

Handbook

PHYSICS

Skill 1 - Understanding

Skill 2 - Calculation

Skill 3 - Comparison

Skill 4 - Modification

Skill 5 - Making Decisions

PHYSICS SPM: PAPER 2

FORCE & MOTION
FORCES & PRESSURE
LIGHT
WAVES

WITHOUT FEAR
THERE CANNOT
BE COURAGE
alainamarif

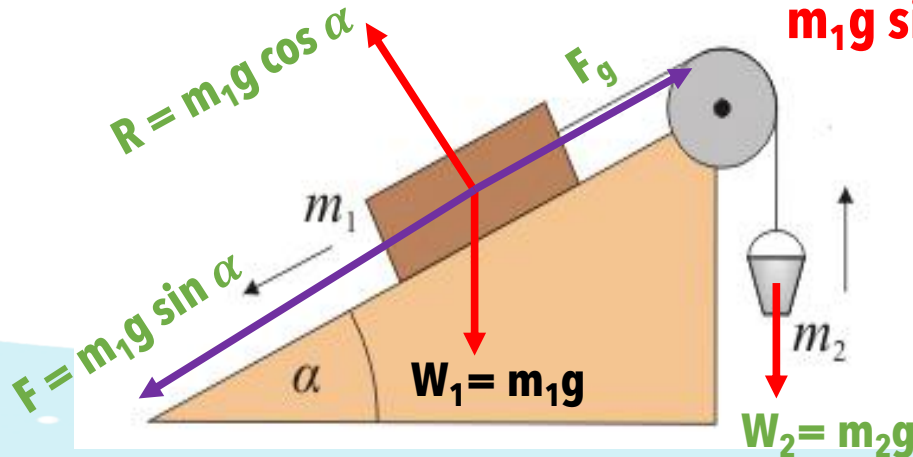


SKILL 1 - UNDERSTANDING

CHAPTER 2: FORCE & MOTION

Diagram 1 shows a box with mass m_1 going down a distance s on an inclined plane with a slope of angle α when the box is coupled by a rope and a pulley to a bucket with mass m_2 . The friction force is F_f .

- (i) On Diagram 1, mark all the forces that affect the box and the bucket



- (ii) Write the motion equation for the box and the bucket.

$$F_{\text{net}} = ma$$

Where; $m = m_1 + m_2$

$$F_{\text{net}} = F - F_g - m_2 g$$

$$m_1 g \sin \alpha - F_g - m_2 g = (m_1 + m_2) a$$

Diagram 1



Newton's First Law

(INERTIA - time taken or period)

Objects keep on doing what there are doing

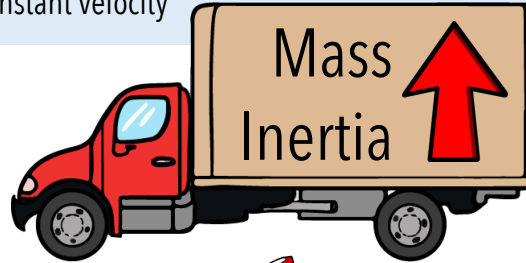
In the absence of external forces, an object at rest remains at rest and an object in motion continues in motion with a constant velocity



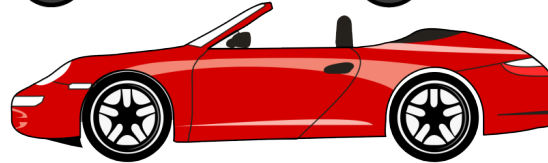
The bus **STOP** suddenly
The boy **JERK forward**




The bus **MOVES** suddenly
The boy **JERK backward**



Difficult
to move or to stop



Mass
Inertia 

easier
to move or to stop

Newton's SECOND LAW

The rate of change of momentum of a body is directly proportional to the resultant force acting on the body and is in the same direction.

$$F = ma$$

Bigger mass
Bigger force



smaller mass
smaller force



Newton's SECOND LAW

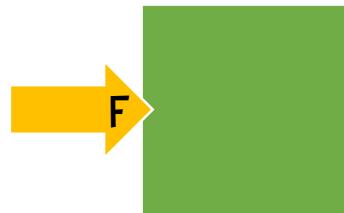
$$F = ma$$

greater force,
same mass



Greater acceleration

smaller force,
same mass



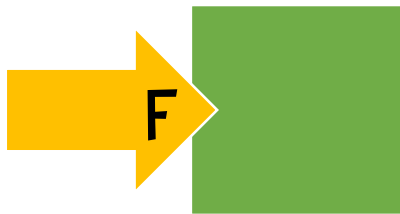
smaller acceleration



Newton's SECOND Law

$$F = ma$$

same force,
smaller mass



Greater acceleration

same force,
greater mass



smaller acceleration



Newton's SECOND LAW

$$F = ma$$

same force,
Greater mass



smaller acceleration

$$F = ma$$



greater force,
same mass

bigger acceleration

$$F = ma$$

IDEA &
CONCEPT:

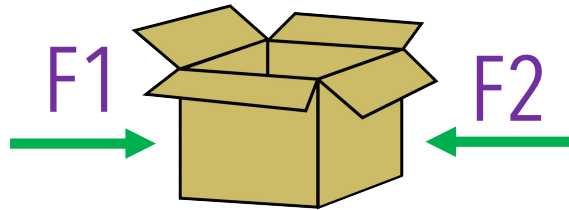


Newton's SECOND LAW

$$F = ma$$

balanced force

Body remain **stationary**
Body move at **constant velocity**
(acceleration = 0 ms^{-2})



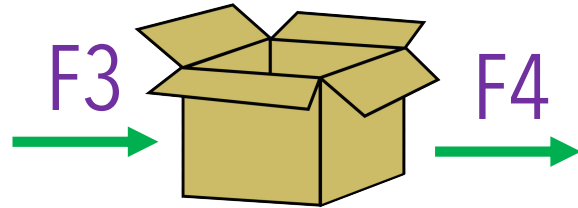
$$F1 = F2$$

(at opposite direction)

Net force = 0 N

unbalanced force

Stationary object will **move**
velocity of an object changes
direction of moving object changes



$$F3 > F4 \text{ or } F4 > F3$$

(same direction)

Net force = $F3 + F4$ or $F4 + F3$

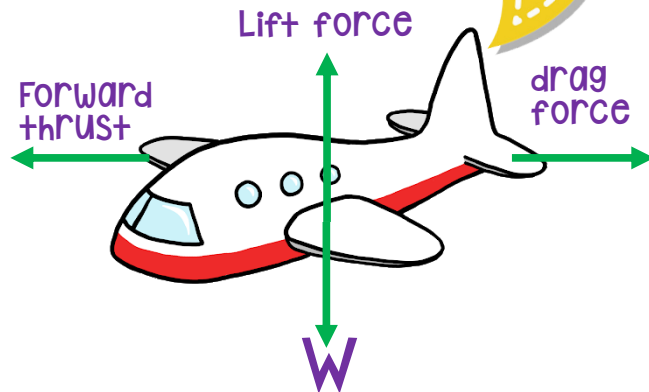
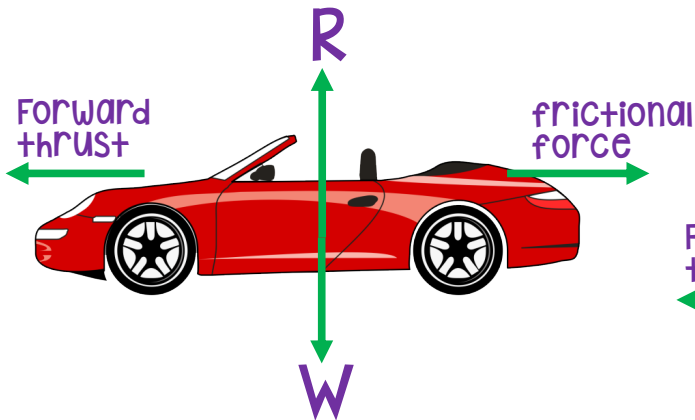
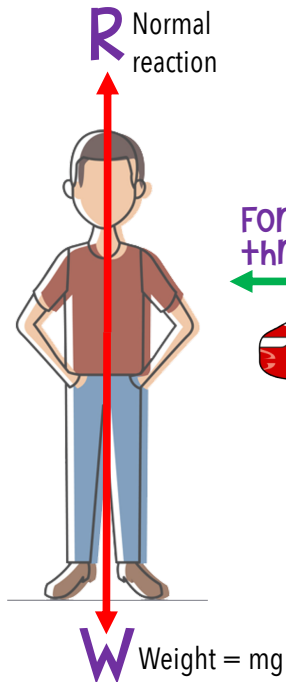


Newton's third Law

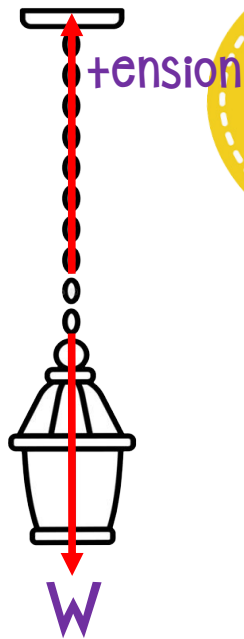
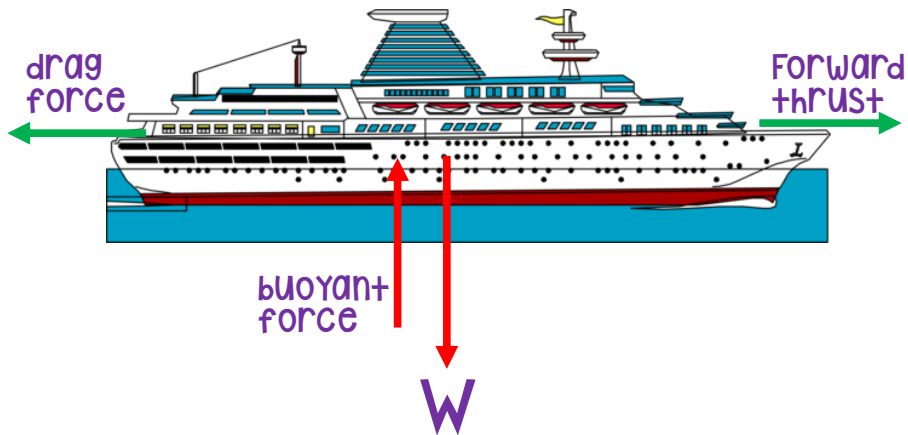
for every force, there is a reaction force with the same magnitude but in the opposite direction



IDEA & CONCEPT:

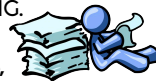


Newton's third Law



IDEA & CONCEPT:

YOUR MIND IS A POWERFUL THING. WHEN YOU FILL IT WITH POSITIVE THOUGHTS, YOUR LIFE WILL START TO CHANGE.



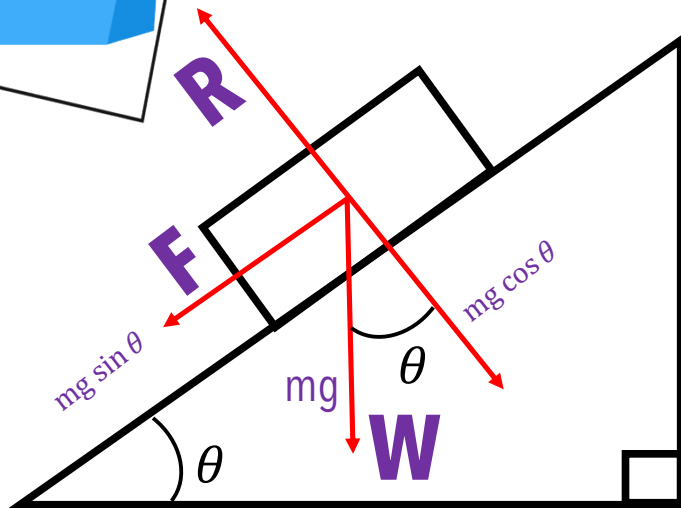


Component **parallel**
to the plane:

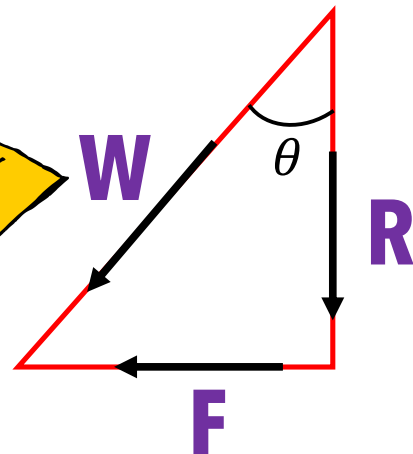
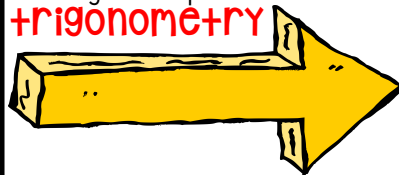
$$F = mg \sin \theta$$

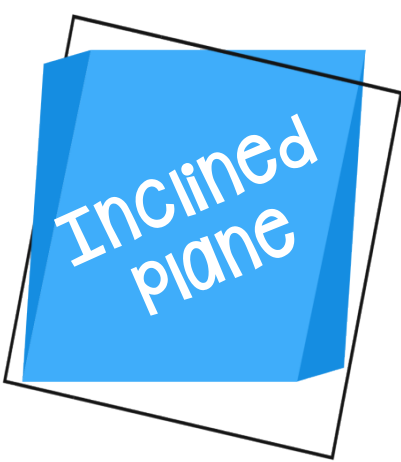
Component **perpendicular**
to the plane:

$$R = mg \cos \theta$$

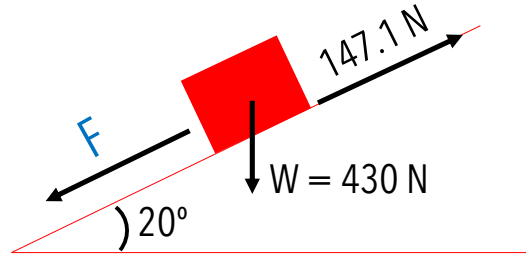


Using a concept of
trigonometry





A box of mass 43 kg on a ramp with 20° slope to horizontal.
Frictional force exerted between the box with the ramp is 147.1 N.



Calculate the resultant force, parallel to the ramp.



Component **parallel** to the plane:

$$\begin{aligned} F &= mg \sin \theta \\ F &= 430 (\sin 20^\circ) \\ &= 147.1 \text{ N} \end{aligned}$$



Resultant force

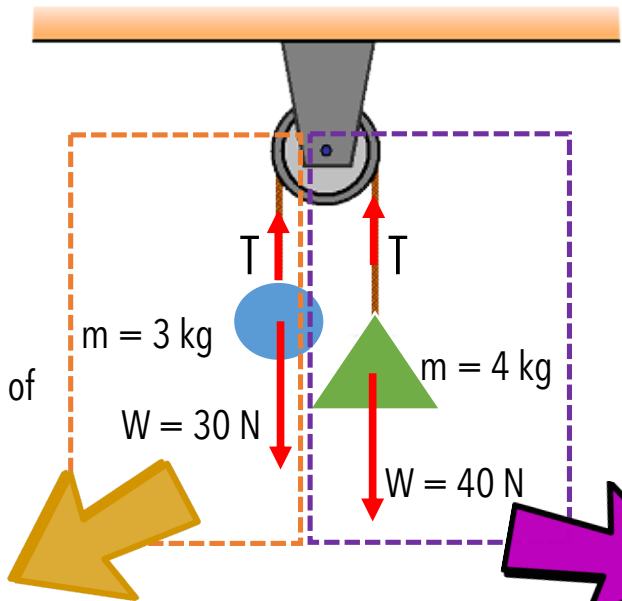
$$\begin{aligned} F_{\text{net}} &= F - \text{frictional force} \\ &= 147.1 - 147.1 \\ &= 0 \text{ N} \end{aligned}$$

**Stationary
(balanced force)**





PULLEY



Calculate the Tension of the rope

Object will rise up

$$\begin{aligned} T &> W \\ T - 30 &= ma \\ T - 30 &= 3(1.43) \\ T - 30 &= 4.29 \\ T &= 34.29 \text{ N} \end{aligned}$$

Resultant force

$$F_{\text{net}} = 40 - 30 = 10 \text{ N}$$

$$\text{Total mass} = 3 + 4 = 7 \text{ kg}$$

Acceleration of the object:

$$F = ma$$

$$10 = 7a$$

$$a = 1.43 \text{ m s}^{-2}$$

Calculate the Tension of the rope

Object will go down

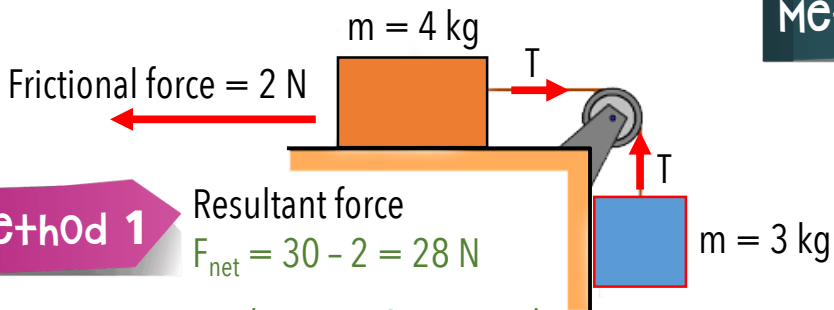
$$\begin{aligned} W &> T \\ W - T &= ma \\ 40 - T &= 4(1.43) \\ 40 - T &= 5.72 \\ T &= 34.28 \text{ N} \end{aligned}$$

Pulley

Calculate the **acceleration** and **Tension** of the load

*has a **frictional force** acting on the table

Method 2



Method 1

Resultant force

$$F_{\text{net}} = 30 - 2 = 28 \text{ N}$$

$$\text{Total mass} = 3 + 4 = 7 \text{ kg}$$

Acceleration of the object:

$$F = ma$$

$$28 = 7a$$

$$a = 4 \text{ m s}^{-2}$$

$$W > T$$

$$30 - T = 3a$$

$$T = 30 - 3(4)$$

$$T = 30 - 12$$

$$T = 18 \text{ N}$$

$$W > T$$

$$30 - T = 3a$$

$$T = 30 - 3a \quad \dots \text{equation 1}$$

$$T - 2 = 4a$$

$$T = 4a + 2 \quad \dots \text{equation 2}$$

$$\text{equation 1} = \text{equation 2}$$

$$30 - 3a = 4a + 2$$

$$7a = 28$$

$$a = 4 \text{ m s}^{-2}$$

Insert (a) equation 2

$$T = 4a + 2$$

$$T = 4(4) + 2$$

$$T = 16 + 2$$

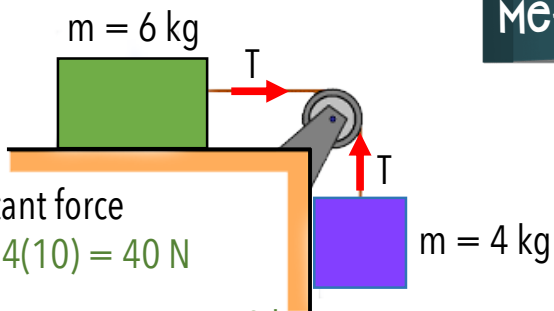
$$T = 18 \text{ N}$$



Pulley

Calculate the **acceleration** and **Tension** of the load

***NO frictional force** acting on the table



Method 1

Resultant force

$$F_{\text{net}} = 4(10) = 40 \text{ N}$$

$$\text{Total mass} = 6 + 4 = 10 \text{ kg}$$

Acceleration of the object:

$$F = ma$$

$$40 = 10a$$

$$a = 4 \text{ m s}^{-2}$$

$$W > T$$

$$40 - T = 4a$$

$$T = 40 - 4(4)$$

$$T = 40 - 16$$

$$T = 24 \text{ N}$$

Method 2

$$W > T$$

$$40 - T = 4a$$

$$T = 40 - 4a \quad \dots \text{equation 1}$$

$$T - 0 = 6a$$

$$T = 6a \quad \dots \text{equation 2}$$

equation 1 = equation 2

$$40 - 4a = 6a$$

$$40 = 10a$$

$$a = 4 \text{ m s}^{-2}$$

Insert (a) equation 2

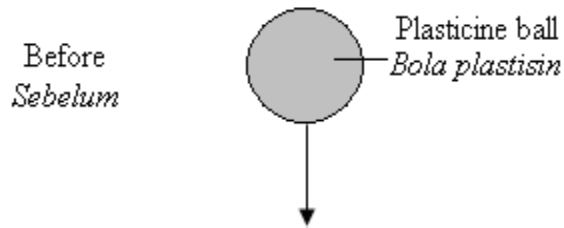
$$T = 6a$$

$$T = 6(4)$$

$$T = 24 \text{ N}$$



Diagram 2 shows a plasticine ball being dropped onto a metal block.
The plasticine ball changes its shape after the impact.



Name the force involved during the impact.

Impulsive force

Explain why the plasticine ball changes its shape after the impact.

- The **surface** of metal block is **hard**.
- The **time impact** is **shorter**
- The **impulsive force** is **bigger**

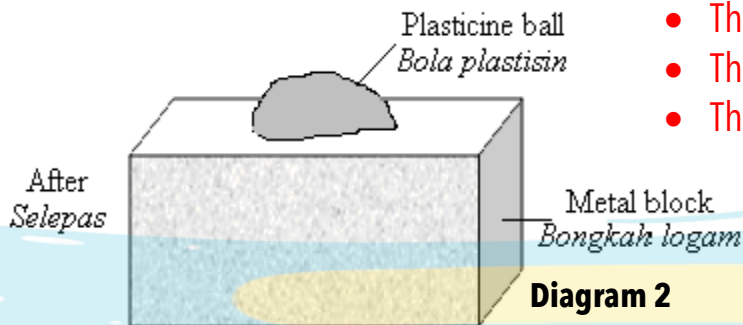


Diagram 2

Diagram 3 show a pile driver used to drive a steel pile to the ground.
The force involved in driving the steel pile is impulsive force.

Explain how the steel pile is driven to the ground.

- Both pile driver and steel pile are material with **hard surface**
- Place the pile driver at a certain height
- Release the pile driver onto the steel pile
- **Short time of impact** between the pile driver and the steel pile
- Produces **high impulsive force** to drive the pile into the ground



Diagram 3

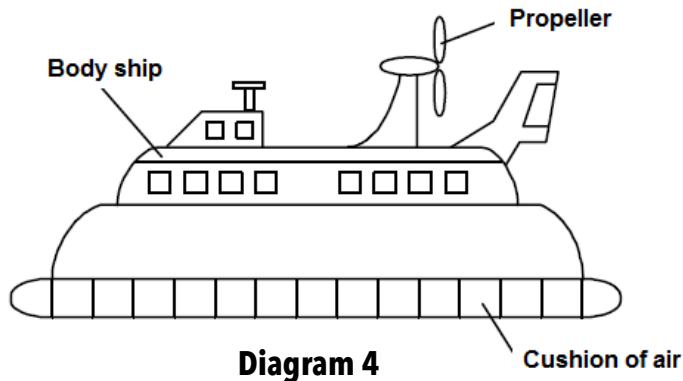
SKILL 1 - UNDERSTANDING

CHAPTER 2: FORCE & MOTION

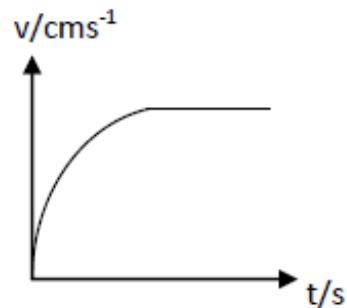
A hovercraft moves on a cushion of air which is trapped underneath it, as shown in Diagram 4.

The trapped air reduces the friction.

The hovercraft starts from rest and as it starts, the propeller produces a forward force until it reaches a constant velocity.



Sketch a velocity-time graph to show the motion of hovercraft.



Explain why the hovercraft moves with constant velocity in terms of the force acting on it.

- The **forward force = friction** // forward thrust = drag
- The **resultant force is zero**

SKILL 1 - UNDERSTANDING

CHAPTER 3: FORCES & PRESSURE

A vessel which has 2 holes, X and Y at difference height as shown on Diagram 1.

When the vessel is filled with water, water spurts out from the two holes due to the water pressure.

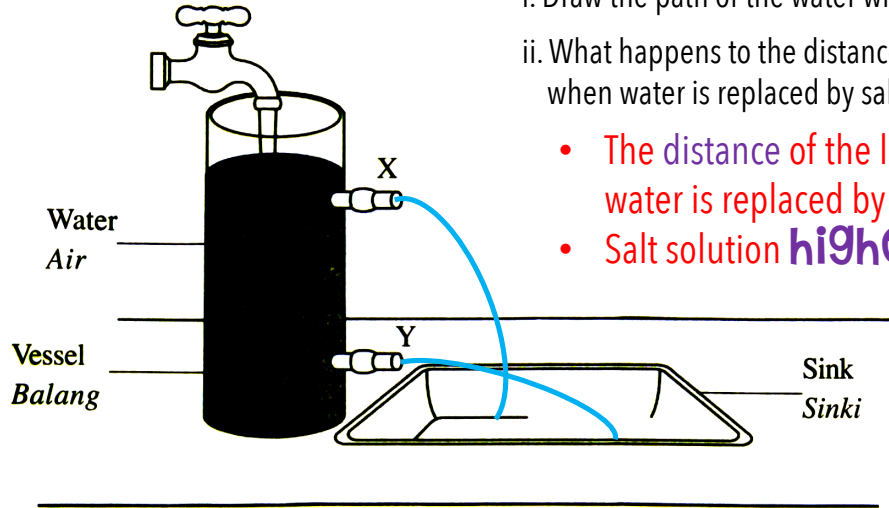


Diagram 1

- Draw the path of the water which spurts out from the holes X and Y.
- What happens to the distance of the liquid spurting out a hole X when water is replaced by salt solution? Explain your answer.

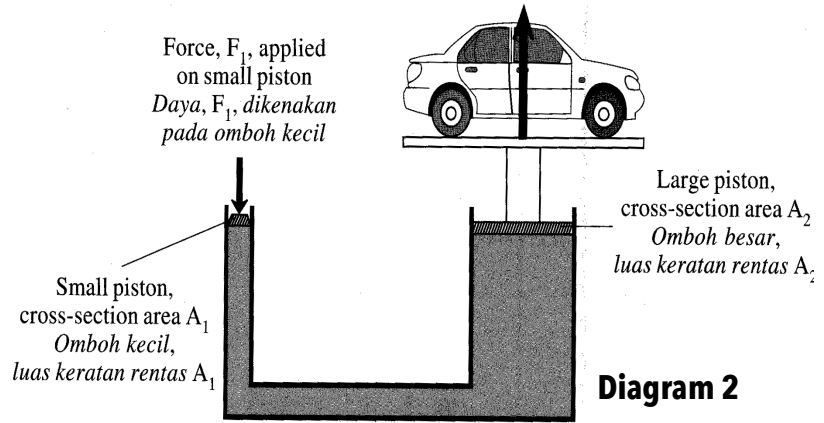
- The distance of the liquid spurting out a hole X when water is replaced by salt solution **increase**.
- Salt solution **higher density** compared to water

- Density **increase**, pressure **increase**

A hydraulic jack which is used to lift up a car as shown on Diagram 2.

The working principle of the hydraulic jack is based on the Pascal's principle.

Explain how the hydraulic jack can be used to lift a car when force F_1 is applied on the small piston with cross-section area A_1 . In your explanation, state the reason why force F_2 is greater than force F_1 .



- Small force exerted on piston A_1 produce **pressure**.
- The **pressure** is transmitted equally throughout the system.
- The pressure exerted on big piston (A_2) produce **output force** (F_2)
- Since the **surface area piston** $A_2 >$ piston A_1 , therefore **output force** produced for big piston is **greater**.

Diagram 3 shows the cross-section of a wing of a moving aeroplane. A lifting force is exerted on to the wing.

Name the shape of the cross section shown in Diagram 3.

Explain how the lifting force is produced.

Aerofoil.

1. The velocity of air is high and the air pressure is low at the top of the aerofoil.

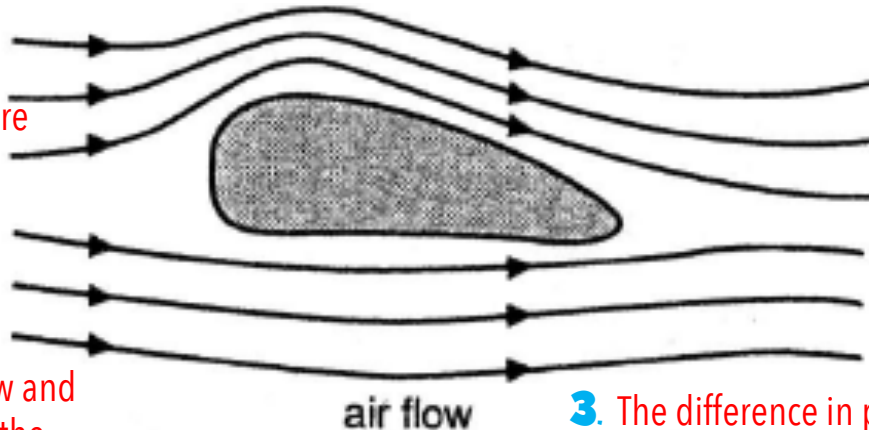


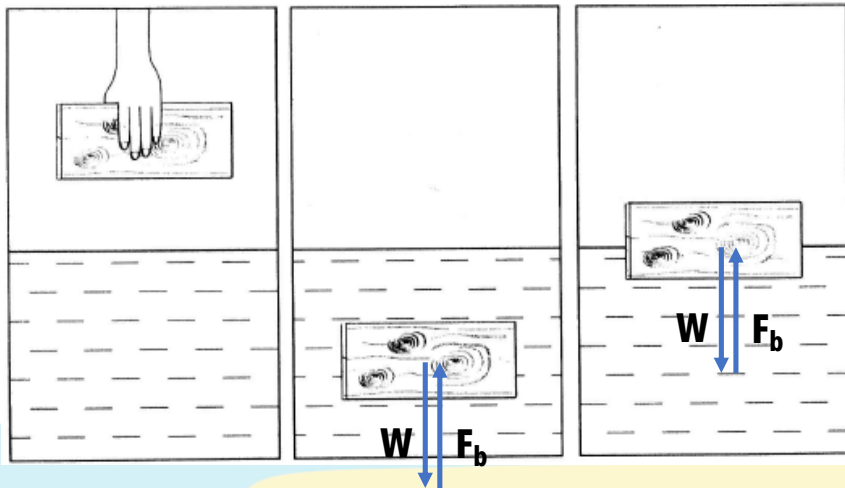
Diagram 3

2. The velocity of air is low and the air pressure is high at the bottom of the aerofoil.

3. The difference in pressure produces a lifting force.

Diagram 4 shows what happens when a wooden block is held above the water surface and then released into the water. When the wooden block is released, it falls into the water and goes completely under the water surface. Then it moves upwards and floats on the water surface.

Using the concept of buoyant force, explain why the **wooden block moves upwards** and then **floats** on the water surface.



Wooden block moves upwards because:

- Buoyant force $>$ weight of wooden block
- Net force acting upward

Wooden block floats because:
buoyant force = weight of block

Diagram 4

Diagram 5 shows a dropper in a bottle.

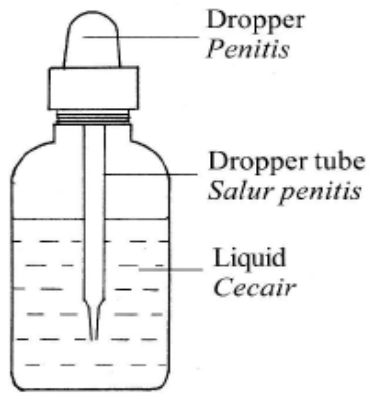
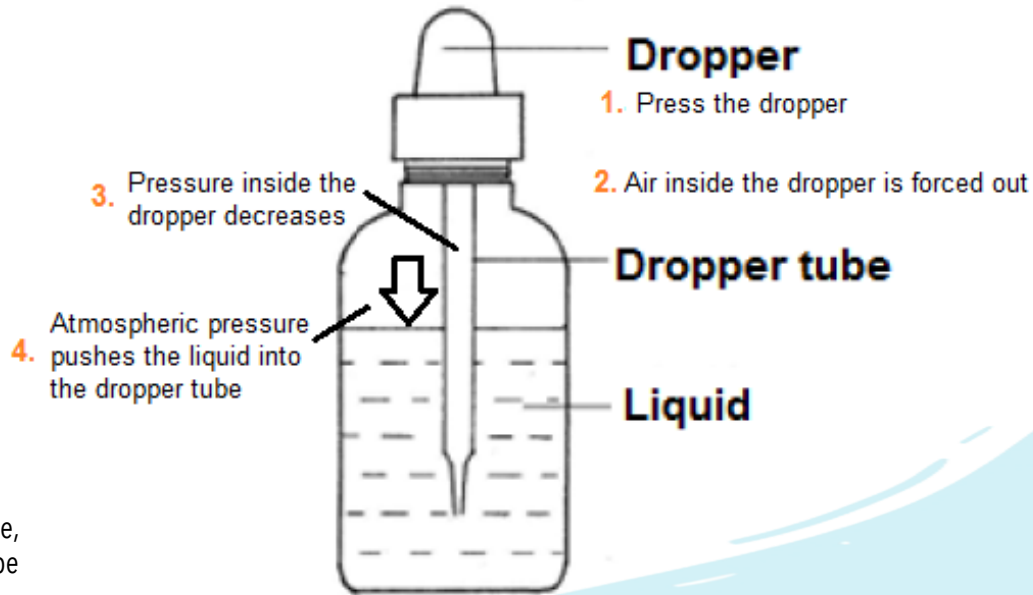


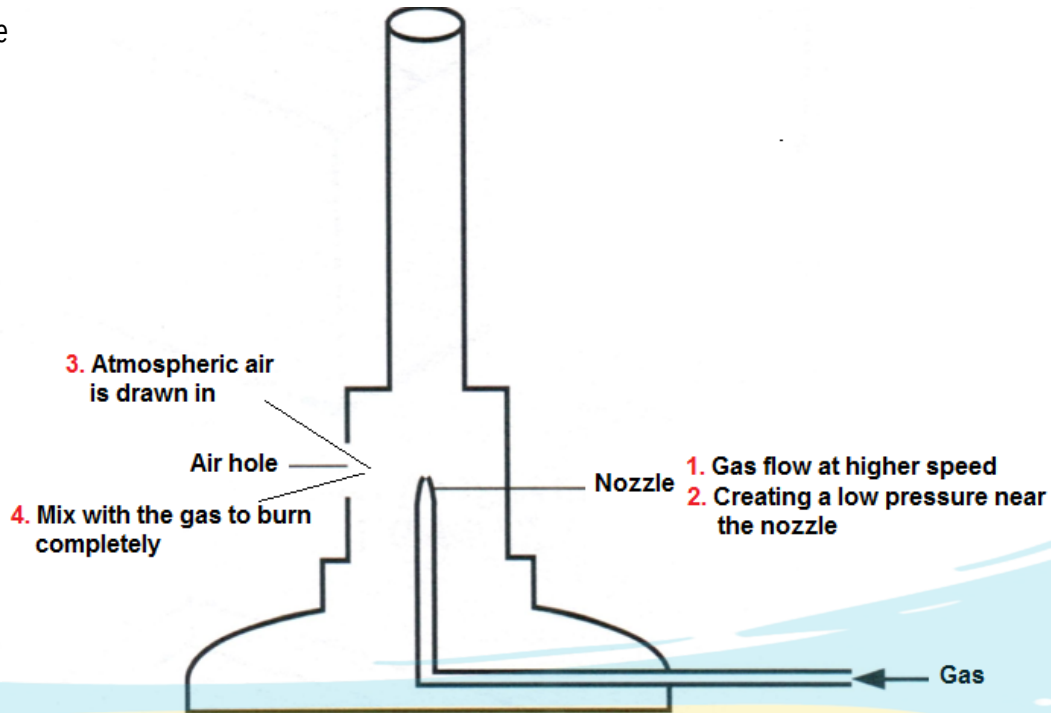
Diagram 5

Using the knowledge of atmospheric pressure, explain how the liquid in the bottle can be sucked into the dropper tube.



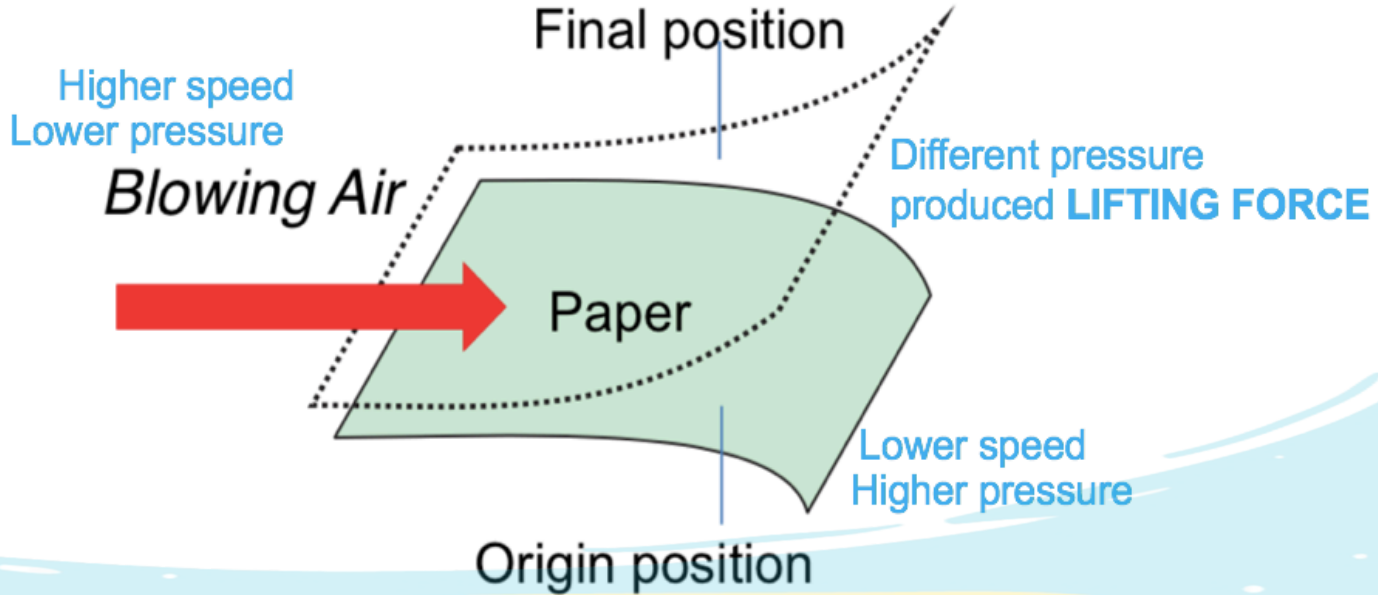


With the aid of suitable diagram, describe the working principle of a Bunsen burner.



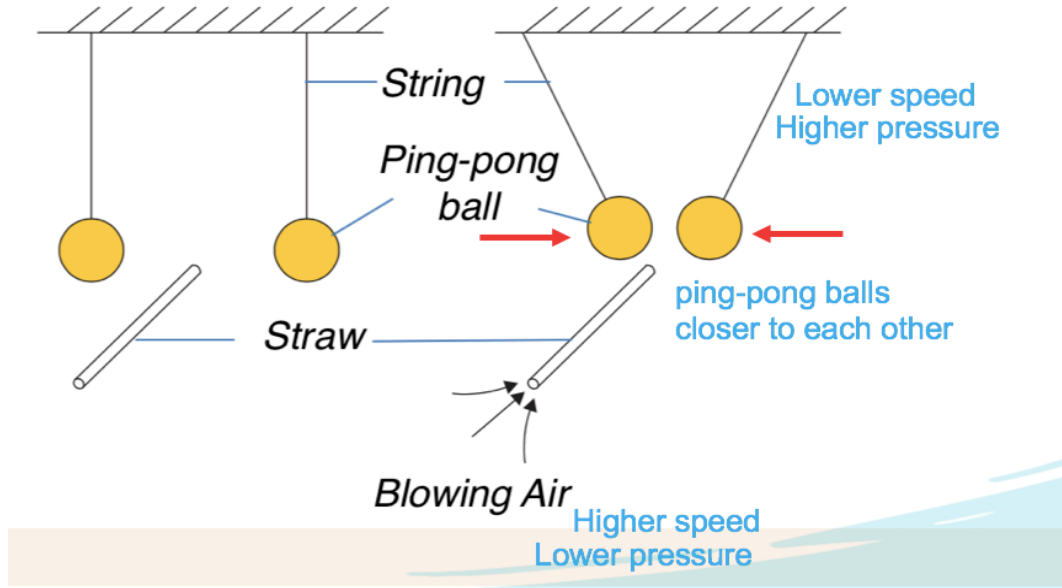


BERNOULLI'S PRINCIPLE



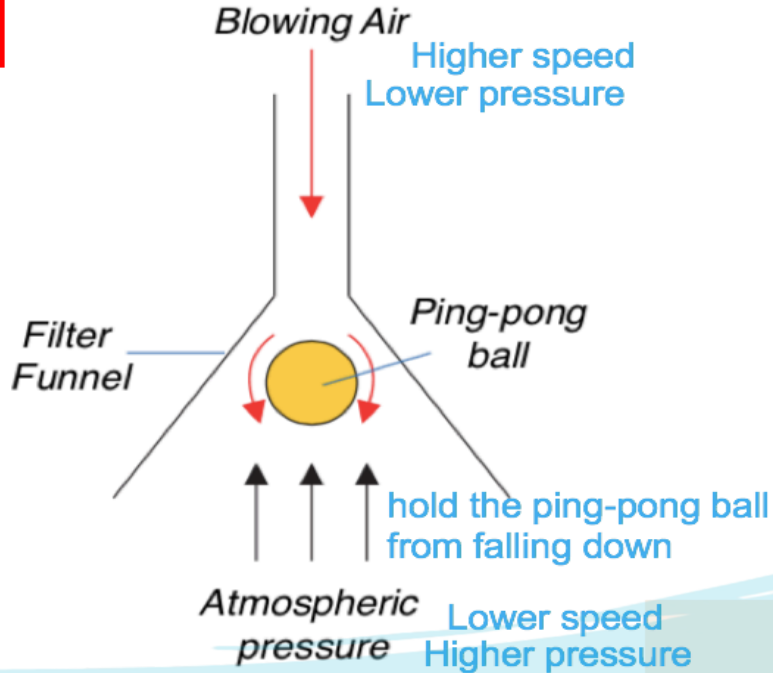


BERNOULLI'S PRINCIPLE





BERNOULLI'S PRINCIPLE





BERNOULLI'S PRINCIPLE

Water level in the vertical tubes P, Q and R

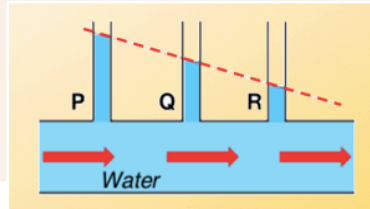
Notes:

Pressure of moving fluid at point **R** (end) always less than pressure at point **P** (initial)

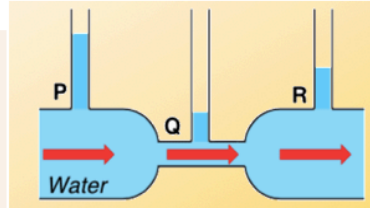


ALINA IMAN ARIF

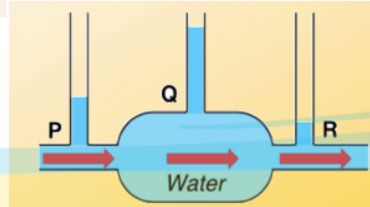
1



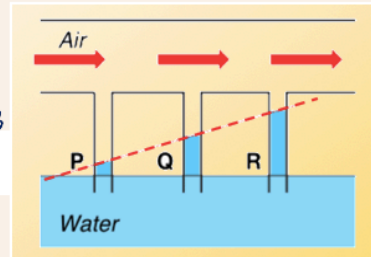
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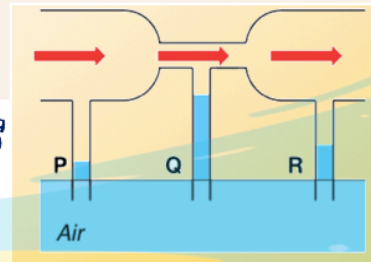
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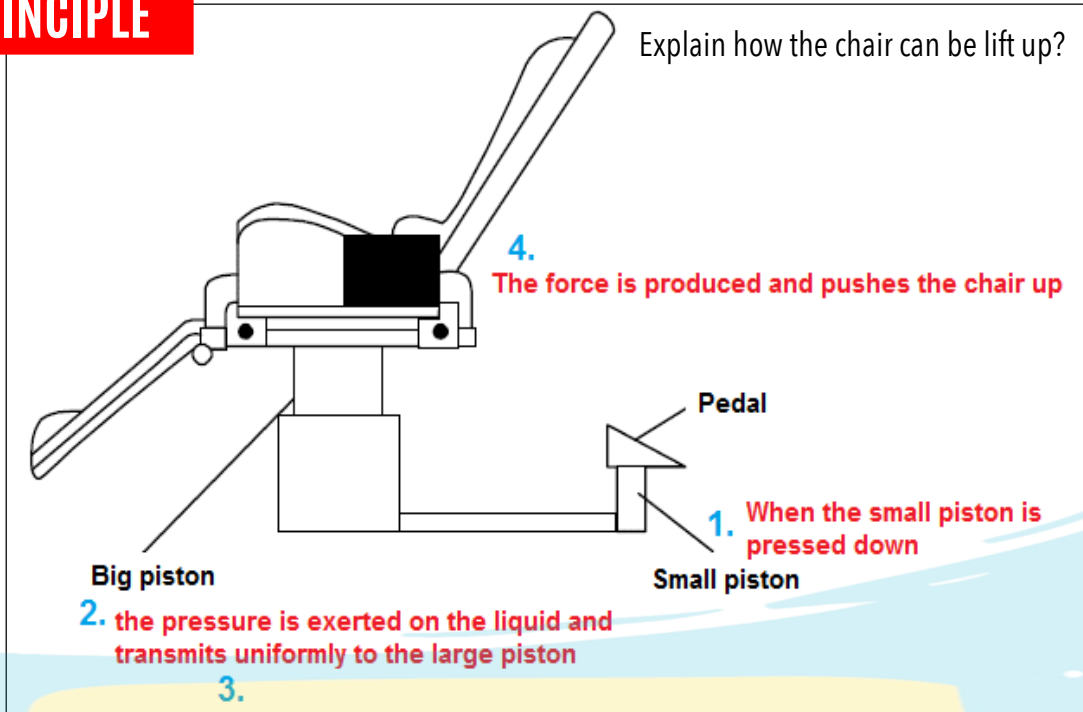
5





PASCAL'S PRINCIPLE

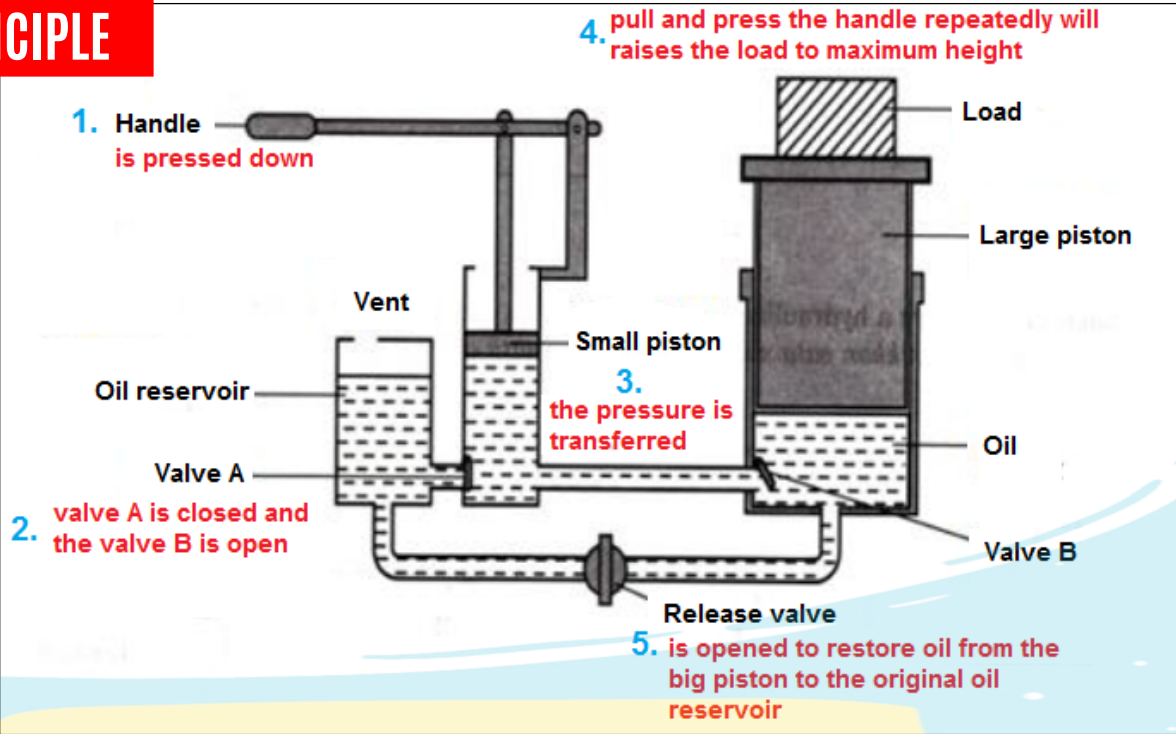
Explain how the chair can be lift up?





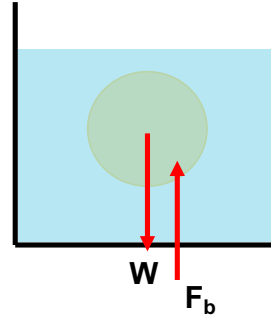
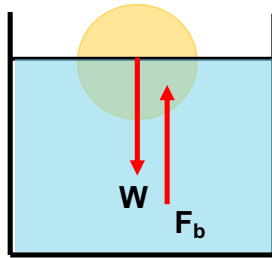
PASCAL'S PRINCIPLE

Explain how the handle is used to lift the load to its maximum height and state how the load is lowered without using the handle.



ARCHIMEDES' PRINCIPLE

For a body *wholly* or *partially* immersed in a fluid, the buoyant force is equal to the weight of the fluid it displaces

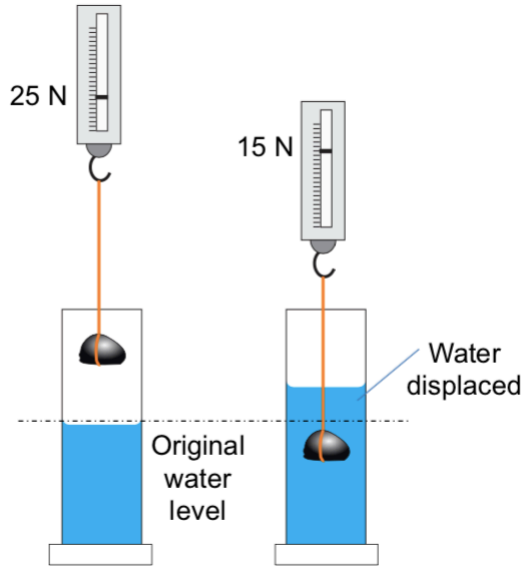


$$W = F_b$$

$$F_b = \rho V g = m g = W \text{ (weight of water displaced)}$$



ARCHIMEDES' PRINCIPLE - example



Actual weight, $W_1 = 25 \text{ N}$

Apparent weight, $W_2 = 15 \text{ N}$

$$F_b = W_2 - W_1 = 10 \text{ N}$$

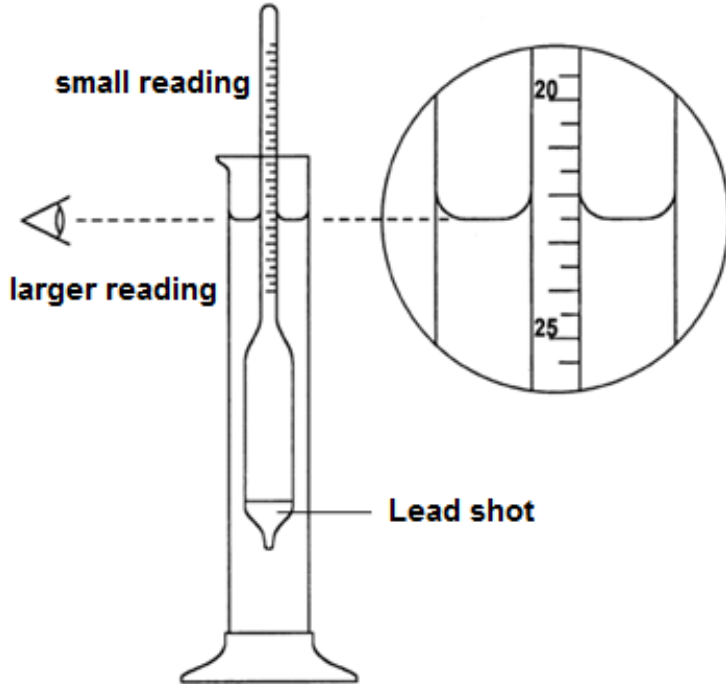
$$W = F_b$$

$$mg = F_b$$

Mass of object = 1 kg



HYDROMETER



- Used to measure relative density of liquids
- Lead shots = to weight it down // enable the hydrometer floats vertically in the liquid
- **LESSER DENSITY** = larger volume of liquid displaced (hydrometer is *submerged*)
- **HIGHER DENSITY** = lower volume of liquid displaced (hydrometer *floats*)



HYDROMETER



Material of stem : **GLASS**
Will not corrode

Length of stem : **LONG**

Wide range of scale

Diameter of stem : **SMALL**

More sensitive / can measure @
detect small changed in density

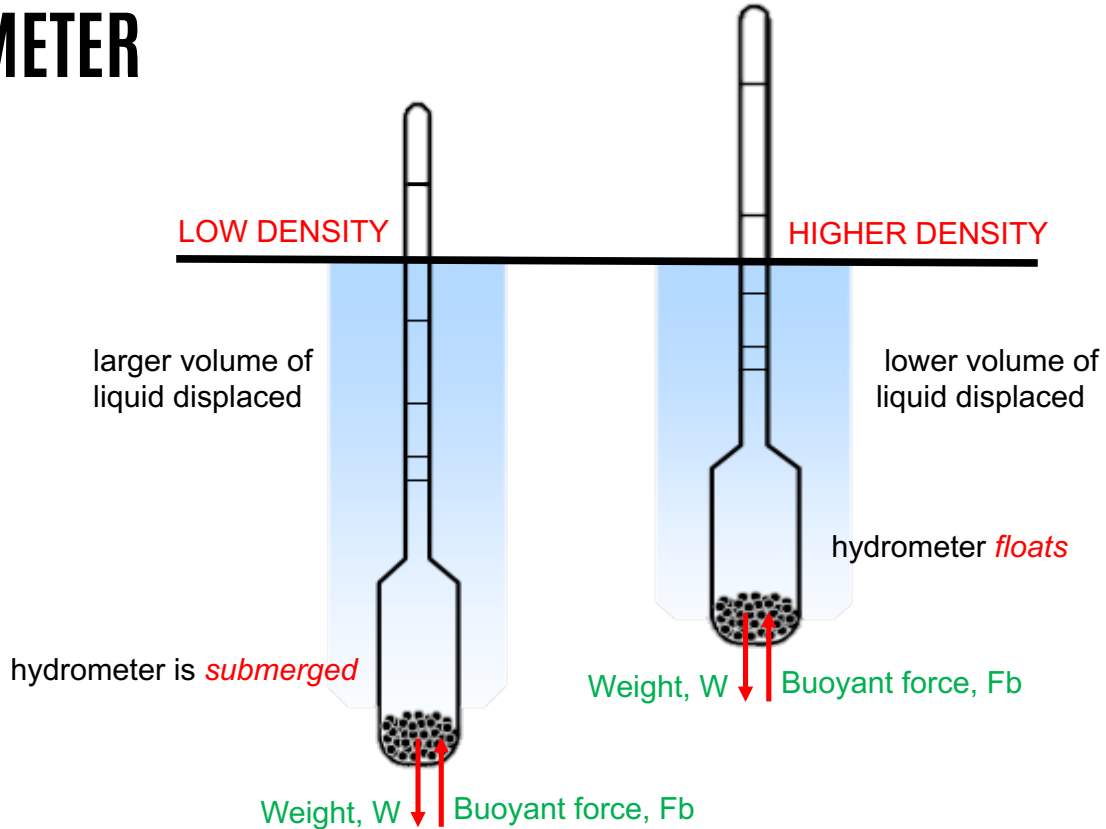
Size of air bulb : **BIG**
easy to floats /
high buoyant force

No. of lead shot : **MANY**
Stay upright /
easy to floats



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HYDROMETER



SITUATION : COMPARISON



RIVER WATER

SEA WATER

Density

LOW

HIGH

Volume of liquid displaced

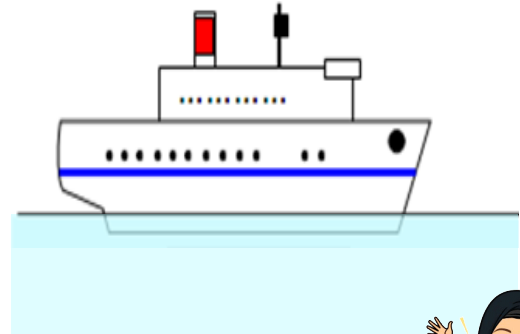
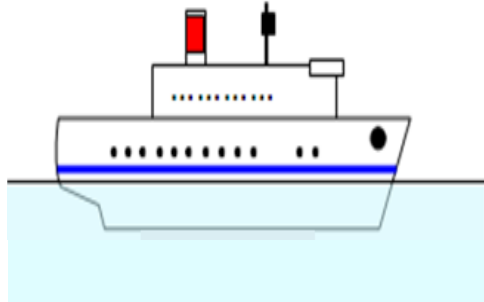
HIGH

LOW

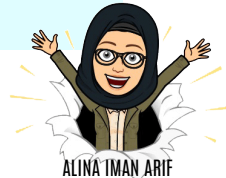
Depth of sinking

HIGH

LOW



$$\text{Weight, } W = \text{Buoyant force, } F_b$$



ALINA IMAN ARIF

SKILL 1 - UNDERSTANDING

CHAPTER 5: LIGHT

convex mirror

Diagram 1 shows a mirror at the corner of a shop.



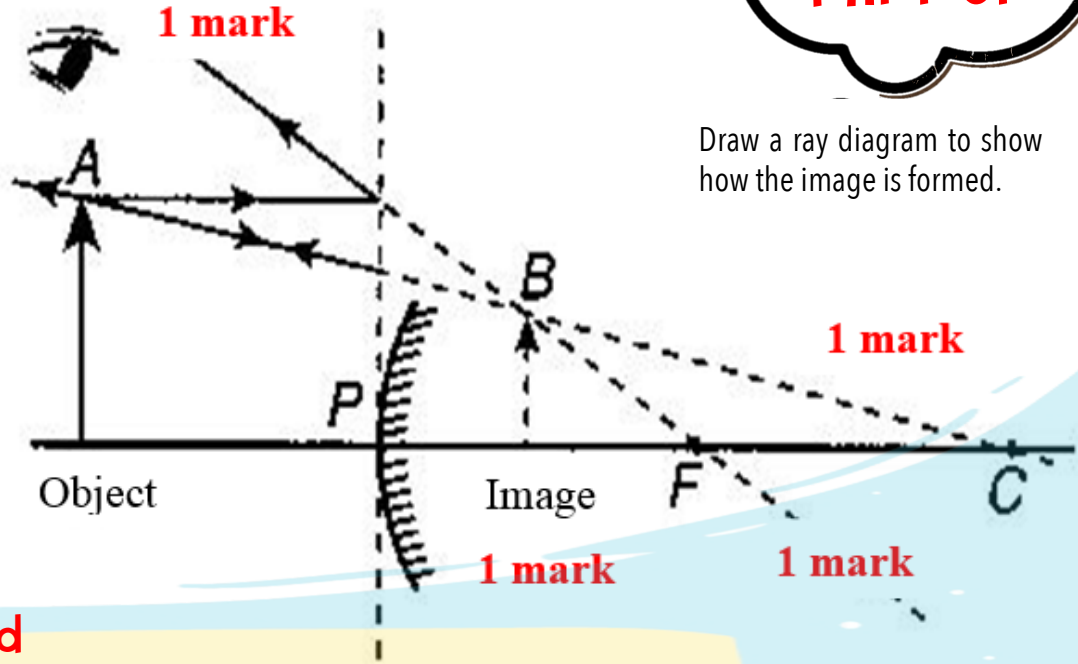
Diagram 1

Name **one** characteristic of the image formed by the mirror.

V virtual

U upright

D diminished



Draw a ray diagram to show how the image is formed.

SKILL 1 - UNDERSTANDING

CHAPTER 5: LIGHT

Diagram 2 shows a convex lens is used to produce fire. The convex lens is aimed towards hot sun rays. A piece of paper is placed under the convex lens.

Sun rays
Cahaya matahari

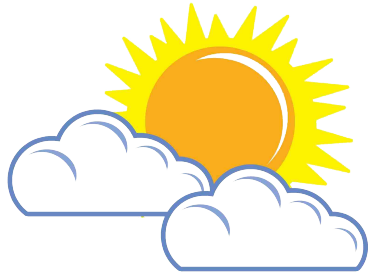
Convex lens
Kanta cembung

Paper
Kertas

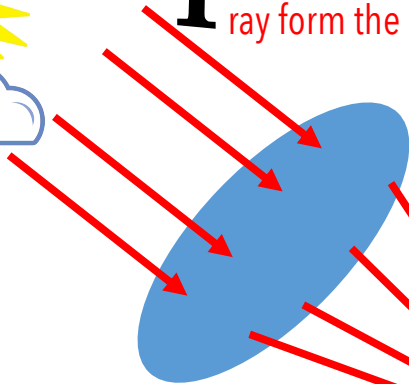


Diagram 2

Explain how the paper burns.



1 parallel light ray form the hot sun



2 The light will converging to the focus point

3 Light ray will be focused



4 Light turns to heat to produce flame

Diagram 3 shows a diamond.

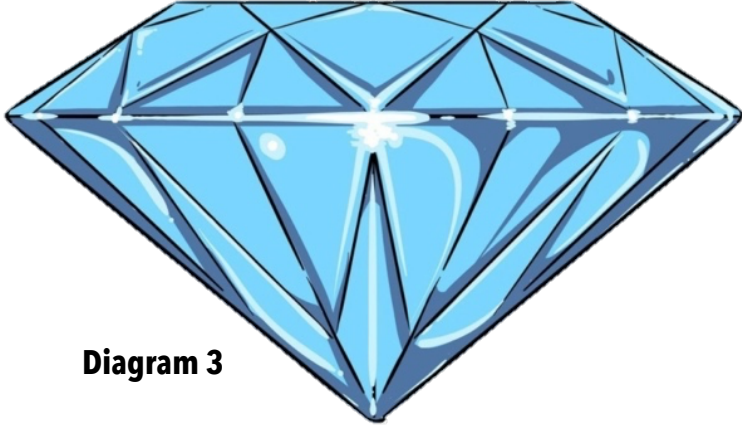


Diagram 3

Explain why the diamond is sparkling when the ray of light pass through.

- A diamond has a very **high refractive index**.
- Its **critical angle** is **small**.
- The facets of a diamond are cut so that angle of incidence **greater** than the critical angle.
- **Total internal reflection** cause the diamond to sparkle.

TOTAL INTERNAL REFLECTION

Explain how total internal reflection occurs in Diagram 4?

- **Increase** the angle of incidence, i then angle of refraction, r will also increase
- Keep on increasing the angle of incidence until **angle of refraction is 90°**
- The angle of incidence is called **critical angle**
- Increase the angle of incidence **more** than the critical angle, the ray will be reflected.

Diagram 4 a ray of light directed perpendicularly at a side of the semi-circular glass block.

The ray passes through the glass block to a point O before leaving the glass block.

The angle of incidence in the glass block is 30° .

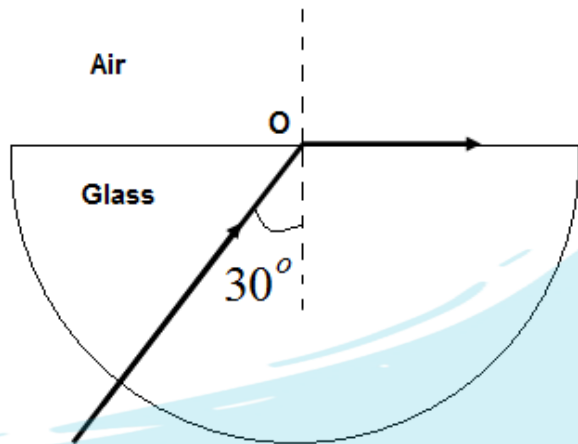


Diagram 4

TOTAL INTERNAL REFLECTION

Diagram 1 shows a loud speaker that produces sound waves in air.

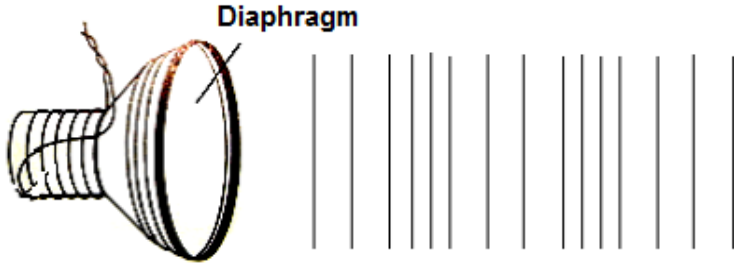


Diagram 1

Explain how a sound wave is produced.

- (When someone speaks the) paper cone will **vibrating**
(The vibrating paper cone will vibrate) the air molecules
- When the paper cone moves to the right, it will produce a layer of **compressed** air
- When the paper cone moves to the left, it will produce a layer of **rarefaction** air
- The **series of compressions and rarefactions**
(produces sound waves)

LONGITUDINAL WAVE

- ultrasonic have high frequency
- ultrasonic is high energy
- ultrasonic can penetrate into deep water
- ultrasonic can be travel far/long distance

Diagram 2 shows a submarine using a sonar system.

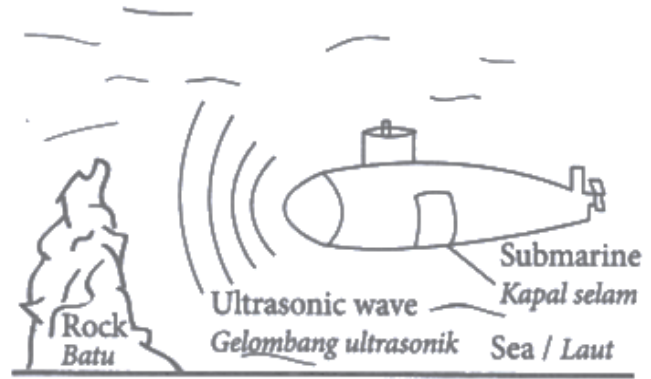


Diagram 2

Explain why ultrasonic wave is used in sonar system instead of radio wave.

REFLECTION OF WAVE

Diagram 3 shows that the glass breaks when the singer sings. Explain why it happens.

- Sound wave transfer to the glass
- Glass vibrate
- Vibration of the glass achieved the natural frequency of the singer
- High amplitude produced, glass broken



Diagram 3

LONGITUDINAL WAVE

SKILL 1 - UNDERSTANDING CHAPTER 5: WAVES

Diagram 4 shows another modification to the harbour to overcome the heavy sea traffic problem.

The wave pattern produced at the entrances is shown in Diagram 4.

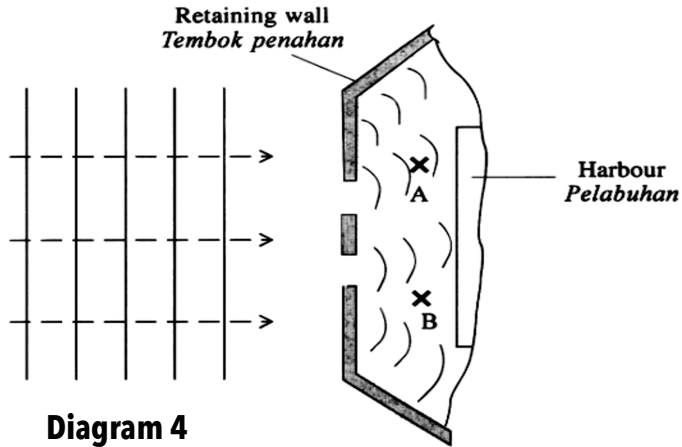


Diagram 4

Describe the movement of two similar ships that are located at A and B. Explain your answer.

Location A:

- Move **UP and down**
- **CONSTRUCTIVE** interference

Location B:

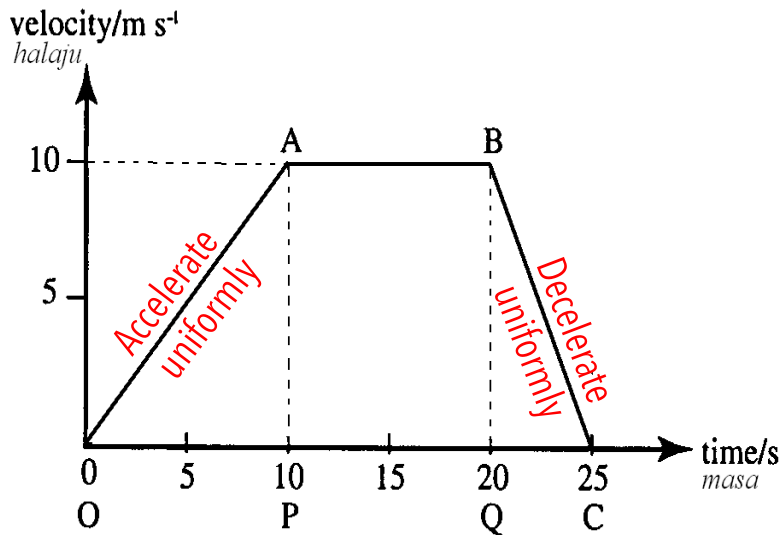
- **STATIONARY** // remain at rest
- **DESTRUCTIVE** interference

INTERFERENCE OF WAVE

SKILL 2 - CALCULATION

CHAPTER 2: FORCE & MOTION

Diagram 1 shows a velocity-time graph for a toy car.



(a) State the motion of toy car at region AB

Constant velocity // $a = 0 \text{ ms}^{-2}$

(b) Calculate:

(i) the acceleration of the car

Acceleration = gradient of the graph (OA)

$$a = \frac{10 - 0}{10 - 0} = \mathbf{1 \text{ ms}^{-2}}$$

(ii) displacement made by the toy car in 20 seconds

$$\begin{aligned} \text{displacement} &= \text{area under the graph} \\ &= \text{area OA} + \text{area AB} \\ &= \frac{1}{2}(10)(10) + (10)(10) \\ &= 50 + 100 \\ &= \mathbf{150 \text{ m}} \end{aligned}$$

SKILL 2 - CALCULATION

CHAPTER 2: FORCE & MOTION

Ali of mass 40 kg is sliding in a flume as shown on Diagram 2.
Ali slides down the flume, which is inclined at 30° to the horizontal.
The frictional force acting on Ali in the flume is 120 N.

Calculate:

- (i) The component of the **weight parallel** to the slope of the flume, W_c

$$\text{Weight parallel, } W_c = mg \sin \theta$$

$$\begin{aligned} W_c &= (40)(10) \sin 30 \\ &= \mathbf{200 \text{ N}} \end{aligned}$$

- (ii) The **resultant** force acting on Ali.

$$\begin{aligned} \text{Resultant force} \\ &= W_c - \text{Frictional force} \\ &= 200 - 120 \\ &= \mathbf{80 \text{ N}} \end{aligned}$$

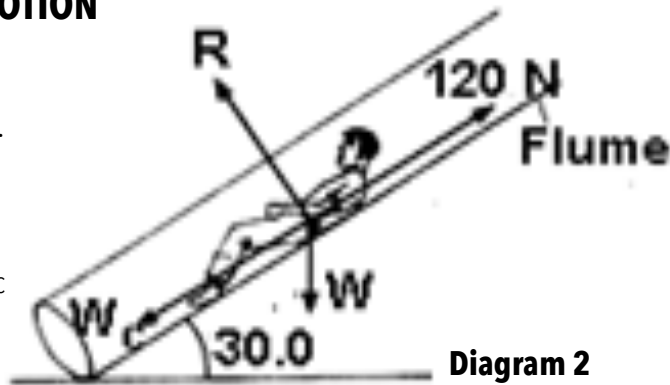


Diagram 2

- (iii) The acceleration of Ali.

$$\mathbf{F_{net} = ma}$$

$$80 = 40 a$$

$$\mathbf{a = 2 \text{ ms}^{-2}}$$

SKILL 2 - CALCULATION

CHAPTER 2: FORCE & MOTION

A metal block with mass 50 kg is being dropped onto a pile to build a tall building as shown on Diagram 3.

The height of the metal block from the pile is 20 m.

Calculate:

(i) Weight of the metal block

$$W = mg = (50)(10) = \mathbf{500 \text{ N}}$$

(ii) Velocity of the metal block just before it hits the pile.

$$\begin{aligned}v^2 &= u^2 + 2gh \\ &= 0 + 2(10)(20) \\ &= 400\end{aligned}$$

$$\mathbf{v = 20 \text{ ms}^{-1}}$$

(iii) Impulsive force acted on the pile if the time impact is 0.5 s.

$$F = \frac{mv - mu}{t}$$

$$F = \frac{(50)(20) - (50)(0)}{0.5}$$

$$\mathbf{F = 2000 \text{ N}}$$

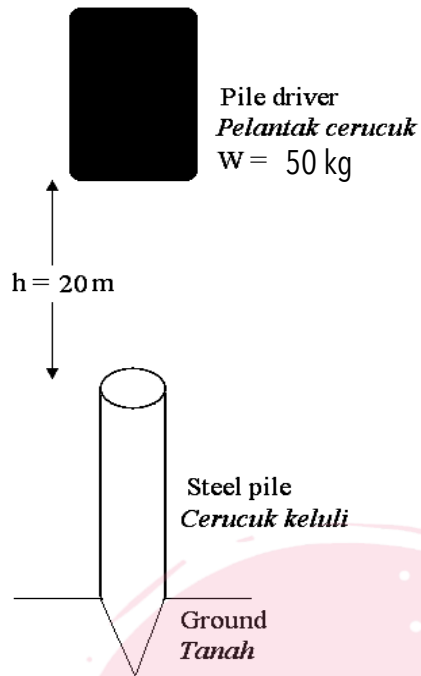


Diagram 3

SKILL 2 - CALCULATION

CHAPTER 2: FORCE & MOTION

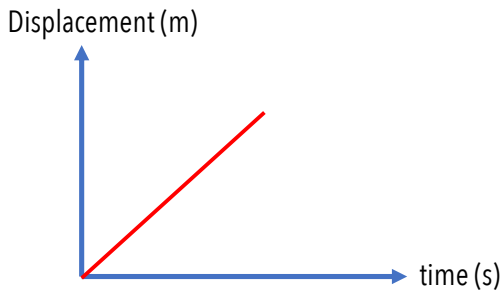
Diagram 4 shows a 50 kg box is pushed by a man with a force of 300 N. The box moved with a constant velocity.

$$\Rightarrow F_{\text{net}} = ma = 0\text{N}$$

(a) What is the frictional force acting on the box?

Frictional force = **300 N**

(b) Sketch a displacement-time graph motion of the box in Diagram 4.



(c) The pushing force of the box is increased to 350 N.

Calculate:

(i) The resultant force acting on the box.

$$\begin{aligned} F_{\text{net}} &= \text{Forward force} - \text{Frictional force} \\ &= 350 - 300 \\ &= \mathbf{50\text{ N}} \end{aligned}$$

(ii) The acceleration of the box

$$\begin{aligned} F &= ma \\ 50 &= 50 a \\ \mathbf{a} &= \mathbf{1\text{ ms}^{-2}} \end{aligned}$$

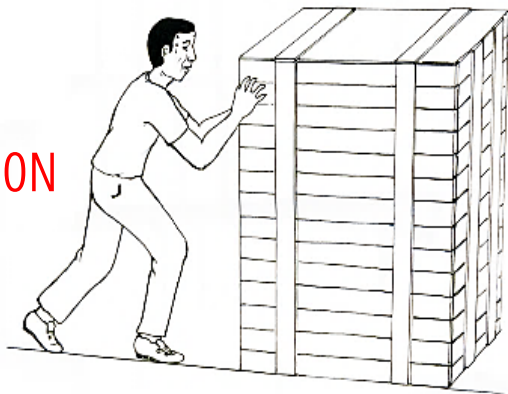


Diagram 4



In a hydraulic brake system, the cross-section area of the pistons in the master cylinder and the front wheel are 2 cm^2 and 6 cm^2 respectively. A force of 50 N is applied to the piston in the master cylinder. Calculate:

(i) the pressure transmitted throughout the brake fluid.

$$A_1 = 2 \text{ cm}^2 \quad F_1 = 50 \text{ N}$$
$$A_2 = 6 \text{ cm}^2$$

$$P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$P = \frac{F_1}{A_1} = \frac{50}{2}$$

$$P = 25 \text{ N cm}^{-2}$$

(ii) the force exerted on the piston of the front wheel.

$$25 = \frac{F_2}{6}$$

$$F_2 = 150 \text{ N}$$

IDEA!



SKILL 2 - CALCULATION

CHAPTER 3: FORCES & PRESSURE

ARCHIMEDES' PRINCIPLE



Diagram 1

Diagram 1 shows a boy on a rubber raft which is placed on water surface.

The mass of the rubber raft is 3 kg.

The volume of water displaced is 0.05 m^3 .

[Density of water = 1000 kgm^{-3}]

[Density of rubber raft = 600 kgm^{-3}]

Calculate:

(i) buoyant force acted on rubber raft

$$F_b = \rho V g$$

$$F_b = (1000)(0.05)(10)$$

$$F_b = 500 \text{ N}$$

(ii) the mass of the boy.

$$F_b = W_{\text{Raft}} + W_{\text{Boy}}$$

$$500 = 30 + W_{\text{Boy}}$$

$$W_{\text{boy}} = 500 - 30 = 470 \text{ N}$$

$$\text{Mass}_{\text{boy}} = 47 \text{ kg}$$

IDEA!



SKILL 2 - CALCULATION

CHAPTER 3: FORCES & PRESSURE

An aeroplane with mass of 3.6×10^5 kg and total surface area of 460 m^2 is at a constant height. The resultant force acting on the aeroplane at that moment is zero.

(i) Calculate the weight of the aeroplane.

$$W = mg = (3.6 \times 10^5)(10)$$

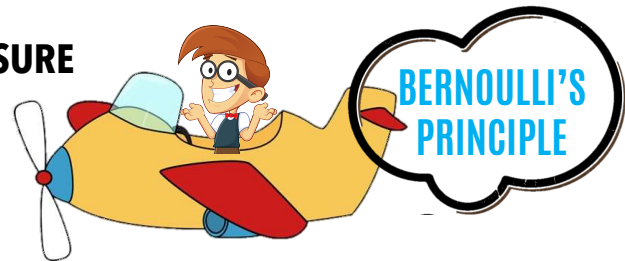
$$W = 3.6 \times 10^6 \text{ N}$$

(ii) Determine the lifting force acting on the aeroplane.

Constant height

Lifting force = Weight of aeroplane

$$\text{Lifting force} = 3.6 \times 10^6 \text{ N}$$



(iii) calculate the pressure difference between the upper and lower surfaces of the wings of the aeroplane.

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

$$P = \frac{3.6 \times 10^6}{460}$$

$$P = 7826 \text{ Pa}$$

IDEA!



SKILL 2 - CALCULATION

CHAPTER 3: FORCES & PRESSURE

Diagram 2 shows a U-tube connected to a cylinder of gas.

- (i) Calculate the value of **d** in unit of cm Hg if height of Y is 6 cm and height of X is 14 cm.

$$d = 14 - 6 = 8 \text{ cm}$$

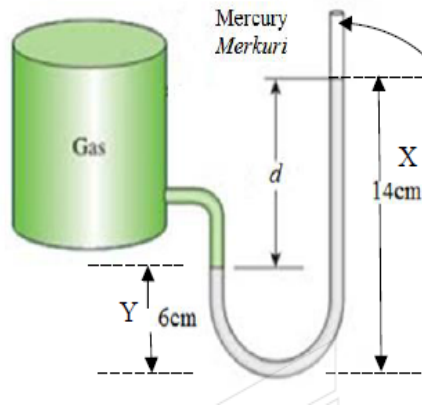
- (ii) Calculate the total gas pressure in the unit of cm Hg
[Atmospheric pressure = 76 cm Hg]

$$P_g > P_{\text{atm}}$$

$$P_g = P_{\text{atm}} + h$$

$$P_g = 76 + 8$$

$$P_g = 84 \text{ cm Hg}$$



Gas pressure instrument Z
Alat pengukur tekanan gas Z

Diagram 2

- (iii) Calculate the total gas pressure in the unit of Pascal
[Density of mercury = $13.6 \times 10^3 \text{ kg m}^{-3}$]

$$P_g = 84 \text{ cm Hg}$$

$$P_g = (13.6 \times 10^3)(10)(0.84)$$

$$P_g = 1.14 \times 10^5 \text{ Pa}$$

$$P = \rho gh$$

IDEA!



A camera has a convex lens of focal length 5.0 cm is used to capture an object of 1 m in height and 4 m from the camera.

(i) Determine the image distance from the camera

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{5} = \frac{1}{400} + \frac{1}{v}$$

$$v = 5.063 \text{ cm}$$

(ii) Calculate the height of image produced in the camera

$$\frac{h_i}{h_o} = \frac{v}{u} \rightarrow \frac{h_i}{100} = \frac{5.063}{400}$$

$$h_i = 1.27 \text{ cm}$$

(iii) State the characteristics of image formed in the camera

R Real
i inverted
D diminished



IDEA!



SKILL 2 - CALCULATION

CHAPTER 5: LIGHT

Diagram 1 shows a path of light ray being refracted in liquid P.

(i) What is meant by refractive index?

ratio of **sine of angle of incidence** to **sine angle of refraction**.

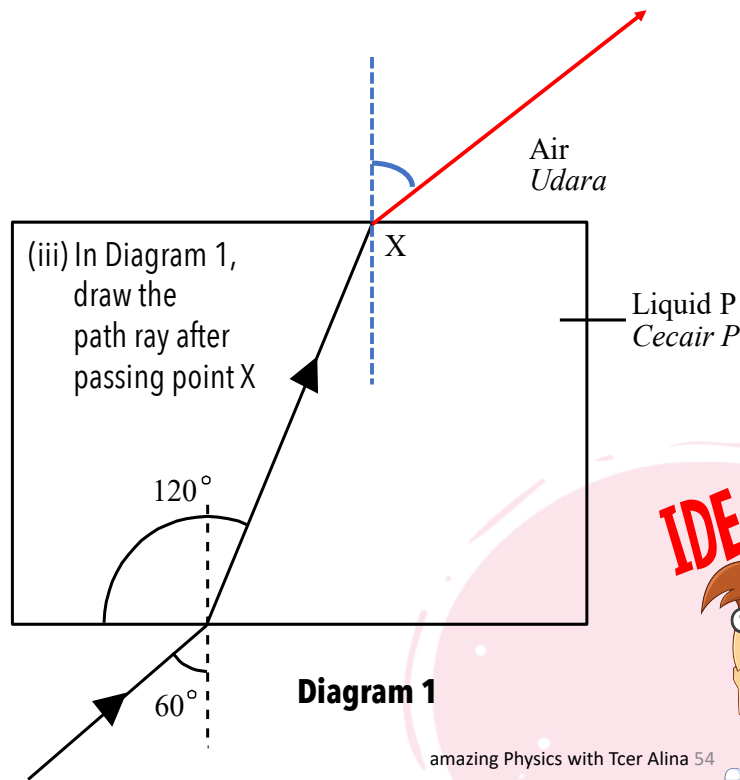
(ii) Determine the refractive angle in liquid P

$$r = 30^\circ$$

(iii) Calculate the refractive index for liquid P

$$\eta = \frac{\sin i}{\sin r}$$

$$\eta = \frac{\sin 60}{\sin 30} = 1.73$$



SKILL 2 - CALCULATION

CHAPTER 5: LIGHT

The speed of light in air and in water are $3.0 \times 10^8 \text{ ms}^{-1}$ and 2.25×10^8 respectively.

Calculate:

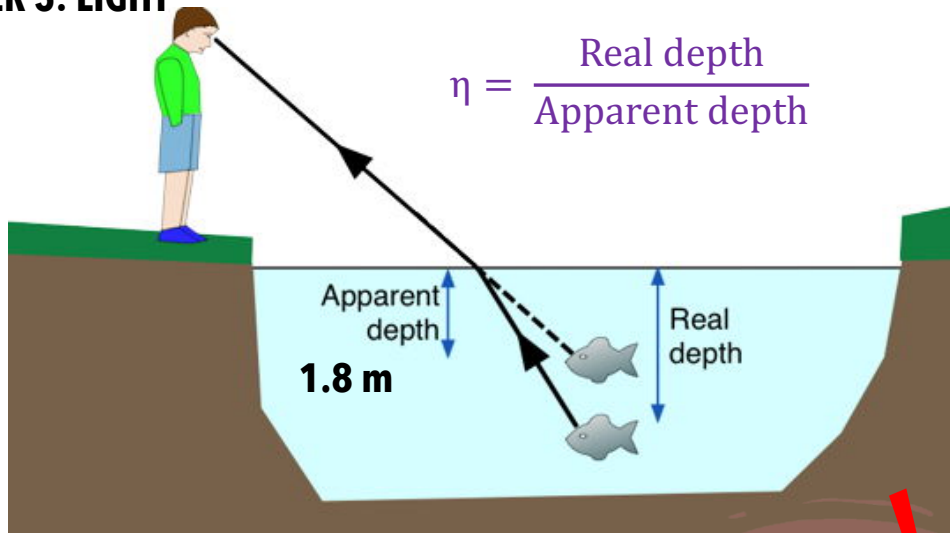
(i) The refractive index of water

$$\eta = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

$$\eta = \frac{3.0 \times 10^8}{2.25 \times 10^8} = 1.33$$

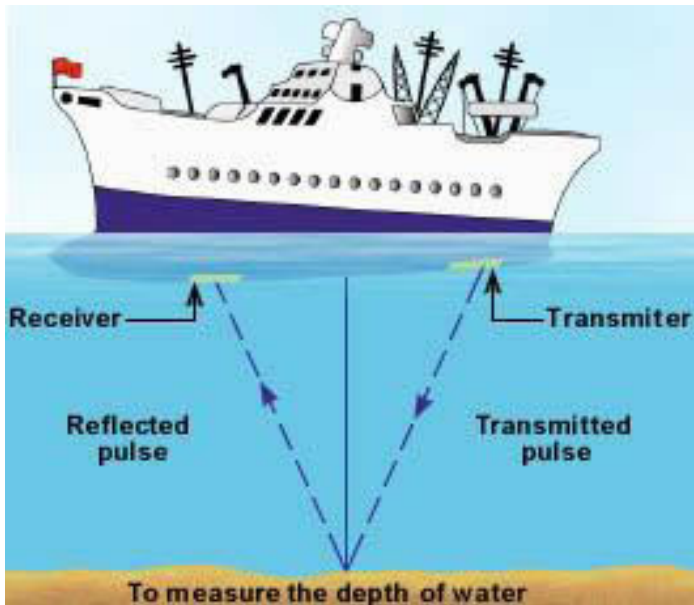
(ii) The real depth of fish in water when the apparent depth is 1.8 m

$$1.33 = \frac{\text{Real depth}}{1.8} \quad \rightarrow \quad \text{Real depth} = 2.394 \text{ m}$$



IDEA!





The depth of a sea is 90 m. A ship transmits an ultrasonic wave of frequency 50 kHz to the seabed and receives an echo 0.12 s later. Calculate:

- (i) the speed of the ultrasonic wave in the water

$$s = \frac{vt}{2}$$

$$v = \frac{2s}{t} = \frac{2(90)}{0.12} = \mathbf{1\ 500\ ms^{-1}}$$

- (ii) the wavelength of the ultrasonic wave in the water

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{1500}{50\ 000} = \mathbf{0.03\ m}$$

IDEA!



A certain microwave has a wavelength of 3.0×10^{-2} m.
The speed of electromagnetic waves in vacuum is 3.0×10^8 ms⁻¹.

(i) Calculate the frequency of this microwave.

$$v = f\lambda$$

$$f = \frac{v}{\lambda} = \frac{3.0 \times 10^8}{3.0 \times 10^{-2}} = 1.0 \times 10^{10} \text{ Hz}$$

(ii) When this wave enters a beaker of water, state what will happen to the frequency, wavelength and speed of the wave.

Frequency will **remain the same**
Wavelength will **decrease**
Speed will **decrease**



SKILL 2 - CALCULATION

CHAPTER 6: WAVES

REFLECTION OF WAVES

Diagram 1.1 shows a sonar system transmitting and receiving waves to determine the depth of sea.

Diagram 1.2 shows the display on the screen of a cathode ray oscilloscope that detects the transmitted and received waves. The speed of the waves is 1400 ms^{-1} . Time base of the cathode ray oscilloscope is set at 50 ms per division.

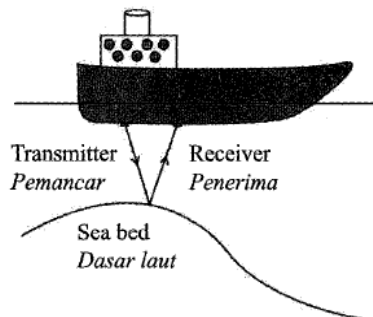


Diagram 1.1

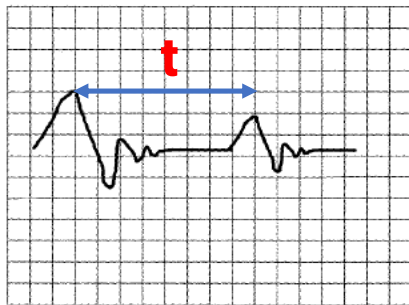


Diagram 1.2

Calculate:

- (i) the time taken for the wave to be received

$$\begin{aligned}t &= 8 \text{ div} \times 50 \text{ ms per division} \\ &= 400 \text{ ms} \\ &= \mathbf{4.0 \times 10^{-1} \text{ s}}\end{aligned}$$

- (ii) the depth of the sea

$$s = \frac{(1400)(0.4)}{2} = \mathbf{280 \text{ m}}$$

- (iii) the wavelength of the wave when its frequency is 35 kHz

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{1400}{35\,000} = \mathbf{0.04 \text{ m}}$$

IDEA!



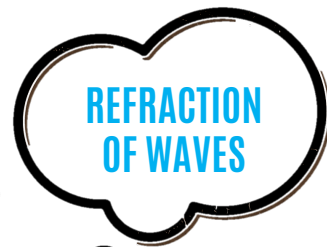


Diagram 2 shows a pattern of wave formed when the water waves with a speed of 6 cm s^{-1} propagates from a deeper area to a shallow region in a ripple tank.

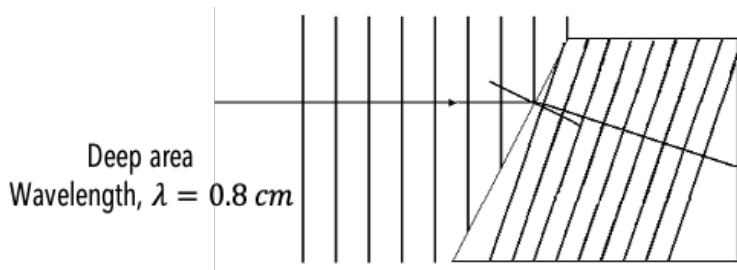


Diagram 2

Shallow area
Wavelength, $\lambda = 0.5 \text{ cm}$

Calculate:

(i) the frequency of water waves at the deeper region

$$v = f\lambda$$

$$f = \frac{v}{\lambda} = \frac{6}{0.8} = \mathbf{7.5 \text{ Hz}}$$

(ii) the speed of the water waves at shallow region

Frequency **unchanged**

$$v = f\lambda$$

$$v = (7.5)(0.5)$$

$$\mathbf{v = 3.75 \text{ cm s}^{-1}}$$

IDEA!



SKILL 3 - COMPARISON

CHAPTER 2: FORCE & MOTION

Diagram 1.1 and Diagram 1.2 show two eggs released from the same height and drop on to surface A and surface B respectively.

What is meant by impulse?

Change of momentum

Based on Diagram 1.1 and 1.2, compare the **force** on the eggs that strike Surface A and Surface B, the **time of impact** of the eggs on Surface A and Surface B and the **change in momentum** of the eggs in both situations. State the **relationship** between the **force produced in a collision** and the **time of impact**.

Characteristics	Diagram 1.1	Diagram 1.2
force	low	high
Time of impact	high	low
Change in momentum	low	high

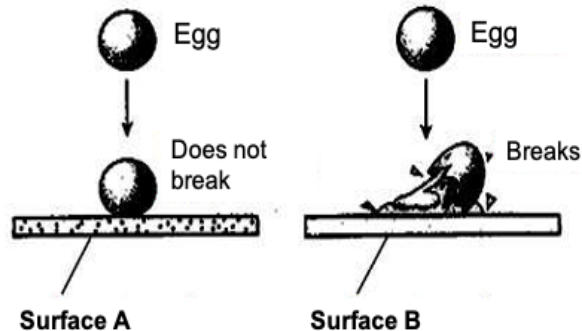


Diagram 1.1

Diagram 1.2

Time of impact
increase,
Force
decrease



SKILL 3 - COMPARISON

CHAPTER 2: FORCE & MOTION

Diagram 2.1 shows two springs with the same original length. Diagram 2.2 shows the two springs attached with 100 g load.

Observe Diagram 2.1 and Diagram 2.2, compare the **diameter** of spring A and spring B, the **extension** of spring A and spring B when are **attached with 100 g loads** and the **spring constant** of spring A and spring B. State the **relationship** between the **extension of the spring** and the **spring constant of the spring**. Name the **physics law** involved.

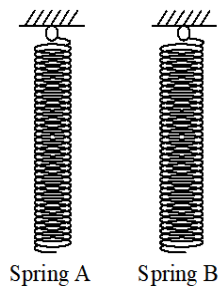


Diagram 2.1

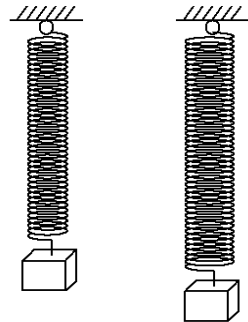


Diagram 2.2

Characteristics	Spring A	Spring B
Diameter of spring	smaller	bigger
Extension of spring when attach with 100 g	smaller	bigger
Spring constant	bigger	smaller

extension of spring
increase,
Spring constant
decrease

Hooke's law



SKILL 3 - COMPARISON

CHAPTER 2: FORCE & MOTION

Diagram 3.1 shows the effect of a man falls from a high position to the ground without opening the parachute. Diagram 3.2 shows a man with the same mass falls from the same height when the parachute is open.

Based on Diagram 3.1 and Diagram 3.2, compare the **acceleration**, the **rate of change of momentum** and the **time of impact**. Relate the **rate of change of momentum** with the **time of impact** to make deduction on the relationship between the **acceleration** and the **rate of change of momentum**.



Diagram 3.1

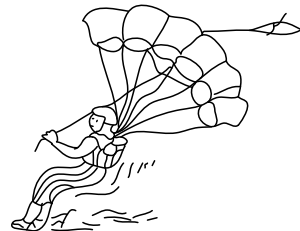


Diagram 3.2

Characteristics	Diagram 3.1	Diagram 3.2
acceleration	higher	smaller
Rate of change of momentum	higher	smaller
Time of impact	smaller	higher

Time of impact **increase**,
Rate of change of momentum
decrease

Acceleration **increase**,
Rate of change of momentum
increase



SKILL 3 - COMPARISON

CHAPTER 3: FORCES & PRESSURE

Diagram 1.1 shows the positions P and Q at different altitude. Two identical simple barometers are placed at both positions. The height of the mercury column in the barometers are shown in Diagram 1.2.

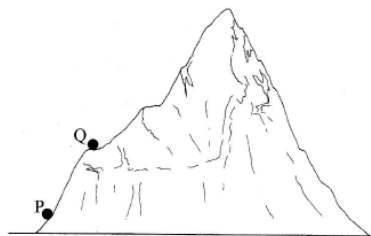


Diagram 1.1

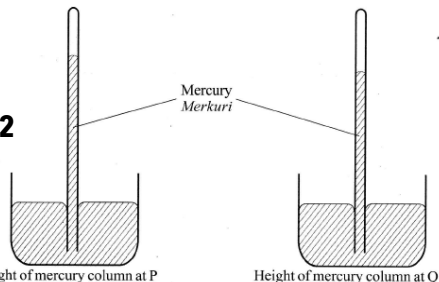


Diagram 1.2

The density of air at P is 1.2 kg m^{-3} and the density of air at Q is 1.0 kg m^{-3} .

Using Diagram 1.1 and Diagram 1.2, compare the altitudes of P and Q, the density of surrounding air and the height of mercury column in the simple barometer at positions P and Q.

Characteristics	P region	Q region
altitudes	low	high
density of surrounding air	high	low
height of mercury column	high	low

State the relationship between the altitude and

(i) the density of the air

Altitude **increase**, density of air **decrease**

(ii) the atmospheric pressure

Altitude **increase**
Atmospheric pressure **decrease**



Diagram 2.1 and Diagram 2.2 show the effect of atmospheric pressure on a sheet of paper before and while the air is blown across the upper surface of the paper.

Using Diagram 2.1 and Diagram 2.2, compare the air speed on the upper and the lower sides of the paper. Relate the speed of air with its pressure to explain how the paper is lifted up when air is blown towards the top of the paper as shown in Diagram 2.2.

Diagram 2.1

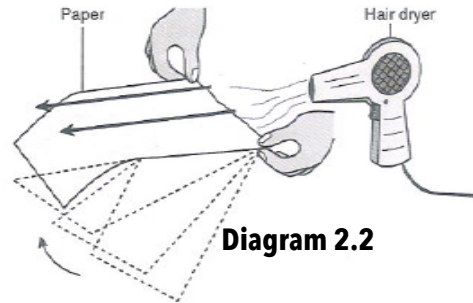
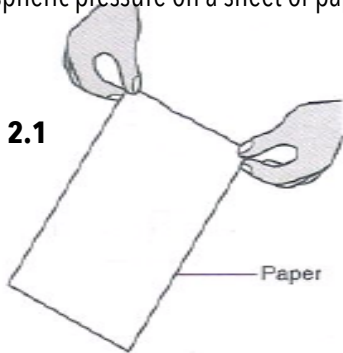


Diagram 2.2

The speed of air at top and bottom in Diagram 2.1 the **same**.

In Diagram 2.2, the speed of air at the **upper** is greater than **lower** side.

Speed of air **increase**, the pressure **decrease**.

The **difference in pressure** at the upper and the lower of the paper produce **lift force**

Name the physics principle involved in the above explanation.

BERNOULLI'S PRINCIPLE



SKILL 3 - COMPARISON

CHAPTER 3: FORCES & PRESSURE

ARCHIMEDES' PRINCIPLE

Diagram 3 shows a boy and his father sitting on two identical beach balls, A and B, respectively. Their weights are balanced by the buoyant force.

- (a) Using Diagram 3, compare the **weight of the boy and his father**, the **volume of the water displaced** and the **buoyant force** acted on both of them.

Characteristics	Boy	Father
Weight	low	high
volume of the water displaced	low	high
buoyant force	low	high

- (b) State the relationship between the buoyant force and:

- (i) The volume of water displaced

Buoyant force **increase**
Volume of water displaced **increase**

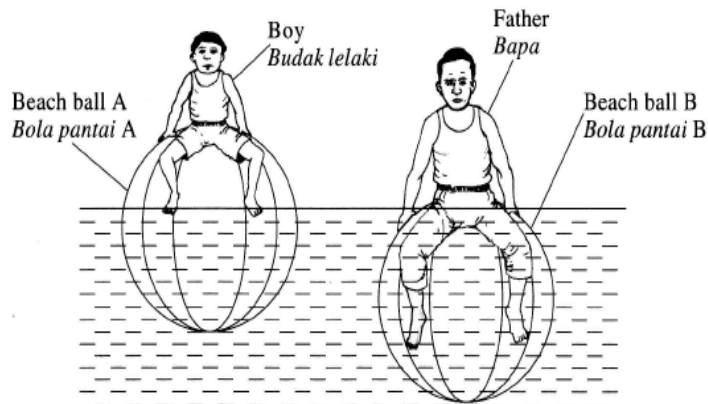


Diagram 3

- (ii) The weight of water displaced

Buoyant force **increase**
Weight of water displaced **increase**



SKILL 3 - COMPARISON

CHAPTER 5: LIGHT

What is the meaning of **real** image?

Image that can formed on the screen

Diagram 1.1 and diagram 1.2 show light rays from two identical objects passing through the convex lenses, M and N. Both of the lenses produce real images. F is the focal point of each lens.

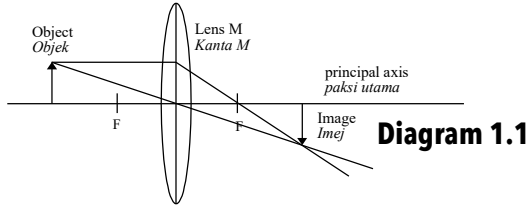


Diagram 1.1

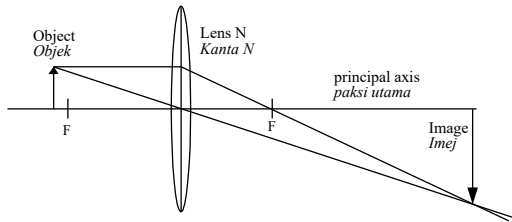


Diagram 1.2

Based on Diagram 1.1 and Diagram 1.2 compare the **thickness** of the lenses, the **image distance** and **focal length**. Relate the **thickness of the lens** with the **focal length**. Name the light phenomenon involved.

Characteristics	Diagram 1.1	Diagram 1.2
thickness	Bigger	Lower
Image distance	Lower	Bigger
Focal length	Lower	Bigger

Thickness **increase**
Focal length **decrease**

REFRACTION OF LIGHT



SKILL 3 - COMPARISON

CHAPTER 5: LIGHT

What is the meaning of focal point?

Diagram 2.1 shows a phenomenon of light on mirror P.
Diagram 2.2 shows the same phenomenon of light on Q.
CX is the radius of curvature and F is the focal point.

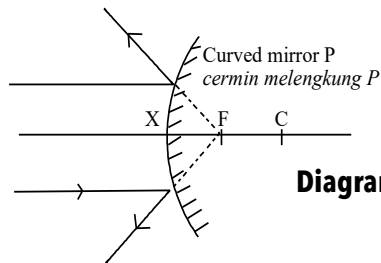


Diagram 2.1

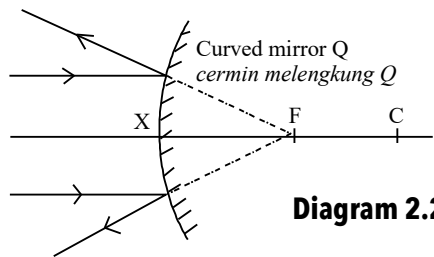


Diagram 2.2

The point on the principal axis where the **reflected rays diverge** that is appear to spread out from behind the mirror

Observe Diagram 2.1 and Diagram 2.2, compare the **curvature** of mirrors, the **focal length** and the **effect on the angle of reflection**. State the relationship between the **curvature** of the mirrors and their **focal lengths**.

Characteristics	Diagram 2.1	Diagram 2.2
curvature of mirrors	More	Lower
focal length	Lower	More
effect on the angle of reflection	Higher	Lower

Curvature of mirror **increase**
Focal length **decrease**



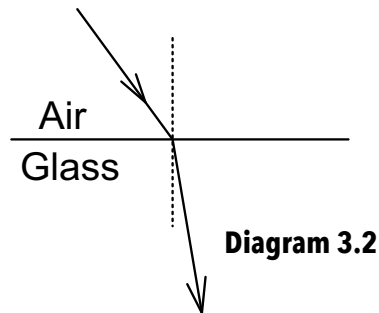
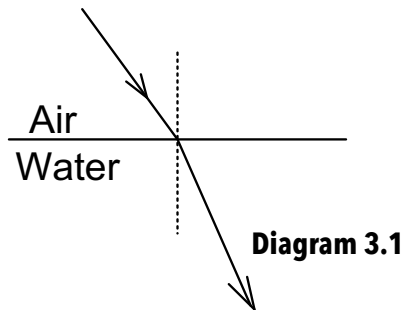
SKILL 3 - COMPARISON

CHAPTER 5: LIGHT

Diagram 3.1 shows a light ray passing through from air into water.

Diagram 3.2 shows a light ray passing through from air into glass.

[Refractive index: Glass = 1.50, Water = 1.33]



Observe Diagram 3.1 and Diagram 3.2, compare the **refractive index**, the **density** and the **angle of refraction** of light ray. Relate the **density of medium with the angle of refraction** to make a deduction of the relationship between the **density of medium and the refractive index**.

Characteristics	Diagram 3.1	Diagram 3.2
refractive index	Lower	Higher
density	Lower	Higher
angle of refraction	Higher	Lower

Density **increase**
Angle of refraction **decrease**

Refractive index **increase**
Density **increase**



SKILL 3 - COMPARISON

CHAPTER 6: WAVES

Diagram 1.1 shows the red fringes formed in a Young's double slit experiment.

Diagram 1.2 shows the green fringes formed when the red light of wavelength 7.0×10^{-7} m is replaced by the green light of wavelength 5.0×10^{-7} m.

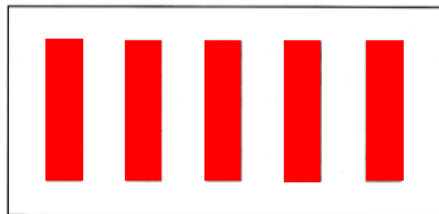


Diagram 1.1



Diagram 1.2

Based on Diagram 1.1 and Diagram 1.2, compare the **wavelength** of the light source used, the **distance between two consecutive fringes** formed by the respective light and the **distance between two consecutive fringes of red light and green light**.

Characteristics	Red	Green
Wavelength	high	low
distance between two consecutive fringes	same	same
distance between two consecutive fringes of red light and green light	high	low

Relate the wavelength of the light with the distance between two consecutive fringes.

Wavelength **increase**
distance between two consecutive fringes **increase**

Name the wave phenomenon involved: **INTERFERENCE OF LIGHT WAVE**



SKILL 3 - COMPARISON

CHAPTER 6: WAVES

Diagram 2.1 shows a tuning fork vibrating near a microphone. The sound waves detected by the microphone are displayed on a Cathode-Ray Oscilloscope (CRO). When the tuning fork is struck harder, sound produced is louder and the sound waves produced are as shown in Diagram 2.2.

Based on Diagram 2.1 and Diagram 2.2, compare the **amplitudes** of vibration of tuning forks, the **peak values**, a_1 and a_2 , of the waves displayed by the oscilloscope.

Characteristics	(Diagram 2.1) a_1	(Diagram 2.2) a_2
amplitude	low	high
Peak values	low	high

Relate the **amplitudes** of vibration of tuning forks to the **peak values** and the **peak value** to the **loudness** of the sound produced.

Amplitude **increase**, Peak value **increase**

Peak value **increase**, Loudness **increase**

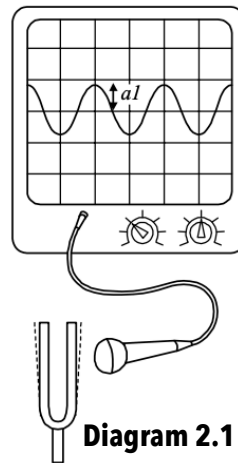


Diagram 2.1

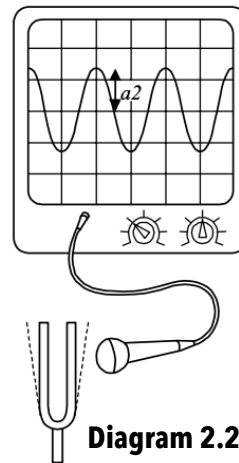


Diagram 2.2

Hence, deduce the relationship between the loudness of the sound and the amplitude of the wave.

Amplitude **increase**,

Loudness **increase**



SKILL 4 - MODIFICATION

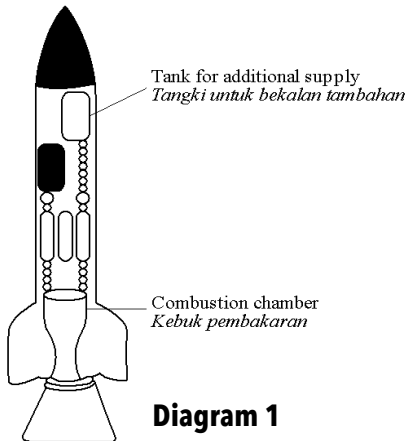
CHAPTER 2: FORCE & MOTION

Diagram 1 shows a rocket.

You are required to give some suggestions to design a rocket which can travel in the outer space with higher acceleration.

Using the knowledge on forces and motion and the properties of materials, explain the suggestions based on the following aspects:

- (i) The shape of the rocket
- (ii) The material used to build the rocket
- (iii) Additional supply needed that enable the rocket to move in outer space
- (iv) The structure of the rocket
- (v) Size of the combustion chamber



Characteristics	Reason
Aerodynamic shape	To reduce air resistance
low density material	Lighter // increase speed // easily to accelerate
liquid oxygen	Boosting combustion
Increase the size of the combustion chamber	More space for the fuel to be burnt
Use strong material	It does not break easily
Has several stages that can be slip / strip off	To decrease the mass

SKILL 4 - MODIFICATION

CHAPTER 2: FORCE & MOTION

An archer is aiming an arrow to a target board as shown on Diagram 2. Using appropriate physics concept, explain the use of suitable equipment and techniques to improve his performance. Your answer should include the following aspects:

- (i) mass of the arrow
- (ii) shape of the arrow
- (iii) elasticity of the bowstring
- (iv) strength of the bow
- (v) position of the aiming arrow compared to the centre of the target board

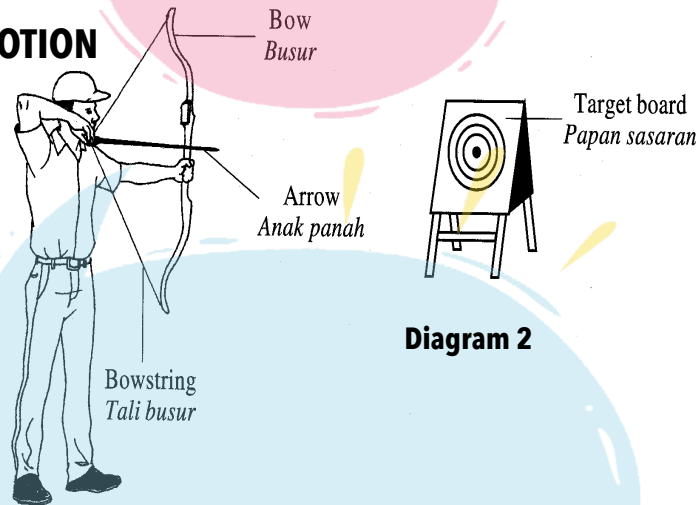


Diagram 2

Characteristics	Reason
Low mass	Lighter // increase speed // easily to accelerate
Aerodynamic shape	To reduce air resistance
Larger elasticity of the bowstring	Higher elastic potential energy
Strong strength of the bow	It does not break easily
position of the aiming arrow above the level of the center of the target board	Gravitational force will pull the arrow downward

An earth-monitoring satellite falls into the earth's atmosphere at a high velocity and reaches a high temperature.

This is caused by the earth's gravitational force and air resistance.

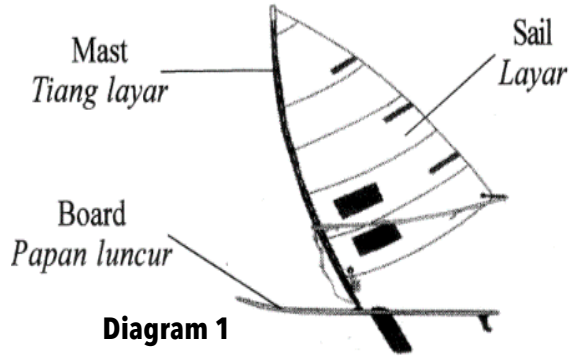
Using the appropriate physics concepts, suggest and explain suitable designs or ways to protect the satellite and its equipment:

- (i) from extreme heat
- (ii) from breaking up on landing



Characteristics	Reason
Aerodynamic	Reduce the air friction
Heat insulator	To protect the capsule from heat or to reduce heat absorption
Parachute // wings	To reduce the speed
High melting point	Do not melt easily / can withstand high temperature
Light materials	Less momentum / inertia
Strong material	Do not break easily

Diagram 1 shows a sailboat.



You are required to give some suggestions to design a sailboat which can travel faster. Using the knowledge on motion, forces and the properties of materials, explain the suggestions based on the following aspect:

- (i) the surface of the board
- (ii) the shape of the board
- (iii) material used for the board
- (iv) material used for the sail
- (v) the size of the sail

Characteristics	Reason
surface of the board: smooth // Coated with wax	reduce water friction
shape of the board: streamlined // aerodynamic	reduce the water friction // increase the lift force
material used for the board: low density (light) and strong	easy to float // not easy to break // can travel faster
material used for the sail: waterproof // low density // light & elastic	the sail will not absorb water // sail faster // not be easy to tear off // be able to withstand strong winds
size of the sail: wide and large	traps more wind // causes a bigger lift force // increases the resistance towards air

SKILL 4 - MODIFICATION

CHAPTER 3: FORCES & PRESSURE

A car needs an efficient hydraulic brake system for safety purposes.

Suggest and explain how to build a hydraulic brake system which can function effectively, based on the following aspect:

- (i) The type and characteristics of the brake fluid.
- (ii) The size of the master piston and slave piston.
- (iii) The material used for the fluid transmission pipe.

Characteristics	Reason
Type of brake fluid: oil	Incompressible
Characteristic of brake fluid : high boiling point	Not easily vaporized
Size of master piston: small	Small force is needed to produce high pressure
Size of slave piston: big	Produce bigger force
Material of transmission pipe: Strong // stainless steel	Not corrode // Not rust // last longer // not easily break

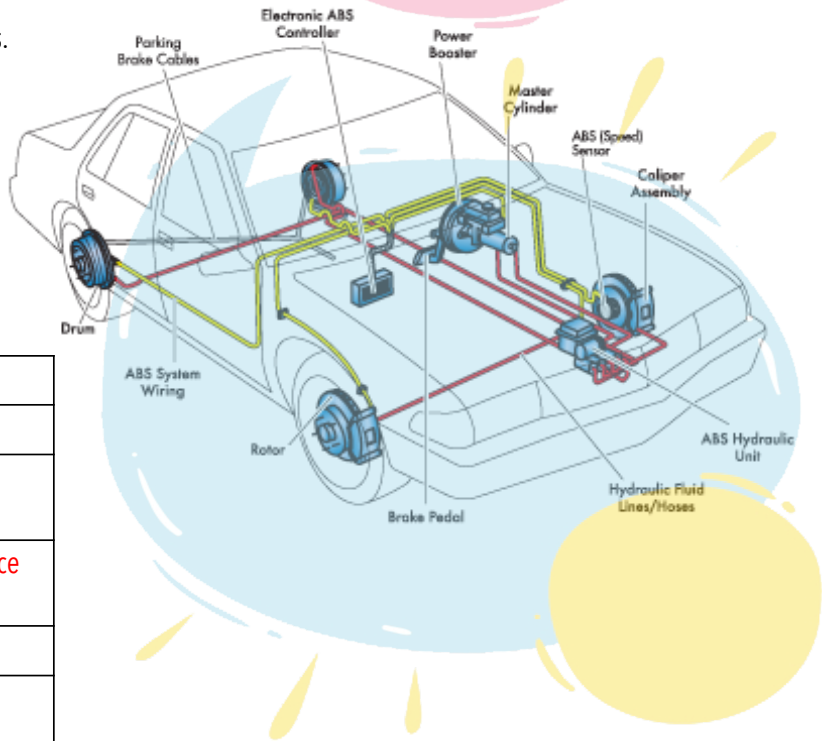


Diagram 2 shows a submarine.

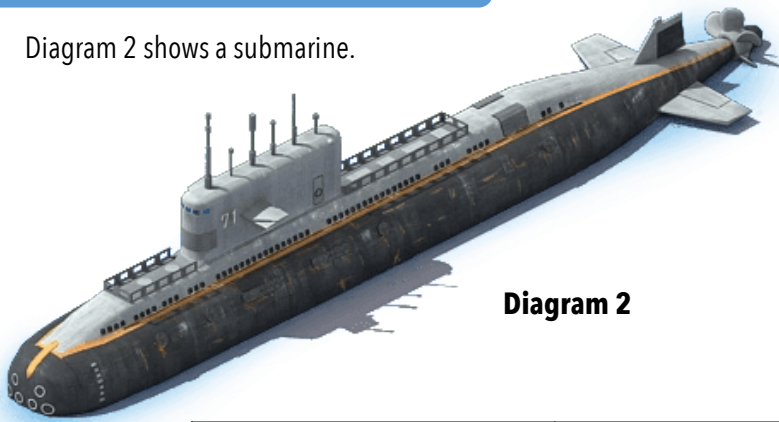


Diagram 2

Using the knowledge on light, pressures and forces, you are required to modify the submarine to enable it to reach a greater depth in the sea and to be able to observe the situation above the surface of water clearly.

In your explanation, include the following aspects:

- (i) The material of the submarine.
- (ii) The size/volume of the ballast tank.
- (iii) The power of the water pump in the ballast tank.
- (iv) The surface area of the submarine.
- (v) The type of periscope.

Characteristics	Reason
Thick and strong material	Withstand high pressure in deep sea
Large volume ballast tank	Can increase the weight and hence able to submerge deeper in the sea
High power water pump	Can pump in and out water in shorter time and so can sink and float quickly
Big surface area of submarine	To reduce the pressure acting toward the submarine
Use prism periscope	Produce clearer and brighter image

SKILL 4 - MODIFICATION CHAPTER 5: LIGHT

Diagram 1 shows two cars, R and S, travelling in the opposite directions, passing through a sharp bend. A mirror is placed at X.

Explain the suitable characteristic of the mirror to be use as outdoor safety mirror at the corner of the road.

Characteristics	Reason
Use convex mirror	Wider field of view
Excellent weather resistance	Able to withstand bad weather
Excellent impact resistance of material	Save cost, everlasting
Bigger size mirror	To enable a wider view and sharper image
Greater reflectivity of material	Clearer image even in bad weather
Place at the sharp road corner, at bending road	To minimize from accident, occur, to enable motorist see the oncoming traffic
Small roof	Protect from rain drop for better image

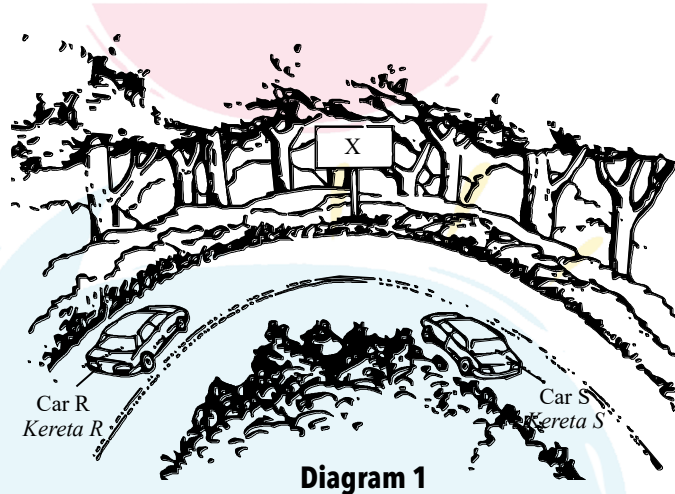


Diagram 1

As a scout, you intend to design a solar cooker that can be used to boil water using direct sun light. Suggest and explain how to build a solar cooker which can boil water in shortest time, based on the following aspect :

- (i) The type of a mirror used
- (ii) The position of the water container
- (iii) The material used for the cooker compartment
- (iv) The colour painted on the outside and inside of the solar cooker



Characteristics	Reason
Use concave mirror	converge / focus the sun light
Put the water container at the focal point of the concave mirror	All the light rays can be reflected and focus at the focal point // get maximum heat
Paint the outside part of the cooker with black colour	To absorb heat
Wrap // use aluminium foil // silver colour inside	So sun light can be reflected back into the cooker
Wrap the cooker with plastic or glass	To trap heat
Put small stones // pebbles // marbles inside the cooker	Absorb heat
Metal	Good conductor of heat

SKILL 4 - MODIFICATION

CHAPTER 5: LIGHT

You are given two convex lenses, R and S, with focal lengths of 40.0 cm and 10.0 cm respectively. Both the lenses are used to build a compound microscope.

Using an appropriate physics concept, suggest and explain suitable modifications or ways to enable the microscope to increase its efficiency and to form a brighter and clear image.

Your modifications can be emphasized on the following aspects:

- (i) The selection of lens as objective lens and as an eyepiece.
- (ii) The position of the object.
- (iii) The position of the eye piece.
- (iv) Additional optical device on the microscope.
- (v) Condition of the place to store the microscope.



Characteristics	Reason
R as eyepiece lens and S as the objective lens	R has longer focal length or $f_e > f_o$
The object is between f_o and $2f_o$	To produced real, inverted and magnified image
The eyepiece lens is adjusted so that $u_2 < f_e$	To produce virtual, inverted and bigger image // to acts as magnifying glass
Add concave mirror	To converge light on the objective lens and get a brighter image
Store in a cool and dry place	To avoid fungus in the lenses

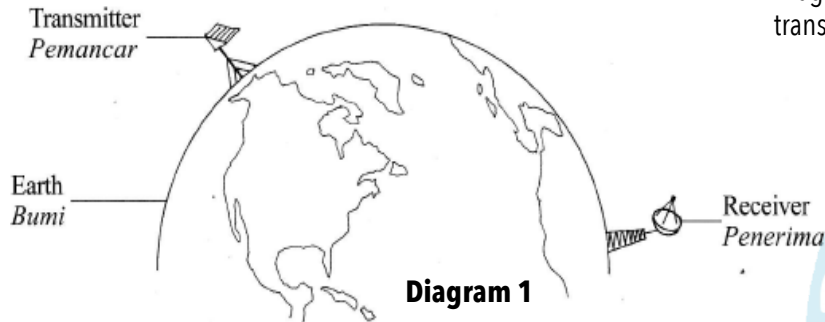


Diagram 1 shows a communication system involved in transmitting information between two distant locations.

Wave is transmitted from the transmitter and received by the receiver. However the signal received is not clear.

You are required to give some suggestions to design a communication system which can improve the quality of signal transmission. Using the knowledge on waves, explain your suggestions based on the following aspects:

- (i) Type of wave transmitted
- (ii) Frequency of the wave
- (iii) Diameter of the receiver
- (iv) The method involved which enable the wave to propagate in a longer distance
- (v) Location of the transmitter and receiver

Characteristics	Reason
Microwave	Can penetrate through the atmosphere
Higher frequency	Higher energy
Larger diameter	To capture more signal
Use relay station // satellite	To overcome damping // to amplify signal
Located on top of hill	Wide receiving range // less obstacle

Diagram 2 shows a boat belonging to a fisherman.

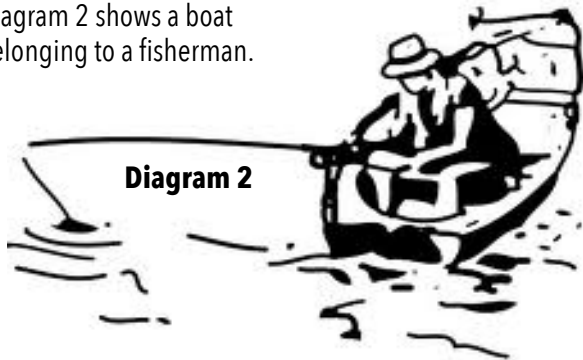


Diagram 2

A group of fishermen plan to go for deep-sea fishing for three months. The boat in Diagram 1 is not suitable for the job and they decide to make modifications to it.

Using the appropriate physics concepts, suggest and explain the modifications that have to be done to the boat.

The modifications should include the following aspects:-

- (i) Shape of the boat
- (ii) Material used to build the boat
- (iii) Type of wave used to detect the fish
- (iv) The freshness of the fish

Characteristics	Reason
Shape of the boat is streamline	To reduce the water resistance
Material used is strong	Can withstands high water pressure
Made of fiber glass // less dense material	The boat is lighter
Uses ultrasonic waves	Have high energy // sounds can travel at further distance
Put fish in a polystyrene box containing ice	ice has larger latent heat // ice can absorb a large quantity of heat from fish as it melts // fish can be kept at a low temperature for an extended period of time

SKILL 5 - MAKING DECISIONS

CHAPTER 2: FORCE & MOTION

Diagram 1 shows a boat carrying two workers roaming around a swamp area. The boat is able to move a constant speed.

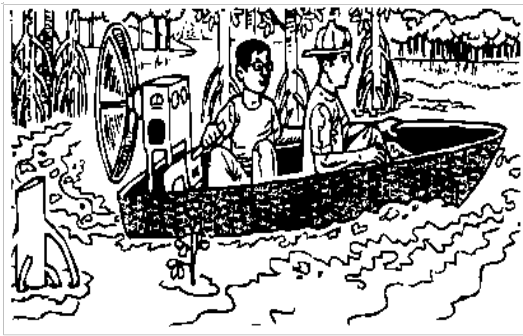


Diagram 1

Table 1 shows the characteristics of five swamp boats.






Swamp boat	Type of bottom shape	Size of motor	Body material	Propeller material
P		Small	Aluminium	Hard stainless steel
Q		Small	Plywood	Wood
R		Big	Aluminum	Soft stainless steel
S		Small	Wood	Aluminium
T		Big	Fiberglass	Fiberglass

Table 1

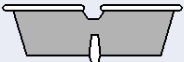




Swamp boat	Type of bottom shape	Size of motor	Body material	Propeller material
P		Small	Aluminium	Hard stainless steel
Q		Small	Plywood	Wood
R		Big	Aluminum	Soft stainless steel
S		Small	Wood	Aluminium
T		Big	Fiberglass	Fiberglass

Table 1

Characteristics	Reason
Type of bottom - flat base shape	Boat can move forward in swamp easily and avoid roots and some obstacles
Size of motor - small	Can produces suitable speed to move in swamp area
Body material - aluminium	High strength // not easily erosion // light // can withstand high water pressure
Propeller material - Hard stainless steel	Can produces strong movement
P	flat base shape small size of motor aluminium body material Hard stainless steel propeller material

SKILL 5 - MAKING DECISIONS

CHAPTER 2: FORCE & MOTION

Diagram 2 shows four methods of towing a cargo ship to a harbour.

You are required to determine the most suitable methods and the characteristics of the cable rope to tow the ship effectively.

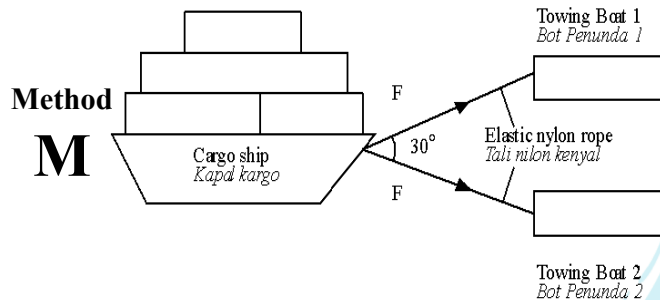
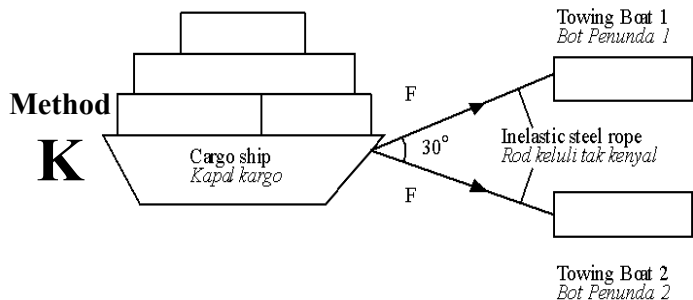
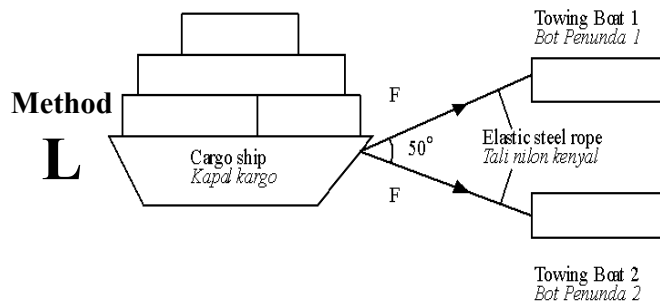
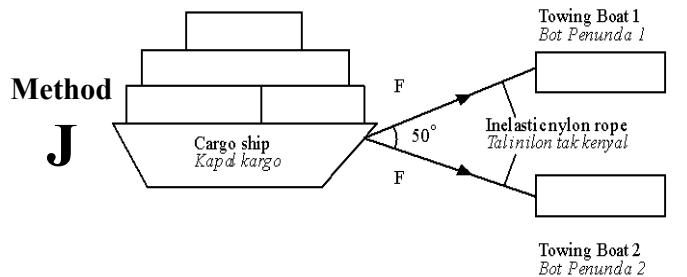


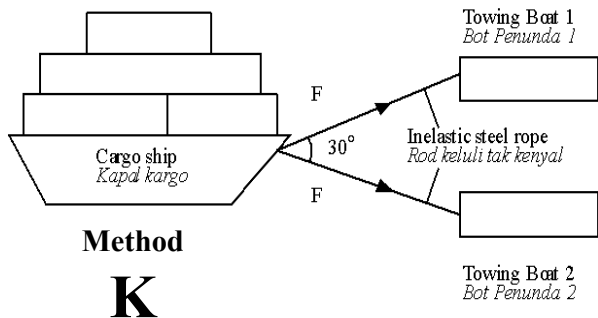
Diagram 2

SKILL 5 - MAKING DECISIONS

CHAPTER 2: FORCE & MOTION

Study the specific of the four arrangements based on the following aspects:

- (i) The angle of the towing boats.
- (ii) The shape of the towing boats.
- (iii) Type of cable rope used.
- (iv) The elasticity of cable used.



Characteristics	Reason
Small angle	Produce bigger resultant force
Streamlined	Reduce water resistance
Steel rod	Strong//able to withstand High tension
Inelastic	Produce uniform force during the towing
K	Small angle Streamlined Steel rod Inelastic

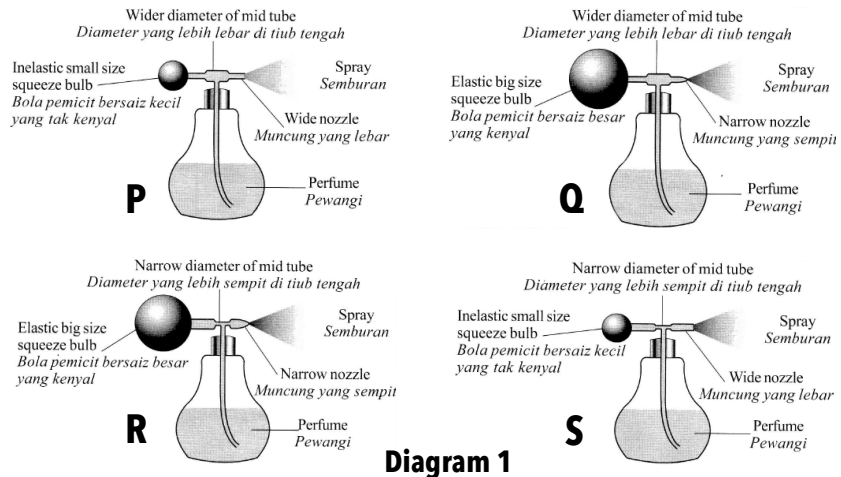


Diagram 1 shows four design of perfume sprays, P, Q, R and S with different specifications. You are required to determine the most suitable design of a perfume spray to produce a fine spray.

Study the specifications of the four perfume sprays based on the following aspects:

- Size of the squeeze bulb.
- Elasticity of the squeeze bulb.
- Shape of the mid tube.
- Size of the nozzle.

Characteristics	Reason
Size of the squeeze bulb: big	To produce more air flow in the tube
Elastic	To allow the squeezed bulb return to its original shape after squeezing
Narrow shape (mid tube)	Produce low pressure, Air travel higher speed to create lower pressure
Size nozzle: narrow	Liquid carried out from the nozzle in a tiny droplets // large area
R	Big size of bulb Elastic Narrow shape Narrow nozzle

SKILL 5 - MAKING DECISIONS

CHAPTER 3: FORCES & PRESSURE

Table 1 shows the characteristics of four structures of ship P, Q, R, and S.

As a researcher in a ship manufacturing company, you are assigned to study the structure used to make the ship to support heavy cargoes.

You are given four choices of the structures P, Q, R and S.

Table 1 shows the structures of the boat.

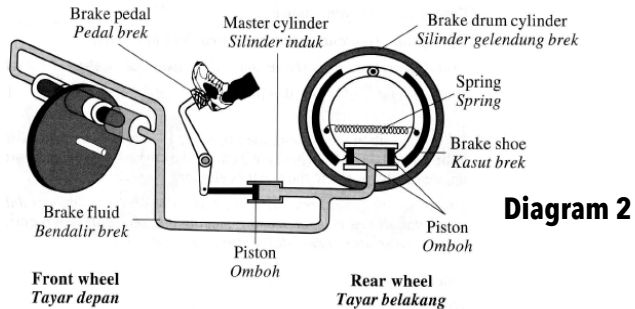
Explain the suitable characteristics of the structure to be used to make the ship.

Ship	Shape	Strength of metal used	Ship base cross section area	Volume of the air space in the ship
P	Streamlined	High	Wide	High
Q	Oval	Low	Wide	High
R	Circle	High	Small	Low
S	Streamlined	Low	Small	Low

Table 1

Characteristics	Reason
Streamline shape	To reduce water resistance
High strength of metal	To withstand high water pressure
Wide base cross section area	So that ship can float / prevent from overturn // ship more stable // ship not sink deeper
High volume of air space in the ship	Produce air buoyant force // ship can float
P	Streamline High strength of metal Wide base cross section area High volume of air space in the ship

Diagram 2 shows a hydraulic brake system in a car.



You are required to investigate the characteristics of a hydraulic brake system as shown in Table 2.

Hydraulic brake	Type of brake fluid	Boiling point of brake fluid	Spring constant of the spring	Ratio of cross-section area of piston in the master cylinder to the brake drum cylinder
J	Incompressible	Low	Low	1:1
K	Compressible	Low	High	5:1
L	Incompressible	High	High	1:5
M	Compressible	High	Low	3:2

Table 2

Characteristics	Reason
Incompressible	Pressure transmitted equally in all direction
High boiling point	Not easy to evaporate
High spring constant	Withstand greater force
Big ratio master to drum cylinder	Larger force exerted on the piston
L	Incompressible High boiling point High spring constant Big ratio master to drum cylinder

Table 3 shows four hot air balloons P, Q, R and S with different features.

Balloon	Volume of balloon	Number of burners	Type of fabric	Temperature of flame
P	Small with 800 m ³	1	Synthetic nylon	100°C
Q	Large with 2500 m ³	2	Synthetic nylon	120°C
R	Large with 2500 m ³	1	Canvas	60°C
S	Small with 800 m ³	2	Canvas	80°C

Table 3

You are required to determine the most suitable hot air balloon which is able to carry three or four people to a higher altitude in a shorter time.



Characteristics	Reason
Large volume	To produce bigger buoyant (up thrust) // Increase the volume of the air displaced
More number of Bunsen burner	To produce bigger flame // heat up the gas in the balloon faster
Synthetic nylon	Light-weight // strong // air-proof material
High temperature of the air in the balloon	Reduce the density // weight of the air in the balloon
Q	Large volume More number of Bunsen burner Synthetic nylon High temperature of the air in the balloon

SKILL 5 - MAKING DECISIONS

CHAPTER 5: LIGHT

Diagram 1 shows an astronomical telescope.

An astronomical telescope is used to view very large objects like moon.

Table 1 shows the characteristics of four different simple astronomical telescopes.

Telescope	Type of objective lens	Objective of focal length	Type of eyepiece lens	Diameter of objective lens
S	Convex	40	Convex	5.0
T	Concave	10	Concave	5.0
U	Convex	10	Concave	2.5
V	Concave	40	Convex	2.5

Table 1



Diagram 1

Characteristics	Reason
convex lens as objective lens	Converge all the rays to one point
Focal length of the objective lens must be long	To view distant object
eyepiece lens is convex lens	Can magnify the first image formed by the objective lens
Diameter of objective lens must be big	Allow more refraction of light and thus produce brighter image
S	convex lens as objective lens Focal length of the objective lens must be long eyepiece lens is convex lens Diameter of objective lens must be big

Diagram 2 shows a glass window which opens outwards at an angle θ .

Diagram 2 shows the side view of the window. If rays of sunlight incident on the window undergo total internal reflection at points like X, direct sunlight would not be able to enter the room and it would be cooler. Four designs P, Q, R and S of the window are available and are designed such that it can be opened at a maximum angle of θ .

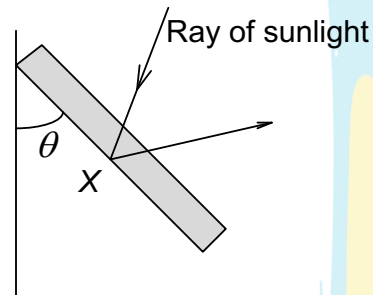
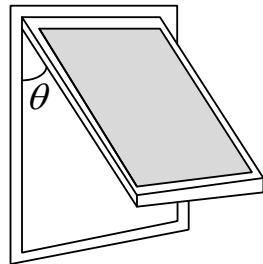


Diagram 2

Table 2 shows the characteristics of the glass used and the angle θ of each design.

Design	Refractive index	Thickness / mm	Thermal conductivity	Temperature, $\theta/^{\circ}\text{C}$
P	1.5	3.0	Low	15
Q	1.8	5.0	Low	10
R	1.8	3.0	Medium	15
S	1.5	5.0	Medium	10

Table 2

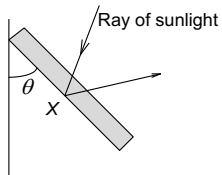
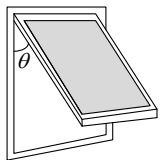


Diagram 2

Design	Refractive index	Thickness / mm	Thermal conductivity	Temperature, $\theta/^\circ\text{C}$
P	1.5	3.0	Low	15
Q	1.8	5.0	Low	10
R	1.8	3.0	Medium	15
S	1.5	5.0	Medium	10

Characteristics	Reason
refractive index must be big	So that the critical angle is small and thus the rays will be easier to be totally reflected
thickness of glass must be high	The ray is harder to refract
The glass must be low in thermal conductivity	Slower conducting the heat into the room through the glass
temperature of the glass must be low	Give cooling effect
Q	refractive index must be big thickness of glass must be high The glass must be low in thermal conductivity temperature of the glass must be low

Table 2

Curved mirrors are always used as security mirror in shops to watch out for shop-lifter.

You are required to investigate the characteristics of curved mirrors as shown on Table 3.

Curved Mirror	Type of curved mirror	Size of curved mirror	Position of curved mirror	Characteristic of coated material for reflection of light inside the curved mirror
P	Convex	Small	Low	Weak reflector
Q	Concave	Big	High	strong reflector
R	Convex	Big	High	strong reflector
S	Concave	Small	Low	Weak reflector

Table 3

Characteristics	Reason
Convex	Wider field of view
Big size	To enable a wider view and sharper image
High position	Wide receiving view // less obstacle // wider coverage area
Strong reflector	Produce bright image // produce sharper image // All the light are reflected // better reflection
R	Convex Big size High position Strong reflector

SKILL 5 - MAKING DECISIONS

CHAPTER 6: WAVES

Diagram 1 shows a guitar with 6 strings. The sound of music note from a guitar depends on the string of the guitar. Each string has its own natural frequency.

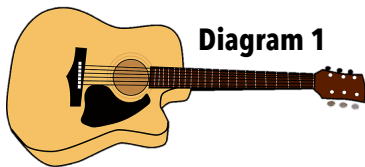


Table 1 shows the characteristic of strings W, X, Y and Z.

String	Density	Tension	Length of string (cm)	String material
W	Small	Low	90.0	Nylon
X	Small	High	70.0	Steel
Y	Medium	Medium	70.0	Nylon
Z	High	Medium	90.0	Steel

Table 1

Explain the suitability of the characteristics of the strings to be used in a guitar that can produce high pitch sound and will not break easily when it is strummed.

Characteristics	Reason
Low density	Lighter // less massive string, wave travel faster and frequency higher
High tension	High frequency // high pitch
Smaller length of the string	Produce higher frequency // low wavelength
Stainless steel	Produce bright sound // high corrosion resistance // Lasting and does not break easily // Prolong and retain their tone longer
X	Low density High tension Smaller length of the string Stainless steel

PHYSICS

Simplicity

Positive

Amazing



**SPM
2021**

"Every great dream begins with a dreamer.

Always remember, you have within you the strength, the patience,

and the passion to reach for the stars to change the world."

**Follow the excellence,
the success will chase you!**