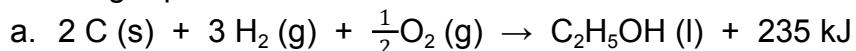


Energy Changes in Chemical Reactions - Worksheet - ANSWERS

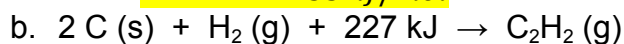
Part 1

- Classify these reactions as exothermic or endothermic:
 - $\text{energy} + \text{SO}_2(\text{g}) \rightarrow \text{S}(\text{g}) + \text{O}_2(\text{g})$ Endothermic
 - $\text{C}_8\text{H}_{18}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g}) + \text{energy}$ Exothermic
 - $\text{energy} + \text{P}_4\text{O}_{10}(\text{s}) \rightarrow \text{P}_4(\text{s}) + 5 \text{O}_2(\text{g})$ Endothermic
 - $\text{Mg}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2(\text{g}) + \text{energy}$ Exothermic
- Which reactions below are endothermic? c, i, k are endothermic
 - $\text{Ba}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{BaO}_2(\text{s}) + \text{energy}$
 - $\text{PCl}_3(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PCl}_5(\text{s}) + \text{energy}$
 - $2 \text{Sb}(\text{s}) + 3 \text{I}_2(\text{s}) + \text{energy} \rightarrow 2 \text{SbI}_3(\text{s})$
 - $\text{C}_3\text{H}_8(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$
 - $\text{H}_3\text{PO}_4(\text{aq}) + \text{LiOH}(\text{aq}) \rightarrow \text{Li}_3\text{PO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{energy}$
 - $\text{Fe}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{FeSO}_4(\text{aq}) + \text{Cu}(\text{s}) + \text{energy}$
 - $\text{CS}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{SO}_2(\text{g}) + \text{energy}$
 - $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s}) + \text{energy}$
 - $\text{CaCO}_3(\text{s}) + \text{energy} \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 - $\text{Mg}(\text{s}) + \text{CrCl}_3(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{Cr}(\text{s}) + \text{energy}$
 - $\text{KNO}_3(\text{s}) + \text{energy} \rightarrow \text{KNO}_2(\text{s}) + \text{O}_2(\text{g})$
 - $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + \text{NaNO}_3(\text{aq}) + \text{energy}$
 - $\text{HNO}_3(\text{aq}) + \text{LiOH}(\text{aq}) \rightarrow \text{LiNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{energy}$
 - $\text{KBr}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{AgBr}(\text{s}) + \text{KNO}_3(\text{aq}) + \text{energy}$
- Is the melting of ice an endothermic change or an exothermic change?
Endothermic - heat energy is required to raise the temperature of the ice to reach the melting point.
- In photosynthesis, plants convert the sun's energy into sugars in the reaction:
 $6 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6 \text{O}_2(\text{g})$
 - Is this reaction exothermic or endothermic?
Endothermic - energy is a reactant
 - What is the sign of the ΔH for this reaction?
 ΔH would be "+"
- Dry ice is solid carbon dioxide. It does not "melt" but instead turns from a solid into a gas in a process called sublimation.
 - Is this change exothermic or endothermic? Endothermic - energy is required
 - What sign would the ΔH value have? ΔH would be "+"
- For the following reaction:
 $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g}) \quad \Delta H = -297 \text{ kJ/mol}$
 - Is the reaction exothermic or endothermic? Exothermic - since ΔH is negative
 - How does the heat content of 1 mole of SO_2 compare to that of 1 mole of S plus 1 mole of O_2 ?
Since the reaction is exothermic the heat content of the products is less than the heat content of the reactants.
 $H(\text{products}) < H(\text{reactants})$

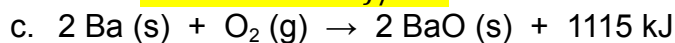
7. Determine the ΔH for the formation of one mole of each product in each of the following equations.



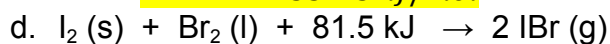
$$\Delta H = -235 \text{ kJ/mol}$$



$$\Delta H = +227 \text{ kJ/mol}$$

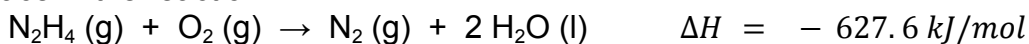


$$\Delta H = -557.5 \text{ kJ/mol}$$



$$\Delta H = +40.8 \text{ kJ/mol}$$

8. This energy from the combustion of hydrazine, N_2H_4 , is used to power rockets into space in the reaction:



How many kilograms of hydrazine would be necessary to produce $1.0 \times 10^8 \text{ kJ}$ of energy?

$$5.1 \times 10^6 \text{ g} = 5.1 \times 10^3 \text{ kg}$$

9. A simple fat molecule has the formula $\text{C}_3\text{H}_5(\text{OH})_2\text{OCO}(\text{CH}_2)_2\text{CH}_3$. The heat of reaction when it is combusted to CO_2 and H_2O is 6405 kJ/mol . Find the amount of energy released per gram of fat. Compare it to the amount of energy released when a carbohydrate is burned (15.6 kJ/g). Which provides more energy per gram?

Fat 39.49 kJ/g Thus, fat provides more energy per gram than carbohydrates.

10. The amount of solar radiation received annually in a certain location is about $8.4 \times 10^6 \text{ kJ/m}^2$. How much coke (C) must be burned to carbon dioxide in the following reaction to produce the same amount of energy?

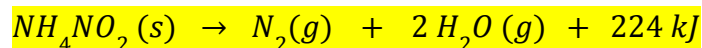


$$2.6 \times 10^5 \text{ g}$$

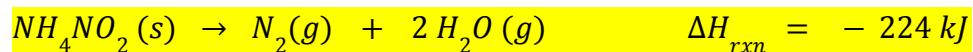
Part 2

1. Solid ammonium nitrite decomposes to form nitrogen gas and water vapour. The decomposition releases 224 kJ per mole of ammonium nitrite decomposed.

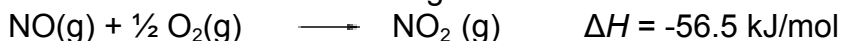
- a. Write the balanced equation for this reaction including the energy term in the equation.



- b. Write the balanced equation for the reaction and use ΔH notation for the energy term.



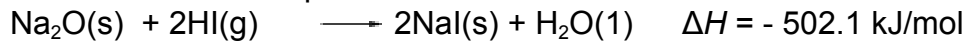
2. Consider the combustion of nitrogen monoxide:



How much heat would be released by the combustion of 65 g of NO (g) ?

$$1.2 \times 10^2 \text{ kJ}$$

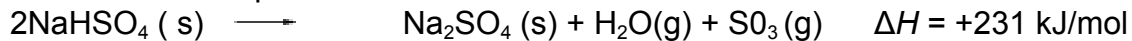
3. Consider the double displacement reaction:



If 9.00 g of NaI(s) are formed by this process, how much heat will be released?

15.1 kJ

4. Consider the decomposition reaction:



If 3.60 g of NaHSO₄ react, how much heat would be absorbed?

3.46 kJ

5. Consider the combustion of carbon:



- a. How many grams of carbon must be burned to produce 2556 kJ of energy?

78.0 g

- b. How many grams of oxygen gas would have to react in order to produce 2556 kJ of energy?

208 g