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Heat and Specific Heat Calculations

1. How much heat is needed to raise the temperature of 5 grams of copper by 10°C?

2. A 50g substance loses 23 calories of heat energy when the temperature falls from 35°C to 20°C. What is the specific heat of the substance?

3. A piece of food is tested in a calorimeter to ascertain how much heat energy it contains. If the water in the calorimeter has a mass of 150 g and the temperature of the water increases by 3°C, how much heat energy was released by the burning of the food?

4. A 500 g piece of iron changes 7°C when heat is added. How much heat energy produced this change in temperature?

5. When 300 calories of energy is lost from 125 g object, the temperature decreases from 45°C to 40°C. What is the specific heat of this object?

6, 1200 calories of heat energy is added to a liquid with specific heat of 0.57 cal/g°C. If the temperature increases from 20°C to 33°C, what is the mass of the liquid?

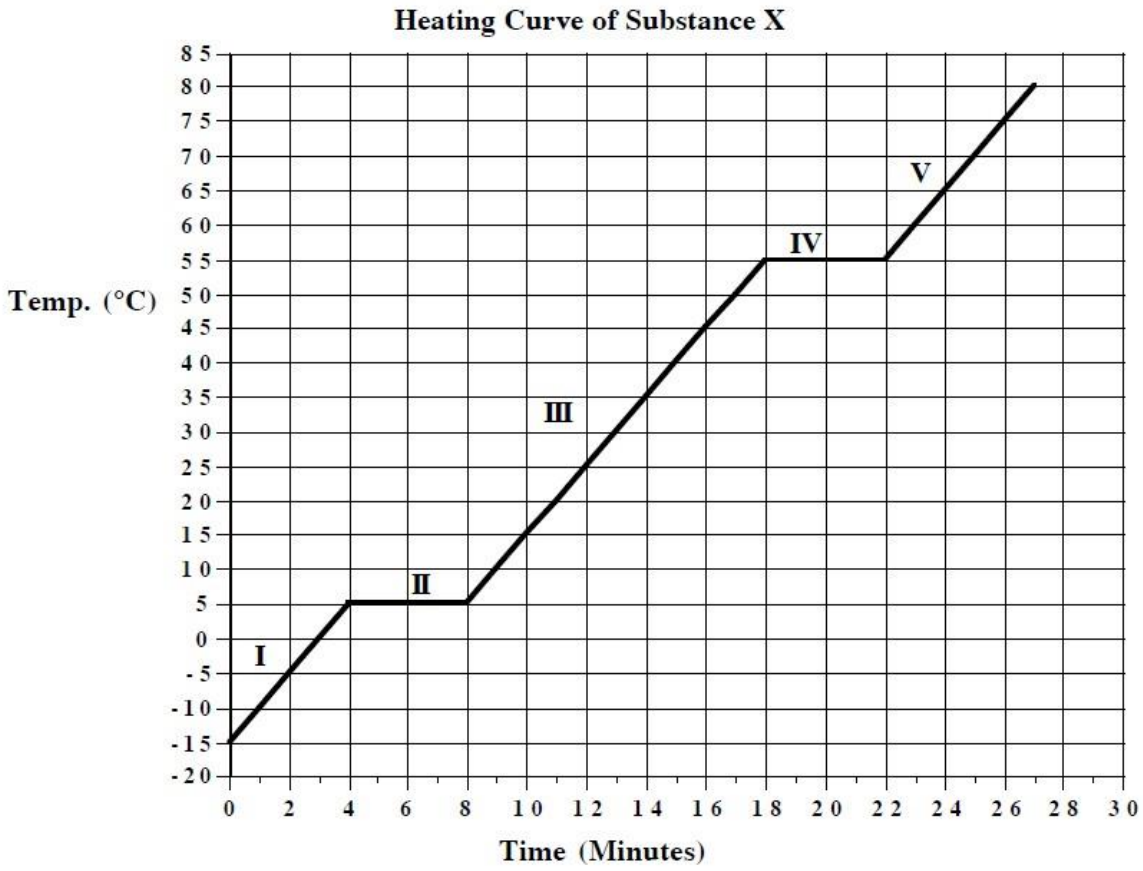
7. A piece of food is burned in a calorimeter that contains 200 g of water. If the temperature of the water rose from 20°C to 45°C, how much heat energy was contained in the food?

8. if the tested food in problem 7 had a mass of 10 grams, how many food calories per gram was contained in the food?

9. If the temperature of a 34.4 g of ethanol increases from 25.0°C to 78.8°C, how much heat has been absorbed by the ethanol?

10. A 4.50g nugget of pure gold absorbed 276 J of heat. What was the final temperature of the gold if the initial temperature was 25.0°C. The specific heat of gold is 0.129 J/g°C.

Heating Curves Worksheet



The heating curve shown above is a plot of temperature vs time. It represents the heating of substance X at a constant rate of heat transfer. Answer the following questions using this heating curve:

_____1. In what part of the curve would substance X have a definite shape and definite volume?

_____2. In what part of the curve would substance X have a definite volume but no definite shape?

_____3. In what part of the curve would substance X have no definite shape or volume?

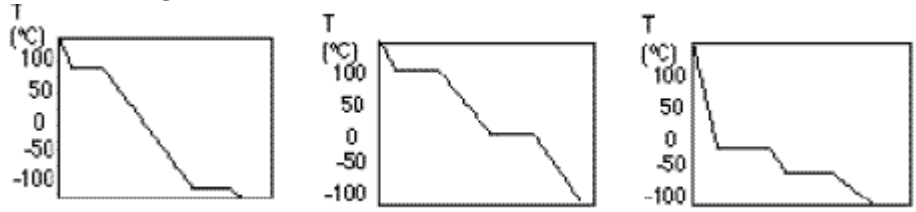
_____4. What part of the curve represents a mixed solid/liquid phase of substance X?

_____5. What part of the curve represents a mixed liquid/vapor phase of substance X?

_____6. What is the melting temperature of substance X?

_____7. What is the boiling temperature of substance X?

Circle the correct cooling curve for water.



_____8. In what part(s) of the curve would increasing kinetic energy be displayed?

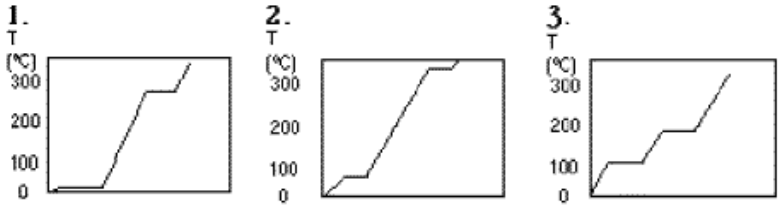
_____9. In what part(s) of the curve would increasing potential energy be displayed?

_____10. In what part of the curve would the molecules of substance X be farthest apart?

_____11. In what part of the curve would the molecules of X have the lowest kinetic energy?

_____12. In what part of the curve would the molecules of X have the greatest kinetic energy?

Substance	Melting/Freezing Point (^{o}C)	Boiling/Condensation Point (^{o}C)
ammonia	-77.7	-33.3
carbon dioxide	-78.5	-78.5
copper	1083.0	2566.0
ethanol	-114.4	78.5
glycerin	20.0	290.0
gold	1064.0	2807.0
iodine	113.5	184.4
mercury	-38.9	356.6
sodium chloride	801.0	1413.0
stearic acid	71.5	360.0
tin	232.0	2270.0
pure water	0.0	100.0



13. Which of the graphs above most likely represents iodine? _____
14. Which of the graphs above most likely represents steric acid? _____
15. Which of the graphs above most likely represents glycerin? _____

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Use the information in the data table to answer the question below. Substance X is represented in the graph on the previous worksheet

Specific Heat for the solid state	2.0 J /g °C
Heat of fusion	100 J/g
Specific Heat for the liquid state	5.0 J /g °C
Heat of vaporization	1000 J/g
Specific Heat for the gas state	1.0 J/g°C

1. How much heat is required to increase the temperature of 20.0 grams of substance X from -10.0° C to 70.0 °C?

Name_____Date_____Block____

Entropy

Determine whether the following reactions show an increase or decrease in entropy.

1.) $2\ KClO_3\ (s) \rightarrow 2\ KCl\ (s) + 3\ O_2\ (g)$

2.) $H_2O\ (\ell) \rightarrow H_2O\ (s)$

3.) $N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$

4.) $NaCl\ (s) \rightarrow Na^{+1}\ (aq) + Cl^{-1}\ (aq)$

5.) $KCl\ (s) \rightarrow KCl\ (\ell)$

6.) $CO_2\ (s) \rightarrow CO_2\ (g)$

7.) $H^{+1}\ (aq) + C_2H_3O_2^{-1}\ (aq) \rightarrow HC_2H_3O_2\ (s)$

8.) $H_2\ (g) + Cl_2\ (g) \rightarrow 2\ HCl\ (g)$

9.) $Ag^{+1}\ (aq) + Cl^{-1}\ (aq) \rightarrow AgCl\ (s)$

10.) $2\ N_2O_5\ (g) \rightarrow 4\ NO_2\ (g) + O_2\ (g)$

11.) $2\ Al\ (s) + 3\ I_2\ (s) \rightarrow 2\ AlI_3\ (s)$

12.) $H^{+1}\ (aq) + OH^{-1}\ (aq) \rightarrow H_2O\ (\ell)$

13) $2\ NO\ (g) \rightarrow N_2\ (g) + O_2\ (g)$

14.) $H_2O\ (g) \rightarrow H_2O\ (l)$

In your best judgment, which of the following in the pair has the highest entropy?

1) (A) messy room (B) neat room
2) (A) ice (B) steam
3) (A) solid salt crystals (B) salt dissolved in water
4) (A) iron filings & sulfur powder (B) solid iron sulfide

Indicate whether the following describes endothermic or exothermic reactions

A) reactants have higher enthalpy than products
(B) produces energy as it proceeds
(C) products have very high enthalpy
(D) ΔH is always positive

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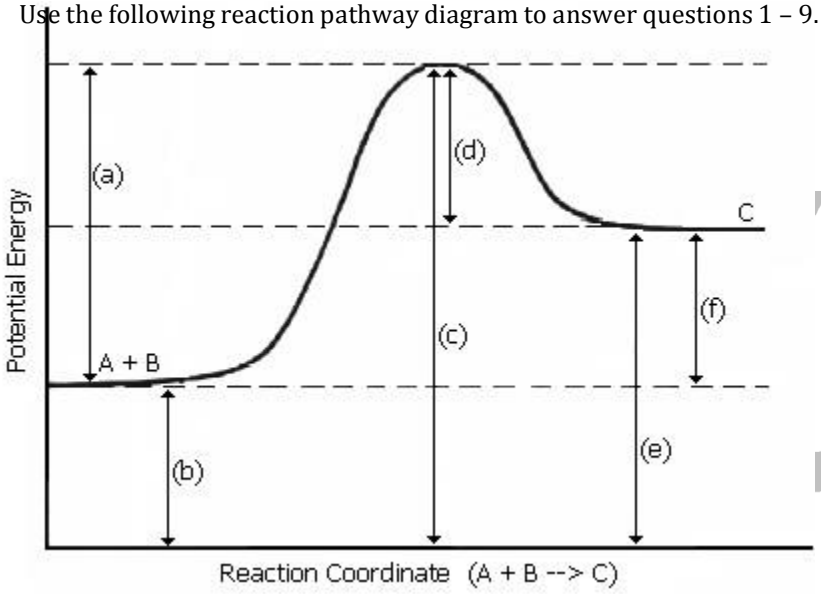
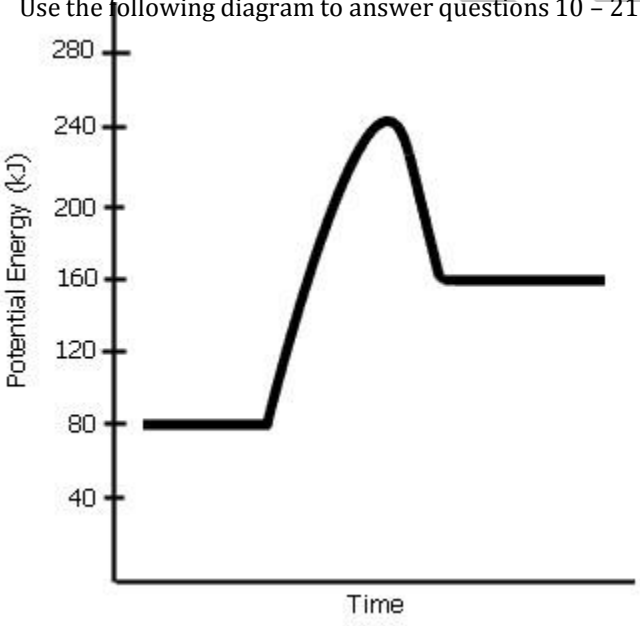
REACTION PATHWAY DIAGRAM WORKSHEET

Use the following reaction pathway diagram to answer questions 1 – 9.



1. Which of the letters a–f in the diagram represents the potential energy of the products?
2. Which letter indicates the potential energy of the activated complex?
3. Which letter indicates the potential energy of the reactants?
4. Which letter indicates the activation energy?
5. Which letter indicates the heat of reaction?
6. Is the reaction exothermic or endothermic?
7. Which letter indicates the activation energy of the reverse reaction?
8. Which letter indicates the heat of reaction of the reverse reaction?
9. Is the reverse reaction exothermic or endothermic?

Use the following diagram to answer questions 10 – 21.



10. The heat content of the reactants of the forward reaction is about _____ kilojoules.

11. The heat content of the products of the forward reaction is about _kilojoules.

12. The heat content of the activated complex of the forward reaction is about kilojoules.

13. The activation energy of the forward reaction is about _____ kilojoules.

14. The heat of reaction (ΔH) of the forward reaction is about _____ kilojoules.

15. The forward reaction is (endothermic/exothermic).

16. The heat content of the reactants of the reverse reaction is about kilojoules.

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Hess's Law

1. The combination of coke and steam produces a mixture called coal gas, which can be used as a fuel or as a starting material for other reactions. If we assume coke can be represented by graphite, the equation for the production of coal gas is

$2\,C\,(s) + 2\,H_2O\,(g) \rightarrow CH_4\,(g) + CO_2(g)$

Determine the standard enthalpy change for this reaction from the following standard enthalpies of reaction :

(1) $C(s) + H_2O\,(g) \rightarrow CO\,(g) + H_2\,(g)$ $\Delta H° = 131.3\,kJ$

(2) $CO\,(g) + H_2O\,(g) \rightarrow CO_2\,(g) + H_2\,(g)$ $\Delta H° = -41.2\,kJ$

(3) $CH_4\,(g) + H_2O\,(g) \rightarrow 3\,H_2\,(g) + CO\,(g)$ $\Delta H° = 206.1\,kJ$

2. Find the ΔH for the reaction below, given the following reactions and subsequent ΔH values:
$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(g)$ $\Delta H = -2439$ kJ
$4PCl_5(g) \rightarrow P_4(s) + 10Cl_2(g)$ $\Delta H = 3438$ kJ

3. Find the ΔH for the reaction below, given the following reactions and subsequent ΔH values:
$N_2H_4(l) + H_2(g) \rightarrow 2NH_3(g)$

$N_2H_4(l) + CH_4O(l) \rightarrow CH_2O(g) + N_2(g) + 3H_2(g)$ $\Delta H = -37$ kJ
$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H = -46$ kJ
$CH_4O(l) \rightarrow CH_2O(g) + H_2(g)$ $\Delta H = -65$ kJ

Heat of Formation Worksheet
Use a standard enthalpies of formation table to determine the change in enthalpy for each of these reactions.

a) $NaOH(s) + HCl(g) \longrightarrow NaCl(s) + H_2O(g)$

b) $2\ CO(g) + O_2(g) \longrightarrow 2\ CO_2(g)$

c) $CH_4(g) + 2\ O_2(g) \longrightarrow CO_2(g) + 2\ H_2O(l)$

d) $2\ H_2S(g) + 3\ O_2(g) \longrightarrow 2\ H_2O(l) + 2\ SO_2(g)$

e) $2\ NO(g) + O_2(g) \longrightarrow 2\ NO_2(g)$

Compound	ΔH_f (kJ/mol)	Compound	H_f (kJ/mol)
$CH_4(g)$	-74.8	HCl(g)	-92.3
$CO_2(g)$	-393.5	$H_2O(g)$	-241.8
NaCl(s)	-411.0	$SO_2(g)$	-296.1
$H_2O(l)$	-285.8	$NH_4Cl(s)$	-315.4
$H_2S(g)$	-20.1	NO(g)	+90.4
$H_2SO_4(l)$	-811.3	$NO_2(g)$	+33.9
$MgSO_4(s)$	-1278.2	$SnCl_4(l)$	-545.2
MnO(s)	-384.9	SnO(s)	-286.2
CO (g)	-110.525	$SnO_2(s)$	-580.7
NaCl(s)	-411.0	$SO_2(g)$	-296.1
NaF(s)	-569.0	$SO_3(g)$	-395.2
NaOH(s)	-426.7	ZnO(s)	-348.0
$NH_3(g)$	-46.2	ZnS(s)	-202.9