

Keep The Heat Test
Virginia Science Olympiad 2012
Regionals

Score _____

School _____

Team Number _____

Student Names _____

Specific Heat

Substance	Specific Heat (J/kg K)
Aluminum	900
Copper	386
Brass	380
Gold	126
Lead	128
Silver	233
Tungsten	134
Zinc	387
Mercury	140
Water	4186
Ice (-10 C)	2050

Phase Change points and H_f and H_v

Substance	Melting Point (°C)	Heat of fusion (10^3 J/kg)	Boiling Point (°C)	Heat of vaporization (10^3 J/kg)
Helium	-269.65	5.23	-268.93	20.9
Hydrogen	-259.31	58.6	-252.89	452
Nitrogen	-209.97	25.5	-195.81	201
Oxygen	-218.79	13.8	-182.97	213
Mercury	-39	11.8	357	272
Water	0	334	100	2256
Sulfur	119	38.1	444.6	326
Lead	327.3	24.5	1750	871
Silver	960.8	88.3	2193	2336
Gold	1063	64.5	2660	1578
Copper	1083	134	2567	5069

1. When Count Rumford conducted his experiments in the early 1800's what did he say caused the heat that was being generated? (1 point)
 - a. Caloric
 - b. Friction**
 - c. Thermal expansion
 - d. Temperature change
2. What is the difference between the units calorie and Calorie? (1 point)
 - a. A calorie is equal to 1000 Calories
 - b. A Calorie is equal to 1000 calories**
 - c. A calorie is equal to .01 Calories
 - d. A Calorie is equal to .01 calories
 - e. The two units are identical

3. Which statement is more correct? (3 points)

- a. Heat rises.
- b. Warm air rises.
- c. Neither is correct.

Explain your answer.

Warm air rises in cooler air, heat does not rise, Heat is simply what we call the transfer of thermal energy.

They could also answer “c. Neither is correct.” if they say that for b. to be correct it had to say “warmer” air rises rather than simply “warm” air.

4. Convert the following temperatures (2 points each)

Show your work.

a. 47 °C to °F

$$(47^{\circ}\text{C} + 40) \times 1.8 - 40 = \mathbf{117^{\circ}\text{F}}$$

They could also use:

$$(9/5) X^{\circ}\text{C} + 32 \text{ for } ^{\circ}\text{C to } ^{\circ}\text{F and}$$

$$X^{\circ}\text{F}(5/9) - 32 \text{ for } ^{\circ}\text{F to } ^{\circ}\text{C}$$

b. 376°F to K

$$((376^{\circ}\text{F} + 40)/1.8) - 40 = 191^{\circ}\text{C}$$

$$271.1^{\circ}\text{C} + 273.15 = \mathbf{464.15\text{K}}$$

c. -135°F to °C

$$((135^{\circ}\text{F} + 40)/1.8) - 40 = \mathbf{57^{\circ}\text{C}}$$

d. 189 K to °C

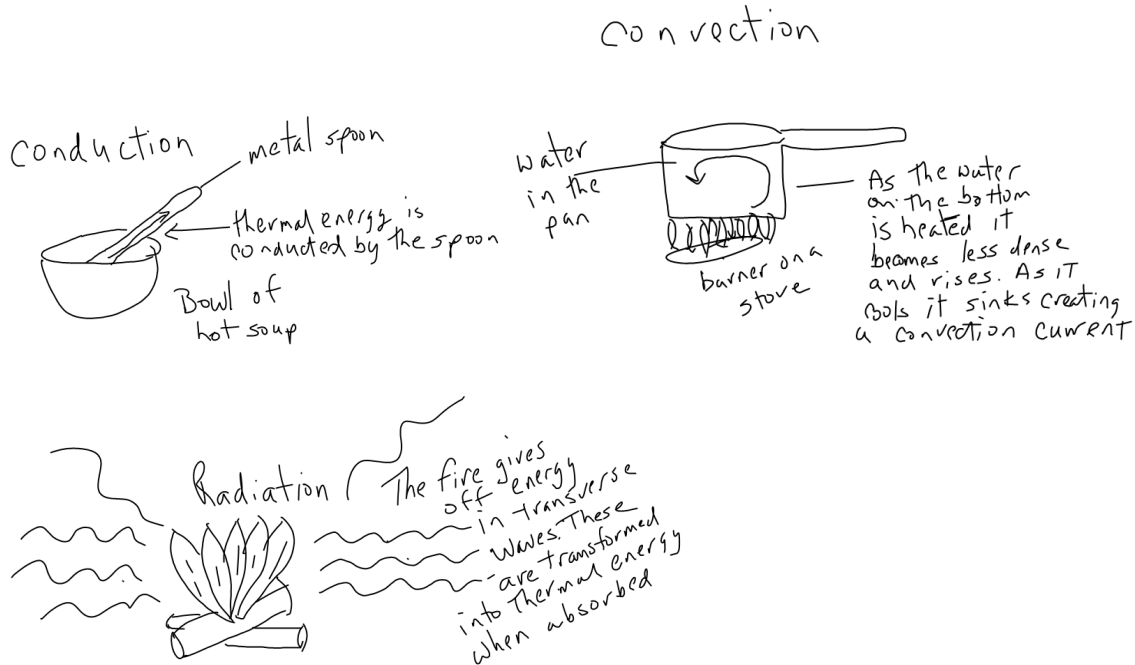
$$189\text{K} - 273.15 = \mathbf{-84.15^{\circ}\text{C}}$$

e. 14 °C to K

$$14^{\circ}\text{C} + 273.15 = \mathbf{287.15\text{K}}$$

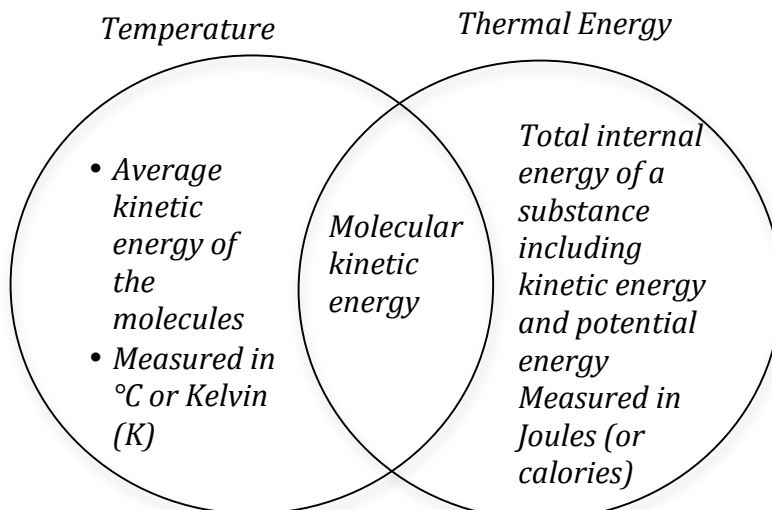
5. Draw and label examples of the three (3) ways that thermal energy is transferred between substances. (10 points)

They should draw and label pictures that clearly describe convection, conduction, and radiation. Important parts of the drawing should be labeled.



6. Compare and contrast temperature and thermal energy. Be sure to include similarities and differences. (5 points)

Answers will vary but should include the following points



7. An aluminum pan and a glass dish filled with water are taken out of a 80°C oven and placed on the counter in a 23°C kitchen. The mass of both is 1.0 Kg. What do you predict their temperatures will be after 20 minutes and why? Be as specific as possible. (5 points)

Their answer should indicate that the aluminum pan will be closer to room temperature than the water.

Their explanation should include that because the specific heat of aluminum is so much less than water's the pan will cool much more quickly under these conditions.

It is expected they will say the pan would be close to 23°C while the water would still be above that temperature.

8. Draw and describe how a liquid filled thermometer measures temperature. (5 points)

The liquid inside expands when its temperature increases causing the temperature on the thermometer to increase. When it cools, the opposite occurs.



9. How much energy (in Joules) is needed to heat 750g of copper from 10°C to 37°C? **You MUST show all your work to get credit.** (5 points)

$$Q = mC \Delta T$$

$$750g * 1Kg/1000g = .75 Kg$$

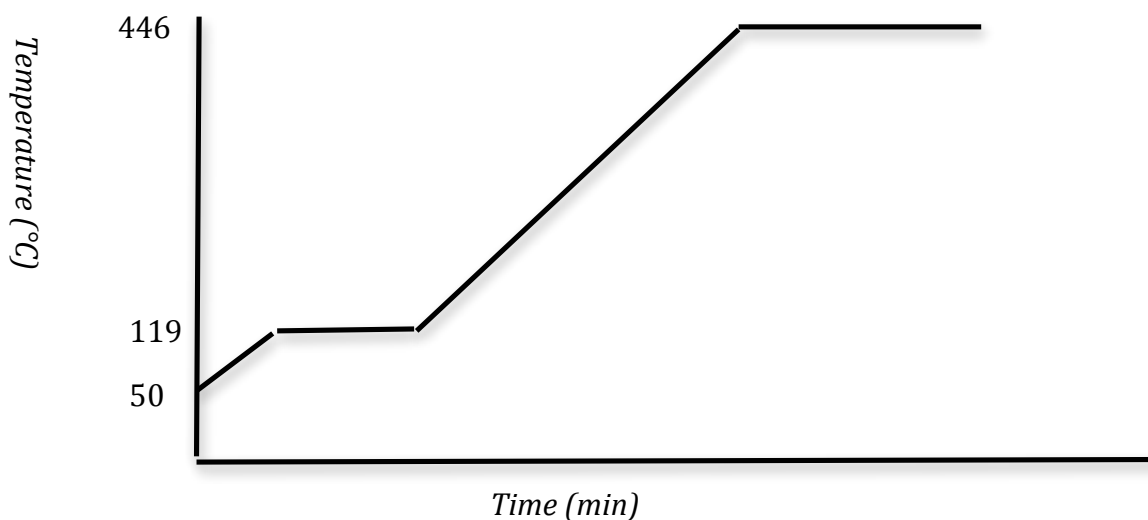
$$\Delta T = 310K - 283K = 27K$$

$$Q = .75Kg * (386J/KgK) * 27K$$

$$Q = 7817 J \text{ or } 7.817 KJ$$

10. Using the information in the Latent Heats of Fusion and Vaporization Table on the first page, sketch a graph showing what would happen to temperature over time as energy was added to sulfur at 50°C as it was changed into a gas. (5 points)

The effect of energy on the temperature of sulfur



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Explain your answer.

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Show your work.

a. $47\text{ }^{\circ}\text{C}$ to $^{\circ}\text{F}$

b. $376\text{ }^{\circ}\text{F}$ to K

c. $-135\text{ }^{\circ}\text{F}$ to $^{\circ}\text{C}$

d. 189 K to $^{\circ}\text{C}$

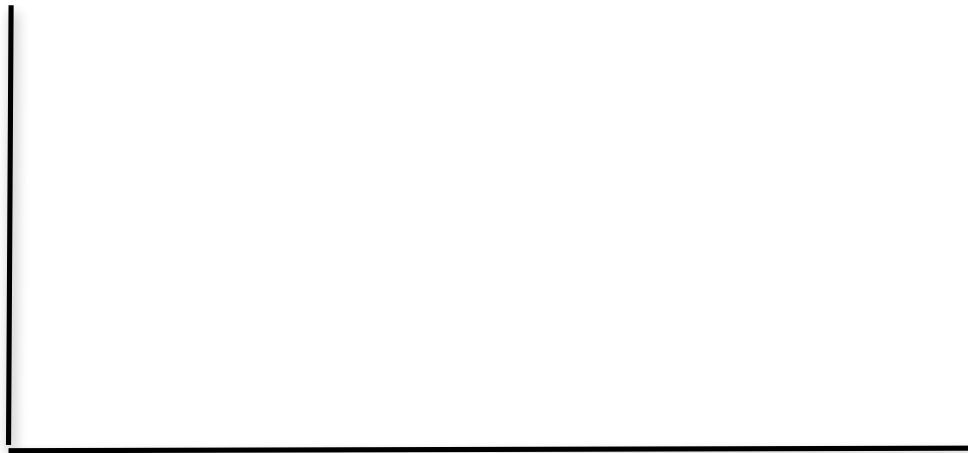
e. $14\text{ }^{\circ}\text{C}$ to K

7. An empty aluminum pan and a glass dish filled with water are taken out of a 180 °C oven and placed on the counter in a 23°C kitchen. The mass of both is the same. What do you predict the temperatures of the empty aluminum pan and the glass dish with water will be after 20 minutes and why? Be as specific as possible. (5 points)

8. Draw and describe how a liquid filled thermometer measures temperature. (5 points)

9. How much energy (in Joules) is needed to heat 750g of copper from 10°C to 37°C? **You MUST show all your work to get credit.** (5 points)

10. Using the information in the Phase Change Points, H_f and H_v Table on the first page, sketch a complete, properly labeled graph showing what would happen to temperature over time as energy was added to sulfur at 50°C as it was changed into a gas. (5 points)



Keep The Heat Score Sheet

Virginia Science Olympiad 2012

School _____ Team Number _____

Student Names (please PRINT clearly)

Device Design Requirements (Must me all requirements to be in 1st Tier)

- Fits inside a 30.0cm x 30.0cm x 30.0cm cube
- Hole in center of lid is ≥ 1.5 cm
- Distance from top of hole to top lip of beaker is ≤ 5.0 cm
- 2 - 250mL beakers

Plot Score

- Plot labeled with School and Students' Names 2 pts
- Plot titled appropriately and with x and y axes labeled 2 pts
- Appropriate units listed and axis increments 2 pts
- Number of Plots/graphs turned in X 1 pt (max:4 pts) _____

Total Plot Score _____

Final Score Calculation

- i. Test Score (Max: 50) _____
- ii. Plot Score(Max: 10) _____
- iii. Heat Retention Score (HRS) * _____
- iv. Prediction Score (PS) ** _____

Total Score _____

Final Ranking _____ Tier 1 Tier 2

* HRS = ((internal beaker water temp/external beaker water temp)-1)X 50

**PS = (1 - (abs(Final internal water temp-predicted internal water temp/final internal water temp)) X 25