SMAN 8 PEKANBARU

Heat Worksheet 2 FISIKA X

Linear Thermal Expansion

1. The coefficient of linear expansion of aluminum is 23×10^{-6}/C°. A circular hole in an aluminum plate is 2.725 cm in diameter at 0 °C. What is the diameter of the hole if the temperature of the plate is raised to 100 °C?

2. A copper plate has a length of 0.12 m and a width of 0.10 m at 25 °C. The plate is uniformly heated to 175 °C. If the linear expansion coefficient for copper is 1.7×10^{-5}/C°, what is the change in the area of the plate as a result of the increase in temperature?

3. A thin, circular disc is made of lead and has a radius of 0.0350 cm at 20.0 °C. Determine the change in the area of the circle if the temperature is increased to 625.0 °C. The coefficient of linear thermal expansion for lead is 29.0×10^{-6}/C°

Volume Thermal Expansion

4. Zirconium tungstate is an unusual material because its volume shrinks with an increase in temperature for the temperature range 0.3 K to 1050 K (where it decomposes). In fact, the volumetric coefficient of thermal expansion is -26.4×10^{-6}/K. Determine the ratio $\Delta V/V0$ for the above mentioned temperature range. Express your answer in percent

5. A steel gas tank of volume 0.0700 m^3 is filled to the top with gasoline at 20.0 °C. The tank is placed inside a chamber with an interior temperature of 50.0 °C. The coefficient of volume expansion for gasoline is 9.50×10^{-4}/C°; and the coefficient of linear expansion of steel is 12.0×10^{-6}/C°. After the tank and its contents reach thermal equilibrium with the interior of the chamber, how much gasoline has spilled?

6. The coefficient of volumetric expansion for gold is 4.20×10^{-5}/C°. The density of gold is 19 300 kg/m^3 at 0.0 °C. What is the density of gold at 1050 °C?

7. A tanker ship is filled with 2.25×10^5 m^3 of gasoline at a refinery in southern Texas when the temperature is 17.2 °C. When the ship arrives in New York City, the temperature is 1.3 °C. If the coefficient of volumetric expansion for gasoline is 9.50×10^{-4}/C°, how much has the volume of the gasoline decreased when it is unloaded in New York?

Specific Heat Capacity

8. A 2.00-kg metal object requires 5.02×10^3 J of heat to raise its temperature from 20.0 °C to 40.0 °C. What is the specific heat capacity of the metal?

9. The specific heat capacity of iron is approximately half that of aluminum. Two balls of equal mass, one made of iron and the other of aluminum, both at 80 °C, are dropped into a thermally insulated jar that contains an equal mass of water at 20 °C. Thermal equilibrium is eventually reached. Which one of the following statements concerning the final temperatures is true?
   (a) Both balls will reach the same final temperature.
   (b) The iron ball will reach a higher final temperature than the aluminum ball.
   (c) The aluminum ball will reach a higher final temperature than the iron ball.
   (d) The difference in the final temperatures of the balls depends on the initial mass of the water.
   (e) The difference in the final temperatures of the balls depends on the initial temperature of the water.

10. Two spheres, labeled A and B, have identical masses, but are made of different substances. The specific heat capacity of sphere A is 440 J/(kg · C°) and that of sphere B is 160 J/(kg · C°). The spheres are initially at 21 °C; and the same quantity of heat is added to each sphere. If the final temperature of sphere A is 72 °C, what is the final temperature of sphere B?

11. A 0.20-kg lead ball is heated to 90.0 °C and dropped into an ideal calorimeter containing 0.50 kg of water initially at 20.0 °C. What is the final equilibrium temperature of the lead ball? The specific heat capacity of lead is 128 J/(kg · C°); and the specific heat of water is 4186 J/(kg · C°).

Latent Heat

12. A 1.0-g sample of steam at 100 °C loses 560 calories of heat. What is the resulting temperature of the sample?

13. A 0.030-kg ice cube at 0 °C is placed in an insulated box that contains a fixed quantity of steam at 100 °C. When thermal equilibrium of this closed system is established, its temperature is found to be 23 °C. Determine the original mass of the steam at 100 °C.

14. A 0.040-kg ice cube at 0 °C is placed in an insulated box that contains 0.0075 kg of steam at 100 °C. What is the equilibrium temperature reached by this closed system? Note: Assume that all of the ice melts.

15. A thermos bottle contains 3.0 kg of water and 2.0 kg of ice in thermal equilibrium at 0 °C. How much heat is required to bring the system to thermal equilibrium at 50 °C?

16. Judy places 0.150 kg of boiling water in a thermos bottle. How many kilograms of ice at –12.0 °C must Judy add to the thermos so that the equilibrium temperature of the water is 75.0 °C?

17. Determine the latent heat of vaporization of unknown substance X in kcal/g if 3.0 g of boiling liquid X are completely vaporized in 1.5 hours by an input of 10 kcal/h into the system by an energy source.

Convection

18. Complete the following statement: The transfer of heat by convection will occur
   (a) only in metals.
   (b) only in a vacuum.
   (c) only in non-metallic solids.
   (d) with or without the presence of matter.
   (e) only in the presence of a liquid or a gas.

19. Which one of the following statements best explains why convection does not occur in solids?
   (a) Molecules in a solid are more closely spaced than in a gas.
   (b) The molecules in a solid are not free to move throughout the volume of the solid.
   (c) Molecules in a solid vibrate at a lower frequency than those in a liquid.
   (d) Solids are more compressible than liquids.
   (e) Solids are less compressible than gases.

20. Which one of the following processes does not occur during the convective transfer of heat within a container of air?
   (a) The volume of a warmed part of the air is reduced and its density increases.
   (b) A continuous flow of warmer and cooler parts of air is established.
   (c) The flow of air molecules results in a flow of heat.
   (d) The cooler portion of the air surrounding a warmer part exerts a buoyant force on it.
   (e) As the warmer part of the air moves, it is replaced by cooler air that is subsequently warmed.

Conduction

21. The two ends of an iron rod are maintained at different temperatures. The amount of heat that flows through the rod by conduction during a given time interval does not depend upon
   (a) the length of the iron rod.
   (b) the thermal conductivity of iron.
   (c) the temperature difference between the ends of the rod.
   (d) the mass of the iron rod.
   (e) the duration of the time interval.

22. The ends of a cylindrical steel rod are maintained at two different temperatures. The rod conducts heat from one end to the other at a rate of 10 cal/s. At what rate would a steel rod twice as long and twice the diameter conduct heat between the same two temperatures?

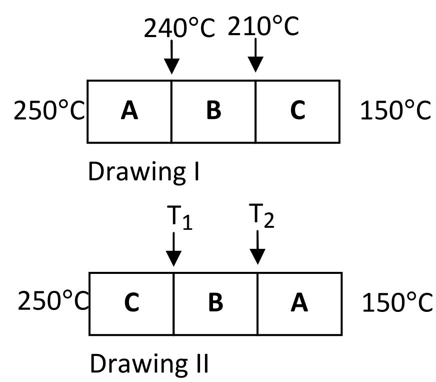
23. At what rate is heat lost through a 1.0 m × 1.5 m rectangular glass windowpane that is 0.5 cm thick when the inside temperature is 20 °C and the outside temperature is 5 °C? The thermal conductivity for glass is 0.80 W/(m · C°).

24. Two cylindrical steel rods A and B have radii of 0.02 m and 0.04 m, respectively. The two steel rods conduct the same amount of heat per unit time for the same temperature differences between their two ends. What is the ratio of the lengths of the rods, LA/LB ?

25. A granite wall has a thickness of 0.61 m and a thermal conductivity of 2.1 W/(m · C°). The temperature on one face of the wall is 3.2 °C and 20.0 °C on the opposite face. How much heat is transferred in one hour through each square meter of the granite wall?

26. On a cold winter day, the outside temperature is –5.0 °C while the interior of a well-insulated garage is maintained at 20.0 °C by an electric heater. Assume the walls have a total area of 75 m^2, a thickness of 0.15 m, and a thermal conductivity of 0.042 W/(m · C°). What is the cost to heat the garage for six hours at these temperatures if the cost of electricity is $ 0.14/kWh? Note: 1 kWh = 3.6 × 106 J.

27. A slab of insulation is made of three layers, as Drawing I indicates. Each of the layers A, B, and C has the same thickness, but a different thermal conductivity. Heat flows through the slab, and the temperatures are as shown. What are the temperatures T_1 and T_2 in Drawing II where the layers are arranged in a different order?



Radiation

28. Assume that the sun is a sphere of radius 6.96 × 10^8 m and that its surface temperature is 5.8 × 103 K. If the sun radiates at a rate of 3.90 × 1026 W and is a perfect emitter, at what rate is energy emitted per square meter at the sun's surface?

29. A person steps out of the shower and dries off. The person’s skin with an emissivity of 0.70 has a total area of 1.2 m2 and a temperature of 33 °C. What is the net rate at which energy is lost to the room through radiation by the naked person if the room temperature is 24 °C?

30. The power radiated by a distant star is 4.2×10^{27} W. The radius of the star, which may be considered a perfect radiator, is 1.06×10^{10} m. Determine the surface temperature of the star.