

## HL Topic 5 & 15. Energetics / Thermochemistry (First test)

For each question choose the answer you consider to be the best.

1. When some solid ammonium nitrate was dissolved in water the temperature decreased from 22 °C to 3 °C. What can be deduced from this observation?

- A. The dissolving is endothermic and  $\Delta H$  is positive.
- B. The dissolving is endothermic and  $\Delta H$  is negative.
- C. The dissolving is exothermic and  $\Delta H$  is positive.
- D. The dissolving is exothermic and  $\Delta H$  is negative.

2. Which of the following conditions normally apply to the standard enthalpy change for a reaction,  $\Delta H^\ominus$  ?

- I. A pressure of 100.0 kPa
  - II. A temperature of 298 K
  - III. One mol of all reactants and all products
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

3. Which statements are correct for all exothermic reactions?

- I. The products are more stable than the reactants
- II. The bonds in the products are stronger than the bonds in the reactants
- III. The enthalpy of the products is less than the enthalpy of the reactants

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

4. Which is a correct statement concerning the reaction shown?



- A. 92 kJ of energy are absorbed for every mol of ammonia formed.
- B. 92 kJ of energy are released for every mol of ammonia formed.
- C. 46 kJ of energy are absorbed for every mol of ammonia formed.
- D. 46 kJ of energy are released for every mol of ammonia formed.

5. The heat capacities (in  $\text{kJ kg}^{-1} \text{K}^{-1}$ ) of four elements are:

carbon (graphite) 0.709

copper 0.385

gold 0.129

iron 0.449

Which element will show the greatest increase in temperature if 2 kJ of heat is supplied to 0.100 kg samples of each element at the same initial temperature?

A. carbon (graphite)

B. copper

C. gold

D. iron

6. The heat produced when 0.010 mol of propanone was combusted raised the temperature of 250 g of water by  $14^\circ\text{C}$ .

The specific heat capacity of water is  $4.2 \text{ J g}^{-1} \text{K}^{-1}$ .

Which is the correct expression for value of the enthalpy of combustion of propanone (in  $\text{J mol}^{-1}$ )?

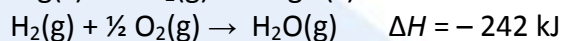
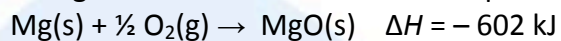
A.  $\frac{250 \times 4.2 \times 287}{0.010}$

B.  $\frac{250 \times 4.2 \times 14}{0.010}$

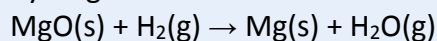
C.  $\frac{0.010 \times 4.2 \times 287}{250}$

D.  $250 \times 4.2 \times 14 \times 0.010$

7. When one mol of magnesium and one mol of hydrogen are combusted the enthalpy changes are  $-602$  kJ and  $-242$  kJ respectively.

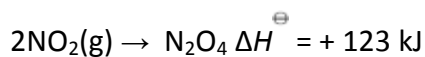


What is the enthalpy change for the reduction of one mol of magnesium oxide by hydrogen?

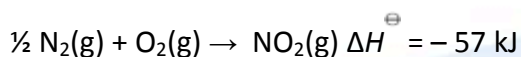


- A.  $+844$  kJ
- B.  $-844$  kJ
- C.  $-360$  kJ
- D.  $+360$  kJ

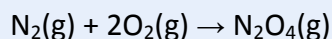
8. The enthalpy change for the dimerisation of two mol of nitrogen dioxide to form one mol of dinitrogen tetroxide is  $+123$  kJ.



The enthalpy change for the formation of one mol of  $\text{NO}_2(\text{g})$  from its elements is  $-57$  kJ

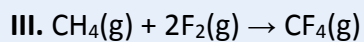
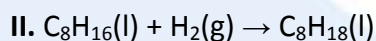
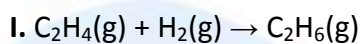


What is the enthalpy change for the formation of one mol of dinitrogen tetroxide from its elements?



- A.  $+9$  kJ
- B.  $-9$  kJ
- C.  $+66$  kJ
- D.  $-66$  kJ

9. Which of the following enthalpy changes can be calculated using **only** bond enthalpies and average bond enthalpies?



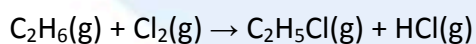
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

10. Ethane can react with chlorine in ultraviolet light to form chloroethane:



The relevant bond enthalpies are:

Bond	$\Delta H / \text{kJ mol}^{-1}$
C-C	347
C-H	413
Cl-Cl	243
H-Cl	432
C-Cl	346

What is the enthalpy change,  $\Delta H$ , for this reaction (in kJ)?

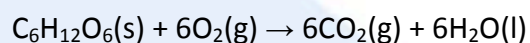
A. - 122

B. + 122

C. + 225

D. - 469

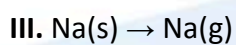
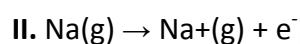
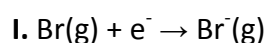
11. Which expression gives the correct value for the standard enthalpy change of combustion of glucose in  $\text{kJ mol}^{-1}$ ?



Compound	$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$	$\text{CO}_2(\text{g})$	$\text{H}_2\text{O}(\text{l})$
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	- 1273	- 394	- 286

- A.  $6(-394) + 6(-286) - 1273$
- B.  $6(-394) + 6(-286) - (-1273)$
- C.  $6[(-394) + (-286) - 1273]$
- D.  $6[(-394) + (-286) - (-1273)]$

12. Which are endothermic steps in the Born Haber cycle for the formation of sodium bromide?



- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

**13.** Which is the correct equation for the lattice enthalpy of magnesium chloride?

- A.  $\text{Mg}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$
- B.  $\text{Mg}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$
- C.  $\text{Mg}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g}) \rightarrow \text{MgCl}_2(\text{g})$
- D.  $\text{Mg}(\text{s}) + 2\text{Cl}(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$

**14.** Which reaction in the Born Haber cycle for the formation of magnesium oxide is the most exothermic?

- A.  $\text{O}(\text{g}) + 2\text{e}^{-} \rightarrow \text{O}^{2-}(\text{g})$
- B.  $\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- C.  $\text{Mg}(\text{g}) \rightarrow \text{Mg}^{2+}(\text{g}) + 2\text{e}^{-}$
- D.  $\text{Mg}^{2+}(\text{g}) + \text{O}^{2-}(\text{g}) \rightarrow \text{MgO}(\text{s})$

**15.** Which compound has the highest lattice enthalpy?

- A. NaF
- B. NaI
- C. MgO
- D. MgS

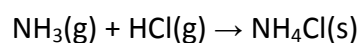
16. Which reaction will have the largest positive entropy change?

- A.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI}(\text{g})$
- B.  $\text{SO}_2(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow 2\text{SO}_2(\text{g})$
- C.  $\text{Mg}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- D.  $\text{PCl}_5(\text{g}) \rightarrow \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$

17. Which change does not lead to an increase in entropy?

- A. Dissolving salt in water
- B. Hydrogenating unsaturated fats
- C. Boiling water
- D. Melting ice

18. What is the standard entropy change (in  $\text{J K}^{-1} \text{mol}^{-1}$ ) for the following reaction?



	$\text{NH}_3(\text{g})$	$\text{HCl}(\text{g})$	$\text{NH}_4\text{Cl}(\text{s})$
$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$	193	187	96

- A. - 96
- B. + 96
- C. - 284
- D. + 284



19. Which are the correct signs for a reaction that is spontaneous at low temperatures but non-spontaneous at high temperatures?

	$\Delta H^\ominus$	$\Delta S^\ominus$
A.	Positive	Positive
B.	Positive	Negative
C.	Negative	Negative
D.	Negative	Positive

20. The standard enthalpy change,  $\Delta H^\ominus$ , for a chemical reaction is  $-100 \text{ kJ mol}^{-1}$  and the entropy change at  $27^\circ\text{C}$  for the reaction is  $+10 \text{ J K}^{-1} \text{ mol}^{-1}$ . What is the value of  $\Delta G^\ominus$  (in kJ) for this reaction?

- A.  $-2900$
- B.  $-103$
- C.  $-370$
- D.  $-97$