- A mass of 1.250 g of benzoic acid ($C_7H_6O_2$) underwent combustion in a bomb calorimeter. If the heat capacity of the calorimeter was 10.134 kJ K^{-1} and the heat of combustion of benzoic acid is –3226 kJ mol^{-1}, what is the change in internal energy during this reaction? **4**

The molar mass of benzoic acid is:

$$(7 \times 12.01\ (C) + 6 \times 1.008\ (H) + 2 \times 16.00\ (O))\ g\ mol^{-1} = 122.1\ g\ mol^{-1}$$

A mass of 1.250 g therefore corresponds to:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{1.250\ g}{122.1\ g\ mol^{-1}} = 0.0102\ mol$$

As 3226 kJ are released per mole, the change in internal change for this amount is:

$$\Delta U = (-3226\ kJ\ mol^{-1}) \times (0.0102\ mol) = -33.02\ kJ$$

Answer: **–33.02 kJ**

Calculate the temperature change that should have occurred in the apparatus.

In a constant volume apparatus like a calorimeter, the change in internal energy is equal to the heat change, q_V. Using $q = C_p\Delta T$, the temperature change is:

$$\Delta T = (33.02\ kJ) / (10.134\ kJ\ K^{-1}) = 3.528\ K$$

As the combustion reaction evolves heat, the temperature *increases*.

Answer: **+3.258 K**