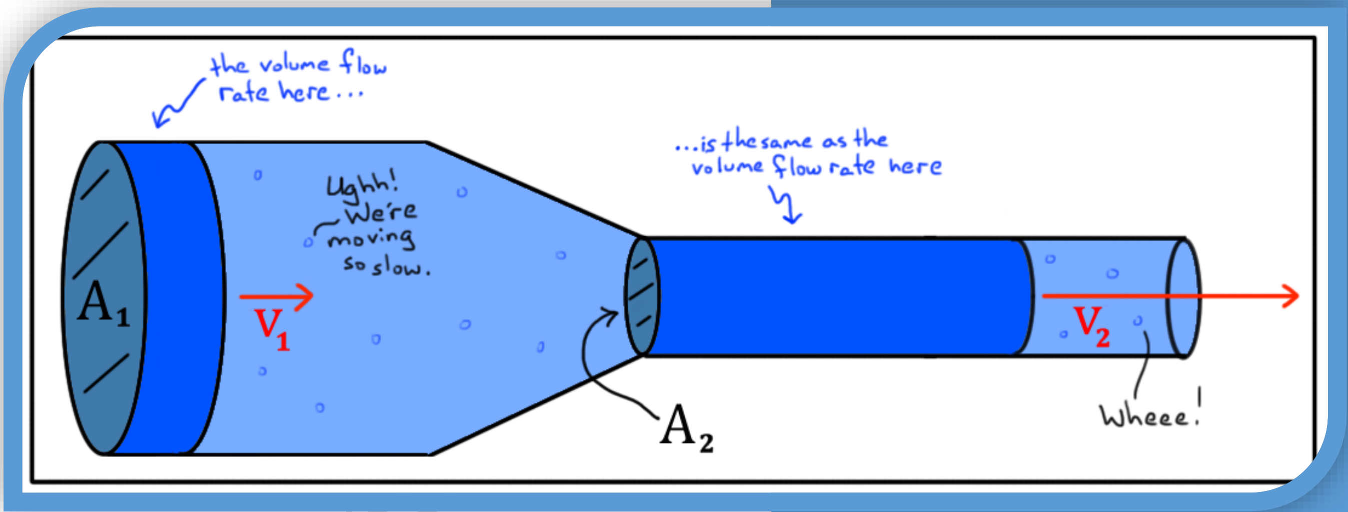
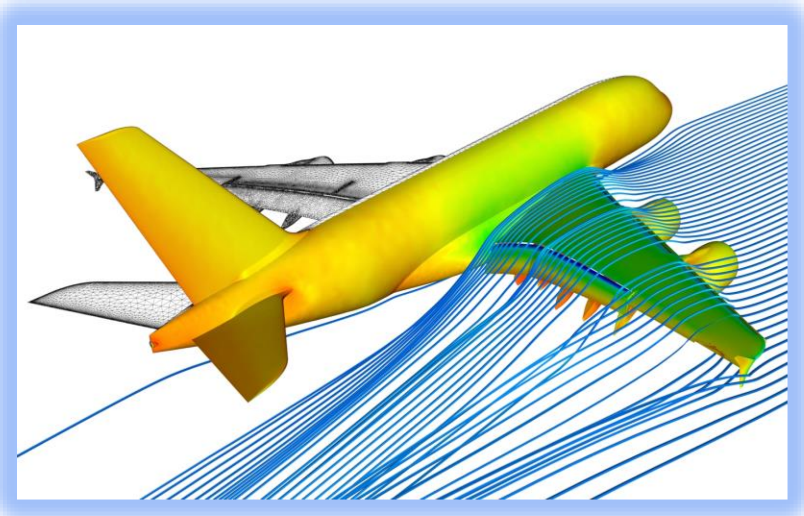
2020

FLUID FLOW





TEACHERS OF PHYSICS

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9/20/2020

1. What is meant by;

(i) Streamline flow (1mk)

- ✓ ***The flow in which the velocity of the fluid particles at any point is constant as time passes. A streamline flow is achieved only when the speed is low***

(ii) Turbulent flow (1mk)

- ✓ ***The flow in which particles of the fluid flow through a point with different velocities and in different directions.***

2. State Bernoulli's principle. (1 mk)

- ✓ ***Provided that a fluid is non viscous, incompressible and its flow streamline, an increase in velocity produces a corresponding decrease in pressure***

3. State **one** assumption made in Bernoulli's fluid flow.

- ✓ ***The fluid is incompressible and non-viscous.***

4. Give three examples of Bernoulli's effect in air. (3 mk)

a) Blowing air over a flat paper
When air is blown over a paper, the paper is observed to rise.

b) Blowing air between two sheets of papers or pith balls
When air is blown between two suspended pith balls, they are seen to be pushed together.

c) Floating pith ball in a funnel
When a funnel is inverted over a pith ball and air blown in, the pith ball floats.

5. State any three properties of an ideal fluid that obeys Bernoulli's principle (3mk)

- ✓ ***Incompressible, non-viscous and with streamline flow.***

6. State the equation of continuity. Define any symbols used.(1 mk)

Av =constant.
A is cross sectional area.
V is the velocity of the fluid in the section.
Av is the rate of flow of the fluid in the section.

$$A_1v_1 = A_2v_2$$

A_1v_1 *is The rate of flow the fluid in the first section.*

A_2v_2 *Is the rate of flow the fluid in the second section.*

7. In deriving the equation of continuity, what three assumptions are made?

a) The fluid has a streamline flow.
b) The fluid is incompressible.
c) The fluid is non-viscous.

8. An oil drop of volume **V m³** introduced on the surface of water spreads to form a patch whose area is ***a* m²**. Derive an expression for obtaining the diameter, **d** of a molecule of oil. (2mk)

Volume of the oil drop = V m^3

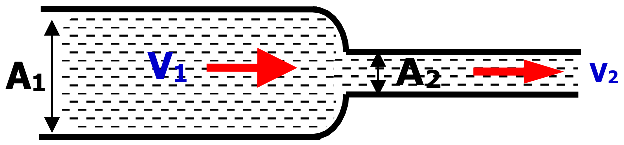
Area of the oil patch = a m^2

Diameter of the oil molecule, d = $\frac{\text{Volume of the oil drop}}{\text{Area of the oil patch}}$

$$d = \frac{V\,m^3}{a\,m^2}$$

$$d = V/am$$

9. The figure below shows an incompressible fluid flowing through a pipe, $\mathbf{A_1}$ and $\mathbf{A_2}$ are the cross-sectional areas of the pipes in the larger section and smaller section of the pipe respectively, while $\mathbf{V_1}$ and $\mathbf{V_2}$ are speeds of the fluid at the two sections of the pipe.



Derive an expression for the ratio of the speeds $\frac{V_2}{V_1}$ in terms of $\mathbf{A_1}$ and $\mathbf{A_2}$

By equation of continuity, $A_1V_1 = A_2V_2$

$$V_1 = \frac{A_2V_2}{A_1}$$

Then, replacing V_1 in $\frac{V_2}{V_1}$ it becomes

$$\frac{\cancel{V_2}}{\frac{A_2\cancel{V_2}}{A_1}} \qquad \text{then } \frac{V_2}{V_1} = \frac{A_1}{A_2}$$

10. State how the pressure in a moving fluid varies with speed of the fluid. **(2mk)**

An increase in its speed produces a corresponding decrease in the pressure it exerts while a decrease in its speed produces a corresponding increase in pressure.

11. Explain **one** danger of Bernoulli's effect **(2mks)**

- ✓ ***Blowing off of roof-tops***

The air flowing over a roof-top has a high velocity compared to the one flowing underneath. Consequently, the pressure acting on the roof from underneath will be higher than that acting from above. Hence, the roof is blown off.

- ✓ ***Road accidents***

A small car travelling at a very high velocity is likely to be dragged into a long track travelling in the opposite direction, also at high speed.
This is because the air between them moves with very high speed, reducing the pressure between them. The atmospheric pressure acting from the sides of the two vehicles will push them closer together, increasing chances of an accident.

12. Explain why a fast moving car appear lighter. **(1mk)**

The air moving above the is moving at higher velocity than the air moving below it thus making the pressure above less than the pressure below hence the pressure below it tends to push it upwards making it appear lighter.

13. A horse rider bends forward when the horse is on speed. Explain.(2mk)
The rider bends forwards so as to try and be streamlined so that he can cut through the air and reduce air resistance (the eddy currents).

14. Give two examples of devices in which Bernoulli's effect is applied. **(2mk)**

i. ***The Aerofoil***
ii. ***Bunsen burner***
iii. ***Spray gun***
iv. ***The carburetor***

15. It is observed that a vehicle which has a door at the rear side gathers more dust inside when moving at high speed on a dusty road with the door open than the one which has an open door on the side. Explain this observation (2mk)

- ✓ ***The vehicle with the door at the rear side is not streamlined at the back thus experiences turbulent flow which cause eddies that push dust into the vehicle from the rear area.***

16. Water flows in a horizontal smooth pipe. State the changes that would be observed in the nature of the flow if the speed of the water is steadily increased from low to high value?

- ✓ ***The flow of the water changes from being streamlined to turbulent at a particular speed.***

17. Two table Tennis balls are in the same level while suspended from threads a short distance apart. A stream of air is blown between the balls in a horizontal direction. Explain what happens to the balls.

- ✓ ***If two balls are held close to each other and air blown between them, the two balls close in towards each other. The moving air between the balls lowers the pressure it exerts on their inner surfaces. The higher atmospheric pressure acting on the outside surfaces causes the balls s to move closer to each other.***

18. When spraying a field of water using a hose pipe, it is common to reduce the pipes opening in order to spray water furthest. Other than pressure, what other quality is varied in the process?

- ✓ ***The cross-sectional area of the horse pipe at the outlet.***

19. State how the pressure in a moving fluid varies with the speed of the fluid.
An increase in its speed produces a corresponding decrease in the pressure it exerts while a decrease in its speed produces a corresponding increase in pressure.

20. It is dangerous to stand close to a road when a fast moving lorry passes. Comment on this statement (1mk)

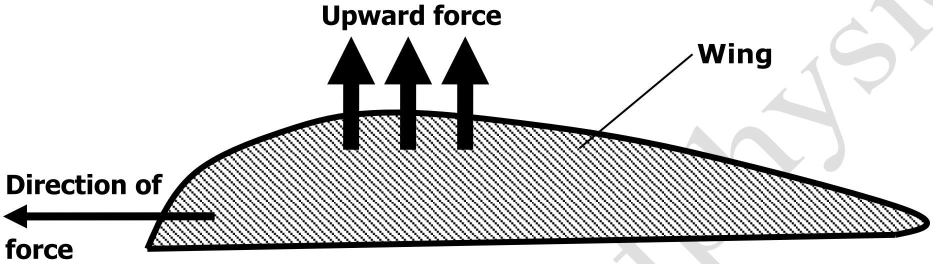
- ✓ ***The air between you and the lorry moves at a high velocity thus reducing the pressure between you and the lorry hence you may be pulled into the lorry due to the reduced pressure.***

DIAGRAMS

1. The passengers in a bus would complain about smoke if the driver smokes when in the driver's seat and the bus is stationary but not when the bus is moving. Explain. (2mk)

When the bus is stationary the pressure in and out of the bus is equal but when it starts moving the velocity of the air outside becomes higher the velocity of air inside thus the pressure outside is reduced compared to inside thus the smoke is pushed out by high pressure inside.

2. The diagram shows a cross-section of an aero plane wing when the aero-plane is moving at constant height and constant speed, an upward force equal and opposite to its weight is exerted on its wing.



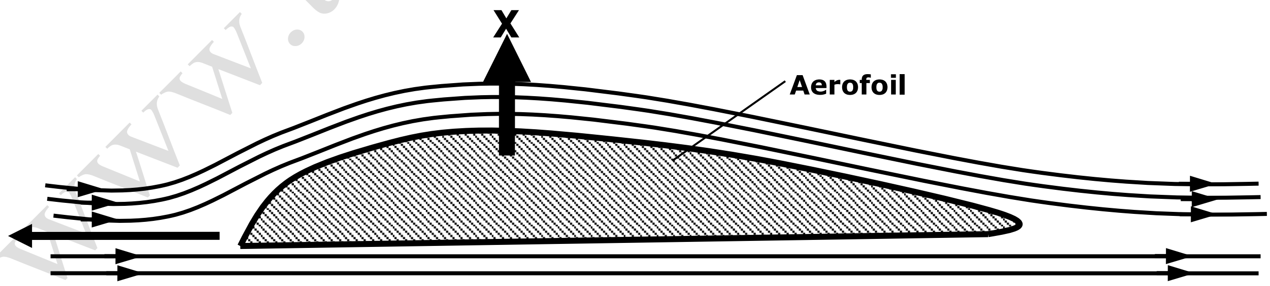
(a) **What** is the cause of the upward force? (2mks)

✓ ***The pressure difference on the upper and lower parts of the wing, the air moving on the upper part of the wing is moving faster thus lower pressure. The air on lower parts is moving slower thus higher pressure causing an upward force.***

(b) **Why** is the shape of the wing crucial in producing this upward force?

✓ ***The shape increases the upper distance thus the air above covers a longer distance thus moving at higher velocity thus lower pressure compared to the lower side thus producing an upward force.***

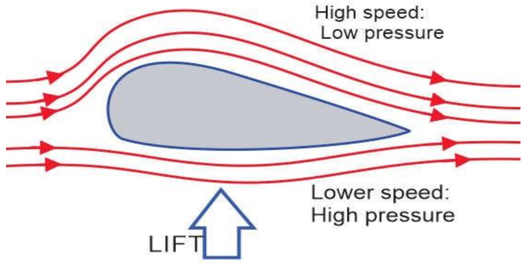
3. The figure below shows an aerofoil.



Explain why it lifts in the direction X indicated. (2mks)

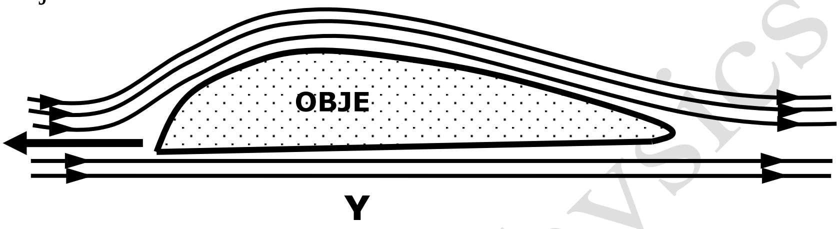
✓ ***The air moving above moves at higher velocity thus lower pressure compared to the lower side where the air moves slower since it covers a shorter distance within the same time hence the higher pressure pushes the aerofoil towards X.***

4. "Air flow over the wings of an aircraft causes a lift. Explain this statement with an aid of a well labelled diagram. (2 marks)



- ✓ ***When the air flows above the wings it creates a low pressure zone since the air above is a higher velocity compared to the lower since it moving at lower velocity. The higher pressure below thus pushes the wing upward thus lifting the aircraft.***

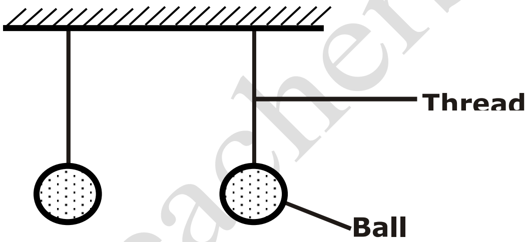
5. Fig below shows streamline of a fluid flowing from left to right of the object. Point Y, is on the lower side of the object.



State with reason, the side of the object on which the velocity of flow of the liquid is higher.

- ✓ ***The upper side, the air above has to cover a longer distance compared to air moving via Y thus it moves at higher velocity.***

6. The figure below shows two balls suspended from threads a short distance apart.



A stream of air is blown between the balls in a horizontal direction.

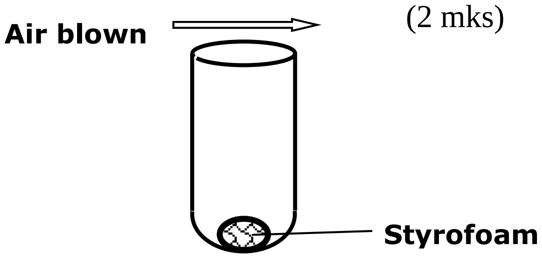
a) State the observation. (1mark)

- ✓ ***The balls move closer to each other.***

b) Explain the observation. (2marks)

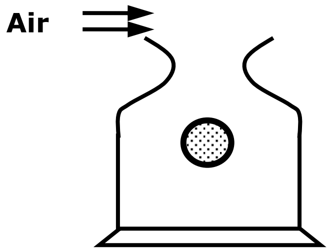
- ✓ ***When air is blown between, being at high speed reduces pressure between them. High atmospheric pressure on the sides pushes them towards each other.***

7. A piece of Styrofoam rests at the bottom of a test tube as in figure 2 below. Explain what is observed when air is blown across the mouth of the test tube. (2 mks)



- ✓ ***The stryofoam rises to the mouth of the tube, the high speed of the air at the mouth reduces the pressure at the mouth pushing the Styrofoam from the bottom of the tube.***

8. The figure below shows a light body floating in a container



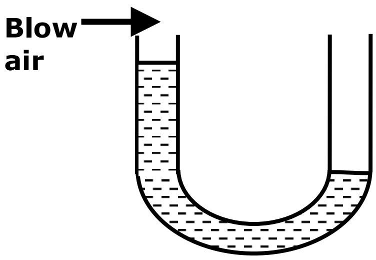
a) State and explain the observation when a stream of air is blown over the mouth of the container as shown. (2mks)

- ✓ ***The body rises to the mouth of the tube, the high speed of the air at the mouth reduces the pressure at the mouth pushing the body from the bottom of the tube.***

b) Explain why the base of the cylinder is wider. (1mk)

- ✓ ***From the narrow section, the speed of air in the wider section reduces. Pressure in the wider section is thus high, pushing the body up to float***

9. Figure below is a manometer containing water. Air is blown across the mouth of one tube and the levels of the water changes as shown.



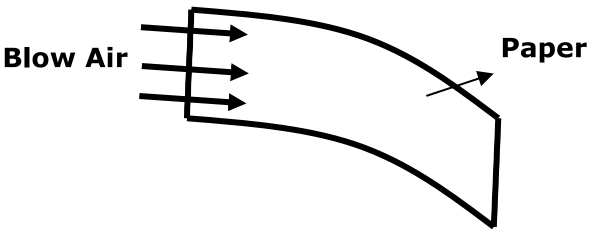
Explain why the level of water in the left limp of manometer is higher. (2mks)

- ✓ ***As air is blown across the left arm of the manometer it reduces the pressure above it below the atmospheric pressure thus the atmospheric pushes down on the water in the right arm thus raising the water in left arm.***

10. A pupil blows a current of air over the surface of a sheet of paper held close to its mouth. State and explain what happens to the paper.

- ✓ ***The paper rises upwards, as air is blown across it at high speed it makes the pressure above it to reduce below the atmospheric pressure thus the atmospheric below the paper pushes it upwards.***

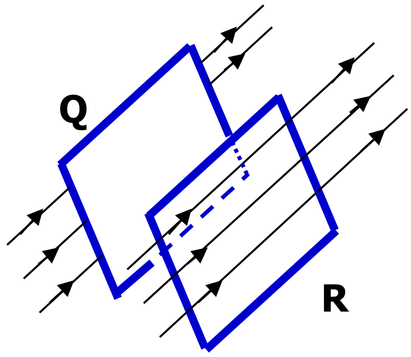
11. A stream of air is passed over a piece of paper as shown below.



State and explain the observations made. (2mks)

- ✓ ***The paper rises upwards, as air is blown across it at high speed it makes the pressure above it to reduce below the atmospheric pressure thus the atmospheric below the paper pushes it upwards.***

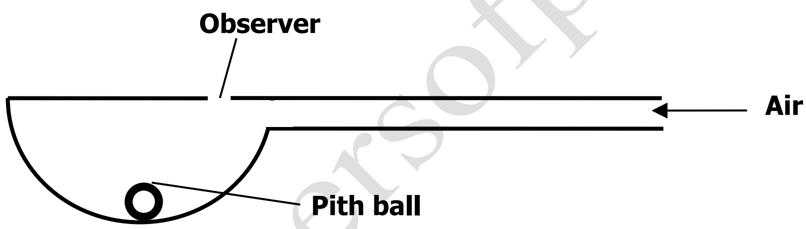
12. The figure 4 below shows two light sheets of paper arranged as shown.



State what is observed if strong air is blown along the lines shown at the same time behind paper **Q** and in front of paper **R** as shown. (1mk)

- ✓ ***The papers Q and R move away from each other.***

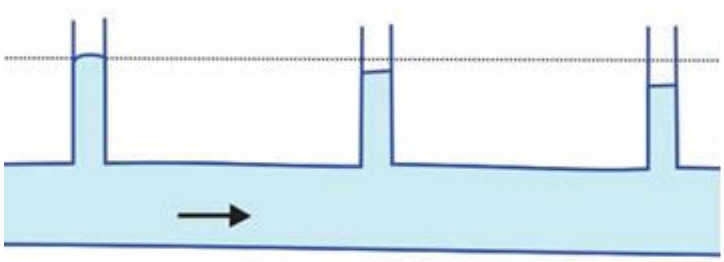
13. Figure shows a whistle.



When air is blown the sound produced varies. Explain this observation using Bernoulli's Principle. (2mks)

- ✓ ***When air is blown in it rushes in and tend to want to leave through the observer's opening, the fast moving air reduces pressure at the exit region thus pith rises up and vibrates as results of the fast moving air vibrate producing sound, variation results from changes in the velocity of air blown in.***

14. Water is made to flow at a high speed in a uniform horizontal tube fitted with vertical tubes **X, Y** and **Z** of same cross -sectional area

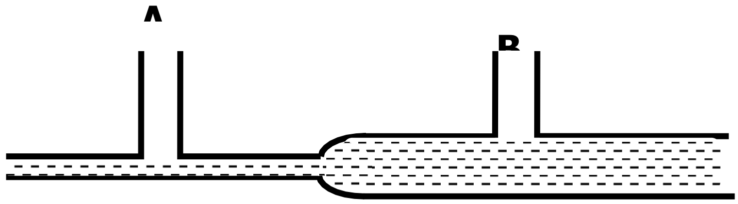


(i) Indicate the possible water levels in the vertical tubes. (1mk)

(ii) Give a reason for your answer in part (i) above. (1mk)

- ✓ ***This is because water pressure decreases from left to right. This pressure difference is due to the fact that liquids flow from places with higher pressure to places with lower pressure.***

15. The diagram below shows water in a long pipe with parts **A** and **B** as shown



(i) Show on the diagram, the likely levels of water in section **A** and **B.**

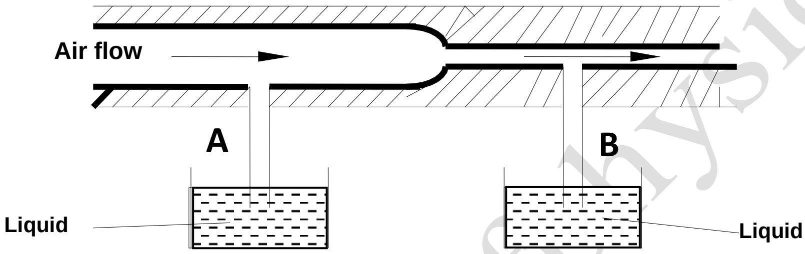
✓ ***The water level in A is lower than in B.***

(1mk)

(ii) Explain your answer. **(1mk)**

✓ ***A reduction in cross-section area increases velocity of the fluid thus reducing the fluid pressure.***

16. Figure shows air flowing through a pipe of non-uniform cross-sectional area. Two pipes **A** and **B** are dipped into liquids as shown.



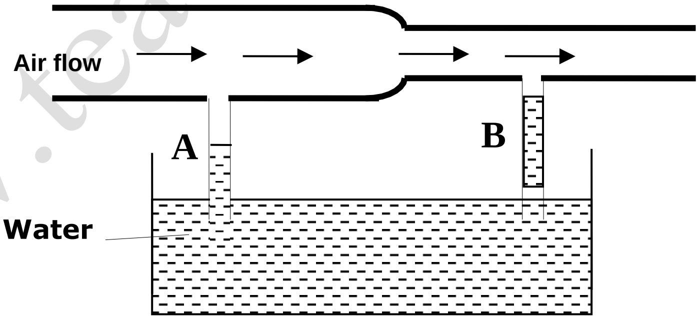
a) Indicate the levels of the liquids in Pipe **A** and pipe **B**. (1mk)

✓ ***The liquid level in A is lower than in B.***

b) Explain your answer in above. (1mk)

✓ ***A reduction in cross-section area increases velocity of the fluid thus reducing the fluid pressure, thus atmospheric pressure acts and pushes the liquid more in B than A.***

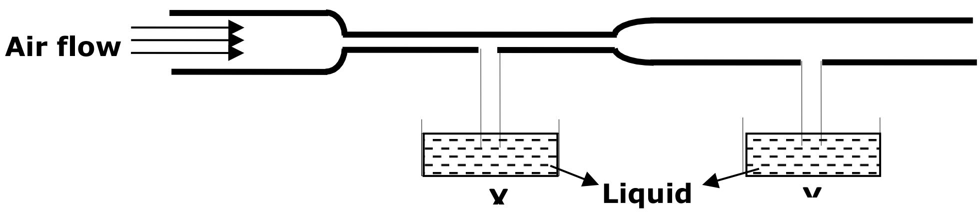
17. The figure below shows air flowing through a pipe of different cross-section areas. Two pipes A and B are dipped into water.



Explain the cause of the difference in the levels of water in the pipes A and B. (2mk)

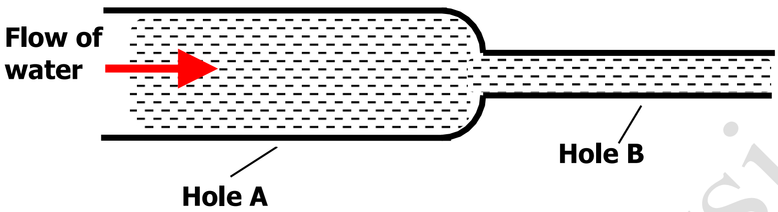
✓ ***The difference in cross sectional area, the larger cross section results in lower velocity thus higher pressure whereas smaller cross sectional area results in higher velocity thus lower pressure hence atmospheric pressure acts more in B than A resulting to higher levels in B than A.***

18. In the figure, below, air is blown into the tube. Indicate the level of water in the beaker X and Y (1mk)



✓ ***The liquid level in X is lower than Y.***

19. Water flows in a pipe of varying diameter as shows in figure 9 below.



a) Two perforations developed with time at points A and B as shown. If the holes are of same dimensions, suggest with a reason which hole leaks more.(2mk)

✓ ***Hole A leaks more than B, a larger cross sectional area results to higher pressure compared to a smaller cross section thus more leakage in A than B.***

b) If the diameters of the larger end of the pipe in figure above is twice that of its smaller end, find the percentage decrease in speed as the water flows from narrow to wider end. (3mk)

$A_1V_1 = A_2V_2$ ***but,*** $A_1 = 2A_2$

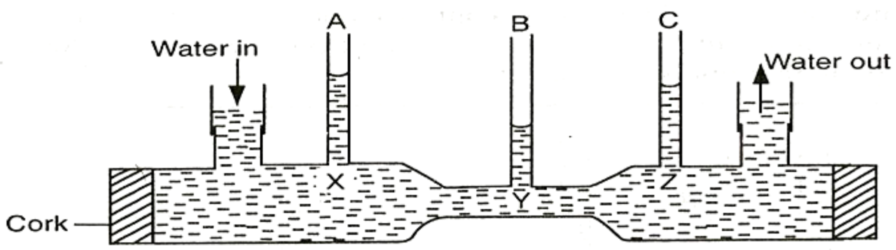
THUS

$2\cancel{A_2}\, V_1 = \cancel{A_2}V_2$

$2V_1 = V_2$

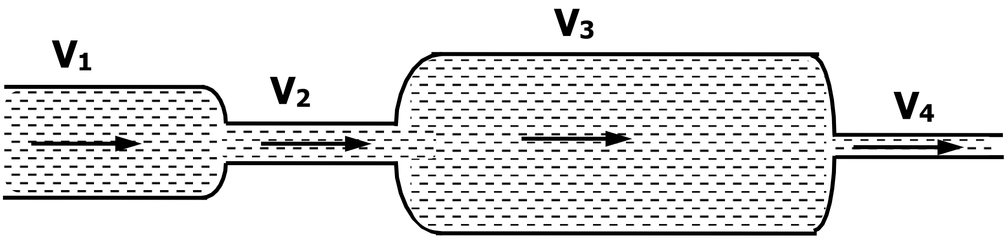
$V_1 = \frac{V_2}{2}$

20. Figure below represents a tube through which liquid is flowing in the direction shown by the arrow.



On the diagram **show** the relative position of the level of the liquid in sections marked x, y and z.

21. Figure shows a tube of varying cross sectional area. **$V_1V_2V_3$** and **V_4** represents the velocities of water as it flows steadily though the sections of the tube.

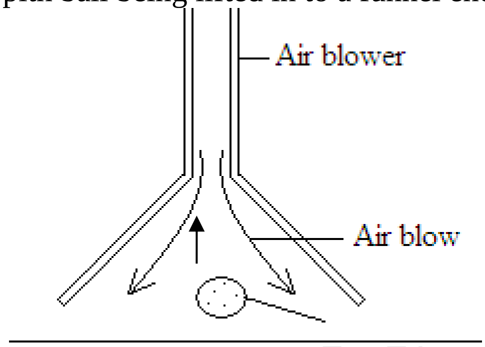


Arrange the velocities **V_1, V_2,V_3** and **V_4** in descending order.

V_3, V_1, V_2, V_4

(b) On the same diagram show the path followed by each body. (2mks)

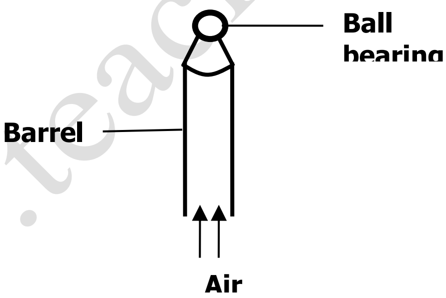
22. The figure below shows a pith ball being lifted in to a funnel end of a blower.



Explain this observation . (2mk)

- ✓ ***From the narrow section, the speed of air in the wider section reduces. Pressure in the wider section is thus high, pushing the pith ball up to float.***

23. Figure shows a ball bearing resting at the top of a barrel of a bic pen.

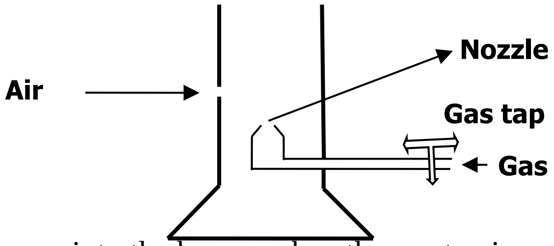


State and explain the observation made when air is blown into the barrel.

(2mks)

- ✓ ***The ball bearing remain on the barrel, as the air rushes to move around the bearing it create lower pressure around the bearing thus the atmospheric pressure which is higher than the pressure around the bearing pushes downward on the ball bearing.***

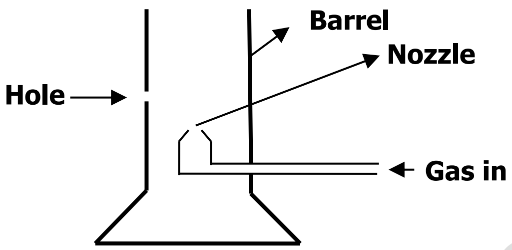
24. The figure below sows a Bunsen burner.



Explain how air is drawn into the burner when the gas tap is open. (2mk)

✓ *Gas from a gas pipe is fed into the Bunsen burner through a nozzle that has a reduced area as compared to the pipe. As gas passes through this nozzle, its velocity is increased, lowering pressure in the barrel. High atmospheric pressure outside pushes air into the barrel mixing with the gas for burning.*

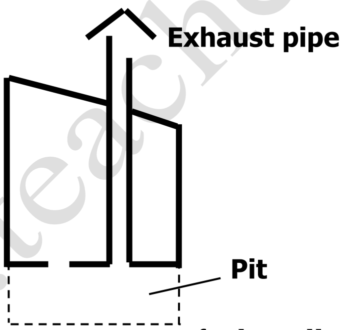
25. The diagram below shows a bursen burner



Explain how air is drawn into the barrel (2mk)

✓ *Gas from a gas pipe is fed into the Bunsen burner through a nozzle that has a reduced area as compared to the pipe. As gas passes through this nozzle, its velocity is increased, lowering pressure in the barrel. High atmospheric pressure outside pushes air into the barrel mixing with the gas for burning.*

26. Figure below shows a modern latrine.

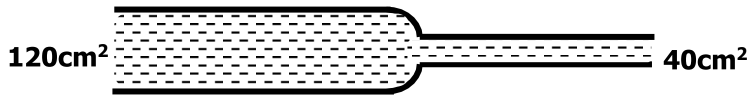


Explain how the exhaust pipe minimizes foul smell especially on a windy day. (2mks)

✓ *As the wind above exhaust pipe it reduces the pressure around it compared to atmospheric pressure acting in the pit. The atmospheric pressure pushes the foul smell out through the exhaust pipe towards the lower pressure region.*

CALCULATIONS

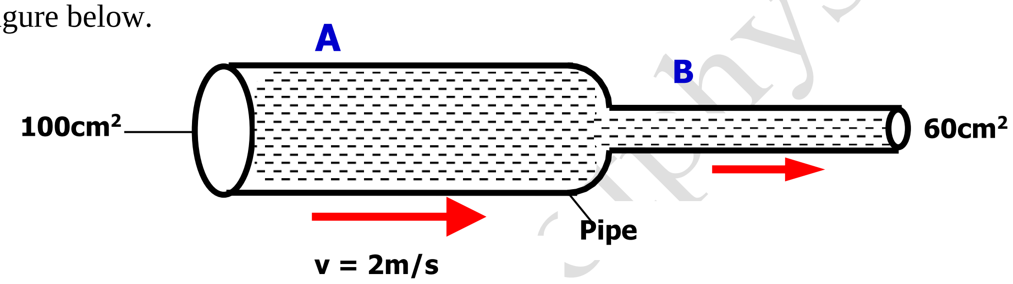
1. The diagram below shows water flowing steadily in a tube of varying cross-sectional area. Study it and answer the question that follows:



If the velocity of the water in the wider section is $0.4ms^{-1}$ what is the velocity in the narrower section? (2mks)

$A_1= 120cm^2$, $V_1=0.4m/s$, $A_2=40cm^2$, V_2 =?
$A_1V_1 = A_2V_2$
$120cm^2$ X $4cm/s$ = $40cm^2$ X Vcm/s
480 = 40 X V
$\frac{480}{40}$ =V therefore V = 12cm/s or 0.12m/s

2. Water flows through a horizontal pipe of varying cross-section area as shown in figure below.



The velocity of water in pipe **A** is **2m/s**
(i) Determine the velocity of water in pipe B. 3mks

$A_1= 100cm^2$, $V_1=2m/s$, $A_2=60cm^2$, V_2 =?
$A_1V_1 = A_2V_2$
100 X 200cm/s = $60cm^2$ X V.
$\frac{20000}{60}$ = 333.3cm/s therefore V = 333.3cm/s or 3.333m/s

(ii) State two assumptions taken in Bernoulli's fluid flow. 2mks
The fluid is incompressible and non-viscous.

3. A pipe of radius **3mm** is connected to another pipe of radius 9mm. If water flows in the wider pipe at a speed of $\mathbf{2ms^{-1}}$, what is the speed in the narrower pipe (3mks)

A_1=3.142 X 0.003^2 = 2.878x $10^{-5}m^2$
A_2= 3.142x 0.004^2 = 2.54502x $10^{-4}m^2$
THUS,
$A_1V_1 = A_2V_2$
2.878X10^{-5} X V_1=2.5402X 10^{-4}X 2
V_1=$\frac{5.09004X\ 10^{-4}}{2.878X10^{-5}}$=17.686m/s

4. Water flows steadily through a pipe of radius **25 mm** at **20 ms^{-1}**. The pipes narrows at some point and its radius reduces to **10mm**. what is the speed of water at this point?

$A_1 = 3.142 X 0.025^2 = 1.96375 X 10^{-3} m^2$

$A_2 = 3.142 X\ 0.01^2 = 3.142 X 10^{-4} m^2$

$A_1 V_1 = A_2 V_2$

$1.96375 X\ 10^{-3} X\ 20 = 3.142 X\ 10^{-4}\ X\ V_2$

$\frac{1.96375 X\ 10^{-3} X\ 20}{3.142 X\ 10^{-4}} = V_2$

$125m/s = V_2$, therefore $V_2 = 125m/s$

5. Water flows through a pipe of varying cross-sectional area, one end of the pipe is **$5cm^2$** and water flows at that point at a velocity of **0.3m/s**. calculate the cross-sectional area of the other end if water flows at that end at $1ms^{-1}$. (3mk)

$A_1V_1 = A_2V_2$

$5x\ 30 = A_2 x100$

$\frac{150}{100} = A_2$

Therefore, $A_2 = 1.5cm^2$

6. Water flows along a horizontal pipe of cross sectional area $48cm^2$ which has a constriction of cross sectional area $12cm^2$ at one place. If the speed of the water at the constriction is 36m/s, calculate the speed in the wider section.

(3mk)

$A_1=48cm^2, A_2= 12cm^2, V_2 =3600cm/s$

$A_1V_1 = A_2V_2$

$V_1 = \frac{12 X 3600}{48} = 900cm/s$ (or 9m/s)

7. Water flows steadily through a pipe of diameter **30 mm** at **20 ms^{-1}**. The pipes narrows at some point and its diameter reduces to **20 mm**. what is the speed of water at this point? (3mk)

$A_1V_1 = A_2V_2$

$\cancel{3.142} x\ r^2V_1 = \cancel{3.142} x\ R^2 x\ V_2$

$0.03^2 x\ 20 = .02^2 x\ V_2$

$\frac{0.018}{0.02^2} = V_2$, therefore $V_2 = 45m/s$

8. Water flows through the horizontal pipe at the rate of **400 cm^3/s**. what is the speed of the water if the diameter of the pipe is **1.4 cm**? (2marks)

$A_1V_1 = 400cm^3/s = 3.142 X r^2 X V$

$400 = 3.142 X 0.7^2 x V$

Therefore,

$\frac{400}{1.53958} = 259.8cm/s$

Thus $V = 259.8cm/s$

9. Water flows along a horizontal pipe of cross – sectional area **$30cm^2$** at a speed of **$40ms^{-1}$**. It reaches a section where the speed is **$7.5ms^{-1}$**. Find the area of this section of the pipe. (2mk)

$A_1=30, V_1=4000cm/s, A_2=? V_2=750cm/s$

$A_1V_1 = A_2V_2$

$\frac{30 x 4000}{750} = V_2$

Therefore, $V_2 = 160cm/s$ (or 1.6m/s)

10. A liquid flows along a horizontal pipe of cross-sectional area **$20cm^2$** with a speed of **5m/s**. The speed increases to **8m/s** where there is a constriction. Calculate the cross- sectional area of the constriction. (2mk)

$A_1=20cm^2, V_1=500cm/s, A_2=? V_2=800cm/s$

$A_1V_1 = A_2 V_2$

$20 X 500 = A_2 X 800$

$\frac{20 X 500}{800} = A_2$

Therefore, $A_2 = 12.5cm^2$

11. Water flows through a pipe with varying cross sectional area. The narrower section has an area of **5cm²** while the wider section has an area of **15cm³**. If the velocity of the water trough the narrow section is **20m/s**, determine the velocity in the wider section. (3mk)

$A_1V_1 = A_2 V_2$

$A_1 = 5cm2$, $V_1 = 20m/s$, $A_2 = 15cm^2$, $V_2 = ?$

$\frac{5 \times 2000}{15} = 666.7\ cm/s$ (or $6.667 m/s$)

12. A heart pumps blood at a rate of **$1.8 \times 10^3\ cm^3/\ min$** though its aorta is of cross sectional area **$0.6\ cm^3$**. The blood spreads into a capillary network that is equivalent to about **4×10^6** fine tubes each of diameter **$6 \times 10^{-3}cm$**.

Calculate:

(a) The average velocity of blood in the aorta

$A_1V_1 = 1.8 X 10^3 cm^3/min$

$A_1 = 0.6cm^2$

No. of capillaries $= 4x10^6$

Radius of capillaries $= 3x\ 10^{-3}cm$

$A_1V_1 = 1.8 X 10^3 cm^3/min$

Thus,

$V_1 = \frac{1.8 X 10^3 cm^3/min}{0.6} = 3.0x\ 10^3 cm/min$ (or $5.0x\ 10^5\ cm/s$)

(b) The average blood velocity in the capillary tubes.

Area of the capillaries

$3.142 \times r^2 = 3.142 \times 3.0 x10^{-3} = 9.426x10^{-3}cm^2$

$A_1V_1 = A_2 V_2$

$1.8 x10^3 = 9.426x10^{-3}cm^2 X V_2$

Therefore,

$V_2 = \frac{1.8 x10^3}{9.426x10^{-3}}$

$= 1.910 \times 10^5 cm/min$ (or $3.183 \times 10^3 cm/s$)

13. Water flows along a horizontal pipe of cross sectional area 30cm². The speed of the water is 4m/s but it reaches 7.5m/s in a constriction in the pipe. Calculate the area of the constriction.

$A_1V_1 = A_2 V_2$

$30 \times 400 = (750) A_2$

$\frac{12000}{750} = 16cm^2$

Therefore,

$A_2 = 16cm^2$

14. Water flows in through a horizontal pipe of cross – sectional area **100cm²**. At the outlet section the cross- sectional area is **5 cm²** . If the velocity of water at the larger cross- section is **1.25m/s**

(i) Find the volume of water leaving the pipe in the second. (2mk)

$A_1 = 100cm^2$, $V_1 = 125cm/s$, $A_2 = 5cm^2$ $V_2 = ?$

Volume flux $= A_1V_1 = 125 \times 100$

$= 12500cm^3/s$

(ii) Calculate the velocity of water in the smaller pipe. (2mk)

$A_1V_1 = A_2 V_2$

A_1V_1 =volume flux.

Thus,

Volume flux = A_2 V_2

$12500cm^3/s = A_2 V_2$

$\frac{12500cm^3/s}{5} = 2500cm/s$

Thus, V_2 = 2500cm/s (or 25m/s)

15. A horse pipe of internal diameter 4cm is connected to a sprinkler with 25 holes each of diameter 0.004 cm, the water in the pipe flows at a speed of 5 cm/s. Determine the velocity with which the water leaves the sprinkler. (3mk)

Radius of Horse pipe= 2cm

Radius of sprinkler = 0.002cm

No. of holes on the sprinkler =25 holes

$A_1V_1 = A_2 V_2$

$\cancel{3.142} \times R^2 \times V_1 = \cancel{3.142} \times r^2 \times V_2$

4 x 5 = (0.000004 x V)25

$\frac{20}{0.000004 \times 25}$ = 200,000cm/s (or 200m/s)

16. A lawn sprinkler has 20 holes each of cross-sectional area $2 \times 10^{-2} cm^2$ is connected to a hose pipe of cross-sectional area $2.4cm^2$. if the speed of water in the hose pipe is 1.5 m/s.

(i) **Calculate** the flow rate in the hose pipe. (3mk)

Flow rate = AV

$=150cm/s \times 2.4cm^2 = 360cm^3/s$

(ii) The speed of water as it emerges from the holes. (3mks)

$A_1 = (2 X10^{-2})20 = 0.4cm^2$

$A_2V_2 = 360cm^3/s$

$V_2 = \frac{360}{0.4}$ = 900cm/s (or 9m/s)

(iii) The mass flux in the hose pipe. Take density of water $1000kg/m^3$. (3mk)

Mass Flux = volume flux X density

= AV X density.

$360cm^3/s$ X $1g/cm^3$

= 360g/s

17. A lawn sprinkler has **20** holes each of cross-sectional area **3×10^{-2} cm^2** is connected to a hose pipe of cross-sectional area **4cm^2**. if the speed of water in the hose pipe is **3.6 m/s**.

(ii) Calculate the flow rate in the hose pipe. (3mk)

Area of small holes = $3.0 X 10^{-2} cm^2$

Total area = $3.0 X 10^{-2} cm^2 x 20$

$=0.6cm^2$

Area of Horse pipe = $4cm^2$

$V_2 = 3.6m/s$

Flow rate= AV =4 X 360

$= 1440cm^3/s$

(iii) The speed of water as it emerges from the holes. (3mks)

Flow rate = A_2 V_2

$1440cm^3/s = 0.6 \times V_2$

$\frac{1440cm^3/s}{0.6} = V_2$

Therefore, $V_2 = 2400cm/s$ (or 24m/s)

(iv) The mass flux in the hose pipe. Take density of water **$1000kg/m^3$**.

(2mks)

Mass Flux = volume flux X density

= AV X density.

Mass Flux = $1440\cancel{cm^3}/s \; 1g/\cancel{cm^3}$

=1440g/s

18. A pump draws water from a tank and issues it from the end of a hosepipe which is 2.5 vertically above the level from which the water is drawn. The cross –sectional area of the hosepipe is**$1.0 \times 10^{-3}m^2$** and the water leaves the end of the hosepipe at a speed of 5m/s. **Calculate** the power of the pump. (density of water = **1000Kg**)

Flow rate = AV

$=1.0 \times 10^{-3}m^2 \times 5m/s$

$= 5 \times 10^{-3}m^3/s$

Mass flux= $5 \times 10^{-3}m^3/s \times 1000Kg$

= 5kg/s

Work done per second = (force X distance)/s

= (5kg X10N/kg X2.5m)/s

= (50 X 2.5)/s

=125J/s

Work done per second = Power

Thus,

Power of the pump=125J/s

= 125Watts

