***Chemistry***

**5: Thermochemistry**

**5.2: Calorimetry**

15. Would the amount of heat measured for the reaction in Example 5.5 be greater, lesser, or remain the same if we used a calorimeter that was a poorer insulator than a coffee cup calorimeter? Explain your answer.

Solution

lesser; more heat would be lost to the coffee cup and the environment and so Δ*T* for the water would be lesser and the calculated *q* would be lesser

17. Would the amount of heat absorbed by the dissolution in Example 5.6 appear greater, lesser, or remain the same if the heat capacity of the calorimeter were taken into account? Explain your answer.

Solution

greater, since taking the calorimeter’s heat capacity into account will compensate for the thermal energy transferred to the solution from the calorimeter; this approach includes the calorimeter itself, along with the solution, as “surroundings:” *q*rxn = –(*q*solution + *q*calorimeter); since both *q*solution and *q*calorimeter are negative, including the latter term (*q*rxn) will yield a greater value for the heat of the dissolution

19. How much will the temperature of a cup (180 g) of coffee at 95 °C be reduced when a 45‑g silver spoon (specific heat 0.24 J/g °C) at 25 °C is placed in the coffee and the two are allowed to reach the same temperature? Assume that the coffee has the same density and specific heat as water.

Solution

Because of the law of conservation of energy, we write:

*q*spoon + *q*coffee = 0; *q*spoon = –*q*coffee

*c*spoon × *m*spoon × Δ*T* = –*c*coffee × *m*coffee × Δ*T*

0.24 J/g °C × 45 g × (*T*f – 25 °C) = 4.184 J/g °C × 180 g × (*T*f – 95 °C)

10.8*T*f – 270 = –753.1*T*f + 71546.4

763.9 *T*f = 71816.4

*T*f = 94 °C.

The temperature of the coffee will drop 1 degree.

21. The temperature of the cooling water as it leaves the hot engine of an automobile is 240 °F. After it passes through the radiator it has a temperature of 175 °F. Calculate the amount of heat transferred from the engine to the surroundings by one gallon of water with a specific heat of 4.184 J/g °C.

Solution

First, find the change in temperature of the water in °C:

240 °F – 175 °F = 65 °F.

We are concerned here only with the difference between temperatures and not the conversion from one temperature to the corresponding temperature.



Assuming 1 mL of water has a mass of 1 g, 1.0 gal of water has a mass of:



*q* = *cm*Δ*T* = 4.184 J/g °C × 3758 g × 36.1 °C

= 5.7 × 102 kJ.

23. If a reaction produces 1.506 kJ of heat, which is trapped in 30.0 g of water initially at 26.5 °C in a calorimeter like that in Figure 5.12, what is the resulting temperature of the water?

Solution

*q* = *cm*Δ*T* = 4.184 J/g °C × 30.0 g × (*T*f – 26.5 °C) = 1506 J

*T*f – 26.5 °C = 1506 J / (4.184 J/g° C × 30.0 g) = 12.0 °C

*T*f = 26.5 °C + 12.0 °C = 38.5 °C

25. Dissolving 3.0 g of CaCl2(*s*) in 150.0 g of water in a calorimeter (Figure 5.12) at 22.4 °C causes the temperature to rise to 25.8 °C. What is the approximate amount of heat involved in the dissolution, assuming the heat capacity of the resulting solution is 4.18 J/g °C? Is the reaction exothermic or endothermic?

Solution

Assume that the mass of the added CaCl2 in solution must be added to the mass of the water:

*q*reaction + *q*solution = 0

*q*reaction = *q*solution

*q*solution = *cm*Δ*T*

= 4.18 J/g °C × 153.0 g × (25.8 – 22.4) °C = 2200 J

= –2.2 kJ.

The heat produced shows that the reaction is exothermic.

27. The addition of 3.15 g ofBa(OH)2·8H2O to a solution of 1.52 g of NH4SCN in 100 g of water in a calorimeter caused the temperature to fall by 3.1 °C. Assuming the specific heat of the solution and products is 4.20 J/g°C, calculate the approximate amount of heat absorbed by the reaction, which can be represented by the following equation:



Solution

*q* = *cm*Δ*T*

= 4.20 J/g °C × (3.15 + 1.52 + 100) g × 3.1 °C

= 1362.8 J = 1.4 kJ (two significant figures)

29. If the 3.21 g of NH4NO3 in Example 5.6 were dissolved in 100.0 g of water under the same conditions, how much would the temperature change? Explain your answer.

Solution

The heat of the reaction would be approximately the same as before or 1.0 × 103 J. The reaction is endothermic, and the temperature would decrease:

*q*rxn = –*q*soln = –(*c* × *m* × Δ*T*)soln

–(4.18 J/g° C) × (103.2 g) × (*T*f – 24.9 °C) = 1000 J

*T*f – 24.9 °C = –2.3 °C

*T*f = 22.6. Since the mass and the heat capacity of the solution is approximately equal to that of the water, the two-fold increase in the amount of water leads to a two-fold decrease of the temperature change.

31. When a 0.740-g sample of trinitrotoluene (TNT), C7H5N2O6, is burned in a bomb calorimeter, the temperature increases from 23.4 °C to 26.9 °C. The heat capacity of the calorimeter is 534 J/°C, and it contains 675 mL of water. How much heat was produced by the combustion of the TNT sample?

Solution

The heat absorbed by the calorimeter is *q*1 = 534 J/°C × (26.9 °C – 23.4 °C) = 1869 J. The heat absorbed by water is *q*1 = 675 mL × 0.997 g/mL × 4.184 J/g °C × (26.9 °C – 23.4 °C) = 9855 J. The overall amount of heat *q* = *q*1 + *q*1 = 11,724 J or 11.7 kJ with three significant digits.

33. The amount of fat recommended for someone with a daily diet of 2000 Calories is 65 g. What percent of the calories in this diet would be supplied by this amount of fat if the average number of Calories for fat is 9.1 Calories/g?

Solution

Energy released by burning fat is:

65 g × 9.1 Calories/g = 5.9 × 102 Calories

% Calories from fat = 5.9 × 102 Calories/2000 Calories × 100%

= 30% (one significant figure).

35. What is the maximum mass of carbohydrate in a 6-oz serving of diet soda that contains less than 1 Calorie per can if the average number of Calories for carbohydrates is 4.1 Calories/g?

Solution

The average energy from carbohydrates is 4.1 kcal/g (4.1 Calories/g). The drink cannot contain more than.

37. A serving of a breakfast cereal contains 3 g of protein, 18 g of carbohydrates, and 6 g of fat. What is the Calorie content of a serving of this cereal if the average number of Calories for fat is 9.1 Calories/g, for carbohydrates is 4.1 Calories/g, and for protein is 4.1 Calories/g?

Solution



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