**Chapter 21**

**Review Questions**

1. How is temperature commonly measured?

*Thermometer*

2. How many degrees are between the melting point of ice and boiling point of water on the Celsius scale?

*0⁰ C to 100⁰ C 🡪 100⁰ C*

4. In terms of differences in temperature between objects in thermal contact, in what direction does heat flow?

*Warm to cold (entropy … warmer object’s particles move faster and spread quicker*

9. What does it mean to say that a material has a high or low specific heat capacity?

*Specific heat (C) indicates the change of heat. Higher Cp means it resists a change in heat.*

10. Do substances that heat up quickly normally have high or low specific heat capacities?

*Lower (C) means it will heat up quickly and cool down quickly.*

11. How does the specific heat capacity of water compare with that of other common substances?

*Water has the 2nd highest C of liquids … high resistance to change in temperature.*

12. Why is the North American west coast warmer in winter months and cooler in summer months than the east coast?

*The Pacific Ocean is warmer than the Atlantic Ocean. Therefore, it has more heat to release into the air over land in the winter and absorbs more heat in the summer.*

14. Which expands most for increase in temperature: solids, liquids, or gases?

*Gases … the particles are farthest apart.*

15. At what temperature is the density of water greatest?

*4⁰ C. Ice is actually less dense than liquid water. Normally, solids are the most dense..*

16. Ice is less dense than water because of its open crystalline structure. But why is water at 0⁰ C less dense than water at 4⁰ C?

*Under 4⁰ C, liquid water expands, therefore, making it less dense.*

17. Why do lakes and ponds freeze from the top down rather than from the bottom up?

*Cold water is more dense so it sinks until 4⁰ C. When temperatures drop below 4⁰ C, liquid water expands, therefore, making it less dense. Otherwise, all water would turn to glaciers and life as we know it could not exist.*

19. Calculate the number of calories of heat needed to change 500 grams of water by 50⁰ C.

*Q = mC∆T = 500 g x 1 cal/g⁰C x 50⁰ C = 25,000 cal or 104,600 j*

20. Calculate the number of calories given off by 500 grams of water cooling from 50⁰ C to 20⁰ C.

*Q = mC∆T = 500 g x 1 cal/g⁰C x (20⁰ C – 50⁰ C) = –15,000 cal or –62,760 j … heat is released (exothermic)*

21. A 30-gram piece of iron is heated to 100⁰ C and then dropped into cool water where the iron’s temperature drops to 30⁰ C. How many calories does it lose to the water (The specific heat capacity of iron is 0.11 cal/g ⁰C.)

*Q = mC∆T = 30 g x 0.11 cal/g⁰C x (30⁰ C – 100⁰ C) = –231 cal or –967 j … heat is released (exothermic)*

22. Suppose the same 30-gram piece of iron is dropped into another container of water and gives off 165 calories in cooling. Calculate the iron’s temperature change.

*Rearrange Q = mC∆T to solve for ∆T … ∆T = Q/mC = 165 cal / (30 g x 0.11 cal/g⁰C)*

*∆T = 50⁰ C*

23. What mass of water will give up 240 calories when its temperature drops from 80⁰ C to 68⁰ C?

*Rearrange Q = mC∆T to solve for m … m = Q/C∆T = 240 cal / (1 cal/g⁰C) x (68⁰ C – 80⁰ C) m = 20 g*

24. When a 50-gram piece of aluminum at 100⁰ C is placed in water, it loses 735 calories of heat while cooling to 30⁰ C. Calculate the specific heat capacity of the aluminum.

*Rearrange Q = mC∆T to solve for C … C = Q/m∆T = 735 cal / (50 g) x (30⁰ C – 100⁰ C)*

*C = 0.21 cal/g⁰C*

26. If you stake out a plot of land with a steel tape measure using map measurements on a very hot day, will you enclose more or less land than on a very cold day?

*Steel expands quickly with increased temperature (low specific heat). Therefore, the distance between marks will be greater.*



27. When cool, the ball will pass through the ring. Will it pass through the ring if the ball is heated? Will the ball pass through if the ring is heated? What happens to the size of the hole when heated (increase, decrease, remain the same)?

*The metal will expand when heated. If only the ball is heated, then it will not pass through the ring. However, if both are heated, the ring also will expand and allow the ball to pass through it. (The size of the ring hole will increase when heated.)*

28. Describe what happens to a steel pipe that is heated. Cooled.

*The steel pipe, a metal, will expand when heated and contract when cooled.*

30. Explain why when biting into a hot pizza, the sauce burns one’s mouth, but the dough does not.

*Pizza sauce contains more water than dough. Water’s high specific heat resists a change in temperature / heat. Therefore, the water in the hot pizza sauce retains the heat more than the dough.*

32. A watermelon and some sandwiches are removed from a picnic cooler on a very hot day. Which will remain cool for a longer time?

*Watermelon contains more water than the sandwiches. Water’s high specific heat resists a change in temperature / heat. Therefore, the water in the watermelon retains the heat more than the sandwiches.*

33. Iceland, so named to discourage conquest by expanding empires, is not at all ice-covered like Greenland and parts of Siberia, even though it is nearly on the Arctic Circle. The average winter temperature of Iceland is considerably higher than regions at the same latitude in eastern Greenland and central Siberia. Explain why this is so.

*Iceland is surrounded by water.* *Water’s high specific heat resists a change in temperature / heat. Therefore, the water around Iceland retains the heat more than the Greenland and central Siberia.*

34. During the winter in colder climates, it is important to not allow the temperature in one’s house to go below freezing. Why? (Hint: think of the water pipes in the house.)

*When water freezes (below 4*⁰ *C), it expands and can burst the pipes.*

37. State whether water will expand, contract, or remain the same size when warmed up from 0⁰ C, 4⁰ C, 10⁰ C.

*Water will condense from 0*⁰ *C to 4*⁰ *C. It is LEAST dense at 0*⁰ *C and most dense at 4*⁰ C*. However, the liquid water will expand above 4*⁰ *C. Almost all naturally occurring substances (except water) are most dense as solids and would expand with increased heat or temperature.*

**Chapter 22**

**Review Questions**

3. What is the difference between a conductor and an insulator?

*A conductor transfers heat easily and quickly; whereas an insulator transfer heat slowly, resisting heat transfer.*

4. Why are materials such as wood, fur, feathers, and even snow good insulators? Also, electric wires are often kept on top of tall poles for the same reason.

*Air is an insulator. Wood, fur, feathers, and pole tops have air pockets.*

7. Why does the direction of coastal winds change from day to night?

*Land is warmer than water during the day (normally), so warmer air above the land will rise and cooler air from the water will take its place. Therefore, convection will cause an inland breeze from water to land. At night, land is cooler than water (normally), so the warmer air in the sky above the land sinks and the warmer air above the water rises (getting replaced by the cooler air from land). Therefore, convection will cause an outward breeze from land to water.*

8. How does the temperature of a gas change when it is compressed? When it expands?

*This relates to adiabatic processes. Gases cool down when compressed (increased pressure) because the random particles are no longer spaced out as far from each other, causing condensation. Gases warm up when expanded (decreased pressure) because the air particles become more random and spread out from each other.*

12. Why does a good absorber of radiant energy appear black?

*Black absorbs light and has low reflectivity (low albedo). We wear darker clothes in winter to absorb heat and lighter clothes in summer to reflect the heat.*

13. Why do eye pupils appear black?

*Pupils appear black because the light entering the eye is absorbed.*

15. Which will normally cool faster, a black pot of hot tea or a silvered pot of hot tea?

*Black is actually a better emitter of heat and will cool faster than the silver. The key point is the surrounding temperature compared to the surface temperature of the pots. If the surrounding temperature is LESS than the surface of the pot, the black pot will ABSORB the heat faster.*

21. At what common temperature will both a block of wood and a piece of metal feel neither hot nor cool when you touch them with your hand?

*When the temperature of your hand is the same as the objects, no heat change will occur.*

22. If you place a metal rod in a snow bank, the end of the rod you are holding will soon become cold. Does the cold flow from the snow to your hand or from your hand to the snow?

*Heat flows from warmer to cooler. In this case, heat will flow from your hand to the end of the rod in the snow.*

24. Notice that a desk lamp often has small holes near the top of the metal lampshade. How do these holes keep the lamp cool?

*The holes allow air to move through the lamp, which is convection based on differing temperature of the air around the hot bulb of the lamp and the air coming in from outside the lamp through the holes.*

25. When a space shuttle is in orbit and there appears to be no gravity in the cabin, a candle cannot stay lit. Explain.

*Without gravity, convection does not occur. Therefore, the carbon dioxide (CO2) build up will extinguish the candle, cutting off the needed oxygen supply to the candle.*

**Chapter 23**

**Review Questions**

2. What is evaporation, and why is it also a cooling process?

*Evaporation is a phase change from liquid to gas (vapor) from the surface of the liquid. As the liquid is heated, the kinetic energy (KE) of the liquid molecules increases, causing the particles to expand and eventually escape the surface of the liquid. As particles escape (changing to gas), they release the heat into the surroundings.*

3. Why does a dog pant on a hot day?

*Panting allows for evaporation through the mouth and throat.*

5. Why is being burned by steam more damaging than being burned by boiling water?

*Steam contains more heat than boiling water.*

6. Which usually contains more water vapor – warm air or cool air?

*Warmer air contains more moisture (water vapor) than cooler air. Warmer air has a higher kinetic energy (KE) so the air molecules move faster and are less likely to condense into liquid. Cooler air has less KE and is more likely to condense.*

7. Why does warm moist air form clouds when it rises in altitude?

*Cloud formation is often due to adiabatic cooling. As warm air rises, pressure decreases, causing the air to expand and therefore, decrease in temperature. The temperature decrease slows the air particles so they can condense more easily on other particles in the air.*

8. Why do you feel less chilly if you dry yourself inside the shower stall after taking a shower rather than in the open air of the bathroom?

*The greater moisture in the shower (greater condensation) saturates the air with water more than outside the shower stall. The greater water content causes more heat to be retained. Outside the shower stall, evaporation would be much greater. Thus, cooling you more.*

10. What is the difference(s) between evaporation and boiling?

*Evaporation occurs at a liquid’s surface, while boiling can occur anywhere throughout the liquid. Boiling usually begins at the heat source and spreads as the heat of molecules farther from the heat source increases.*

17. Does water vapor give off or absorb energy when it turns into a liquid? What is this process called?

*Condensation (gas to liquid) releases heat, slowing vapor molecules down (reducing KE) so they can condense.*

20. Why is it important that a finger be wet before touching a hot clothes iron to test if it is ready to use?

*Water has a high specific heat and resists a change in heat / temperature. The heat of the iron will cause water to heat up and even evaporate. It takes a lot of heat for water to go through a phase change from liquid to gas.*

**Chapter 24**

**Review Questions**

1. What is the meaning of the Greek words from which we get the word “thermodynamics”?

*Thermo (heat) dynamics (motion)*

6. What happens to the internal energy of a system when work is done on it? What happens to its temperature?

*Work is driven by energy. Therefore, internal energy increases in order for work to be done. Temperature increases when work is done because motion (KE) is involved.*

13. How does the second law of thermodynamics relate to the direction of heat flow?

*In essence, the second law of thermodynamics is entropy, which measures a system’s ability to become less orderly, more random. If outside energy is not changed, then entropy increases. Warmer objects are more random (more entropy) and will move / spread faster than cooler objects (more orderly, less entropy). So heat flows from warmer to cooler.*

18. Why are heat engines intentionally run at high operating temperatures?

*The higher the temperature, the more the entropy (randomness) or particles, and therefore, the more efficiency for heat engines.*

22. What is the physicist’s term for a measure of messiness?

*Entropy, which measures a system’s ability to become less orderly, more random.*