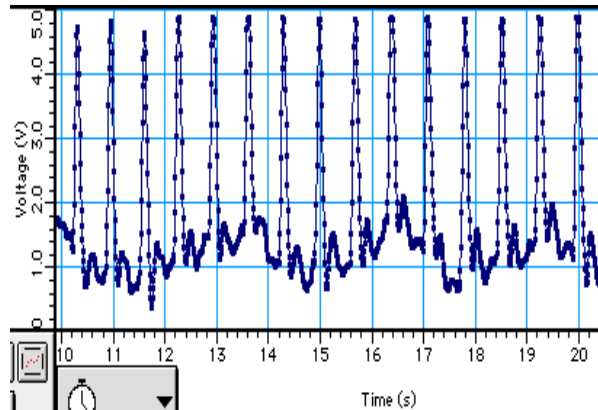
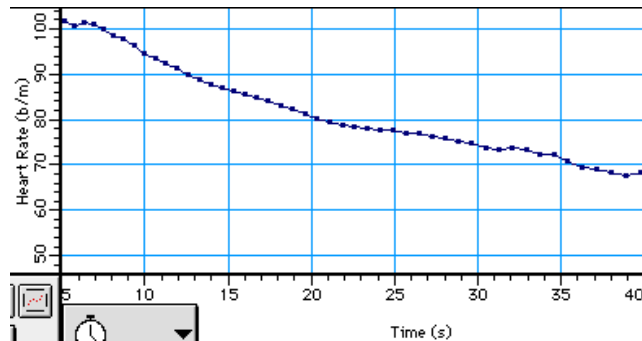


Questions 1-5 refer to the Lab, *Chaos*:

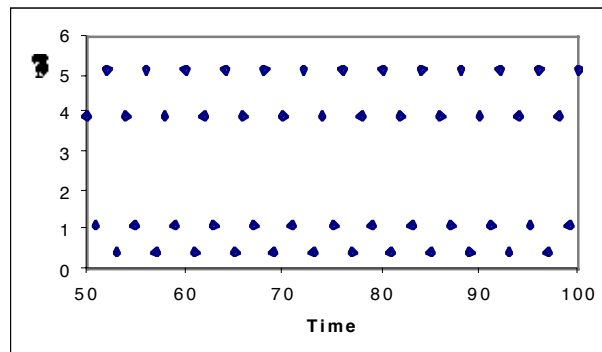
1. Typical data from this lab are shown to the right. Over the interval shown these data correspond to an average heart rate (beats per minute) of about (a) 15, (b) 60, (c) 90, (d) 120.



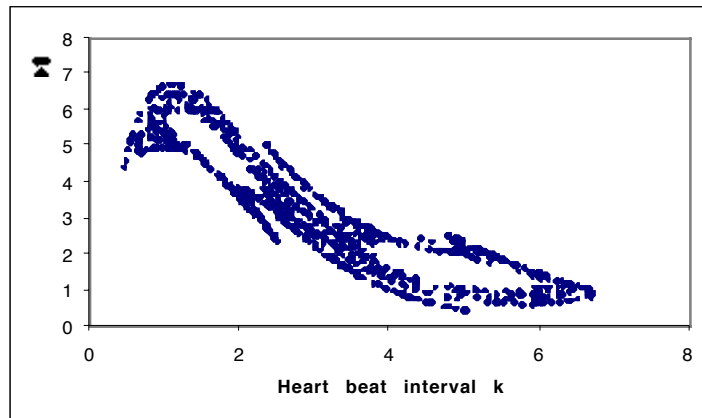
2. Another typical data set is shown in the figure to the right. Which of the following best describes the variation of heart rate seen there? (a) The data were taken immediately after exercise. (b) The ear clip was not fastened properly. (c) The data are an example of a potentially dangerous heart condition. (d) Such variation is typical of chaotic behavior.



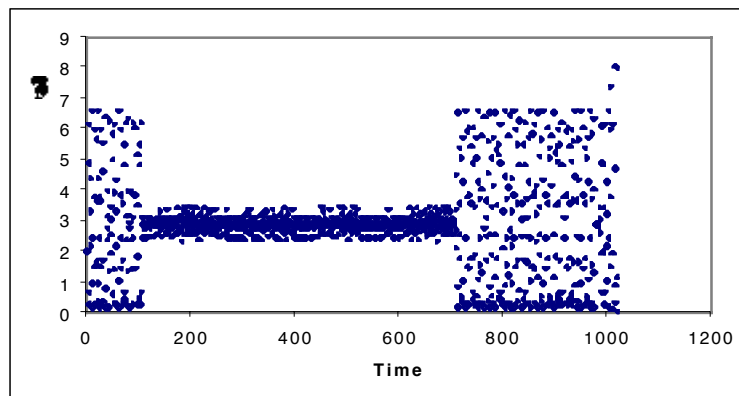
3. The figure to the right shows heart rate as a function of time. Which of the following best describes what is shown? The heart rate is (a) a fixed point, (b) a two-cycle, (c) a four-cycle, (d) chaotic.



4. The first return map shown to the right is most likely a result of a (a) one-dimensional chaotic process, (b) chaotic process of dimension higher than one, (c) periodic process, (d) purely random process.



5. Which of the following best describes the control of chaos that is shown in the figure to the right? (a) Control is never established. (b) Once control is established, it is never turned off. (c) Control is maintained with an extremely small tolerance (e.g., less than 0.001). (d) Control is maintained with a fairly loose tolerance (e.g., greater than 0.1).



9. The fundamental dimensions of pressure are (a)  $MLT^{-2}$ , (b)  $ML^{-3}$ , (c)  $MLT^{-1}$ , (d)  $ML^{-1}T^{-2}$ .

10. It is conventional to give blood pressure as a gauge pressure measured in mm Hg. If a person's diastolic pressure is 76 mm Hg and atmospheric pressure is 760 mm Hg the absolute diastolic pressure is (a) 10% of atmospheric pressure, (b) 90% of atmospheric pressure, (c) the same as atmospheric pressure, (d) 110% of atmospheric pressure.

11. A sphere of volume  $1\text{ m}^3$  and a rectangular solid whose dimensions are 2 m by 2 m by  $1/4$  m (that is, also with volume  $1\text{ m}^3$ ) are immersed to a depth of about 2 m in water. The rectangular solid is oriented so that its 2x2 side is horizontal. Which of the following is true? (a) The buoyant force on the sphere is greater than that on the rectangular solid. (b) The buoyant force on the sphere is less than that on the rectangular solid. (c) The buoyant force on the sphere equals that on the rectangular solid. (d) The buoyant forces on each object depend on the materials from which they are made.

12. Which of the following is a direct result of the Equation of Continuity? (a) The pressure one meter below the surface of water is about 10% greater than atmospheric pressure. (b) The pressure on the inlet side of a horizontal pipe through which water is flowing at a constant speed equals the pressure on the outlet side. (c) When the open end of a long evacuated tube is

inserted into a pool of water, water rises to about 10 m in the tube. (d) Placing your thumb partially over the opening of a hose causes the flow rate of the water leaving the hose to increase.

13. When blood flows through into an aneurysm (a) the flow rate slows and the pressure increases, (b) the flow rate slows and the pressure decreases, (c) the flow rate increases and the pressure increases, (d) the flow rate increases and the pressure decreases.

14. Which of the following best describes how a plane's wing generates lift? (a) The wing is thick so the air pressure on the top is less than the air pressure on the bottom by an amount equal to  $\rho_{\text{air}}gh$  ( $h$  is the thickness). (b) The wing is curved; to assure continuity of flow, air has to pass over the top faster than over the bottom, and a higher pressure on the bottom than the top results. (c) The curvature of the wing forces air to be more densely packed on its bottom than on its top and a higher pressure on the bottom than on the top results. (d) As the plane flies through the air the wing vibrates vertically causing momentum to be departed to the air, in the same manner that birds fly.

15. A passenger in the back seat of a moving car is smoking. The driver opens a *front* window slightly and the smoke is drawn out of the car through it. This is due primarily to (a) Bernoulli's equation, (b) Archimedes' Principle, (c) Pascal's Principle, (d) the Equation of Continuity.

16. Liquid nitrogen is used by dermatologists to remove precancerous growths on the skin by flash-freezing the unwanted cells. The temperature of liquid nitrogen is approximately (a) 77 K, (b) 273 K, (c) 373 K, (d)  $-273$  K.

17. The difference in Fahrenheit temperature between the steam point and ice point of water is (a) 100, (b) 180, (c) 212, (d) 273 degrees.

18. The *internal energy* of a beaker of gas in thermal equilibrium at room temperature is more than 10,000 J, while the *internal momentum* of the gas is zero. That is most closely related to the fact that (a) the gas molecules aren't moving at room temperature, (b) kinetic energy is a positive number, independent of the direction of motion, while momentum is a vector, (c) the kinetic energy of an atom is totally independent of its momentum, (d) electrons cannot be excited by room temperature collisions.

19. Two identical containers of gas (same volumes, same number of atoms) are at different temperatures. Which of the following is higher in the gas that has the higher temperature: its (a) heat, (b) density, (c) internal energy, (d) average atomic spacing.