# Heat and Temperature – Cut from Jan 2007 – Jan 2008 Exams

1. Given the balanced equation:

$$I + I \rightarrow I_2$$

Which statement describes the process represented by this equation?
(1) A bond is formed as energy is absorbed.
(2) A bond is formed and energy is released.
(3) A bond is broken as energy is absorbed.
(4) A bond is broken and energy is released.

2. Which term is defined as a measure of the average kinetic energy of the particles in a sample?
(1) temperature
(2) pressure
(3) thermal energy
(4) chemical energy

3. Which term refers to the difference between the potential energy of the products and the potential energy of the reactants for any chemical change?
(1) heat of deposition
(2) heat of fusion
(3) heat of reaction
(4) heat of vaporization

56 + 273

4. Which kelvin temperature is equal to 56°C?
(1) –329 K
(2) –217 K
(3) 217 K
(4) 329 K

OMIT
Did not learn.

5. Which reaction releases the greatest amount of energy per 2 moles of product?
(1) $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
(2) $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
(3) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
(4) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Use the reaction shown below to answer questions 6 and 7.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell) + 2219.2\ kJ$$

6. Draw a potential energy diagram for this reaction. [1]

OMIT

7. Determine the total amount of energy released when 2.50 moles of propane is completely reacted with oxygen. [1]

1 mol $C_3H_8$ = −2291.2 kJ

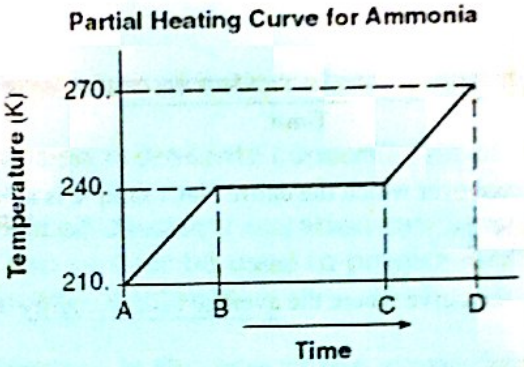
2.50 mol $C_3H_8$ = 2.5 (−2291.2) = −5728 kJ

8. Given the balanced equation representing a reaction: $N_2(g) + O_2(g) + 182.6\ kJ \rightarrow 2NO(g)$
Draw a potential energy diagram for this reaction. [1]

OMIT

Base your answers to questions 9 through 11 on the information below.

A 5.00-gram sample of liquid ammonia is originally at 210. K. The diagram of the partial heating curve below represents the vaporization of the sample of ammonia at standard pressure due to the addition of heat. The heat is *not* added at a constant rate.




Some physical constants for ammonia are shown in the data table below.

**Some Physical Constants for Ammonia**

| | |
|---|---|
| specific heat capacity of $NH_3(\ell)$ | 4.71 J/g•K |
| heat of fusion | 332 J/g |
| heat of vaporization | 1370 J/g |

9. Calculate the total heat absorbed by the 5.00-gram sample of ammonia during time interval *AB*. Your response must include *both* a correct numerical setup and the calculated result. [2]

$q = mc\Delta T = (5.00g)(4.71\ J/g \cdot K)(240 - 210\ K)$
$= \boxed{706.5\ J}$

10. Describe what is happening to *both* the potential energy and the average kinetic energy of the molecules in the ammonia sample during time interval *BC*. Your response must include *both* potential energy and average kinetic energy. [1]

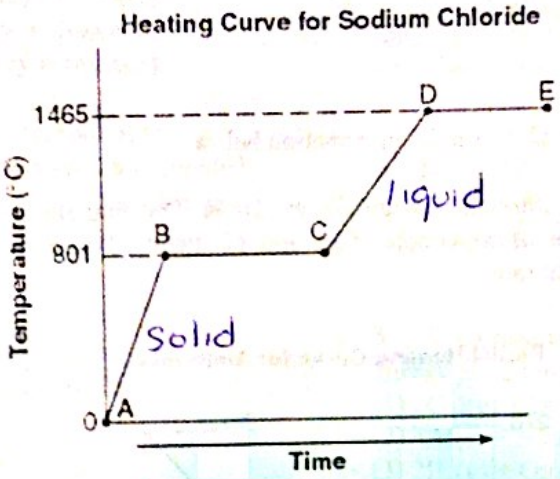
Avg Kinetic Energy remains the same because temperature remains constant.
Potential energy increases during BC.

11. Determine the total amount of heat required to vaporize this 5.00-gram sample of ammonia at its boiling point. [1]

$q = m\Delta H_{vap.}$
$= (5.00g)(1370\ J/g)$
$= \boxed{6850\ J}$

Base your answers to questions 12 through 14 on the information below.

A 100.0-gram sample of NaCl(s) has an initial temperature of 0°C. A chemist measures the temperature of the sample as it is heated. Heat is *not* added at a constant rate. The heating curve for the sample is shown below.




12. Determine the temperature range over which the entire NaCl sample is a liquid. [1]

CD

13. Identify *one* line segment on the curve where the average kinetic energy of the particles of the NaCl sample is changing. [1]

AB or CD

14. Identify *one* line segment on the curve where the NaCl sample is in a single phase and capable of conducting electricity. [1]

NaCl conducts electricity as a liquid because it is an ionic compound, (metal + nonmetal)

so CD.

# Equations & Stoichiometry – Practice Questions

1. Which substance has the greatest molecular mass?
   (1) $H_2O_2$ (2) NO (3) $CF_4$ (4) $I_2$

2. What is the gram formula mass of $Ca(OH)_2$?
   (1) 29 g (2) 34 g (3) 57 g (4) 74 g

3. What is the total number of moles of atoms present in 1 gram formula mass of $Pb(C_2H_3O_2)_2$?
   (1) 9 (2) 14 (3) 3 (4) 15

4. The percent by mass of carbon in $HC_2H_3O_2$ is equal to
   (1) $\frac{12}{60}\times 100$ (2) $\frac{24}{60}\times 100$ (3) $\frac{60}{24}\times 100$ (4) $\frac{60}{12}\times 100$

5. What is the empirical formula of $C_3H_6$?
   (1) CH (2) $CH_2$ (3) $CH_3$ (4) $CH_6$

6. The name of the compound $KClO_2$ is potassium
   (1) hypochlorite (2) chlorite (3) chlorate (4) perchlorate

7. Which formula is correct for ammonium sulfate?
   (1) $NH_4SO_4$ (2) $(NH_4)_2SO_4$ (3) $NH_4(SO_4)_2$ (4) $(NH)_3(SO_4)_2$

8. The molecular formula of a compound is represented by $X_3Y_6$. What is the empirical formula of this compound?
   (1) $X_3Y$ (2) $X_2Y$ (3) $XY_2$ (4) XY

9. The number of moles of molecules in a 12.0-gram samples of $Cl_2$ is
   (1) $\frac{12.0}{35.5}$ mole (2) $\frac{12.0}{71.0}$ mole (3) 12.0 moles (4) 12.0 x 35.5 moles

10. What is the total number of moles of sulfur atoms in 1 mole of $Fe_2(SO_4)_3$?
    (1) 1 (2) 15 (3) 3 (4) 17

11. Given the unbalanced equation:

$$\_\_3\_\_\ CaSO_4 + \_\_2\_\_\ AlCl_3 \rightarrow \_\_\_\ Al_2(SO_4)_3 + \_\_3\_\_\ CaCl_2$$

What is the coefficient of $Al_2(SO_4)_3$ when the equation is completely balanced using the smallest whole-number coefficients?
(1) 1 (2) 2 (3) 3 (4) 4

**Base your answers to questions 21 through 23 on the information below.**

Some dry chemicals can be used to put out forest fires. One of these chemicals is $NaHCO_3$. When $NaHCO_3(s)$ is heated, one of the products is $CO_2(g)$, as shown in the balanced equation below.

$$2\ NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

21. Show a correct numerical setup for calculating the percent composition by mass of carbon in the product $Na_2CO_3$. [1]

$\frac{\text{part}}{\text{whole}} \times 100 = \frac{12\ g}{2(23)+12+3(16)} \times 100$

22. Identify whether the reaction is endothermic or exothermic. [1] endothermic (absorbs heat)

23. Determine the total number of moles of $CO_2(g)$ produced when 7.0 moles of $NaHCO_3(s)$ is completely reacted. [1]

$\frac{2\ mol\ NaHCO_3}{1\ mol\ CO_2} = \frac{7.0\ mol\ NaHCO_3}{x}$

$\frac{2x}{2} = \frac{7}{2} \rightarrow x = 3.5$

3.5 moles

24. Balance this chemical equation: [1]

3 $S(s)$ + 2 $KClO_3(s)$ → 3 $SO_2(g)$ + 2 $KCl(s)$ + energy

**Base your answers to questions 25 through 27 on the information below.**

Rust on an automobile door contains $Fe_2O_3(s)$. The balanced equation representing one of the reactions between iron in the door of the automobile and oxygen in the atmosphere is given below.

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

25. Identify the type of chemical reaction represented by this equation. [1] Synthesis

26. Determine the gram-formula mass of the product of this reaction. [1]

$Fe_2O_3$

$2(56) + 3(16) = 112 + 48 = 160\ g/mol$

27. Write the IUPAC name for $Fe_2O_3$. [1] Iron (III) Oxide

$Fe^{+3}\ O^{-2}$