

## Thermochemical equations and combustion reactions

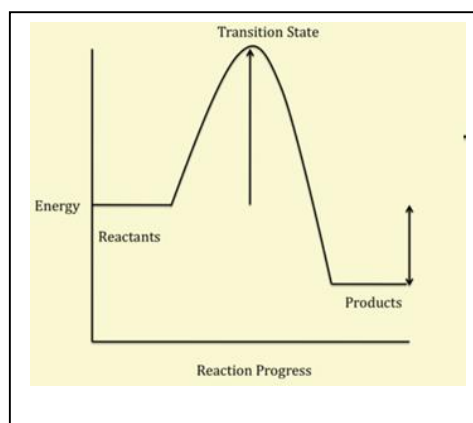
### Lesson 2

**Heat of combustion** may be defined as the heat energy released when a specified amount of a substance burns completely in oxygen and is, therefore, reported as a **magnitude**, no sign. **Enthalpy of combustion** ( $\Delta H$ ) for fuels would be reported as negative values, indicating the exothermic nature of the combustion reaction. So the VCAA data booklet will show the **molar heat of combustion** (kJ/mol) as a magnitude.

1) a) Exothermic

Label the:

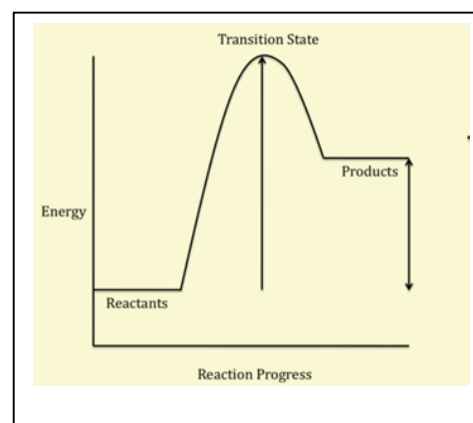
- Activation energy
- $\Delta H$  and its sign



b) Endothermic

Label the:

- Activation energy
- $\Delta H$  and its sign



c) What is activation energy?

d) Combustion reactions are always exothermic and as such have a \_\_\_\_\_  $\Delta H$

e) Two types of combustion reactions exist.

i. \_\_\_\_\_ occur when \_\_\_\_\_ and produce

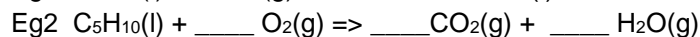
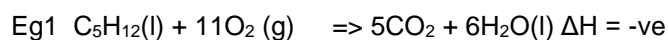
\_\_\_\_\_

ii. \_\_\_\_\_ occur when \_\_\_\_\_ and produce

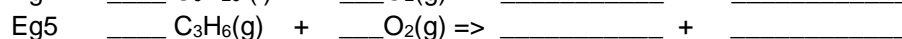
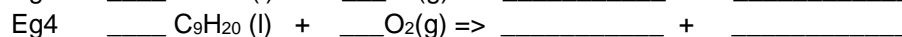
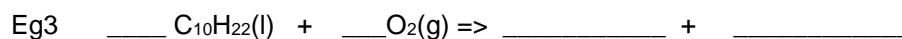
\_\_\_\_\_

f) Combustion reactions involve fuels that are oxidised in oxygen and give off heat energy.

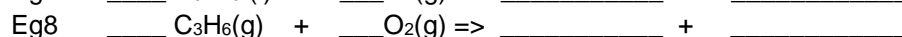
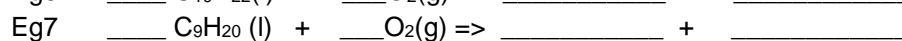
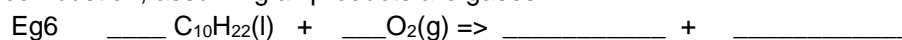
Combustion reactions involving hydrocarbons and other carbon based molecules containing oxygen, such as alcohols, react with oxygen to produce water and carbon dioxide. Carbon monoxide, instead of carbon dioxide, or solid carbon are formed when oxygen is in \_\_\_\_\_ supply.



Write balanced chemical equations for each of the following hydrocarbons undergoing complete combustion.

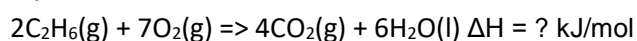


Write balanced chemical equations for each of the following hydrocarbons undergoing incomplete combustion, assuming all products are gases.



Write a balanced chemical equation for the incomplete combustion of liquid benzene if water and a solid substance are formed.

- 2) Ethane undergoes complete combustion in the presence of oxygen according to the equation below.

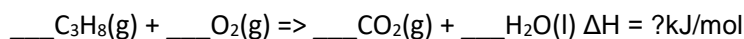


- a) Given the molar heat of combustion ( $\Delta H_c$ ), which is the energy released when one mol of the substance undergoes complete combustion of ethane, as 1560 kJ mol<sup>-1</sup> calculate the  $\Delta H$  for the equation above.

- b) What amount of energy in kJ is produced when 9.00 grams of ethane burns completely in oxygen gas?

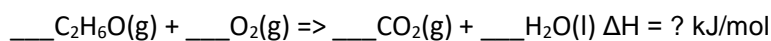
- c) What mass of carbon dioxide is produced if 1060 kJ of energy is released?

- 3) Propane undergoes complete combustion in the presence of oxygen according to the equation below.



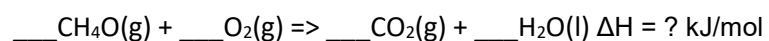
- a) Given the molar heat of combustion ( $\Delta H_c$ ), which is the energy released when one mol of the substance undergoes complete combustion, of propane as 2220 kJ mol<sup>-1</sup> calculate the  $\Delta H$  for the equation above.
- b) What amount of energy in kJ is produced when 88.0 grams of propane burns completely in oxygen gas?
- c) What mass of oxygen is needed to produce 66.6 kJ of energy?

- 4) Ethanol undergoes complete combustion in the presence of oxygen according to the equation below.



- a) Balance the equation above
- b) Given the molar heat of combustion ( $\Delta H_c$ ), which is the energy released when one mol of the substance undergoes complete combustion, of ethanol as 1367 kJ mol<sup>-1</sup> calculate the  $\Delta H$ .
- c) What amount of energy in kJ is produced when 9.20 grams of ethanol burns completely in oxygen gas?
- d) What mass of carbon dioxide is produced when 27.0 kJ of energy is released?

- 5) Methanol undergoes complete combustion in the presence of oxygen according to the equation below.



- a) Balance the equation above.
- b) Given the molar heat of combustion ( $\Delta H_c$ ), which is the energy released when one mol of the substance undergoes complete combustion, of methanol as 725 kJ mol<sup>-1</sup> calculate the  $\Delta H$ .
- c) What amount of energy in kJ is produced when 9.20 grams of methanol burns completely in oxygen gas?
- d) What mass of carbon dioxide is produced when 27.0 kJ of energy is released?