MOTION

CHAPTER 5

ANALYSING THE MOTION OF VEHICLES ON LAND

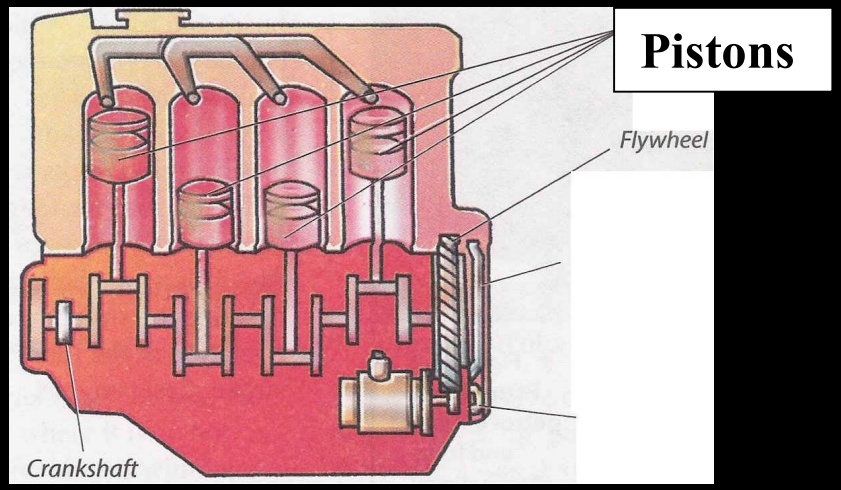
VEHICLES WITHOUT ENGINE:

- Powered by the muscles of human beings or animals.
- Example: Bicycles are two-wheeled vehicles

ANALYSING THE MOTION OF VEHICLES ON LAND

VEHICLES WITH ENGINES

- have a front-mounted, gasoline-burning engine, and front-wheel drive.
- internal-combustion engine, which works by burning a mixture of gasoline and air inside closed cylinders.



FOUR-STROKE PETROL ENGINE

- Most cars have a petrol engine which operates on a four-stroke cycle.
- Structure and operation of a four-stroke petrol engine:

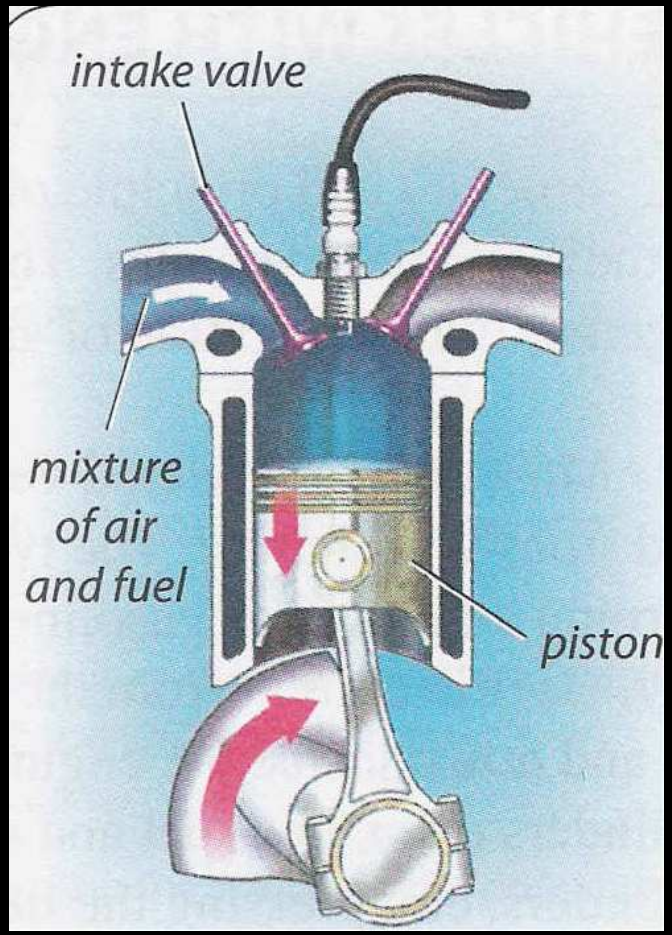
1. Intake stroke

2. Compression stroke

3. Power stroke

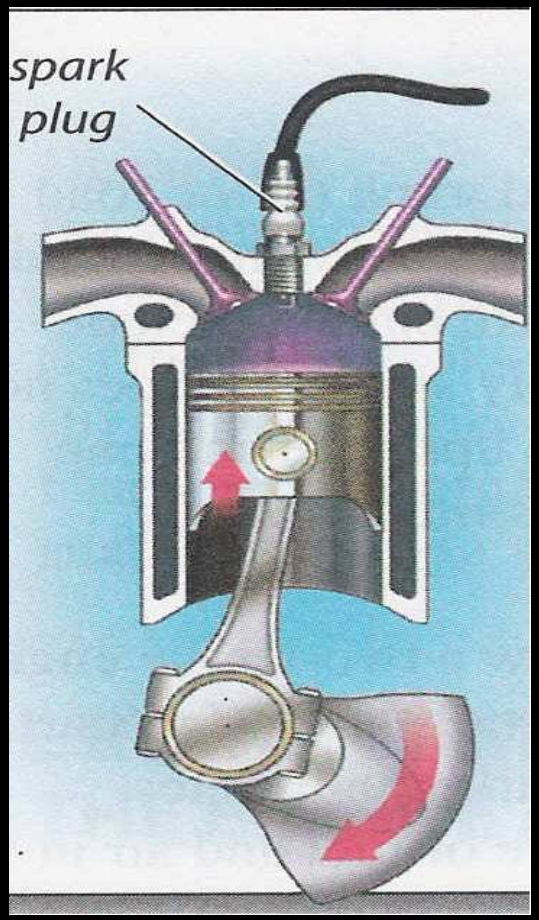
4. Exhaust stroke

1. Intake stroke



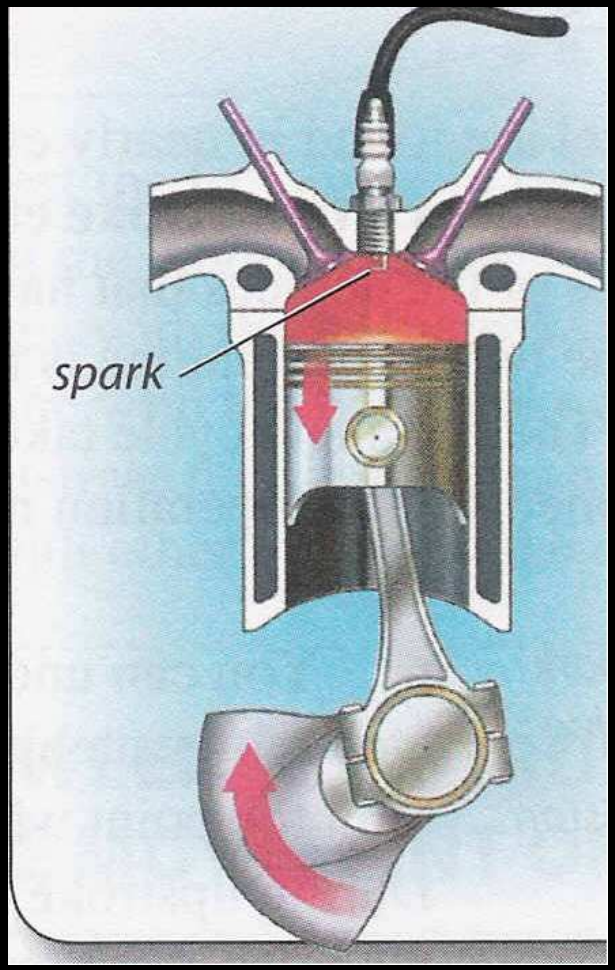
- The piston moves down the cylinder and draws in a mixture of air and fuel as the intake valve opens.

2. Compression stroke



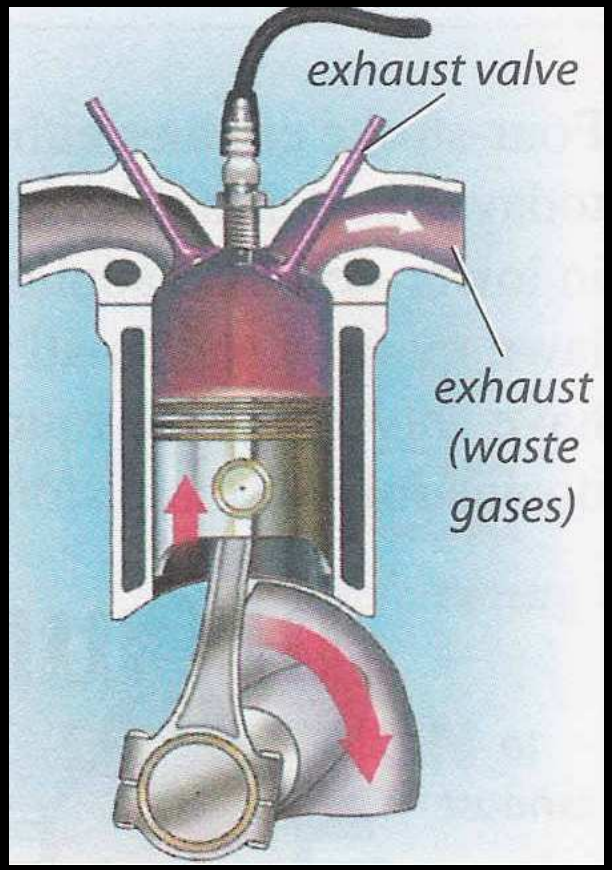
- The intake valve closes.
- The piston goes up the cylinder, compressing fuel and air mixture.
- This heats the mixture and the spark plug ignites.

3. Power stroke



- Spark from the spark plug ignites the fuel.
- The fuel burns and produces hot gases.
- The hot gases expand and force piston downwards.

4. Exhaust stroke



- The exhaust valve opens.
- The piston rises again, pushing out waste gases through the exhaust valve.

FOUR-STROKE DIESEL ENGINE

- Diesel fuel is used mainly by larger vehicles such as buses and trucks
- The way the four-stroke diesel engine works is different from the four-stroke petrol engine.
- Structure and operation of a four-stroke diesel engine:

1. Intake stroke

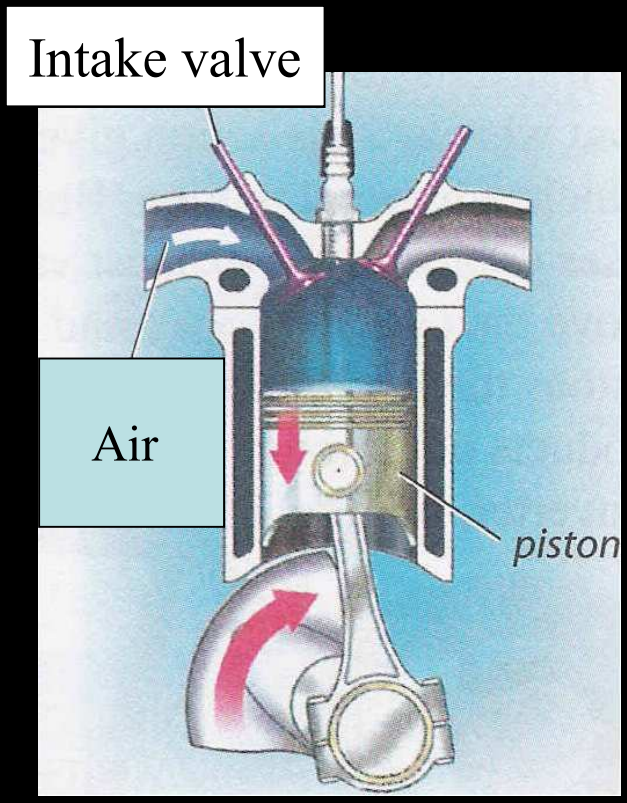
2. Compression stroke

3. Power stroke

4. Exhaust stroke

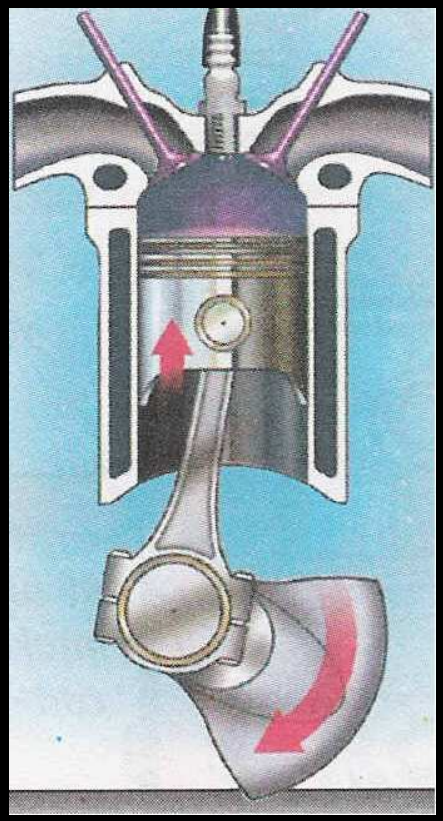
1. Intake stroke

- The piston moves down the cylinder and draws in air as the intake valve opens.



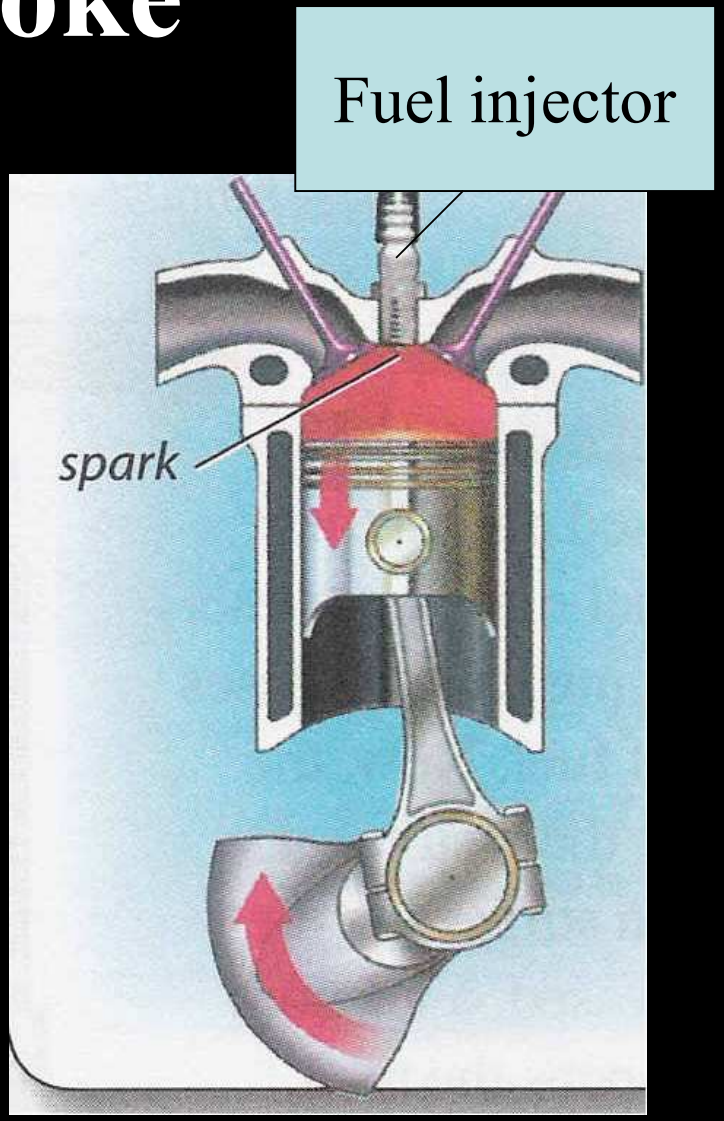
2. Compression stroke

- The intake valve closes.
- The piston goes up the cylinder, compressing the air.
- This heats the air to a very high temperature.



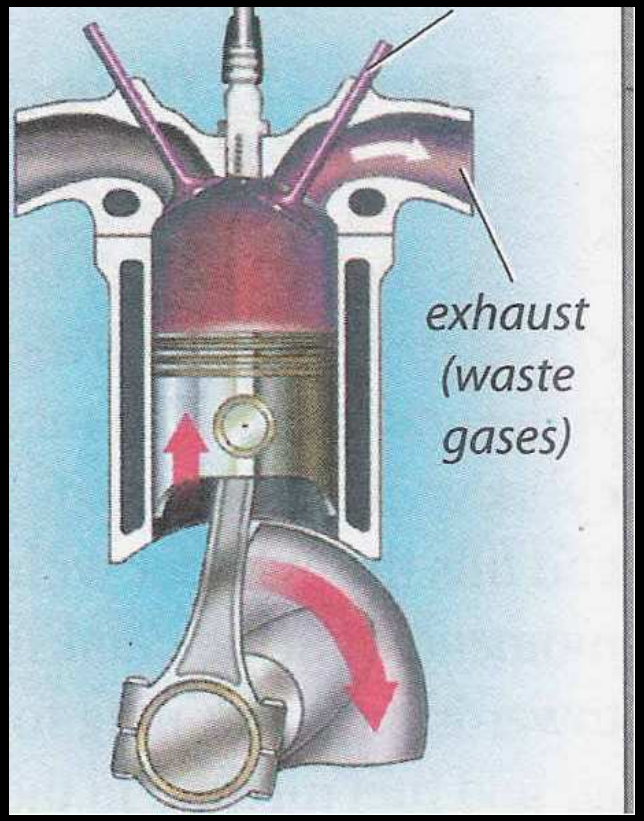
3. Power stroke

- Diesel fuel is forced into the cylinder where it is so hot that the fuel burns without a spark.



4. Exhaust stroke

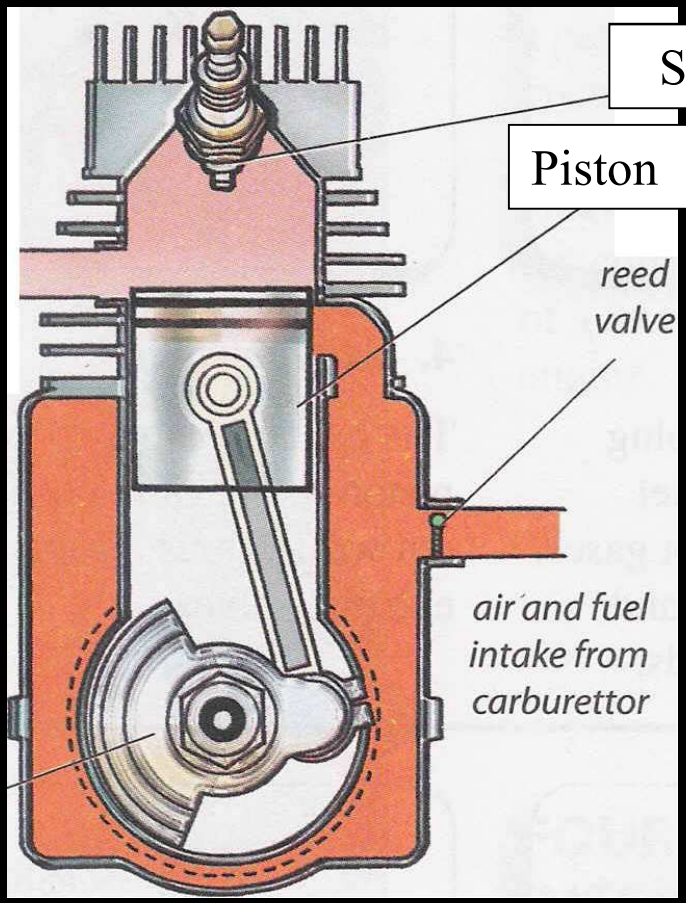
- The exhaust valve opens.
- The piston moves up, pushing out waste gases through the exhaust valve.



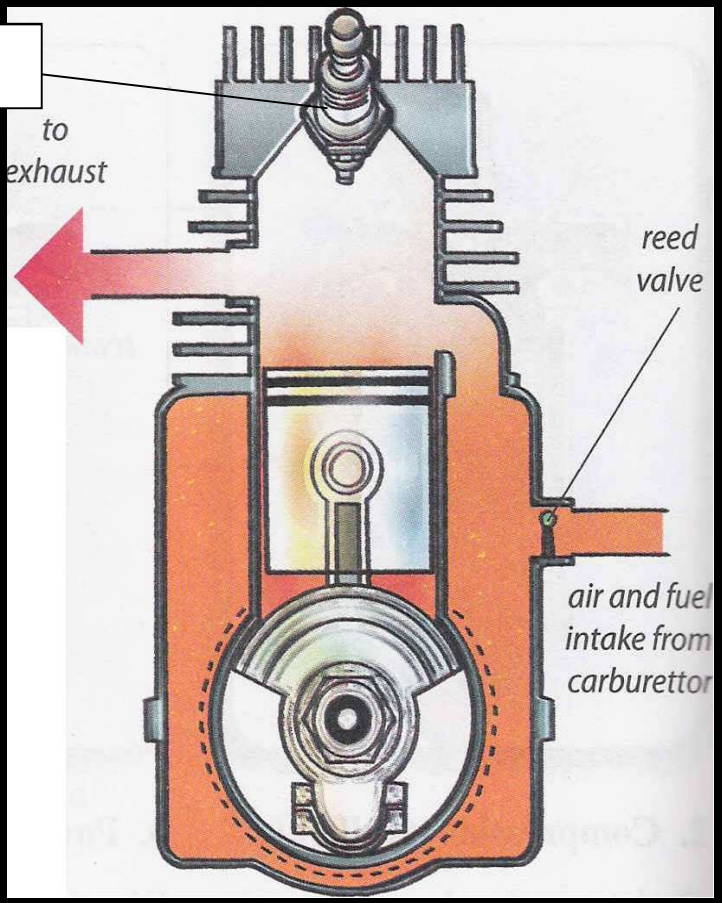
TWO-STROKE PETROL ENGINE

- Commonly found in lower-powered applications.
- Examples : lawn mowers and small motorcycles.
- Mechanically simple - not have valves like the four-stroke engine.
- The complete cycle takes only one upstroke and one downstroke of the piston

TWO-STROKE PETROL ENGINE



The upstroke of two-stroke engine



The downstroke of two-stroke engine

THE RELATIONSHIP BETWEEN THE STRUCTURE AND OPERATION OF THE ENGINE AND THE MOVEMENT OF VEHICLES

- The engine block contains the cylinder cavities in which the pistons move.
- The more cylinders an engine has, the greater is its power
- Internal combustion engines burn petrol or diesel, creating gases that push pistons up and down in a cylinder.
- This motion creates the engine's power.
- The power is transferred from the engine to the drive shaft of the wheels, via the gear box, enabling the car to move.

SPEED, VELOCITY, AND ACCELERATION

- When an object moves, it ends up in a different point or place.
- The faster the object moves, the further the object ends up.
- Distance is how far an object moves - measured in metres.

HOW FAST IS AN OBJECT MOVING?

- Speed is a measure of how fast an object moves
- This toy car has gone 20 metres in 4 seconds.
- The average speed is:

$$= \frac{\text{Distance (metres)}}{\text{Time (seconds)}}$$

$$= 20 / 4$$

$$= 5 \text{ ms}^{-1}$$

- The unit of measurement for speed is metres per second (m/s) or in kilometres per hour (km/h).
- It tells how far an object moves in one second or in an hour.

VELOCITY, SPEED WITH A DIRECTION

- Velocity: measures the direction in which an object is travelling as well as its speed.
- Measure of the distance travelled in a given time in a particular direction.
- This motorcycle is travelling at a constant speed of *5 m/s,*
- Velocity is changing because it is changing direction.

- Velocity : measured in metres per second *(m/s)* in a particular direction.
- Example: the boy is jogging at 4 *m/s* toward the south. He is jogging at a velocity of 4 *m/s* south.

- Use a negative sign to show that an object is moving in the opposite direction.

Speed: 5 *m/s*

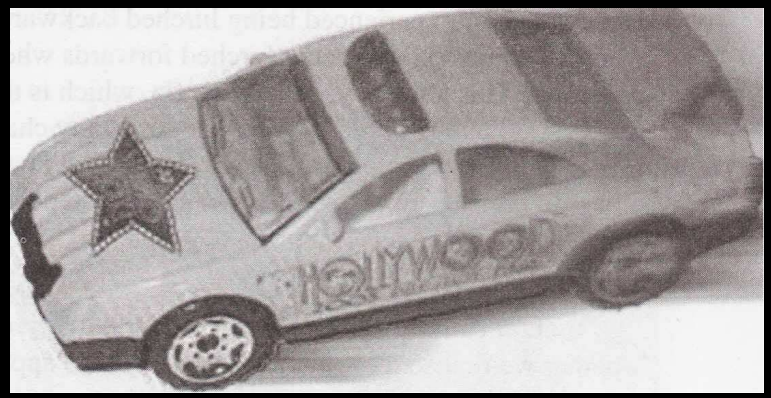
Velocity: 5 *m/s* or +5 *m/s*

Speed: 5 *m/s*

Velocity: 5 *m/s* or - 5 *m/s*

ACCELERATION

- An object accelerates or decelerates where there is a change of speed or velocity.
- When an object speeds up, it accelerates.
- When an object slows down, it decelerates.
- Measured in metres per second per second (m/s^2 @ ms^{-2}).



Time (s)	Velocity (m/s)
0	0
1	3
2	6
3	9

What is the acceleration of the toy car?

$$\text{Acceleration} = \frac{\text{Change in velocity (m/s)}}{\text{Time taken (s)}}$$

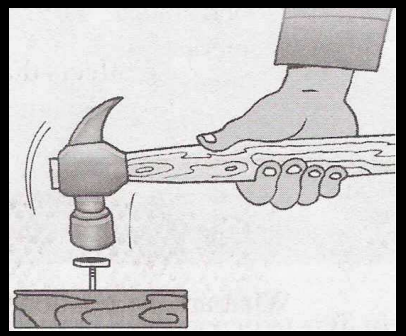
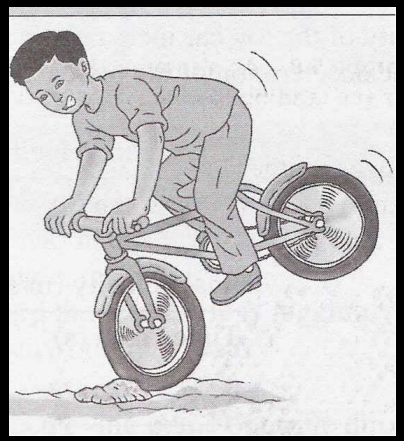
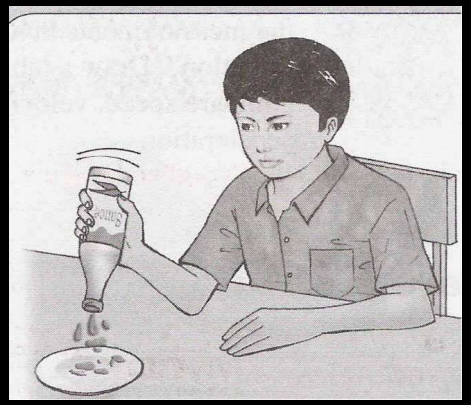
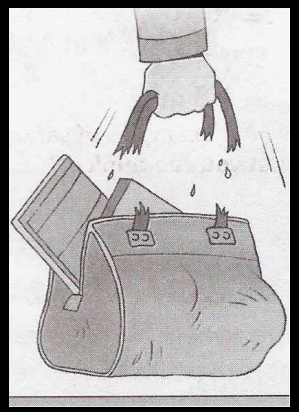
$$= \frac{\text{final velocity (m/s) - initial velocity (m/s)}}{\text{Time taken (s)}}$$

$$= \frac{9 \text{ m/s} - 0 \text{ m/s}}{3 \text{ s}}$$

$$= 3 \text{ m/s}^2 \ @ \ 3 \text{ms}^{-2}$$

INERTIA

- The property of an object that causes it to resist any change in its motion.
- An object at rest remains at rest or an object in motion continues to move unless acted upon by an external force.
- Examples :

- The greater the weight (or mass) of an object, the more inertia it has.
- Heavy objects are harder to move than light ones because they have more inertia.
- Inertia also makes it harder to stop heavy things once they are moving.

Aeroplane

Tanker

Safety features used in vehicles to reduce the risks of injuries

Car bumper

Air bag

Seatbelt

Test

- What is inertia?

.....

- What are the safety features used in vehicles to reduce negative effects of inertia?

.....

.....

.....

MOMENTUM

- Momentum is the mutiplication of an object's mass with its velocity.
- The momentum of a heavy object is larger than the momentum of a small object.
- The momentum also increases as the velocity increases.

MOMENTUM, MASS, AND VELOCITY

- If a 2.5 kg toy car is moving at a velocity of 4 *m/s,* what is its momentum?
- Momentum = mass x velocity

  = 2.5 kg x 4 *m/s*

  = 10 kg m/s

MOMENTUM, MASS, AND VELOCITY

- If two shopping carts are moving at the same velocity, which cart has greater momentum, a full load cart, or an empty cart?

Mass=20 kg
Velocity= 2 m/s east

= 20 kg x 2 m/s
= 40 kg *m/s*

Mass= 5 kg
Velocity= 2 m/s east

= 5 kg x 2 m/s
= 10 kg m/s

The greater the velocity of an object, the greater is its momentum.

If two shopping carts of equal mass are moving at a different velocity, which cart has greater momentum, a high velocity, or low velocity?

Mass = 5 kg

Velocity = 2 m/s east

Momentum

= 5 kg x 2 *m/s*

= 10 kg *m/s*

Mass = 5 kg

Velocity = 4 m/s east

Momentum

= 5 kg x 4 m/s

= 20 kg *m/s*

CONSERVATION OF MOMENTUM

- The law of conservation of momentum states that the total amount of momentum before a collision equals the total amount of momentum after the collision.

The law of conservation of momentum

The total amount of momentum before collision = The total amount of momentum after collision

MOMENTUM IN DAILY LIVES

- Car manufacturers design cars that can absorb momentum during collision.
- The front and the rear part of the car easily crushed.
- To extend the time of impact during collisions to absorb the momentum of the car.
- The people in the car would absorb less momentum.

MOMENTUM IN DAILY LIVES

Car crash

Test

- Calculate the momentum of 20 kg shopping cart moving at a velocity of 2 m/s west.
- Momentum = mass x velocity

  = 20 kg x 2 m/s

  = 40 kg m/s

TEST

1. A motorcycle traveling on a straight road takes 4s to increase its speed from 40m/s to 80 m/s. what is its acceleration.
2. A lorry has a mass of 120000 kg. it accelerates from rest to 4m/s in 10 s. what is it acceleration?

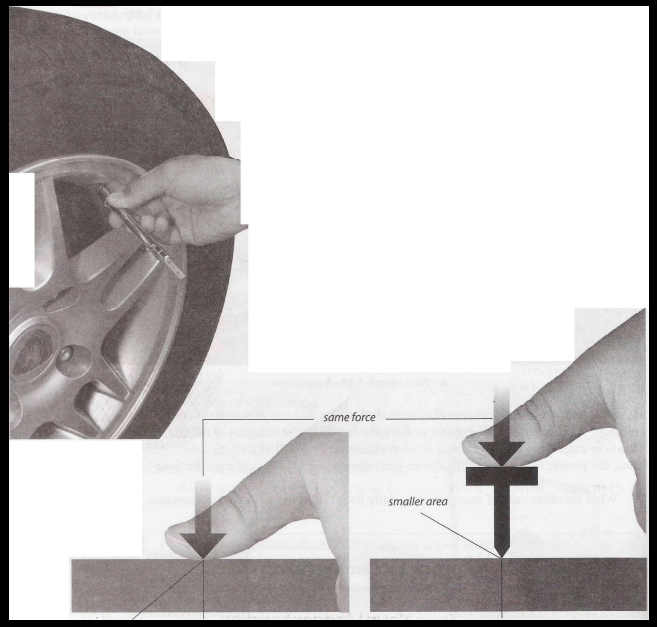
3. A car accelerates uniformly from rest to 60km/s. if its acceleration is 20km/s$^{2.}$ what is the time taken to reach 60km/s?

4. A tennis ball of mass 0.05 kg have 1 kgm/s of momentum, what is its velocity?

5. A lorry is moving at speed of 50km/s towards a stop car. After they collide, both the trolleys move together at a speed of 15 km/s. calculate the momentum before and after collision.

PRESSURE

- Pressure is defined as the force exerted over a given area by a solid, liquid or gas.
- Pressure is measured in Newtons per square metre (N/m^2)



$$\text{Pressure} = \frac{\text{force}}{\text{area}}$$

$$P = \frac{F}{A}$$

Example

- If a force of 1200 N pushes on an area of 4 m^2, the pressure will be:
- P = F / A

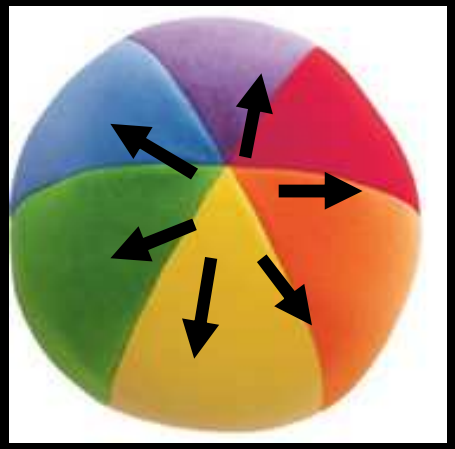
  = 1200 / 4

  = 300 N/m^2

THE PRINCIPLE OF HYDRAULIC SYSTEM IN EVERYDAY LIFE

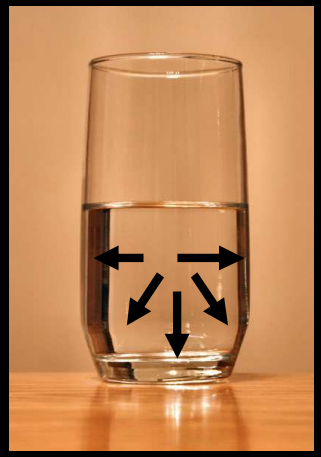
- Gases and liquids are fluids can change shape according to their containers.
- The pressure inside them acts outwards in all directions.
- Liquids be have differently from gas when they are under pressure.
- Gas can be compressed or squashed. When compressed, the volume of the gas is reduced.

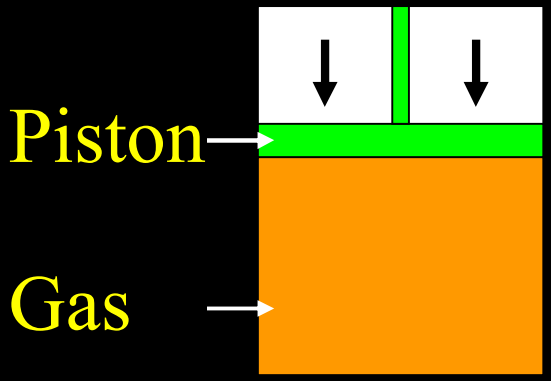
THE PRINCIPLE OF HYDRAULIC SYSTEM IN EVERYDAY LIFE

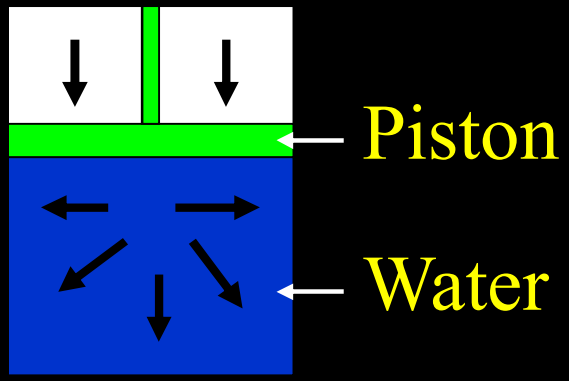


Air inside a basketball pushes out in all directions.

Liquid in a glass pushes out on the side as well as the bottom of the glass





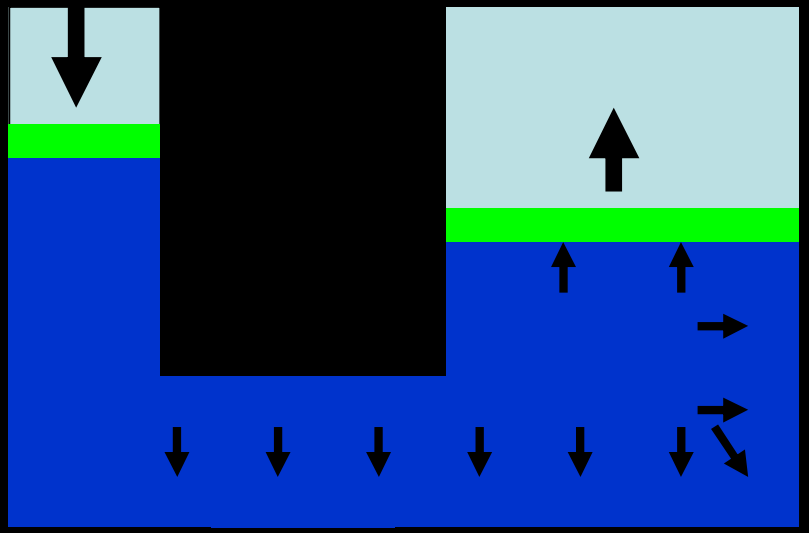


Gas can be compressed

Liquid cannot be compressed

The principle of transmission of liquids states that pressure is transmitted equally in all directions.

- Pressure can be transmitted equally throughout liquid, so force can transmit using the following hydraulic system.



• The total output force exerted on the right piston is larger than the input (applied) force exerted on the left piston.
• This is due to the size of the surface of the output piston which is larger than the surface of the input piston.

Hydraulic Lift

- A car or any heavy object can be lifted much easier.
- When a force is applied to the left piston, it will exert a pressure ten times bigger on the right-hand piston.

From the Pascal's principle

The input pressure = The output pressure

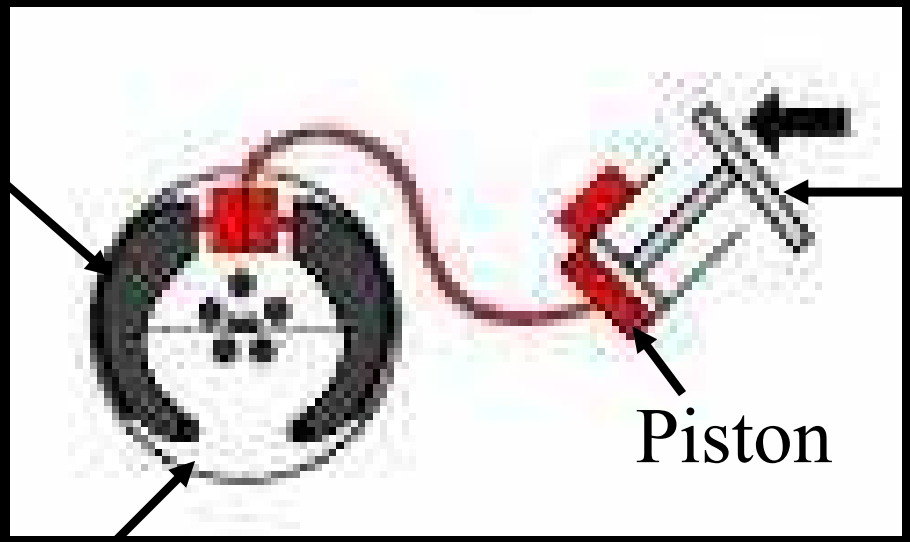
$$P_{input} = P_{output}$$

$$\frac{F_{input}}{A_{input}} = \frac{F_{output}}{A_{output}}$$

Pressure X = Pressure Y

Using Of Hydraulic System



Hydraulic break system

Test

- A girl pushes an input piston using a force of 5N in a hydraulic system. If the output piston is 5 times larger, what is the total force exerted on it?


OOCL EUROPE
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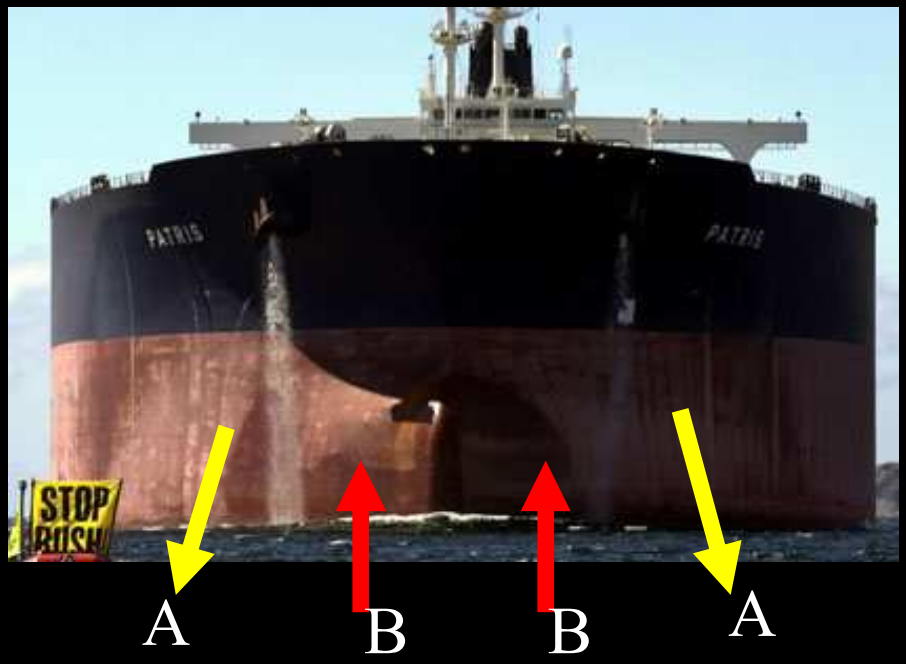
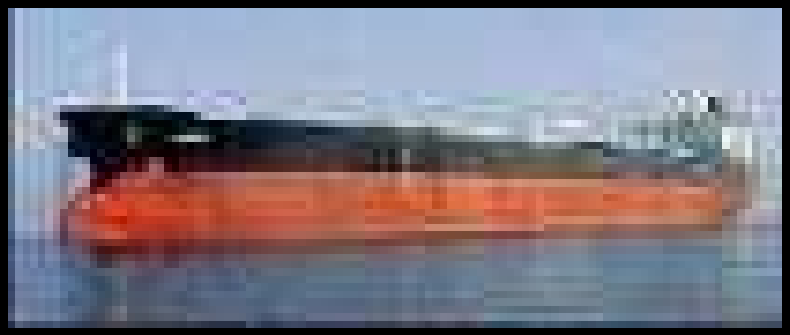
THE MOTION OF VEHICLES IN WATER

- When an object such as a boat floats on water, it has to displace (push aside) some of the water to make room for itself.
- The weight of the object pulls downwards, while the pressure of the water pushes upward with a force called upthrust.
- The object sinks if the upthrust is less than its weight, but floats if the upthrust is more than its weight.

THE MOTION OF VEHICLES IN WATER



Water is displaced (arrows A) as the weight of the ship pushes downward.
Upthrust (arrows B) pushes back the ship upward.



Their huge volume pushes aside a huge amount of water that creates huge upthrust.

A Large cruise carry hundreds of people.

- Modern ships are made of steel, which is eight times denser than water.
- Not sink because their overall density is lower than the density of water.
- Since the ships are made hollow, the total space inside make them less dense than water.
- The huge volume of the ship pushes aside (or displaces) a large amount of water thus creating a huge upthrust on the ship.

The shape of water vehichles

- The bow or front of a boat is V -shaped and curved.
- Reduce drag or resistance when they move through water.
- Also make the vehicles move faster.

A boat

A canoe

Examples of water vehicles

Aircraft carrier

Speed boat

A hydrofoil

A submarine

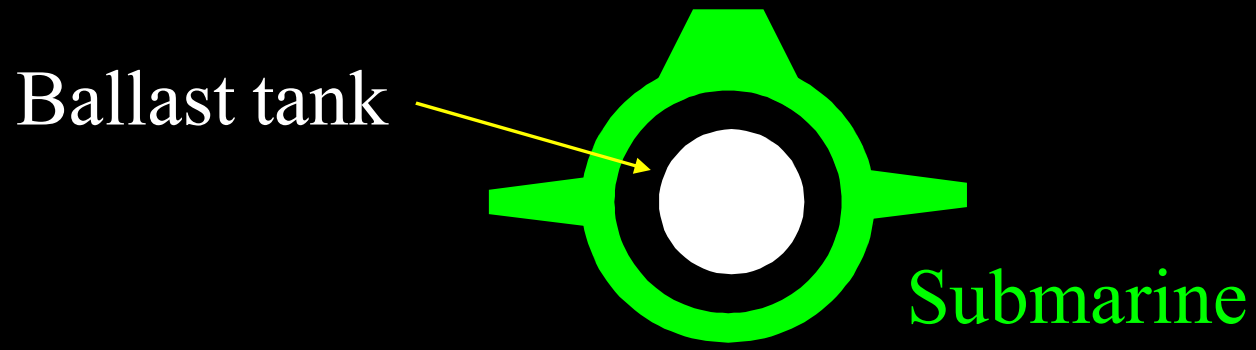
A hovercraft

Archimedes' Principle

- The upthrust acting on an object is equal to the weight of the fluid that the object displaces.
- An object will sink into a fluid, such as water, and keep on sinking until the force of the upthrust from the fluid is equal to the weight of the object.

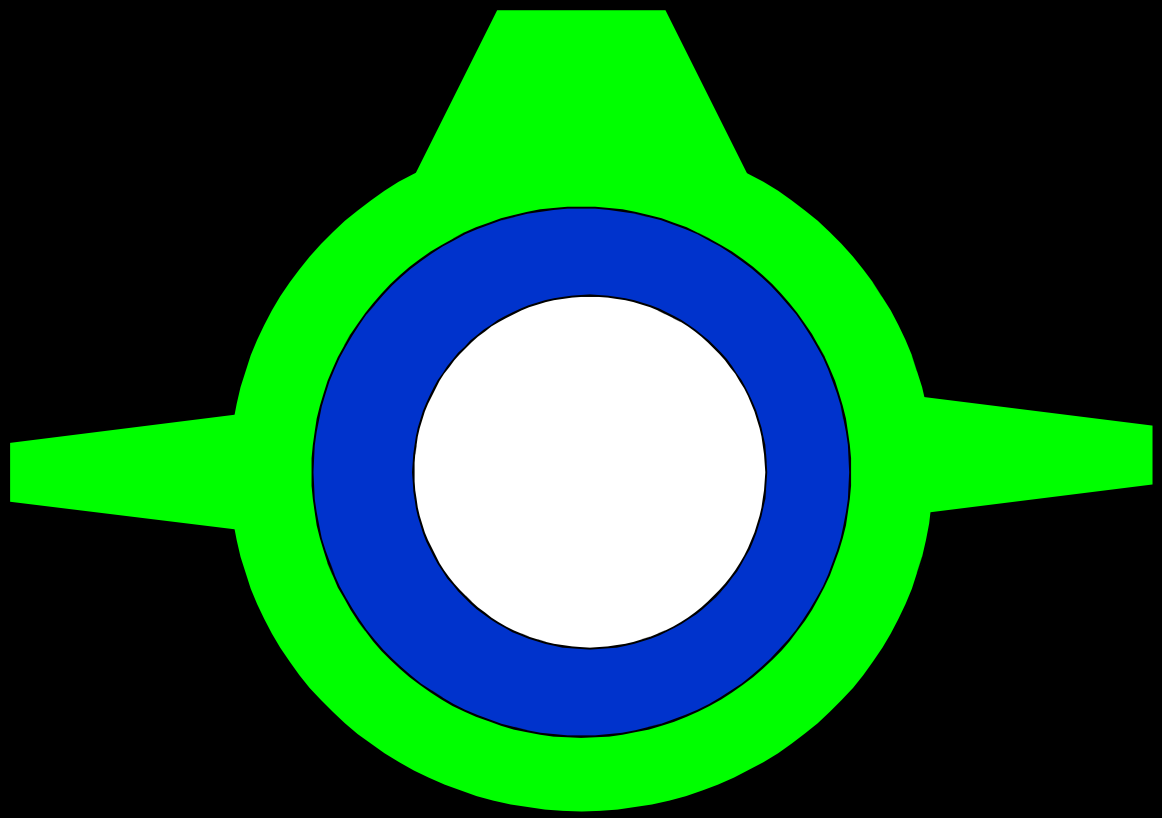
Archimedes' Principle

- The application of this principle enables the ships to float and the submarines do not only float on the sea, but sink just beneath the surface, or dive to the seabed.
- The submarines dive or surface using tanks that can either be filled with water or air.

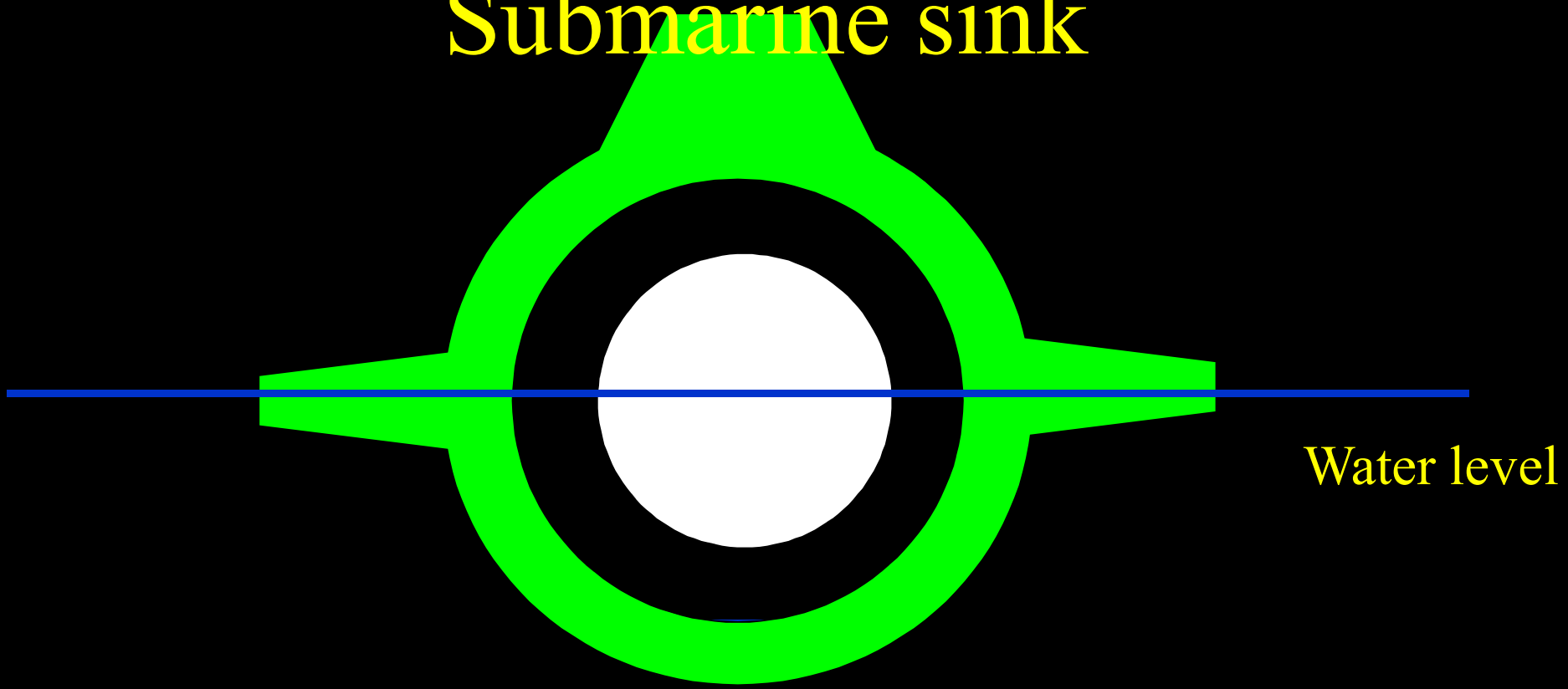


Submarine float

Water level



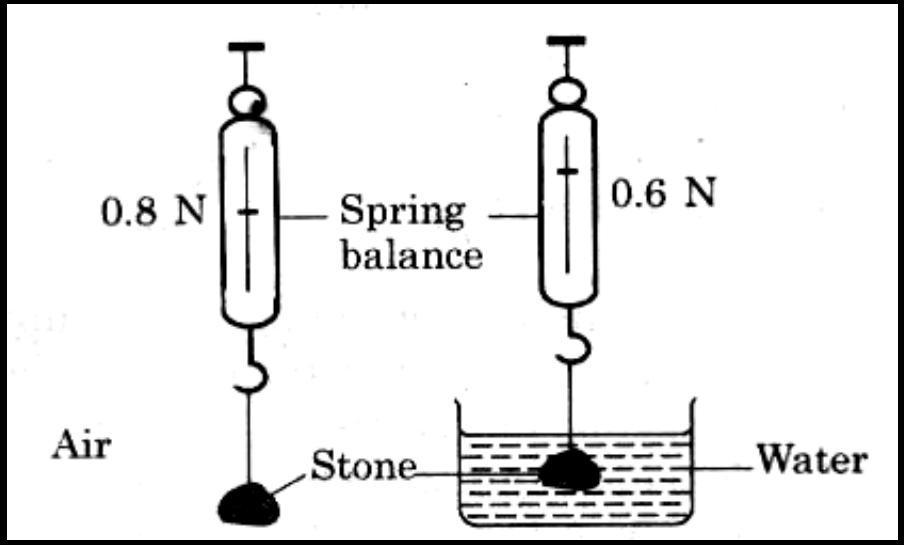
Submarine sink



Fast Quiz *(SPM2006)*

1. Diagram 13 shows a stone weighed in the air and then in water.

   Rajah 13 menunjukkan seketul batu ditimbang di dalam udara dan kemudian di dalam air.



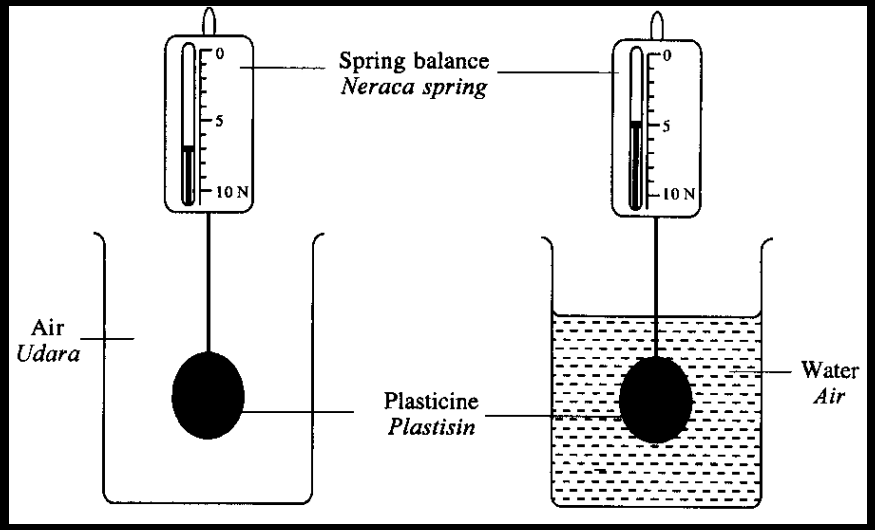
   What is the upthrust experienced by the stone?

   Berapakah tujah ke atas yang dialami oleh batu tersebut?

Fast Quiz *(SPM2008)*

2. Diagram 17 shows an experiment to investigate the upthrust on a piece of plasticine.

   Rajah 17 *menunjukkan suatu eksperimen untuk mengkaji tujah ke atas bagi seketul plastisin.*



   What is the upthrust on the plasticine?

   Apakah tujah ke atas bagi plastisin itu ?

Fast Quiz *(SPM2009)*

3. Diagram 16 shows the weight of a stone.

Rajah 16 menunjukkan berat sebiji batu.

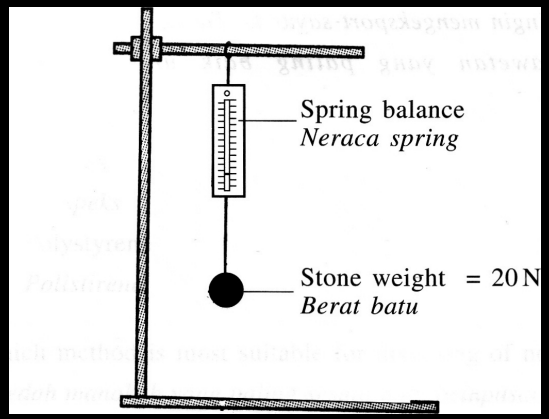
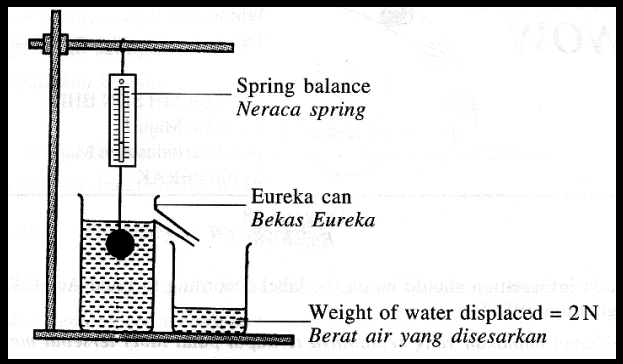


Diagram 17 shows the weight of water displaced by the stone.

Rajah 17 menunjukkan berat air yang disesarkan oleh batu itu.

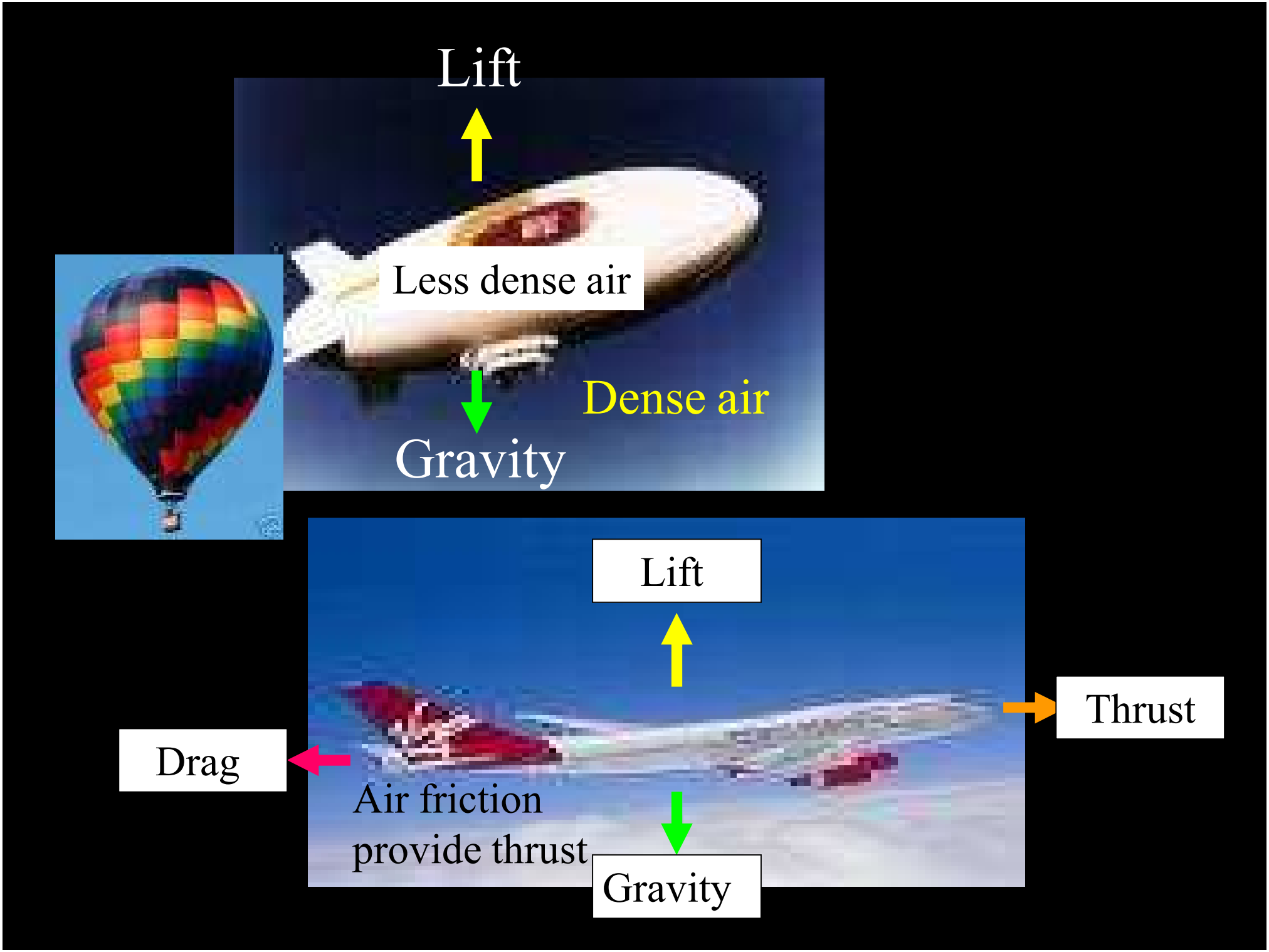


What is the weight of the stone in the water?

Berapakah berat batu itu dalam air?

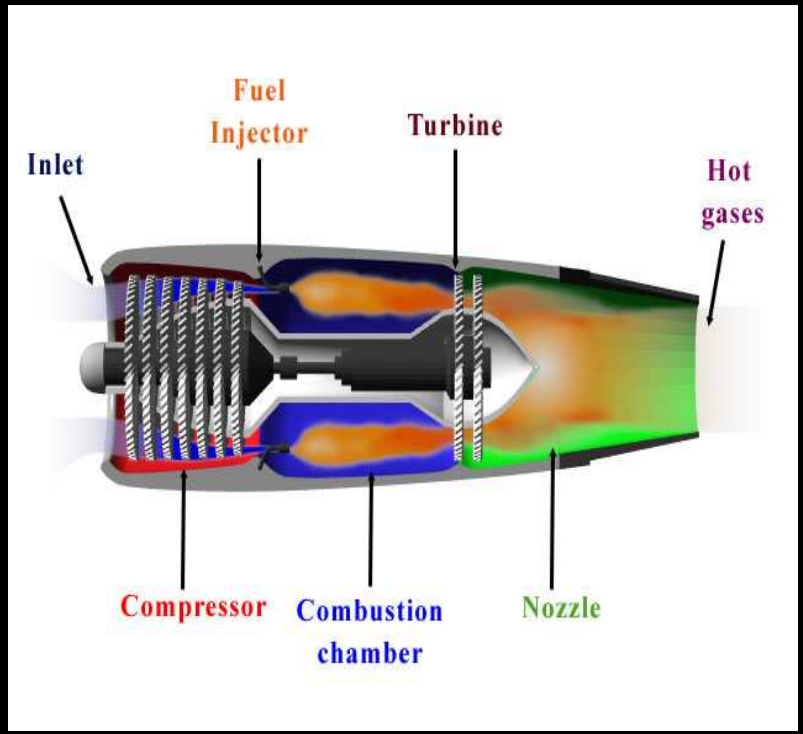
VEHICLES IN THE AIR

- When a vehicle flies, it overcomes the force of gravity
- An aeroplane has wings that generate lift because of their curved shape known as **aerofoil.**
- When the air flows along the wings, the wings tend to lift upwards.
  - supports the aeroplane in the air.


Lift
Less dense air
Dense air
Gravity
Lift
Thrust
Drag
Air friction
provide thrust
Gravity

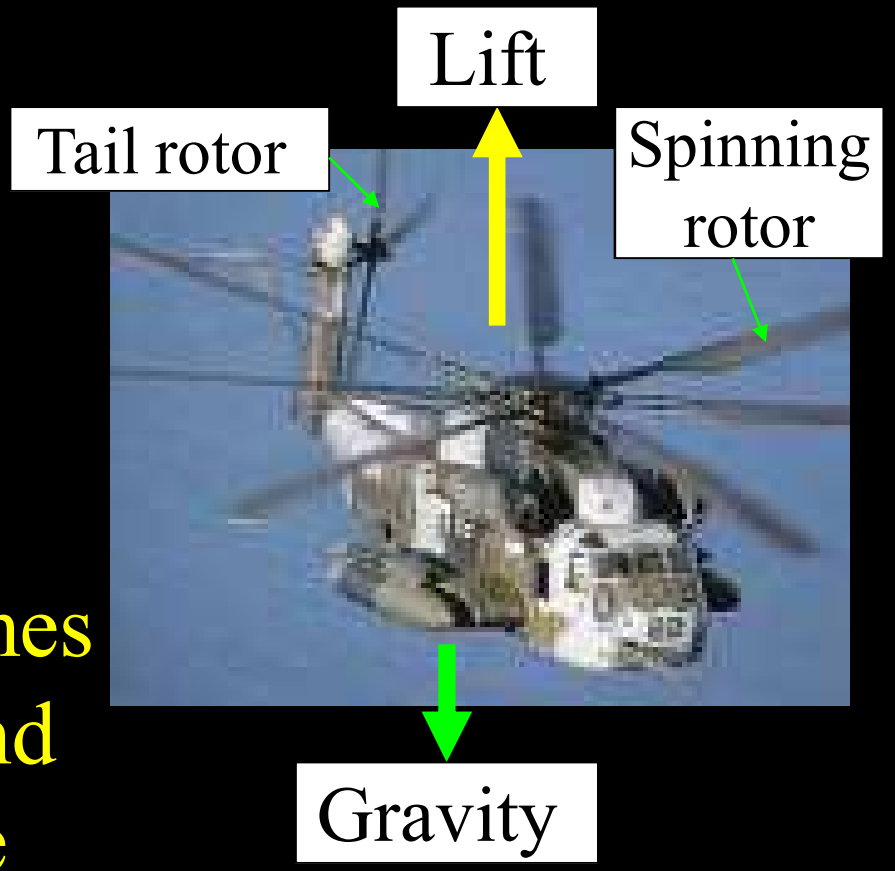
A jet engine

- The mixture of fuel with air burns in the combustion chamber producing hot gases.
- As the gases expand, they turn a turbine that spins the fan.
- The force of the hot air rushing backward causing the aeroplane to move forward.



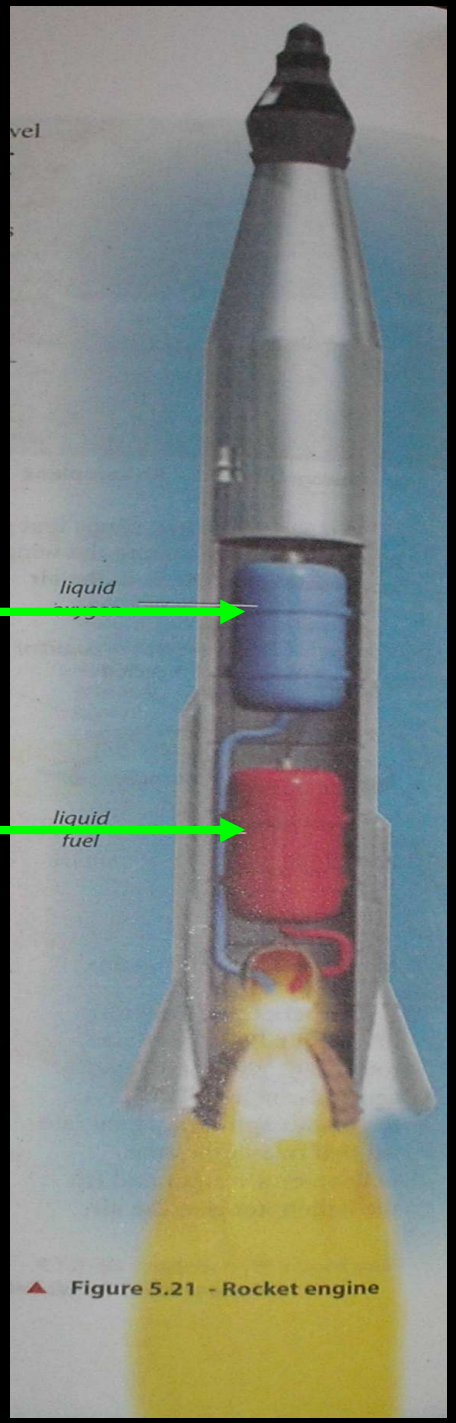
A Helicopter

- A helicopter generates lift using a huge overhead rotor.
- The rotor has several aerofoil-shaped blades.
- As the blades spin, they generate lift that overcomes the helicopter's weight and lift the helicopter into the air.



A Rocket

- Rocket engines have a **combustion chamber** where fuel is mixed with oxygen and burnt.
- Produces a lot of hot gas, which expands and rushes out of the exhausts.
- Carry their own oxygen in the form of high pressurised liquid.



ROCKETS AND JETS ENGINES

Similarities

- Use the principle of conservation of momentum
- Hot gases is pushed backward while the vehicle is pushed forward providing the thrust

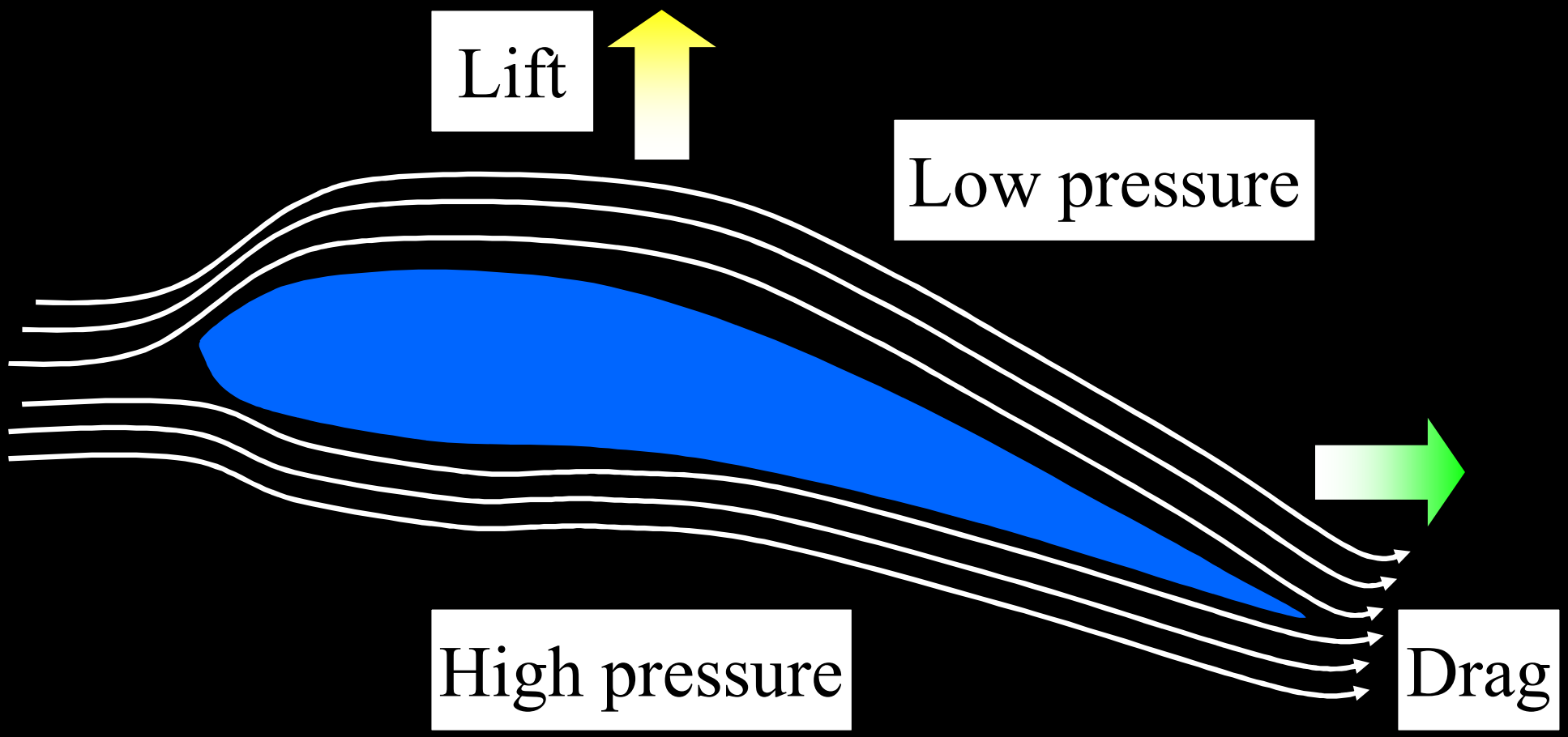
Differences

Rockets	Jet engines
Carry their own oxygen	Get oxygen from surrounding air
Can travel into outer space	Cannot travel into outer space
Gain thrust by combustion of fuel and liquid oxygen	Gain thrust by compressing and pushing surrounding air using turbines

BERNOULLI'S PRINCIPLE

- When a fluid (liquids and gases) moves with a high velocity, its pressure is reduced or vice versa.
- The pressure on the top of the wing is reduced because the air travels faster compared to the air at the bottom of the wing.
- Generates upthrust or lift - causes the wing to rise up into the air.

Aerofoil



APPRECIATING THE ABILITY AND CREATIVITY OF MANKIND IN INVENTING AND DESIGNING VEHICLES FOR THE BETTERMENT OF LIFE

- Vehicles must be efficient, have better fuel consumption, and must be environmentally friendly.
- Research and development are a must to promote creativity in designing today's vehicles.

Example of vehicles

Cargo flight

Giant aeroplane

Bullet train

Mountain bike

Solar car

Light rail

PRACTICE GOOD HABITS IN HANDLING VEHICLES

- Wear proper attire when riding motobikes.
- Wear seatbelt when drive car.
- This could avoid serious injury should accident happens.

PRACTICE CARING ATTITUDES WHEN USING PUBLIC TRANSPORT SYSTEM

- Show caring attitudes especially to pregnant mothers, women carrying babies, senior citizens and handicapped people.
- Allow them to board the bus first and let them be seated while in the bus.

Exercises

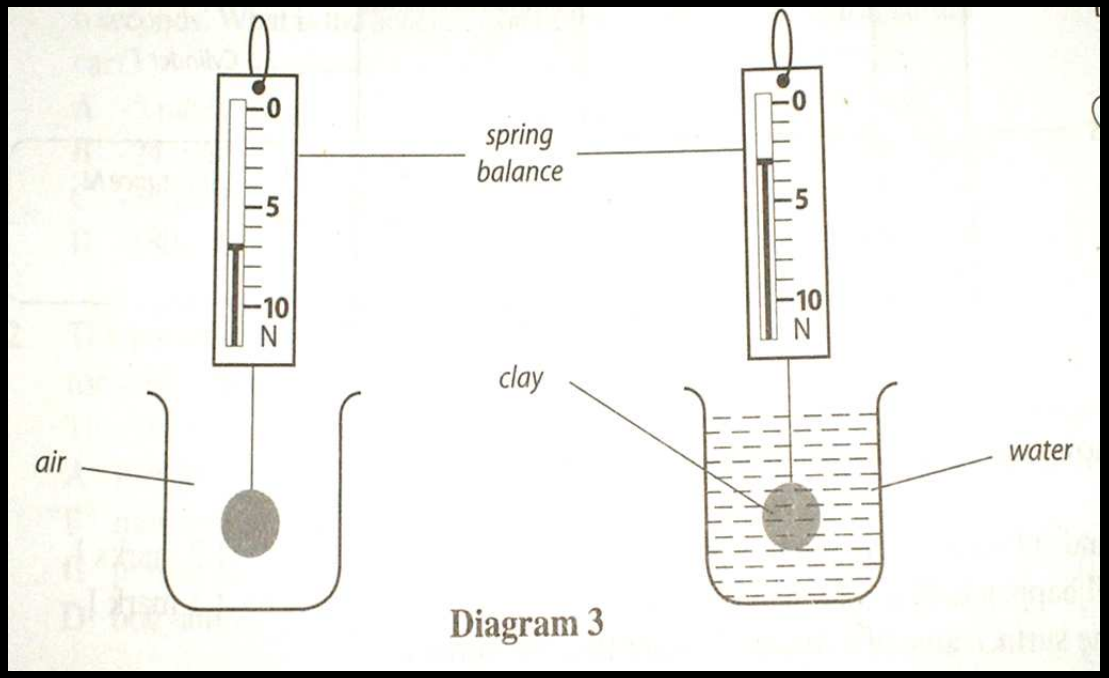


Diagram 3

Diagram 3 shows an experiment to investigate the weight of clay in the air and in the water.

1. What is the weight of the clay in the air?

   .....

2. What is the manipulated variable of the experiment?

   .....

3. Predict the reading of the spring balance if the clay is put into the sea water: .....

Keywords

English	Malay
Internal-combustion	Pembakaran dalam
Stroke	Lejang
Velocity	Halaju
Acceleration	Pecutan
Collision	Pelanggaran
Upthrust	Apungan
Combustion chamber	Ruang pembakaran
Deceleration	Nyahpecutan