Exercises

21.1 Temperature (pages 407–408)

1. Define temperature.

_____

_____

2. Explain how a common liquid thermometer works.

_____

_____

_____

Match each number with the corresponding description.

	Temperature	Description
_____	**3.** –273	a. Water freezes on the Celsius scale.
_____	**4.** 0	b. Water freezes on the Fahrenheit scale.
_____	**5.** 32	c. Water boils on the Celsius scale.
_____	**6.** 100	d. Water boils on the Fahrenheit scale.
_____	**7.** 212	e. Absolute zero on the Celsius scale.

8. Define absolute zero.

_____

_____

9. Identify where each temperature scale is primarily used.

a. Celsius:_____

b. Fahrenheit:_____

c. Kelvin:_____

10. Divisions on the Celsius and Fahrenheit scales are called _____, but divisions on the Kelvin scale are called _____.

11. For an ideal gas, temperature is _____ to the average kinetic energy of molecular translational motion.

12. Define translational motion.

_____

_____

13. Is the following sentence true or false? For solids and liquids, temperature is unrelated to the average kinetic energy of molecular translational motion._____

14. What is the relationship between the temperature of a substance and the rate of motion of its molecules?

_____

_____

15. Suppose you have a 2-liter pot of boiling water, and you pour out 1 liter of the water. Explain whether the average kinetic energy and temperature of the water in the pot has changed.

_____

_____

21.2 Heat (page 409)

16. Define heat.

_____

_____

17. Describe the spontaneous energy transfer that occurs when you touch a cube of ice.

_____

_____

18. Is the following sentence true or false? A cup of hot water contains more heat than a cup of cold water._____

19. Explain the meanings of the terms *thermal energy* and *internal energy.*

_____

_____

_____

_____

20. Define thermal contact.

_____

_____

21. When two substances of different temperature are in thermal contact, heat flows from the _____ substance into the _____ substance.

22. Is the following sentence true or false? Heat always flows from a substance with more total molecular kinetic energy to a substance with less._____

23. Is the following sentence true or false? Heat never flows on its own from a cooler substance into a hotter substance._____

21.3 Thermal Equilibrium (page 410)

24. After objects in thermal contact with each other reach the same temperature, the objects are in _____.

25. When a thermometer is in contact with a substance, heat flows between them until _____.

26. Why is it important for a thermometer to be small in comparison to the substance it is measuring?

_____

21.4 Internal Energy (page 411)

27. Name four types of energy within substances.

a. _____

b. _____

c. _____

d. _____

28. _____ is the grand total of all energies inside a substance.

29. What are two ways the internal energy of a substance can change?

_____

_____

30. Describe two ways a substance can change when it absorbs heat.

a. _____

_____

b. _____

_____

21.5 Measurement of Heat (pages 411–412)

31. How can you determine the amount of heat transferred from one substance to another?

_____

_____

32. In order to quantify heat, we must specify the _____ and _____ of substance affected.

33. Suppose you place a pot with 1 cup of water and an identical pot with 2 cups of water on a hot stove for the same amount of time. Circle the letters beside the sentences that correctly describe what happens.

a. More heat is added to the pot with 2 cups of water.

b. The same amount of heat is added to both pots.

c. The temperature of the pot with 1 cup of water increases more.

d. The temperature increase of both pots is the same.

34. Define calorie.

_____

_____

35. Circle the letter beside the number of kilocalories that equals 50,000 calories.

a. 5 b. 50

c. 500 d. 5000

36. A Calorie, used to describe the energy of _____, is equivalent to one _____.

37. One calorie is equivalent to _____ joules, the SI unit for all forms of energy.

21.6 Specific Heat Capacity (pages 413–414)

38. The capacity of a substance to store heat depends on its _____.

39. What is specific heat capacity?

_____

_____

Specific Heat Capacities		
Material	**(J/g°C)**	**(cal/g°C)**
Aluminum	0.900	0.215
Copper	0.386	0.092
Lead	0.128	0.031

40. Use the table above to complete these statements.

a. _____ calorie(s) of heat are needed to raise the temperature of 1 gram of aluminum by 1 Celsius degree.

b. _____ joule(s) of heat are needed to raise the temperature of 2 grams of copper by 1 Celsius degree.

c. _____ joule(s) of heat are needed to raise the temperature of 1 gram of lead by 2 Celsius degrees.

41. Explain this statement: We can think of specific heat capacity as thermal inertia.

_____

_____

_____

42. Why does water have a higher specific heat capacity than iron?

_____

_____

_____

21.7 The High Specific Heat Capacity of Water (pages 415–416)

43. Is the following sentence true or false? Water takes longer to heat to a certain temperature than most substances, and it takes longer to cool. _____

44. Explain why Europe is much warmer than northeastern Canada, even though they are at similar latitudes.

_____

_____

_____

45. The high specific heat of ocean water near the west coast of North America causes the winters there to be _____ and the summers to be _____ than near the east coast.

21.8 Thermal Expansion (pages 416–419)

46. Why do most forms of matter expand when they are heated?

_____

_____

_____

47. If concrete sidewalks and highway paving were laid down in one continuous piece, cracks would appear as the materials _____ on hot summer days and _____ on cold winter days.

48. Describe one way that each of the following handles the different rates of thermal expansion in materials.

a. Dentist: _____

_____

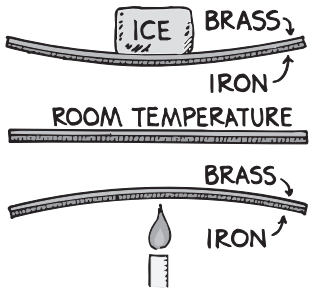
b. Automobile engines: _____

_____

c. Civil engineer: _____

_____

49. Roadways on bridges often have tongue-and-groove-type gaps called _____ to allow for thermal expansion.



50. Explain how the bimetallic strip in the figure above is affected in each case.

a. Heated by a flame:

_____

_____

_____

b. Cooled by ice:

_____

_____

_____

51. Describe how a thermostat uses a bimetallic strip.

_____

_____

_____

21.9 Expansion of Water (pages 419–422)

52. Water is most dense at a temperature of _____.

53. Complete the table by writing *increase* or *decrease* to describe how the volume and density of water changes during each temperature change.

Temperature Change	Change in Volume	Change in Density
0°C to 4°C		
4°C to 10°C		

54. Describe how the thermal expansion and contraction of water is different from most other materials.

_____

_____

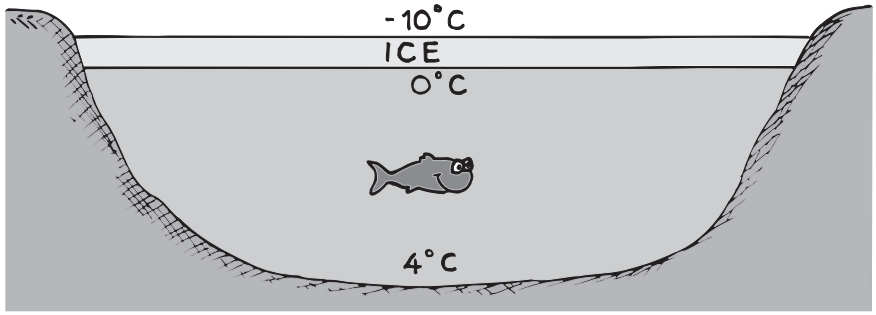
55. Explain why water has such an unusual thermal expansion and contraction behavior.

_____

_____

_____

Use the figure below to answer questions 56–60.



56. Where does most of the cooling in the pond take place?

_____

57. What determines whether the water will float at the surface?

_____

_____

58. What must be true in order for water at 4°C to remain at the surface?

_____

_____

_____

59. What must be true in order for ice to begin forming at the surface of the pond?

_____

_____

60. If only some of the water in a deep pond is 4°C, where will it be?

_____