Pressure of Fluid Demonstration Kit

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II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
2	Rectangular Water Tank	1
3	U-tube Manometer	1
4	Liquid Pressure Indicator	1
5	Liquid Top Pressure Observation Device	1
6	Parallel Acrylic Tubes	1
7	L-type Glass Tube	1
8	S-type Glass Tube	1
9	Acrylic Prop	2
10	Clamp with Hook	1
11	Soft Tube	1
12	Density Cylinders (the same volume)	3
13	Density Cylinders (the same mass)	3
14	Buoyancy Cylinders (density more than 1)	1
15	Buoyancy Cylinders (density less than 1)	1

16	Archimedes' Cylinder	1
17	Capillary	3
18	Capillary Holder	1
19	Glass Plate	1
20	Glass Plate with grids	1
21	Surface Tension Device: Circularity	1
22	Surface Tension Device: Tetrahedron	1
23	Surface Tension Device: Square Pyramid	1
24	Binder Clip (1 Big, 4 Small)	5
25	Siphon	1
26	Pascal's Law Device	1
27	L-type Metal Pipe	1
28	Spring Scale	1
29	Graduated Cylinder	1
30	Pipette	1
31	Hard Foam Support Base	2
32	Mass Set	1
33	String	1
34	Connector 1	1
35	Connector 2	1

Experiment 1, Experiment of Water Level of Communicating Pipe.

I. Purpose

Observe the principle of communicating pipe and the definition of pressure for comprehension of the applying communicating pipe in daily life.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
7	L-type Glass Tube	1
8	S-type Glass Tube	1

III. Theory

The principle of communicating pipe is that among the containers which are filled with the liquids with the same density; the deeper position in the liquid, the higher pressure, and the liquid flows to a low-pressure position. Therefore, in this experiment, as the liquid stops flowing, the liquid pressure with the same height will be the same and represents the same height of horizontal.

In this experiment, the Water Tank Stand and two different glass tubes are set up. Stain the liquid to observe the water level in diverse containers.

IV. Procedure

1. The experiment device is as **Figure 1**. Fix the L-type and S-type Glass Tube next to the Water Tank Stand.
2. Pour water in the Water Tank Stand and drop several stains in the water to for observation.
3. Observe and note down the difference of the water level in different glass tubes.

Figure 1

V. Discussion

Are both the levels the same height after pouring water in at the 1st time?	
Are both the levels the same height after pouring water in at the 2nd time?	
Are both the levels the same height after pouring water in at the 3rd time?	

1. After pouring water in every time, is the water level in the Water Tank Stand the same height as the one in both of the glass tubes?
2. Discuss how to apply the principle of communicating pipe in daily life.

Experiment 2, Hydrostatic Pressure

I. Purpose

In order to understand different water pressure, observe diverse phenomena caused by floating water pressure with the water close to or far away from the tank.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
2	Rectangular Water Tank	1
24	Binder Clip (1 Big, 4 Small)	5
31	Hard Foam Support Base	2
34	Connector 1	1

III. Theory

According to the principle of communicating pipe, with the same atmosphere pressure above each pipe, as the liquid inside the pipes flows lightly, the water level of the liquid in the container will be the same. Meanwhile, if drilling a hole at the bottom of the communicating pipe and let water flow out, what will the water level be before being out of water? From this experiment, the position further away from the hole, the higher water level, and it is because different pressures at both of the extremities make the water flow. The pressures of the flowing water at every point are not the same, and they gradually fall/flow from high to low pressures. On the contrary, different pressures at each point cause the water flowing. The water in the communicating pipe belongs to nearly silent status.

IV. Procedure

1. The experiment kit is as **Figure 2**.
2. Clip the end of the Parallel Acrylic Tube with the Big Binder Clip to prevent the water from leaking.
3. Pour water in the Water Tank Stand and drop several stains for observation.
4. Remove the Big Binder Clip, observe and note down the difference of the water level in the Parallel Acrylic Tube.

Figure 2

V. Discussion

Water Tank	Acrylic Tube 1	Acrylic Tube 2	Acrylic Tube 3	Acrylic Tube 4	Acrylic Tube 5	Exit
High water level						Exit

(Fill in highest, higher, high, lower, or lowest in the blanks.)

1. After the water starts to flow, the water in the Water Tank Stand becomes less and less. Is the water level the same in the same Parallel Acrylic Tube?
2. Discuss how to apply the variation of water close to or far away from the Water Tank Stand in daily life.

Experiment 3, Top Pressure in the Water.

I. Purpose

Observe the top pressure in the water by Liquid Pressure Indicator and use the U-tube Manometer to observe the variation of water level caused by pressure.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
3	U-tube Manometer	1
4	Liquid Pressure Indicator	1
11	Soft Tube	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P=\frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by density D, which is F = A x h x d. In other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P=\frac{F}{A}=\frac{A\times h\times d}{A}=h\times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, observe the top pressure in the water by Liquid Pressure Indicator, and observe the variation of the water level caused by pressure by U-tube Manometer. Since the water pressure transforms the rubber membrane and squeeze the internal air, the increasing pressure after the internal air is squeezed shows on the U-tube Manometer.

IV. Procedure

1. The experiment kit is as **Figure 3**.
2. Pour appropriate amount of water in the Water Tank Stand and drop several stains for observation.
3. Make the rubber membrane of the Liquid Pressure Indicator face up and slowly put it into the water.
4. Observe and note down the depth showed on the Liquid Pressure Indicator and the differences of the water level indicated by U-tube Manometer.

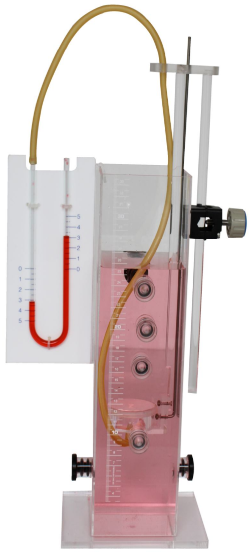

Figure 3

V. Discussion

Depth on Liquid Pressure Indicator (cm).						
Differences between water levels on U-tube Manometer (cm).						

1. If the depth in the Liquid Pressure Indicator is deeper, what will the differences between both of water levels change in the U-tube Manometer?
2. Why are one of the water level high but the other low in the U-tube Manometer.

Experiment 4, Bottom Pressure in the Water.

I. Purpose

Observe the bottom pressure in the water by Liquid Pressure Indicator and observe the variation of water level caused by pressure by U-tube Manometer.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
3	U-tube Manometer	1
4	Liquid Pressure Indicator	1
11	Soft Tube	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P=\frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by the density D, so which is F = A x h x d, in other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P=\frac{F}{A}=\frac{A\times h\times d}{A}=h\times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, observe the bottom pressure in the water by Liquid Pressure Indicator, and observe the variation of the water level caused by pressure by U-tube Manometer. Since the water pressure transforms the rubber membrane and squeeze the internal air, the increasing pressure after the internal air is squeezed shows on the U-tube Manometer.

IV. Procedure

1. The experiment kit is as **Figure 4**.
2. Pour appropriate amount of water in the Water Tank Stand and drop several stains for observation.
3. Make the rubber membrane of the Liquid Pressure Indicator face down and slowly put it into the water.
4. Observe and note down the depth showed on the Liquid Pressure Indicator and the differences of the water level indicated by U-tube Manometer.

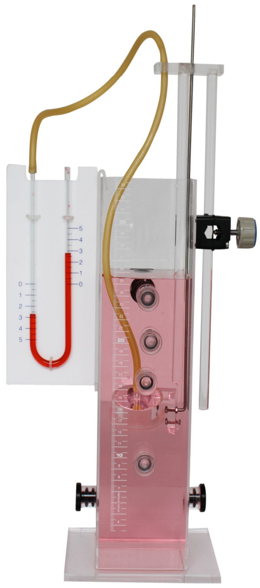

Figure 4

V. Discussion

Depth on Liquid Pressure Indicator (cm).						
Differences between water levels on U-tube Manometer (cm).						

1. If the depth in the Liquid Pressure Indicator is deeper, what will the differences between both of water levels change in the U-tube Manometer?
2. Why are one of the water level high but the other low in the U-tube Manometer.
3. Is the result of this experiment the same as the experiment 3?

Experiment 5, Side Pressure in the Water.

I. Purpose

Observe the bottom pressure in the water by Liquid Pressure Indicator and observe the variation of water level caused by pressure by U-tube Manometer.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
3	U-tube Manometer	1
4	Liquid Pressure Indicator	1
11	Soft Tube	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P=\frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by the density D, so which is F = A x h x d, in other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P=\frac{F}{A}=\frac{A\times h\times d}{A}=h\times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, observe the side pressure in the water by Liquid Pressure Indicator, and observe the variation of the water level caused by pressure by U-tube Manometer. Since the water pressure transforms the rubber membrane and squeeze the internal air, the increasing pressure after the internal air is squeezed shows on the U-tube Manometer.

IV. Procedure

1. The experiment kit is as **Figure 5**.
2. Pour appropriate amount of water in the Water Tank Stand and drop several stains for observation.
3. Make the rubber membrane of the Liquid Pressure Indicator face left or right and slowly put it into the water.
4. Observe and note down the depth showed on the Liquid Pressure Indicator and the differences of the water level indicated by U-tube Manometer.

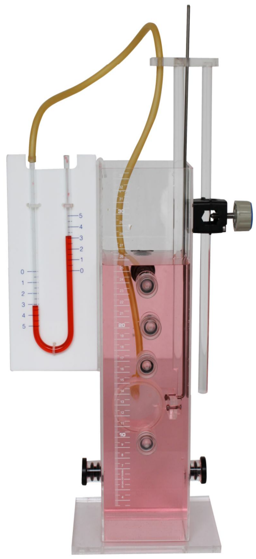

Figure 5

V. Discussion

Depth on Liquid Pressure Indicator (cm).						
Differences between water levels on U-tube Manometer (cm).						

1. If the depth in the Liquid Pressure Indicator is deeper, what will the differences between both of water levels change in the U-tube Manometer?
2. Why are one of the water level high but the other low in the U-tube Manometer.
3. Is the result of this experiment the same as the experiment 3 and 4?

Experiment 6, Pressure and Depth in the Water.

I. Purpose

Observe the bottom pressure in the water by Liquid Pressure Indicator and observe the variation of water level caused by pressure by U-tube Manometer.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
3	U-tube Manometer	1
4	Liquid Pressure Indicator	1
11	Soft Tube	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P = \frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by the density D, so which is F = A x h x d, in other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P = \frac{F}{A} = \frac{A \times h \times d}{A} = h \times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, observe the relationship between the pressure and depth in the water by Liquid Pressure Indicator, and observe the variation of the water level caused by pressure by U-tube Manometer. Since the water pressure transforms the rubber membrane and squeeze the internal air, the increasing pressure after the internal air is squeezed shows on the U-tube Manometer.

IV. Procedure

1. The experiment kit is as **Figure 6**.
2. Pour appropriate amount of water in the Water Tank Stand and drop several stains for observation.
3. Make the rubber membrane of the Liquid Pressure Indicator face up and slowly put it into the water.
4. Observe and note down the depth showed on the Liquid Pressure Indicator and the differences of the water level indicated by U-tube Manometer.
5. Have the Liquid Pressure Indicator front down and repeat step 3 and 4.
6. Make the Liquid Pressure Indicator face left or right and re-perform step 3 and 4.

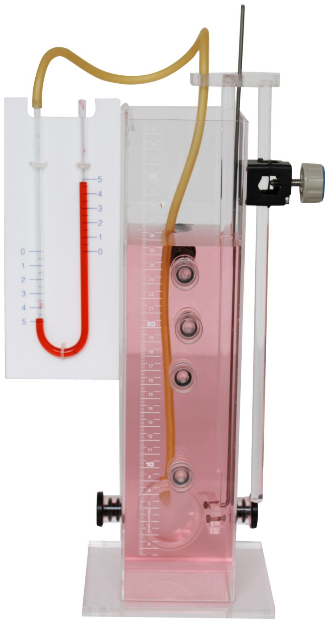

Figure 6

V. Discussion

Liquid Pressure Indicator face-up:

Depth on Liquid Pressure Indicator (cm).						
Differences between water levels on U-tube Manometer (cm).						

Liquid Pressure Indicator face-down:

Depth on Liquid Pressure Indicator (cm).						
Differences between water levels on U-tube Manometer (cm).						

Liquid Pressure Indicator face-left or right:

Depth on Liquid Pressure Indicator (cm).						

Differences between water levels on U-tube Manometer (cm).						

1. If the depth in the Liquid Pressure Indicator is deeper, what will the differences between both of water levels change in the U-tube Manometer?
2. Why are one of the water level high but the other low in the U-tube Manometer.

Experiment 7, Observation of Side Pressure in the Water.

I. Purpose

Observe side pressure in different depth of water and phenomena of water pressure perpendicular to the surface of the wall.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
2	Rectangular Water Tank	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P = \frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by the density D, so which is F = A x h x d, in other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P = \frac{F}{A} = \frac{A \times h \times d}{A} = h \times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, there are small holes drilled in different depths in the Water Tank Stand, and comprehend the deep depth, the higher pressure by the observation of the water gushing out closely to or far away from the tank.

IV. Discussion

1. The experiment kit is as **Figure 7**.
2. Pour appropriate amount of water in the Water Tank Stand and drop several stains in the water for observation.
3. Pull out the bolt/cork quickly, observe and note down the distance which the water gushes out.

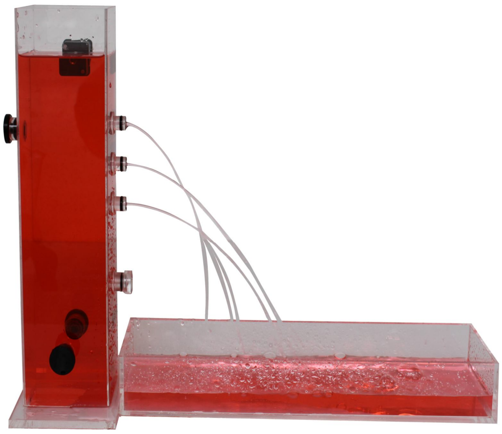

Figure 7

V. Discussion

1st time		2nd time		3rd time	
	Distance		Distance		Distance
Highest point		Highest point		Highest point	
Middle point		Middle point		Middle point	
Lowest point		Lowest point		Lowest point	

1. Is the angle which the water gushes out perpendicular to the surface of the wall?
2. From which point does the water gush out the furthest?

Experiment 8, Observation of Top Pressure in the Water.

I. Purpose

By Liquid Top Pressure Observation Device, observe the top pressure in the water, pour the water slowly in the Water Tank Stand and observe the round plate fall.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
5	Liquid Top Pressure Observation Device	1

III. Theory

Pressure is a unit area which the direction of the perpendicular force acts on $P=\frac{F}{A}$. In the depth h of a liquid, assume there is an area A, the force which A is applied is the weight of the liquid above, which is the volume of the liquid A x h, and multiplied by the density D, so which is F = A x h x d, in other words, the force which acts on the area A is A x h x d, and the pressure which each point is applied on the area is $P=\frac{F}{A}=\frac{A\times h\times d}{A}=h\times d$. Consequently, the pressure of each point in the water is related to the depth of liquid only. The top, bottom, and side pressure in the same depth are the same. In this experiment, by Liquid Top Pressure Observation Device, as pressing it into the water, part of the cylinder is filled by air, the red plastic round plate of the observation device is applied on by top pressure in the water $P_{up}=h\times d$, and pour the water into the air part in the cylinder. When the water column is the same height as the water level, the red plastic round plate is not applied not only by top pressure in the water P_{up}, but also by the water column $P_{down}=h\times d$, and both of the pressures are equal and make the round plate drop.

IV. Procedure

1. The experiment kit is as **Figure 8**.
2. Pour appropriate amount of water in the Water Tank Stand, but no stain is needed.
3. Place the plastic plate of the Liquid Top Pressure Observation Device at the bottom, pull the string and press it into the water slowly. (Pull it tightly to avoid the water leak into the observation device.)
4. Pour the stain slowly into the cylinder in the centre of the Liquid Top Pressure Observation Device (along the wall of the cylinder). When observing and noting down the water level, the

plastic round plate falls.

Figure 8

V. Discussion

Liquid Top Pressure Observation Device in the water, depth: _____ cm.

Water level in the cylinder.	1cm	2cm	3cm	4cm	5cm	6cm
Whether the plastic round plate falls down or not.						
Water level in the cylinder.	7cm	8cm	9cm	10cm	11cm	12cm
Whether the plastic round plate falls down or not.						

1. Why is it necessary to slowly pour the water in the cylinder (along the wall of the cylinder)?
2. If the Liquid Top Pressure Observation Device is pressed into the Water Tank Stand more deeply, should the water level ascend or descend to make the plastic plate fall?

Experiment 9, Buoyancy and Flotation.

I. Purpose

Measure and sink a sinking object into the water, the weight loss is the buoyancy which the water applies to the sinking object. Change the direction of applied force by Fixed Pulley, pull the floating object into the water, the buoyancy which the floating object is applied to will present on the Spring Scale.

II. Instrument

NO	Name	Amount
1	Water Tank Stand	1
9	Acrylic Prop	2
10	Clamp with Hook	1
14	Buoyancy Cylinders (density more than 1)	1
15	Buoyancy Cylinders (density less than 1)	1
28	Spring Scale	1
32	Mass Set	1

III. Theory

A substance in the fluid which is acted on by buoyancy B can be written as $B = V_{in} \times d$, V_{in} is the space which the object occupies, which means the volume which is pushed by the object as well, d belongs to the density of the fluid, and the direction of buoyancy is opposite to the direction of gravitation. If the substance is a sinking object, it will automatically sink into the water completely; V_{in} is equal to the volume V of the object, and the density of water is 1, so the buoyancy of the sinking object is $B = V_{in} \times d = V \times 1 = V$. If the substance is floating object, the gravity and buoyancy reach balance when the floating object floats in the water, hence the buoyancy is $B = W$. In this experiment, it is available to measure the buoyancy of the sinking object with the weight loss of it in the water; pull the floating object down into the water with the Spring Scale by pulley, and the buoyancy acts on the object will indicate on the Spring Scale.

IV. Procedure

Identification between sinking and floating object.

1. Pour the water in the Water Tank Stand for 80%-full.
2. Put both of the Buoyancy Cylinders into the water.
3. Observe and note down which one sinks and floats.

Experiment of sinking object.

1. As shown as **Figure 9**, fasten the Acrylic Prop on the Water Tank Stand, fix the Clamp with