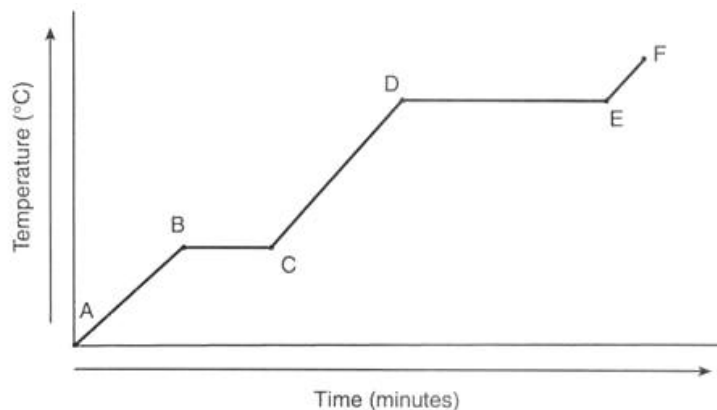


ThermoChem Notes

1. Thermo = _____ the _____ that happen in a chemical reaction.
2. When heat is given off it is an _____ reaction.
3. Sometimes energy is absorbed in order for the reaction happen; this is called an _____ reaction.
4. You must ADD energy to melt solids into liquids example: _____
5. You must REMOVE energy to freeze liquids into solids example: _____.
6. You must ADD energy to vaporize liquids into gases example: _____.
7. You must REMOVE energy to condense gases into liquids example: _____.



8. On a heating curve:

9. On a heating curve:

Draw a simple cooling curve for water

10. On a cooling curve:

11. On a cooling curve:

12.. Thermochem is partly:

13. Thermochem is also partly:

14. Even though we won't do much work below freezing, substances like ICE or any other solids can be really cold or warmer, but remain solid. For example:

15. And, steam (water gas) forms at 373 Kelvin, but it could also get to be much hotter.

16. Thermochem...

17. Thermochem will also help us to measure the amount of heat _____ in a chemical reaction (exothermic) or how much heat is _____ in a chemical reaction (endothermic).

18. How much heat is going to be very mathematical when we get to in next week. It's called the _____ written as this: _____ that is THE CHANGE IN HEAT

19. The energy is _____ with the mole ratio, so we can do math (stoichiometry) to the chemical and energy parts of a balanced thermochemical equation.

Open your reference tables to the first page. Look for Table B, let's fill it in on the next page.

Table B	
Physical Constants for Water	
Heat of Fusion	
Heat of Vaporization	
Specific Heat Capacity of H ₂ O _(L)	

21. The heat of fusion constant for water is

22. Every substance has

23. The 334 J/g is the constant just for

24. H_v is the _____ constant.

This is the energy that must be _____ 1 gram of steam at 373 K **or** 100°C
or to be _____ 1 gram of water.

25. Every substance has

26. The 2260 Joules/gram is the constant just for

27. Capital “C” is the symbol for the specific heat capacity constant for water.

This is the energy required to _____ by 1 K or 1°C

28. Every substance has its own

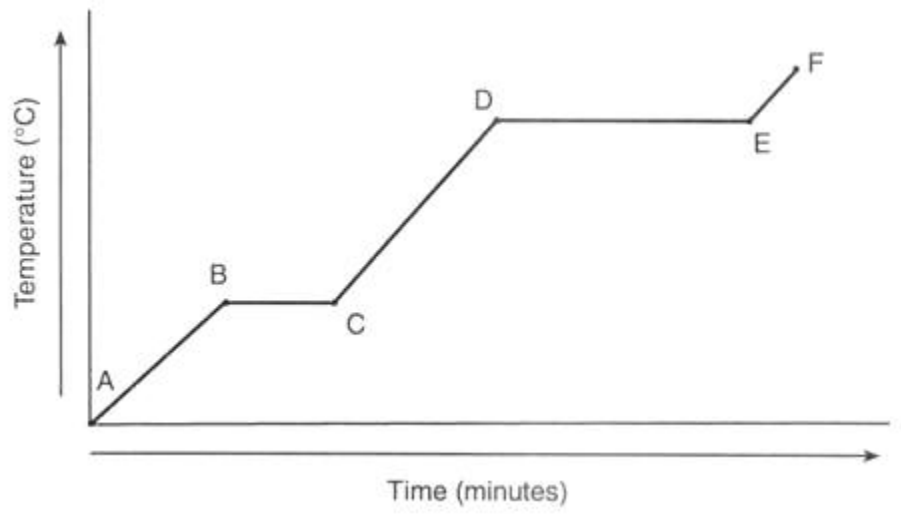
29. The 4.18 J/g·K is the constant for _____ **water only.** Not solid or gas H₂O, just liquid.

30. Liquid water has a _____ specific heat capacity constant. It’s hard to

A metal, such as iron has _____ $C_{Fe} =$ _____

Because water has such a high specific heat capacity constant (the amount of energy it takes to heat up, or cool down one gram of water by 1 Kelvin) pools...

31. The reason $BC < DE$ is because



32. Fill in this table.

BC		
CD		
DE		

33. The reason $BC > DE$ is because

Heating Curve for Water



34. Fill in this chart

BC		
CD		
DE		

35. To vaporize 1 gram of water you must _____ (the heat of vaporization).

When 1 gram of steam condenses, you _____ (the heat of vaporization)

It's the same amount of energy, just a matter of adding it, or removing it.

To melt 1 gram of _____ (the heat of fusion).

When 1 gram of water freezes, _____ (the heat of fusion)

It's the same amount of energy, just a matter of adding it, or removing it.

36. To change temperature of ONE GRAM of liquid water HOTTER, _____

To change temperature of ONE GRAM of liquid water COLDER, _____

Energy Unit Conversion Math

37. There are

38. A calorie (lower case "c")

39. A _____ Calorie is different.

40. A calorie

41. That's the same as changing the temperature of one gram of water from _____

42. A Food Calorie (capital "C")

43. We will use cal for _____ and we will use Calorie for _____

44. It takes 1000 cal = _____

45. A joule is tiny. It takes _____ = _____

46. 1000 joules is called a _____

47. Under Table B, in small ink, write these out: 4.18 J = 1 cal 1000 cal = 1 C 1000 joules = 1 kJ

48. You will get used to these units. In size order, from BIGGEST to smallest, here goes”

49. It takes 354 calories to make 354 g H₂O at 7°C to warm to 8°C. How many joules is 354 cal?

50. If you remove 5675 cal from 5675 g of H₂O at 297 K, it will cool to 296 K. How many Food Calories is 5675 cal?

51. Convert 3429 cal into kilojoules. (kJ)

52. When one mole of methane (CH₄) combusts at room temperature, exactly 890.4 kJ are released in this exothermic reaction. Convert 890.4 kJ into cal.

53. There are 225 Calories in a medium sized Hershey bar. Convert 225 C into joules.

54. To melt ice it takes 334 Joules/gram. To melt lots of grams takes _____.

55. The three Thermochemistry formulas on the back page of the reference tables are as follows:

--	--	--

In each one, the letters and the symbols stand for this. (add some notes to the reference tables now too)

56. How many joules of energy does it take to melt an ice cube of 83.0 grams?

57. How many joules of energy are required to freeze 355 mL of water at 273K?

58. How many joules required to melt a snow ball of 415 g?

59. This is important:

If your stuff is condensing, or vaporizing, at the HOT PHASE CHANGE TEMP,

60. When 12.5 g of water at 373 K but still liquid - is vaporized, how many joules does it take to turn it into a gas?

61. A big steam pipe breaks and releases 625 grams of steam onto a wall. How much energy is released when the steam condenses?

62. Making water change temperature is _____ than phase changing it.
There is a temperature change, and requires a formula that takes that temperature change into account.

The change in temperature is called the _____.

63. Draw in this simple heating curve for water. Label it ABCDEF. For BC use the formula _____

For DE, use the formula _____



64. For CD there is a temperature change, so you use this formula: _____

65. How much energy is needed to be removed to cool a glass of water (325 grams) from (room temp) 296 K down to “drinkable-cool” of 284 K?

66. A pot holds 650. grams of water at room temperature (24.0°C) You think to make some mac and cheese and turn on the stove to heat the water. It heats up to 95.0°C when your BFF shows up with pizza and you turn off the stove. How much energy would your Dad say you wasted heating up this water for nothing?

67. In this problem, the water changes temperature from 24.0 to 95.0°C. If we convert those temps first, the water changes from _____ . The $\Delta T = 71.0$ Kelvin (3 SF)

In centigrade it's: _____ . The $\Delta T = 71.0^\circ\text{C}$ (3 SF)

The change in temp is the same even though the actual numerals are different.

Centigrade is NOT the same as Kelvin, but the change in C is equal to the change in K.

68. If water changes from 0° to 25°C, the ΔT is _____

69. If water changes from 273 K to 298 K, the ΔT is _____

70. This is important! $273 \neq 0$ and $25 \neq 298$, but the difference between

71. _____

72. If there is a change of temperature, there is ONLY one formula to choose. It is: _____

73. If there is melting or freezing, there is ONLY one formula to choose. It is: _____

74. If there is condensing or vaporizing, there is ONLY one formula to choose. It is: _____

75. Choose wisely, you must.

76. When 650. grams of water at room temperature (24.0°C) goes into a pot to boil at 100.0°C. You vaporize 35.0 grams of it. How much energy did it take to all of this?

77. A 273.4 gram snowball at 273.0 K first melts, then warms to 26.55°. How many joules did it take to do that?

Take out your Thermochem Maps now. We need to look it over, and save it somewhere good for reference.

78. The specific heat capacity constant for LIQUID WATER is _____

79. But for ICE it is different: it's _____

80. For STEAM it is different again, it's _____

Write these 2 constants underneath table B now

Now it is time for the *COOLEST DEMO* of the year. You can sit back and just enjoy the show. I dare you not to giggle because this is *SO, SO* cool.

81. When something like iron melts, it has its own _____ which is sort of high compared to water. It has its own heat of fusion constant too.

82. When you warm up iron on the way to melting it, it takes a certain amount of energy to make each gram get hotter by _____. Every substance has its own specific heat capacity constant.

83. Every substance has a unique _____.

84. How many grams of water can be frozen when you remove 87,500 joules from it?

85. How many grams of water can be heated by 25.5 K when it absorbs 17,500 joules?

86. What is the HEAT OF FUSION for candle wax if it takes 3388 Joules to melt a whole birthday candle with mass of 23.04 grams?
87. What is the C of Cu, if it takes 951 joules to warm up 41.63 grams of copper from 294.5 K up to 352.9 Kelvin?
88. What is the specific heat capacity constant for GOLD if it takes 271 joules to warm up a ring with mass of 34.2 g from room temp (294.0 K) to a “too hot to wear” temperature of 355.5 Kelvin?
89. When a 355 mL can of seltzer, is warmed from a temperature of 293 K by adding 64,000 Joules of energy to it, what is the final temperature? Assume the seltzer is just water.

90. When 51.1 g copper at 381.5 K emits 1788 Joules, it cools down. What is the final temp if $C_{\text{Cu}} = 0.391 \text{ J/g}\cdot\text{K}$?

The C of Cu Lab Explained. Look at the Lab Handout Now. Take a few notes on white paper.

91. There is no easy way to directly measure the energy that is in food.

An indirect way has been well figured out, using a machine called a _____

92. Let's draw and label a calorimeter now.

93. Let's assume that there is exactly 2120. mL of water in our bomb calorimeter and it's at exactly 295.0 K.

After burning up our food sample, the temperature of the water rises to 354.5 K.

How many Calories of energy are in this food sample?

Dorito's Lab Explained. Take out the Lab Handout, take some notes on white paper.

Take out Table I now. (when I don't know what I need to know in a thermochem problem, sometimes I fret, sometimes I yell, sometimes I even cr-I! What I should do when I have a hard problem is to look at TABLE ___!!!

96. Table I is called the _____ table.

97. Unusually, it is at _____

98. It's at _____, which is room temperature

99. $\text{CH}_{4(\text{G})} + 2\text{O}_{2(\text{G})} \rightarrow \text{CO}_{2(\text{G})} + 2\text{H}_2\text{O}_{(\text{G})}$ The mole ratio here is _____

100. This reaction has a $\Delta H =$ _____

101. Which means this reaction

102. What's with that NEGATIVE SIGN?

103. A minus sign indicates:

104. If the ΔH is a + number, that means the _____.

105. In an exothermic reaction, energy is a _____ (it's given off)

106. In an endothermic reaction, energy is a _____
(energy is absorbed to make the reaction occur).

107. Well, now I'm telling you that:

108. The mole ratio for the combustion of CH_4 is now: _____

109. If 23.4 moles of CH_4 combust, how much energy is released?

110. Propane gas, C_3H_8 combusts according to Table I.
How much energy (in kJ) is released when 5.75 moles C_3H_8 combusts? (find this - Table I, it's the 2nd reaction)
111. How much energy is absorbed by the reaction of 99.0 moles of $HI_{(g)}$ forming?
112. How much energy is required to melt a snow ball at 273 K up to body temperature of 294 Kelvin? (think hard)
113. If 16.3 grams of steam at exactly 373 K condenses onto a kitchen window, then cools quickly to 305 K.
How much energy was released?

114. $C_{ICE} =$ _____ (this is NOT liquid water, NOT 4.18 J/g·K)

115. For fun, you obtain a snowball (255 g) at -5.00°C and put it in the back of your friend's shirt. It melts then warms up to body temperature of 36.0°C . How much energy does that take?

116. Draw the simple Cooling Curve for Chromium, labels, titles, axis labels, etc.



117. A. What temps are 1 + 2?

C. What's KE doing AB and DE

E. Which thermochem formula do you use for BC?

B. What's PE doing BC and CD?

D. Why is BC longer than DE?

F. How about for EF?

118. Use table I, choose the equation of propane combusts. Write the balanced chemical equation with the ΔH

119. Write a balanced thermochemical equation

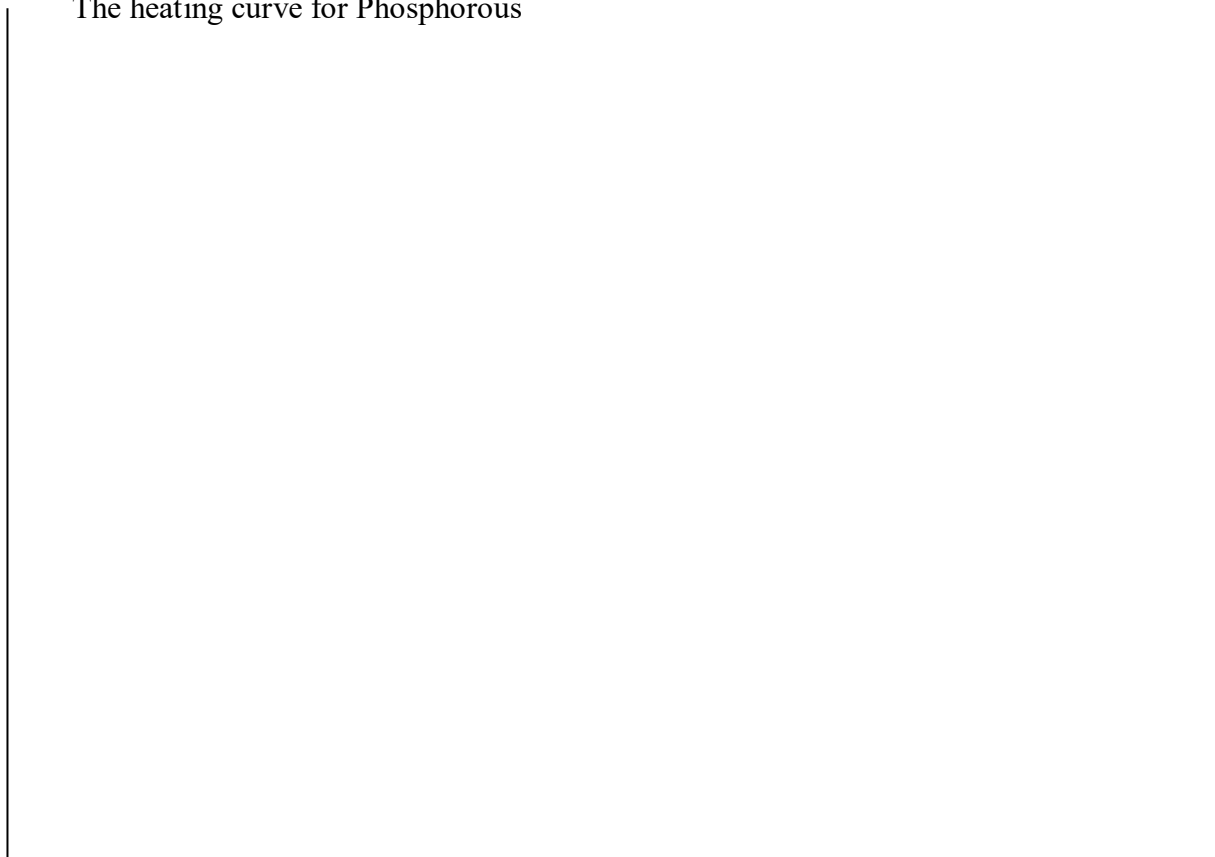
120. Find the most endothermic equation on Table I, write the balanced chemical equation with the ΔH

121. Write the balanced thermochemical equation for this reaction too.

122. You decide to warm up some water for oatmeal. How much energy does it take to warm up 354 mL of water from 24.5°C to the boiling point and to let 7.50 grams vaporize making the teapot whistle.

123. Write the balanced thermochemical equation for the synthesis of aluminum oxide, then calculate how much energy is released (or absorbed) when you form 21.0 moles of Al_2O_3 .

The heating curve for Phosphorous



124. What formula would you use For BC _____ For CD _____

Or for DE _____ What happens to PE + KE at BC and CD?

125. When 45.0 g of an unknown metal absorbs 1.51 kJ of heat. The temperature changes from 268 K to 345 K. What is the specific heat capacity constant for this metal?

126. Which takes more energy? Melting 50.0 g of ice or vaporizing 50.0 g of water into steam?

127. Which takes more energy? Heating 23.0 mL of water from 274 K to 299 K

Or Heating 23.0 mL of water from 299 K to 323 K?

128. Which takes more energy? Vaporizing 21.0 g water from 373 K liquid to gas

or Changing the temp of 100.0 g H₂O by 97.0 K?

129. Which has the LOWEST AVERAGE KINETIC ENERGY?

100 mL water at 51.0°C

100 mL water at 50.0°C

175 mL water at 49.0°C

175 mL water at 23.0°C

130. This horse has a boo boo. That's an ICE PACK on his leg. Describe the thermochem:

A. Heat flows from ice pack → leg

B. Cold flows from ice pack → leg

C. Heat flows from leg → ice pack

D. Cold flows from leg → ice pack

131. Copy these CAREFULLY, they are not the same. Be Complete.

The Law of Conservation of Matter (or mass)

The Law of Conservation of Energy