Specific Heat Capacity (c)

- the quantity of energy , in Joules (J), needed to change the temperature of one gram (g) of a substance by one degree Celsius (˚C).

- **c** values are on p. 632 (will be provided on the public exam)

  *eg. **c** for water is 4.184 J/g •°C*

Formula: $q = mc\Delta T$

q = heat lost or gained
m = mass of object heated/cooled
c = specific heat capacity

ΔT = change in temperature
$\Delta T = T_2 - T_1$

- You will be given all but one of the above variables and asked to find the missing variable.

Examples:

1. A student must use 225 mL of hot water in a lab procedure. Calculate the amount of heat required to raise the temperature of 225 mL of water from 20.0 ˚C to 100.0 ˚C.

Solution:
- since the density of water is 1.00 g /mL, the mass of 225 mL of water is 225 g
*- **c** for water is 4.184 J/g •°C*

$q = mc\Delta T$

$q = (225\ g)(4.184\ J/g{\bullet}°C)(100.0°C - 20.0\ °C)$

$= 755312\ J$

$= 75.5\ kJ$

2. Calculate the specific heat capacity of a new alloy if a 15.4 g sample absorbs 393 J when it is heated from 0.0˚C to 37.6 ˚C.

Solution:
$m = 15.4\ g$ $T_2 = 37.6\ ˚C$
$q = 393\ J$ $T_1 = 0.0\ ˚C$

$q = mc\Delta T$

$393\ J = (15.4\ g)\ (c)\ (37.6\ ˚C - 0.0\ ˚C)$

$393\ J = (579.04\ g\ {\bullet}˚C) \times (c)$

$c = 0.679\ J/g\ {\bullet}˚C$

3. A 40.0 g sample of ethanol releases 2952 J as it cools from 50.0 °C. Calculate the final temperature of the ethanol.

Solution:
Use 2 steps:
- First solve for ΔT

$m = 40.0\ g$ $T_1 = 50.0\ ˚C$
$q = -\ 2952\ J$ $c = 2.46\ J/g\ {\bullet}˚C$

$q = mc\Delta T$

$-2952\ J = (40.0\ g)(2.46\ J/g\ {\bullet}˚C)(\Delta T)$

$-2952\ J = (98.4\ J/˚C)(\Delta T)$

$\Delta T = -\ 30\ ˚C$

- Next find the final temperature

$\Delta T = T_2 - T_1$

$-30˚C = T_2 - 50˚C$

$T_2 = 20\ ˚C$

Exercises: (Be careful with positive and negative signs!!)

1. Calculate the heat change involved when 2.00 L of water is heated from 20.0˚C to 99.7˚C in an electric kettle. ***(667 kJ)***

2. Calculate the heat change associated with cooling a 350.0 g aluminum bar from 70.0˚C to 25.0˚C. Is the change endothermic or exothermic? Why? ***(-14.2 kJ)***

3. A 175 g piece of iron and a 175 g piece of aluminum are placed in a hot water bath so that they are warmed to 99.7˚C. The metal samples are removed and cooled to 21.5˚C. Which sample undergoes the greater heat change? ***(Al; -12.3 kJ Fe; - 6.08 kJ)***

4. A 63.5 g sample of an unidentified metal absorbs 355 J of heat when its temperature changes by 4.56˚C. Calculate the specific heat capacity of the metal. ***(1.23 J/g •˚C)***

5. Calculate the specific heat capacity of titanium if a 43.56 g sample absorbs 0.476 kJ as its temperature changes from 20.13˚C to 41.06˚C. ***(0.522 J/g •˚C)***

6. The burning of a sample of propane generated 104.6 kJ of heat. All of this heat was use to heat 500.0 g of water that had an initial temperature of 20.0˚C. What was the final temperature of the water? ***(70.0˚C)***

7. 750.0 g of water that was just boiled (heated to 100.0 ˚C) loses 78.45 kJ of heat as it cools. What is the final temperature of the water? ***(75.0 ˚C)***