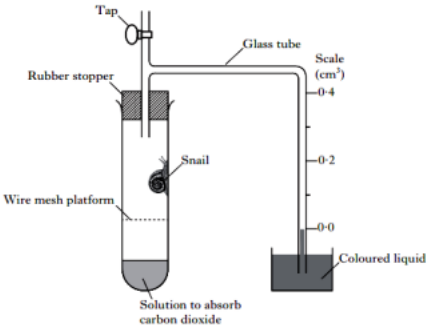
Measuring Metabolic Rate

Measurement of metabolic rate

1. Oxygen consumption (apparatus—respirometer OR O_2 probe)
2. Carbon dioxide production (apparatus—CO_2 probe)
3. Heat production (apparatus Calorimeter)

Respirometer

Used to measure oxygen consumption as an indirect measurement of the dependent variable of respiration rate/metabolic rate.



VALID results

Variables kept constant for

1. Diameter of tubing
2. Volume of solution to absorb CO_2

The solution at the bottom of the test tube is critical to the success of the experiment as the animal uses up O_2 and the CO_2 is absorbed by the solution. This causes liquid to be forced up the tubing to replace the volume of gas lost to the solution.

Time (minutes)	Distance dye moved up tube (cm^3 per minute)	Metabolic Rate
0	0.0	↑
2	0.15	
4	0.20	
6	0.25	
8	0.30	
10	0.35	

Conclusion

As time increases, metabolic rate increases.

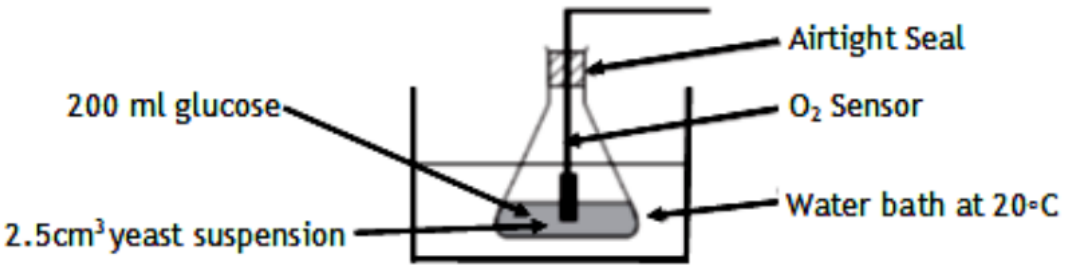
Hint: Remember the further the distance travelled = higher metabolic rate

Measuring Metabolic Rate

Oxygen/Carbon Dioxide Probes

Another piece of apparatus to measure dependant variable is metabolic rate indirectly is oxygen probes/sensors.

This measure O_2 consumption in a sealed container.



Time (minutes)	Oxygen Concentration in airtight flask (mg per litre)	Metabolic Rate
0	10.8	↑
2	8.5	
4	6.2	
6	4.1	
8	2.8	
10	0.0	

Conclusion

As time increases, metabolic rate increases

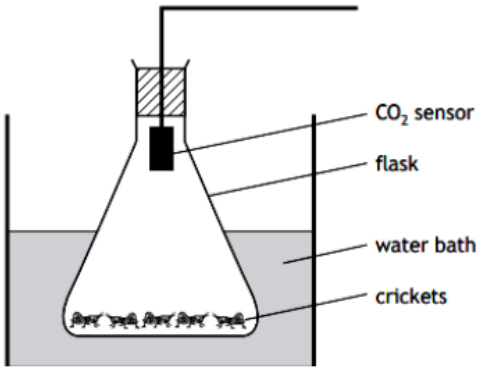
Hint

Remember lower oxygen concentration = higher metabolic rate

Measuring Metabolic Rate

Oxygen/Carbon Dioxide Probes

Another piece of apparatus to measure dependant variable of metabolic rate indirectly is CO_2 probes/ sensors which measures CO_2 production in a sealed container.



Time (minutes)	CO_2 Concentration in airtight flask (mg per litre)	Metabolic Rate ↑
0	0.0	
2	2.8	
4	4.1	
6	6.9	
8	7.3	
10	10.1	

Conclusion

As time increases, metabolic rate increases.

Hint Remember higher CO_2 concentration = higher metabolic rate

Measuring Metabolic Rate

Calorimeter

Apparatus used to measure the dependent variable of metabolic rate indirectly via **heat production by a subject** in a sealed container.

Measurements

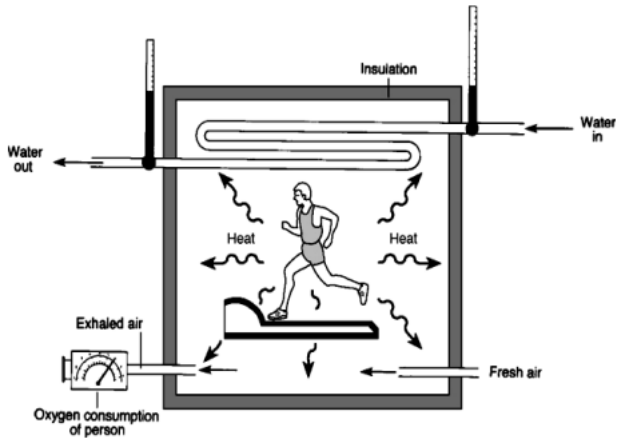
1. Measure temperature of water at start of experiment by probe/thermometer.
2. Measure temperature of water at end of experiment by probe/thermometer.

Metabolic rate measured indirectly from heat produced by subject via a specific formula.

Features of calorimeters

To maximize absorption of heat produced by subject into water pipe.

1. Copper tube coiled to increase surface area .
2. Insulated container to keep heat in/prevent heat loss to surroundings.



Time (minutes)	Heat released (◦C per minute)	Metabolic Rate
0	0.0	
2	2.8	
4	4.1	
6	6.9	
8	7.3	
10	10.1	

Conclusion

As time increases, metabolic rate increases

Hint: Remember the more heat produced = the higher the metabolic rate

Metabolic Rate Calculations

Metabolic Rate Calculations

As organisms all have **DIFFERENT** starting masses , when calculating different animal's metabolic rate it is important to divide by their weight.

Four athletes were weighed then given a fitness test during which their maximum oxygen uptake and body mass was measured.

Maximum oxygen uptake **per kg of** body mass can be used as a measure of fitness.

The **fitter** an individual, the **higher** their maximum oxygen uptake,

Athlete	*Body mass* (kg)	*Maximum oxygen uptake* (litres per minute)
A	60	3·6
B	55	3·6
C	60	3·7
D	55	3·7

To calculate the fitness level of Athlete C's the individual's maximum oxygen uptake is divided by the body mass.

3.7 litres per minute ÷ 60kg = **0.062** litres/minute/kg

Metabolic Rate Calculations

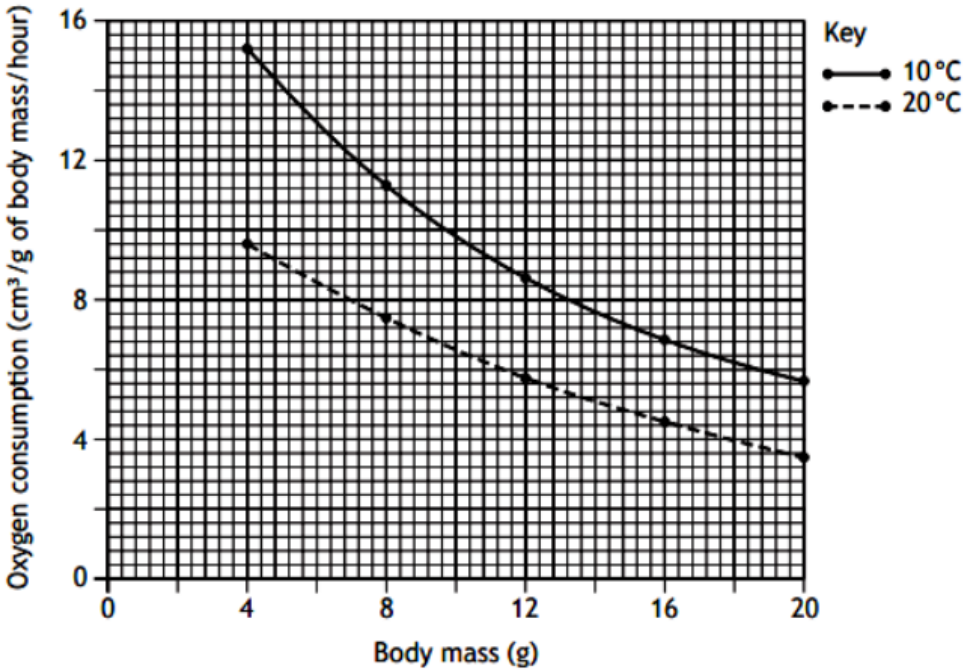
Metabolic Rate Calculations

Graphs and tables display metabolic rate **per gram** of body mass **per hour**.

Therefore when given information about an organism's metabolic rate, calculations will involve **MULTIPLYING** by body mass and OR hours.

Calculation One Example

The graph shows the relationship between body mass and oxygen consumption of different masses of shrews at two environmental temperatures.



The metabolic rate of the shrew at 10°C at 4g of body mass is 15.2 cm^3/g of body mass/hour.

To calculate the **TOTAL** metabolic rate of the **4g** shrew over 1 day is

15.2 x 4g x 24 = 1459.20 cm^3/g of body mass/hour