Lecture Notes D: Demo on Combustion Processes

In this demo, we will consider the combustion of the following gases: hydrogen (H_2), methane (CH_4), and propane (C_3H_8). The amount of heat released by the combustion can be calculated as follows.

Concept

Assume the balloons all have the same size (volume). Which contains the most molecules:
(a) hydrogen (H_2) (b) methane (CH_4) (c) propane (C_3H_8) (d) they contain the same # molecules

Which weighs more, a liter of dry air or a liter of wet air?
(a) wet air (b) dry air (c) they weigh the same

	MW (amu)	ΔH^o_f(kJ/mol)
hydrogen (H_2)	2.016	0
methane (CH_4)	16.043	-74.81
propane (C_3H_8)	44.096	-103.85
$H_2O(g)$	18.01	-241.82
$CO_2(g)$	44.01	-393.51kJ/mol

Consider ΔH for the combustion reactions,

$$H_{2\,(g)} + \tfrac{1}{2}\, O_{2\,(g)} \rightarrow H_2O_{(g)} \qquad \Delta H = \Delta H^o_f(\, H_2O_{(g)}\,) = -241.82 \text{kJ/mol}$$

$$CH_{4\,(g)} + 2\, O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\, H_2O_{(g)} \quad \Delta H = 2\,\Delta H^o_f(\, H_2O_{(g)}) + \Delta H^o_f(CO_{2\,(g)}) - \Delta H^o_f(CH_{4\,(g)})$$
$$= 2\,(-241.82) + (-393.51) - (-74.81) = -802.34 \text{ kJ/mol}$$

$$C_3H_{8\,(g)} + 5\, O_{2\,(g)} \rightarrow 3\, CO_{2\,(g)} + 4\, H_2O_{(g)} \quad \Delta H = 4\,\Delta H^o_f(\, H_2O_{(g)}) + 3\,\Delta H^o_f(CO_{2\,(g)}) - \Delta H^o_f(C_3H_{8\,(g)})$$
$$= 4\,(-241.82) + 3\,(-393.51) - (-103.85) = -2044 \text{ kJ/mol}$$

Concept

Which balloon will give off the most heat when exploded
(a) hydrogen (H_2) (b) methane (CH_4) (c) propane (C_3H_8)