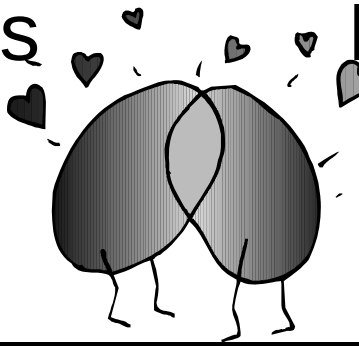
The Combined Gas Law



Manipulating Variables in equations

- Often in an equation we want to isolate some variable, usually the unknown
- From math: what ever you do to one side of an equation you have to do to the other side
- Doing this keeps both sides the same
- E.g. **x + 5 = 7**, what does x equal?
- We subtract 5 from both sides …
- x + 5 – 5 = 7 – 5, thus x = 2
- Alternatively, we can represent this as 5 moving to the other side of the equals sign …
- **x + 5 = 7** becomes **x = 7 – 5** or x = 2
- Thus, for addition or subtraction, when you change sides you change signs

Multiplication and division

- We can do a similar operation with multiplication and division
- E.g. 5x = 7, what does x equal?
- We divide each side by 5 (to isolate x) …
- **5x/5 = 7/5** … **x = 7/5** … x = 1.4
- Alternatively, we can represent this as 5 moving to the other side of the equals sign …
- **5x = 7** becomes **x = 7/5**
- Thus, for multiplication and division, when you change sides you change position (top to bottom, bottom to top)

Multiplication and division

- Let's look at a more complicated example:

$$\frac{(x)\,(y)}{5} = \frac{\mathbf{7}a}{\mathbf{b}}$$

- Isolate a in the equation:
- Move b to the other side (from bottom to top)

$$\frac{(x)\,(y)}{5} = \frac{\mathbf{7}a}{\mathbf{b}}$$

- Move 7 to the other side (from top to bottom)

$$\frac{(x)(y)(\mathbf{b})}{5} = \mathbf{7}a$$

$$\frac{(x)(y)(\mathbf{b})}{(5)(\mathbf{7})} = a \quad \text{or} \quad \boxed{a = \frac{(x)(y)(b)}{(35)}}$$

Multiplication and division

- This time, isolate b in the equation:

$$\frac{\mathbf{(x)\,(y)}}{5} = \frac{7a}{\mathbf{b}}$$

- Move b to the other side (it must be on top) …

$$\frac{\mathbf{(x)\,(y)}}{5} = \frac{7a}{\mathbf{b}}$$

- Move everything to the other side of b

$$\frac{\mathbf{(b)(x)(y)}}{5} = 7a \qquad \mathbf{b} = \frac{35a}{\mathbf{xy}}$$

Q - Rearrange the following equation to isolate each variable (you should have 6 equations) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Combining the gas laws

- So far we have seen two gas laws:

Robert Boyle

$P_1V_1 = P_2V_2$

Jacques Charles

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Joseph Louis Gay-Lussac

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

These are all subsets of a more encompassing law: the combined gas law $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Read pages 437, 438. Do Q 26 – 33 (skip 31)