Name: _____

Class: _____

Due Date: _____

Physics Topic 23 – States of Matter and Thermal Energy Transfers

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: Define *solid*. What are its characteristics?

2. C: Define *fluid.*

3. C: Define *liquid*. What are its characteristics?

4. C: Define *gas*. What are its characteristics?

5. C: Define and give the units for each variable for density $\rho = \frac{m}{V}$. Is it a scalar or vector? Do not confuse density ρ with power P or momentum $\vec{p}$ or pressure p!

6. E: Determine the volume of a 1.00 kg gold bar if gold has a density of approximately 19,300 kg/m^3.

7. C: Define *diffusion.*

8. C: Which state of matter has the most potential energy: a solid, a liquid, or a gas? What about kinetic energy?

9. C: Define *temperature.*

10. C: Define *Degrees Celsius*. What is the melting point and the boiling point of water in *degrees Celsius*?

11. C: Define *Kelvin*. What is the melting point and the boiling point of water in Kelvin?

12. C: Define *absolute zero.*

13. C: Which has greater kinetic energy: 0℃ ice or 0℃ water? Which has greater potential energy?

14. C: Define and give the units for each variable of the equation for *Boltzmann's constant* $k_{\mathrm{B}} = \frac{R}{N_{\mathrm{A}}}$.

15.C: Define and give the units for each variable for the equation for the internal energy of an ideal gas $\overline{E_{\mathrm{k}}} = \frac{3}{2}k_{\mathrm{B}}T = \frac{3}{2}\frac{R}{N_{\mathrm{A}}}T$.

16.C: Define *thermal equilibrium.*

17.C: Define *heat.*

18.C: Define *internal energy*.

19.C: Define *phase change*.

20.C: What does the equation $Q = mc\Delta T$ tell us? Define and give the units of each variable.

21.C: Define *melting*. Does an object gain potential energy or lose potential energy when it melts? What about kinetic energy?

22.C: Define *freezing*. Does an object gain potential energy or lose potential energy when it freezes? What about kinetic energy?

23. C: Define *vaporization/boiling*. Does an object gain potential energy or lose potential energy when it vaporizes/boils? What about kinetic energy?

24. C: Define *condensation*. Does an object gain potential energy or lose potential energy when it condenses? What about kinetic energy?

25. C: What does the equation $Q = mL_{\mathrm{f}}$ tell us? Define and give the units of each variable.

26. C: What does the equation $Q = mL_{\mathrm{v}}$ tell us? Define and give the units of each variable.

27. E: Moses has 500 grams of gold.

    a. Go online to find the specific heat capacity of gold in its solid state in $\frac{\mathrm{J}}{\mathrm{kg}\times\mathrm{K}}$.

    b. How much energy will it take to increase the temperature of solid gold by 50°C?

    c. How much energy will be lost by solid gold if its temperature decreases by 50°C?

28.E: How much energy will be needed to increase the temperature of 0.8 kg of solid ice from minus 30°C to steam at plus 140°C? Draw a *temperature vs. energy* graph of this process.

$c_{\text{solid}} = 2{,}108\ \frac{\text{J}}{\text{kg} \times \text{K}}$	$c_{\text{liquid}} = 4{,}186\ \frac{\text{J}}{\text{kg} \times \text{K}}$	$c_{\text{gas}} = 1{,}996\ \frac{\text{J}}{\text{kg} \times \text{K}}$
$L_{\text{f}} = 3.34 \times 10^{5}\ \frac{\text{J}}{\text{kg}}$	$L_{\text{v}} = 2.26 \times 10^{6}\ \frac{\text{J}}{\text{kg}}$	

29. E: Approximately how much energy will be needed to melt 1.25 kg of silver which is at a room temperature of 22.0°C? The specific heat capacity of silver is approximately $236\ \frac{\text{J}}{\text{kg}\times°\text{C}}$, the latent heat of fusion of silver is approximately $1.05 \times 10^5\ \frac{\text{J}}{\text{kg}}$, and the melting point of silver is approximately 962°C.

30. E: Aaron drops a 6.00 kg gold block with a temperature of 20.0°C into a tub with 2.00 kg of liquid water at 90.0°C. What will be the final temperature of the system?

31. E: A ball of copper, which has a specific heat capacity of $c = 390.\frac{\text{J}}{\text{kg°C}}$, has a mass of 165 grams and is initially at a temperature of 115°C. This ball is quickly inserted into an insulated cup containing 125 ml of water at a temperature of 22.0°C.

    a. What will be the final, equilibrium temperature of the ball and the water?

    b. How much heat did the copper ball lose to the water?

    c. How much heat did the water gain from the ball?

32.C: Define *conduction, convection,* and *radiation.* Give an example of each.

33.C: What is the difference between a *thermal conductor* and *thermal insulator*? Give an example of each.

34.C: Describe the equation $\frac{\Delta Q}{\Delta t} = kA\frac{\Delta T}{\Delta x}$.

35.E: A silver plate 3.00 cm thick has a cross-sectional area of $4{,}000.\,\mathrm{cm}^2$. One face is at 160.°C and the other is at 130.°C. How much heat passes through the plate each second? For silver, $k = 406\ \frac{\mathrm{W}}{\mathrm{mK}}$.

36.E: A metal plate 6.00 mm thick has a temperature difference of 48.0°C between its faces. It transmits 200. kcal/h through an area of $7.00\ \mathrm{cm}^2$. Calculate the thermal conductivity of this metal in $\frac{\mathrm{W}}{\mathrm{mK}}$.

37.E: Two metal plates are soldered together. It is known that $A = 70.0\ \mathrm{cm}^2$, $L_1 = 2.00\ \mathrm{mm}$, $L_2 = 4.00\ \mathrm{mm}$, $T_1 = 110.\,℃$, and $T_2 = 20.0℃$. For the plate on the left $k_1 = 45.0\ \frac{\mathrm{W}}{\mathrm{mK}}$ and for the plate on the right $k_2 = 85.0\ \frac{\mathrm{W}}{\mathrm{mK}}$. Determine the temperature of the soldered junction in K and the heat flow rate in J/s.