12

DepED
DEPARTMENT OF EDUCATION

General Physics 1

Quarter 2 – Module 7:
Bernoulli’s Principle

SELF-LEARNING MODULE

SLM

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

General Physics- Grade 12
Self-Learning Module (SLM)
Quarter 2 – Module 7: Bernoulli's Principle
First Edition, 2020

Development Team of the Module

Writers: Al Jane S. Bacolod, Mariel Grace Jamero

Editors: Nestor A. Raguindin, Retchie Joy B. Pisana, Emma T. Surita, Mitsheroos C. Menguita

Reviewers: Blessy Mae M. Cabayao, Murdy F. Bautista, Jay Sheen A. Molina

Illustrator: Lyndin S. Bordamonte

Layout Artist: Solomon P. Lebeco Jr.

Cover Art Designer: Ian Caesar E. Frondoza

Management Team:

Allan G. Farnazo, CESO IV – Regional Director
Atty. Fiel Y. Almendra, CESO V – Assistant Regional Director
Ruth L. Estacio PhD, CESO VI – OIC – Schools Division Superintendent
Jasmin P. Isla - Assistant Schools Division Superintendent
Gilbert B. Barrera – Chief, CLMD
Arturo D. Tingson Jr. – REPS, LRMS
Peter Van C. Ang-ug – REPS, Science, ADM
Lalaine SJ. Manuntag PhD – CID Chief
Nelida S. Castillo PhD – EPS LRMS
Marichu Jean R. Dela Cruz – EPS Science, ADM

Printed in the Philippines by Department of Education – SOCCSKSARGEN Region
Office Address: Regional Center, Brgy. Carpenter Hill, City of Koronadal
Telefax: (083) 2288825/ (083) 2281893
E-mail Address: region12@deped.gov.ph

12

General Physics 1

Quarter 2 – Module 7: Bernoulli’s Principle

SELF-LEARNING MODULE

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

Introductory Message

For the facilitator:

Welcome to the **General Physics – Grade 12** Self-Learning Module (SLM) on **Bernoulli's Principle**

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the **General Physics – Grade 12** Self-Learning Module (SLM) on **Bernoulli's Principle**

The hand is one of the most symbolized part of the human body. It is often used to depict skill, action and purpose. Through our hands we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

What I Need to Know	This will give you an idea of the skills or competencies you are expected to learn in the module.
What I Know	This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.
What's In	This is a brief drill or review to help you link the current lesson with the previous one.
What's New	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.
What is It	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
What's More	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
What I Have Learned	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.
What I Can Do	This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.

Assessment — This is a task which aims to evaluate your level of mastery in achieving the learning competency.

Additional Activities — In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.

Answer Key — This contains answers to all activities in the module.

At the end of this module you will also find:

References — This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

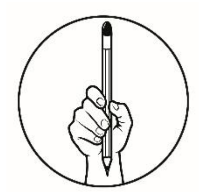
What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of physical science. The scope of this module permits it to be used in many different situations, and lets you explore the vast concept of physical science. The lessons are arranged to follow the standard sequence of the course.

At the end of this module, you will be able to **apply Bernoulli's principle and continuity equation whenever appropriate to infer relations involving pressure, elevation, speed and flux.**

After going through this module, you are expected to:

1. Explain the concept of Bernoulli's Principle and the Continuity Equation
2. Calculate problems related to Bernoulli's Principle



What I Know

Pre-Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on the space provided before each number.

___ 1. Bernoulli's equation refers to the relationship between pressure and velocity in an inviscid, incompressible flow. Which of the following refers to the relationship?

a) p = constant
b) p + 0.5ρ*V2 = constant
c) 0.5ρ*V2 = 0
d) p + 0.5ρ*V2 = 0

___ 2. Which of the following principles is based with aircrafts?

a) Newton's third law
b) Conservation of mass
c) Bernoulli's principle
d) Gravity

___ 3. Which of the following is applicable with Bernoulli's equation?

a) Irrotational flow
b) Viscous flow
c) Inviscid, incompressible flow
d) Compressible flow

___ 4. The streamline divides the flow into two parts- the upper flow and the lower flow. At a point, the flow cannot enter into an object so the fluid has to stop and gradually comes to rest. What do you call this point?

a) Rest point
b) Stagnation point
c) Viscous point
d) Boundary layer point

___ 5. What is the sum of stagnation pressure or the total pressure?

a) Kinetic and potential energy
b) Static and dynamic pressure
c) Kinetic energy +potential energy +gravity
d) Cannot be determined

___ 6. Which of the following is derived from Bernoulli's Principle?

a) Conservation of mass
b) Conservation of energy
c) Newton's law of motion
d) Conservation of momentum

___ 7. What assumptions can we make about ideal fluids?

a. They are compressible, have laminar flow, and are viscous
b. They are incompressible, have turbulent flow, and are non-viscous
c. They are incompressible, have laminar flow, and are viscous
d. They are compressible, have turbulent flow, and are viscous

___ 8. What will happen to the cross-sectional area if the speed of the water increases?

a. increases
b. decreases
c. stays the same
d. become s zero

___ 9. Which of the following is the representation of the Continuity Equation?

a. $A_1V_1 = A_2V_2$
b. $A_1V_2 = A_2V_2$
c. $A_1V_1 = A_1V_2$
d. $A_2V_1 = A_1V_1$

___ 10. Which of the following principles relate the speed of a fluid moving through a pipe to the cross-sectional area of the pipe?

a. Pascal's Principle
b. Bernoulli's Principle
c. Conservation of velocity
d. Continuity Equation

___ 11. Continuity equation depends on _________.

a. Conservation of energy
b. Conservation of mass
c. Conservation of speed
d. Conservation of area

___ 12. Which of the following refers to Daniel Bernoulli's study of fluid dynamics "Hydrodynamica"?

a) It refers to the study of water.
b) It refers to the study of everything that doesn't work.
c) It refers to the study of how the three state of matter behave.
d) It refers to the study of how fluids behave when they are in motion.

___ 13. The shape of an airplanes' wing is called an airfoil helps generate "lift", one force needed for an airplane to fly. Which of the following perfectly describes an airfoil?

a) The wings lower surface is curved so that air rushing over the top of the wing speeds up and stretches out, which decreases the air pressure above the wing, allowing the air flow below the wing moves in a straighter line, thus its speed and pressure remain about the same.
b) The wings upper surface is curved so that air rushing over the top of the wing speeds up and stretches out, which decreases the air pressure above the wing, allowing the air flow below the wing moves in a straighter line, thus its speed and pressure remain about the same.
c) The wings lower surface is curved so that air rushing under the wing speeds up and stretches out, which decreases the air pressure above the wing, allowing the air flow the wing moves in a curvier line, thus its speed and pressure remain about the same.
d) The wings upper surface is curved so that air rushing under the wing speeds up and stretches out, which decreases the air pressure above the wing, allowing the air flow the wing moves in a curvier line, thus its speed and pressure remain about the same.

___ 14. What will happen to the pressure if the fluid moves faster?

a) Less
b) More
c) Many
d) Massive

___ 15. There are four forces acting upon an aircraft. Which of the following forces is the key aerodynamic force that keeps an object in the air?

a) Lift
b) Weight (gravity)
c) Drag
d)Thrust

Lesson 1 Flow of Words *(Bernoulli's Principle)*

This module was designed and written with you in mind. It is here to help you master the nature of physical science. The scope of this module permits it to be used in many different situations, and lets you explore the vast concept of physical science. The lessons are arranged to follow the standard sequence of the course.

What's In

Activity 1. Word Search

Look at the word bank below. Find and encircle the hidden words in the **GRID**. The words may be hidden across, down or diagonally.

BERNOULLI'S EQUATION
BERNOULLI'S PRINCIPLE
DANIEL BERNOULLI
FLUID
HYDRODYNAMICA

P	T	M	N	S	P	V	V	M	C	P	C	F	U	C	F	I	I	I	N
E	U	S	P	C	F	R	G	C	Z	U	Y	Y	X	W	K	L	S	N	O
I	N	E	Q	M	X	O	E	T	Z	C	Z	U	C	H	L	E	A	V	I
E	E	C	A	V	D	C	S	S	H	C	F	W	M	U	T	T	T	E	T
D	P	I	I	E	F	O	N	X	S	M	L	H	O	P	Q	J	R	R	A
J	X	H	A	L	G	T	J	G	M	U	L	N	G	Q	I	Y	X	S	M
B	E	R	N	O	U	L	L	I	S	P	R	I	N	C	I	P	L	E	R
Q	Q	P	O	C	Y	E	U	U	B	E	R	E	E	D	S	U	P	R	O
R	Z	N	A	I	B	I	P	V	B	P	W	O	J	X	G	Q	R	E	F
M	J	G	N	T	P	N	I	L	O	R	Y	M	B	N	H	U	N	L	E
I	O	G	S	Y	I	G	E	J	X	E	U	Z	N	G	D	H	S	A	D
P	R	G	N	Q	J	I	A	C	N	B	Y	E	N	I	Q	Z	C	T	C
E	A	C	B	S	N	N	L	U	L	W	D	Q	L	L	Q	K	H	I	I
N	O	I	T	A	U	Q	E	S	I	L	L	U	O	N	R	E	B	O	T
P	H	Y	D	R	O	D	Y	N	A	M	I	C	A	P	S	I	W	N	S
V	E	U	O	A	C	P	D	I	U	L	F	L	I	M	Z	Y	F	S	A
A	V	D	W	Q	O	M	M	Z	G	N	B	I	A	W	I	X	M	H	L
M	Y	Z	P	E	Y	V	U	M	L	K	I	N	P	M	U	I	U	I	P
E	Z	K	E	M	W	K	G	F	D	H	V	E	P	K	I	J	A	P	D
E	X	J	Q	N	R	W	U	D	Q	V	Q	S	C	J	Q	E	K	L	R

What's New

Activity 2. Guess What?

Each number comprises of words, combine all those words to create another word/s that is related to the topic to be discussed. Place your answer at the blank provided after the last word of each number.

Example:

- **Nook, Clay, You, Sin, Tease and Cease = Nucleosynthesis**
- **High, Draw, Fist, and Six = Hydrophysics**

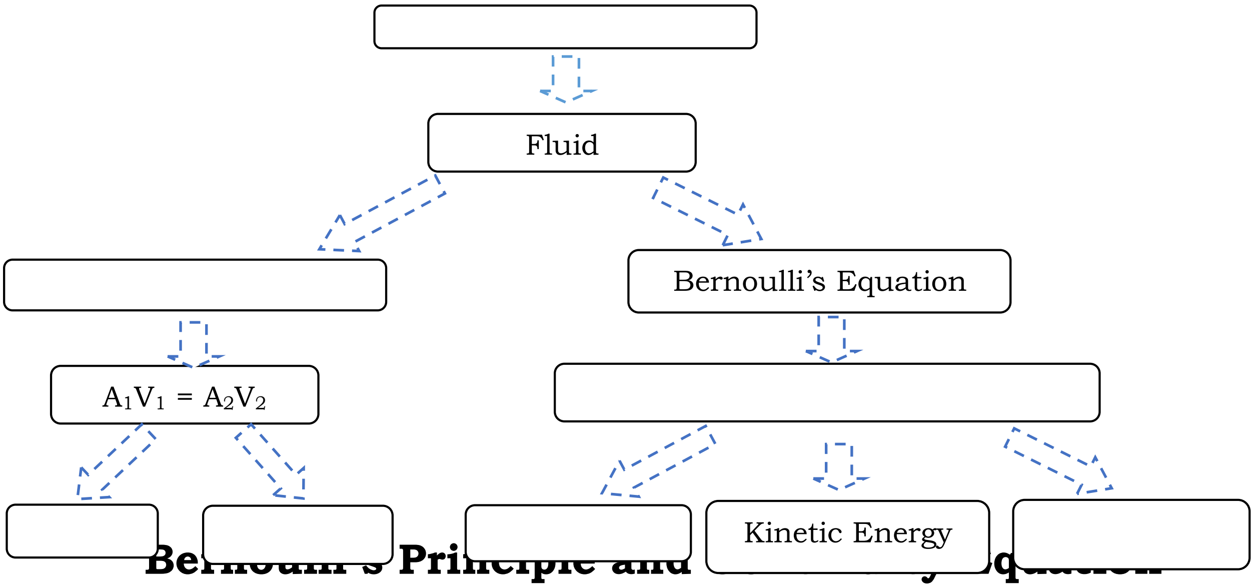
1. Burn, No, Less, Prince, Sea and Poll = ____________________
2. Pressed and Sure = ____________________
3. Done, Yell, Burn, No and Less = ____________________
4. Kin, Net , Tick, Inner and Gee = ____________________

5. Bale, Loss, See and Tea = ______________________________

What is It

Activity 3. Putting it All Together

Complete the missing pieces of the concept map. Based your answers on the selection that follow.



Daniel Bernoulli states that as the speed of a moving fluid (liquid or gas) increases, the pressure within the fluid decreases. It is a physical principle known as the **Bernoulli's Principle** that was published in his book Hydrodynamica in 1738**.** Bernoulli's principle can be explained in terms of the law of conservation of energy. As a fluid moves from a wider pipe into a narrower pipe or a constriction, a corresponding volume must move a greater distance forward in the narrower pie and thus have a greater speed. At the same time, the work done by corresponding volumes in the wider and narrower pipes will be expressed by the product of the pressure and the volume. Since the speed is greater in the narrower pipe, the kinetic energy of that volume is greater. Then, by the law of conservation of energy, this increase in kinetic energy must be balanced by a decrease in the pressure-volume product, or, since the volumes are equal, by a decrease in pressure. The formula for Bernoulli's Principle is $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$.

Meanwhile, derivation of continuity equation is one of the most important derivations in fluid dynamics. It is defined as the product of cross-sectional area of the pipe and the velocity of the fluid at any given point along the pipe is constant. This product is equal to the volume flow per second or simply the flow rate. It was given as, R = Av = **constant**. Thus, the formula for continuity equation is $A_1V_1 = A_2V_2$.

Ideal Fluids in Motion

The motion of *real fluids* is very complicated and not yet fully understood. Instead, we shall discuss the motion of an **ideal fluid,** which is simpler to handle mathematically and yet provides useful results. Here are four assumptions that we make about our ideal fluid; they all are concerned with *flow:*

1. *Steady flow* in *steady* (or *laminar*) *flow,* the velocity of the moving fluid at any fixed point does not change with time. The gentle flow of water near the center of a quiet stream is steady; the flow in a chain of rapids is not. Figure 14-12 shows a transition from steady flow to *non-steady* (or *nonlaminar* or *turbulent*) *flow* for a rising stream of smoke. The speed of the smoke particles increases as they rise and, at a certain critical speed, the flow changes from steady to non-steady.

2. *Incompressible flow* We assume, as for fluids at rest, that our ideal fluid is incompressible; that is, its density has a constant, uniform value.

3. *Non-viscous flow* Roughly speaking, the viscosity of a fluid is a measure of how resistive the fluid is to flow. For example, thick honey is more resistive to flow than water, and so honey is said to be more viscous than water. Viscosity is the fluid analog of friction between solids; both are mechanisms by which the kinetic energy of moving objects can be transferred to thermal energy. In the absence of friction, a block could glide at constant speed along a horizontal surface. In the same way, an object moving through a non-viscous fluid would experience no *viscous drag force*—that is, no resistive force due to viscosity; it could move at constant speed through the fluid. The British scientist Lord Rayleigh noted that in an ideal fluid a ship's propeller would not work, but, on the other hand, in an ideal fluid a ship (once set into motion) would not need a propeller!

4. *Irrotational flow* Although it need not concern us further, we also assume that the flow is *irrotational.* To test for this property, let a tiny grain of dust move with the fluid. Although this test body may (or may not) move in a circular path, in irrotational flow the test body will not rotate about an axis through its own center of mass. For a loose analogy, the motion of a Ferris wheel is rotational; that of its passengers is irrotational.

The Equation of Continuity

You may have noticed that you can increase the speed of the water emerging from a garden hose by partially closing the hose opening with your thumb. Apparently, the speed v of the water depends on the cross-sectional area A through which the water flows. Here we wish to derive an expression that relates v and A for the steady flow of an ideal fluid through a tube with varying cross section, like that in Fig. 1. The flow there is toward the right, and the tube segment shown (part of a longer tube) has length L. The fluid has speeds v_1 at the left end of the segment and v_2 at the right end. The tube has cross-sectional areas A_1 at the left end and A_2 at the right end. Suppose that in a time interval 't a volume 'V of fluid enters the tube segment at its left end (that volume is colored purple in Fig. 1). Then, because the fluid is incompressible, an identical volume 'V must emerge from the right end of the segment (it is colored green in Fig. 1)

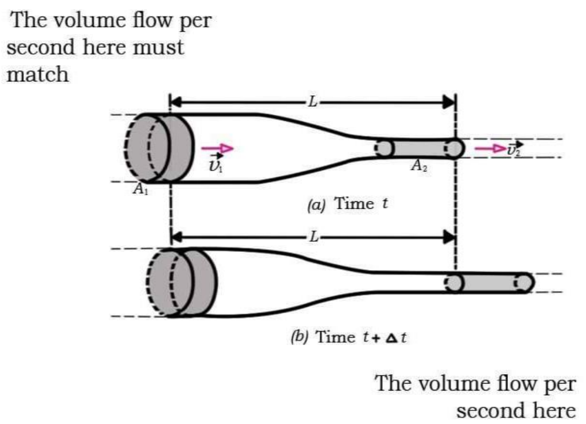


Figure 1. Fluid flows from left to right at a steady rate through a tube segment of length L. The fluid's speed is $v1$ at the left side and $v2$ at the right side. The tube's cross-sectional area is $A1$ at the left side and $A2$ at the right side. From time t in (a) to time $t + \Delta t$in (b), the amount of fluid shown in purple enters at the left side and the equal amount of fluid shown in green emerges at the right side.

We can use this common volume 'V to relate the speeds and areas. To do so, we first consider Fig. 2, which shows a side view of a tube of *uniform* cross-sectional area A. In Fig. 2a, a fluid element e is about to pass through the dashed line drawn across the tube width. The element's speed is v, so during a time interval Δt, the element moves along the tube a distance $\Delta x = v\,\Delta t$. The volume ΔV of fluid that has passed through the dashed line in that time interval Δt is

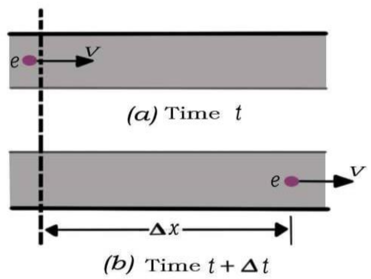


Figure 2. Fluid flows at a constant speed v through a tube. (a) At time t, fluid element e is about to pass the dashed line. (b) At time $t + \Delta t$, element e is a distance $\Delta x = v\,\Delta t$ from the dashed line.

$$\Delta V = A\,\Delta x = Av\,\Delta t.$$

Applying the equation above to both the left and right ends of the tube segment in Fig. 1, we have

$$\Delta V = A_1 v_1\,\Delta t = A_2 v_2\,\Delta t$$

or

$$A_1 v_1 = A_2 v_2 \text{ (equation of continuity).}$$

This relation between speed and cross-sectional area is called the **equation of continuity** for the flow of an ideal fluid. It tells us that the flow speed increases when we decrease the cross-sectional area through which the fluid flows. Equation of continuity applies not only to an actual tube but also to any so-called *tube of flow,* or imaginary tube whose boundary consists of streamlines. Such a tube acts like a real tube because no fluid element can cross a streamline; thus, all the fluid within a tube of flow must remain within its boundary. Figure 3 shows a tube of flow in which the cross-sectional area increases from area A_1 to area A_2 along the flow direction. From the equation of continuity, we know that, with the increase in area, the speed must decrease, as is indicated by the greater spacing between streamlines at the right in Fig. 3. Similarly, you can see that in Fig. 4 the speed of the flow is greatest just above and just below the cylinder.

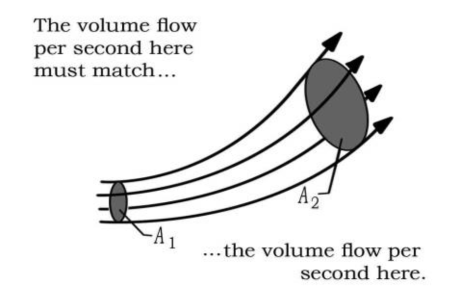


Figure 3. A tube of flow is defined by the streamlines that form the boundary of the tube. The volume flow rate must be the same for all cross sections of the tube of flow.

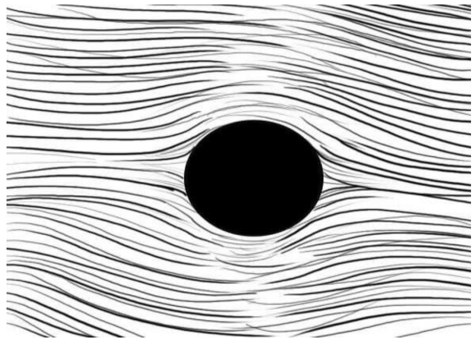


Figure 4. The steady flow of a fluid around a cylinder, as revealed by a dye tracer that was injected into the fluid upstream of the cylinder.

Bernoulli's Equation

Fig. 5 represents a tube through which an ideal fluid is flowing at a steady rate. In a time interval Δt, suppose that a volume of fluid ΔV, colored purple in Fig. 5, enters the tube at the left (or input) end and an identical volume, colored green in Fig. 5, emerges at the right (or output) end. The emerging volume must be the same as the entering volume because the fluid is incompressible, with an assumed constant density ρ.

Let y_1, v_1, and $p1$ be the elevation, speed, and pressure of the fluid entering at the left, and y_2, v_2, and p_2 be the corresponding quantities for the fluid emerging at the right. By applying the principle of conservation of energy to the fluid, we shall show that these quantities are related by

$$\mathbf{P_1 + \tfrac{1}{2}\,\rho v_1^2 + \rho g y_1 = P_2 + \tfrac{1}{2}\,\rho v_2^2 + \rho g y_2}.$$

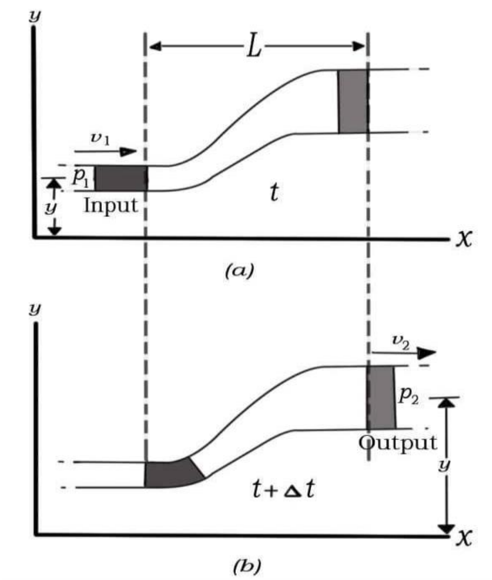


Figure 5. Fluid flows at a steady rate through a length L of a tube, from the input end at the left to the output end at the right. From time t in (*a*) to time $t + \Delta t$ in (*b*), the amount of fluid shown in purple enters the input end and the equal amount shown in green emerges from the output end.

In general, the term is called the fluid's **kinetic energy density** (kinetic energy per unit volume).We can also write the equation above as

$$p + \frac{1}{2}\rho v^2 + \rho g y = \text{a constant} \quad \text{(Bernoulli's equation).}$$

Equations above are equivalent forms of **Bernoulli's equation,** after Daniel Bernoulli, who studied fluid flow in the 1700s.* Like the equation of continuity, Bernoulli's equation is not a new principle but simply the reformulation of a familiar principle in a form more suitable to fluid mechanics. As a check, let us apply Bernoulli's equation to fluids at rest, by putting $v_1 = v_2 = 0$ in the first equation. The result is :

$$p_2 = p_1 + \rho g(y_1 - y_2).$$

A major prediction of Bernoulli's equation emerges if we take y to be a constant ($y = 0$, say) so that the fluid does not change elevation as it flows. First equation then becomes

$$p_1 + \frac{1}{2}\rho v_1^2 1 = p2 + \frac{1}{2}\rho v_2^2,$$

which tells us that:

If the speed of a fluid element increases as the element travels along a horizontal streamline, the pressure of the fluid must decrease, and conversely.

Put another way, where the streamlines are relatively close together (where the velocity is relatively great), the pressure is relatively low, and conversely. The link between a change in speed and a change in pressure makes sense if you consider a fluid element that travels through a tube of various widths. Recall that the element's speed in the narrower regions is fast and its speed in the wider regions is slow. By Newton's second law, forces (or pressures) must cause the changes in speed (the accelerations). When the element nears a narrow region, the higher pressure behind it accelerates it so that it then has a greater speed in the narrow region. When it nears a wide region, the higher pressure ahead of it decelerates it so that it then has a lesser speed in the wide region. Bernoulli's equation is strictly valid only to the extent that the fluid is ideal. If viscous forces are present, thermal energy will be involved, which here we neglect.

Sample Problem:

Problem 1. In an altitude 0f 4.6 m , the speed of the hose from the nozzle 1.96 m/s and its pressure is 63000 Pa. What happen to the pressure when the altitude is increased to 6.8 m and has a speed of 2.47 m/s?

Given:
P_1= 63000 Pa,
v_1= 1.96 m/s, ,
h_1= 4.6 m, **P_2 = ?,**
v_2= 2.47 m/s, h_2= 6.8 m,

ρ = 1000 kg/m³ ,
g= 9.8 m/s²

Derivation of Formula:

$$P_1 + ½\,\rho v_1^2 + \rho g h_1 = P_2 + ½\,\rho v_2^2 + \rho h y_2$$

$$\frac{P1 + ½\,\rho v12 + \rho gh1}{½\,\rho v22 + \rho gh2} = \frac{P2 + ½\,\cancel{\rho} v22 + \cancel{\rho} gh2}{½\,\cancel{\rho} v22 + \cancel{\rho} gh2}$$

$$\frac{P1 + ½\,\rho v12 + \rho gh1}{½\,\rho v22 + \rho gh2} = P_2$$

Newly Derived Formula: $P_2 = P_1 + ½\,\rho[v_1^2 - v_2^2] + \rho g\,[h_1 - h_2]$

Solution:

$P_2 = P_1 + ½\,\rho[v_1^2 - v_2^2] + \rho g\,[h_1 - h_2]$

$\boxed{m^3 - m^1 =}$

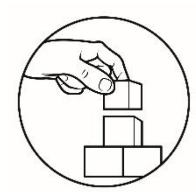
$= 63000\ kg/m \times s^2 + [½\,(1000\ kg/m^3)[(1.96\ m/s)^2 -)(2.47\ m/s)^2]] + [(1000\ kg/m^3)(9.8\ m/s^2)(4.6m - 6.8\ m)]$

$= 63000\ kg/m \times s^2 + [500kg/m^3\ (3.8416\ m^2/s^2 - 6.1009\ m^2/s^2)] + [(9800\ kg/m^2 \times s^2)(-\,2.2\ m)]$

$= 63000\ kg/m \times s^2 + [500kg/m^3\ (-\,2.2593\ m^2/s^2)] + [(9800\ kg/m^2 \times s^2)(-\,2.2\ m)]$

$= 63000\ kg/m \times s^2 + (-1129.65\ kg/m \times s^2) + (-\,21560\ kg/m \times s^2)$

$\boxed{P_2 = 40\,310.35\ kg/m \times s^2 \text{ or } 40\,310.35\ Pa}$



What's More

Activity 4. Flow Fast

Look for an empty bottle or an empty milk cartoon, using a pen or a nail punch a three holes on the side of the bottle or cartoon (the holes be in a vertical position). Put a number on the holes 1 on the topmost hole then 2 in the middle hole and 3 for the last hole. Give at least a 2 inch distance between the holes. Cover the holes using a tape. Fill in the bottle or cartoon with water.

a) Remove the tape on the hole number 1, observe the streamlines and draw a sketch of what you have observe. Repeat the process for hole number 2 and 3. Draw your sketch on the space provided.

Guide Questions:

1. How do the streams of water differ from each hole? Which hole had the farthest distance covered?

3. Relate this activity using the Bernoulli's Principle.

Activity 5. AM I TRUE OR FALSE?

Write **TRUE** if the statement is correct and if it is FALSE, **change the underlined word** to the correct one to make the whole statement correct. Place your answer on the space provided before the number.

__________ 1. If fluid is incompressible and is steady, its mass is conserved.

__________ 2. Constant of continuity equation is also known as the fluid flow.

__________ 3. Bernoulli's equation cannot be directly applied to viscous flow.

__________ 4. An aircraft fly was based on Bernoulli's principle.

__________ 5. Bernoulli's principle states that increasing the velocity increases the pressure which gives us a higher lift.

Activity 6. Fill Me In

Calculate the problems using Bernoulli's Equation. Write the Given, Derivation of Formula, Solution and enclose your final answer in a box.

Problem 1. A water conveyor's pressure at the first point is 128 kPa with a velocity of 3.9 m/s at a height of 3.3 m. On the last point of the water conveyor the velocity is reduced to 2.6 m/s at a height of 1.8 m. What is pressure in the last point?

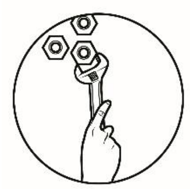
What I Have Learned

Activity 7. Complete Me

Fill in the blanks with the correct answer.

1. **Bernoulli's Equation** can be considered to be a statement of the __________________ principle appropriate for flowing fluids.
2. **Bernoulli's Equation** accounts for the trade-off between ________ and pressure.
4. **Bernoulli's Principle** states that as the speed of a moving fluid (liquid or gas) increases, the pressure within the fluid____________.
5. **Velocity** is the rate of change of____________.
6. **Bernoulli's equation** is applicable only for __________ and incompressible flow
7. **Stagnation point** is the point where the flow slows down and come to __________.
8. **Pressure** as a measure of energy per unit volume from its *definition* as ____________ per unit area is given in.
9. **Speed** is a scalar quantity that refers to "how ____________ an object is moving."
10. **Inverse Relationship** is when one value ____________ at the same rate that the other increases.
11. **Plastic Deformation** is a permanent deformation or change in shape of a solid body without ____________ under the action of a sustained force
12. **Hydrodynamica** written by Daniel Bernoulli in 1738 in which he considered the properties of basic importance in fluid flow, particularly ____________, density, and ____________, and set forth their fundamental relationship.

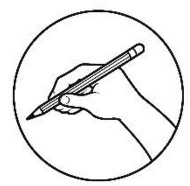
13. Fluid any liquid or ____________ or generally any material that cannot sustain a tangential, or shearing, force when at rest and that undergoes a continuous change in shape when subjected to such a stress.
14. Daniel Bernoulli's most important work considered the basic properties of ____________, pressure, density and velocity, and gave the Bernoulli principle.
15. An aircraft fly was based on ____________ principle.
16. If fluid is incompressible and is steady, its **mass** is ____________.



What I Can Do

3-2-1 Journal Writing
Write the following:

Three (3) things you have learned from the topic.
Two (2) concepts that are not clear to you.
One (1) question you wanted to ask.



Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on the space provided before each number.

___ 1. Who authored the book entitled "Hydrodynamics?
- a. Albert Einstein
- b. Daniel Bernoulli
- c. Isaac Newton
- d. Marie Curie

___ 2. How does airplane fly based on Bernoulli's principle?
- a. Airplanes have jet blasters beneath the wing.
- b. Gravity creates an equal and opposite reaction because it is not strong.
- c. High pressure presses up against the low pressure on the bottom of the wing.
- d. High pressure presses up against the low pressure on the top of the wing.

___ 3. What assumptions can we make about ideal fluids?
- a. They are compressible, have laminar flow, and are viscous.
- b. They are incompressible, have laminar flow, and are viscous.
- c. They are compressible, have turbulent flow, and are viscous.
- d. They are incompressible, have turbulent flow, and are non-viscous

___ 4. In Bernoulli's principle velocity and pressure is inversely proportional to each other. What does it imply?
- a) Both Velocity and Pressure decreases.
- b) Both Velocity and Pressure increases.
- c) When Velocity Increases the Pressure decreases
- d) None of the above.

___ 5. What is a dynamic pressure?

a) It is an actual pressure.
b) It simply justifies the decrease in pressure due to the increase in the velocity.
c) When the density is half and the velocity is squared, the pressure increases.
d) It talks about the pressure and the velocity being directly proportional to each other.

___ 6. A pipeline has an initial height of 0.0 m having a pressure of 150,000 Pa and a velocity of 5.0 m/s. What happen to the pressure if the velocity is now at 10.0 m/s at a height of 2.0 meter?

a) 90, 900 Pa
b) 91, 900 Pa
c) 92, 900 Pa
d) 93, 900 Pa

___ 7. What do you call the paths of individual fluid particles?

a) Fluid Line
b) Pipeline
c) Streamline
d) Water Line

___ 8. When Static Pressure and Dynamic Pressure are added together it is called total pressure. What is the other term for total pressure?

a) Gravitational Force
b) Kinetic Energy
c) Potential Energy
d) Stagnation Pressure

___ 9. At section A, the elevation of the pipeline is 100m with a velocity of 15 m/s and in Section B the elevation is 7 meter higher than at Section A having a velocity of 30 m/s. Calculate the pressure at Section A if the pressure in Section B is 35, 000 Pa.

a) 441, 100 Pa
b) 541, 100 Pa
c) 641, 100 Pa
d) 741, 100 Pa

___ 10. Bernoulli's principle is widely used in our daily life. Among the choices, below what is **NOT** an example of Bernoulli's principle?

a) Aircraft
b) Baseball
c) Hydraulic Jack
d) Sailing

___ 11. Which of the following is the formula of Bernoulli's Equation?

a) $P_1+3/4\rho v_1^2+\rho gh_1=P_2+1/2\rho v_2^2+\rho gh_2$
b) $P_1+1/2\rho v_1^2+\rho gh_1=P_2+1/2\rho v_2^2+\rho gh_2$
c) $P_1+1/3\rho v_1^2+\rho gh_1=P_2+1/2\rho v_2^2+\rho gh_2$
d) $P_1+1/6\rho v_1^2+\rho gh_1=P_2+1/2\rho v_2^2+\rho gh_2$

___ 12. How does laminar flow differ from turbulent flow?

a) Laminar flow and Turbulent flow are the type of fluid that flows smoothly or in irregular fluctuations.
b) Laminar flow is a type of fluid that flows smoothly or in a regular paths while Turbulent flow undergoes irregular fluctuations and mixing.
c) Laminar flow and Turbulent flow are the type of fluid that flows roughly or in regular fluctuations.
d) Turbulent flow is a type of fluid that flows smoothly or in a regular paths while Laminar flow undergoes irregular fluctuations.

___ 13. There are four natural types of matter, solid, liquid, gas and plasma. Bernoulli's principle deals with what types of matter?

a) Liquid only
b) Liquid and Gas
c) Liquid and Solid
d) Liquid and Plasma

___ 14. How does aircrafts apply the concept of Bernoulli's principle?
   a) Bernoulli's principle helps explain that an aircraft can't achieve lift because of the shape of its wings.
   b) Fast moving air equals high air pressure while slow moving air equals low air pressure.
   c) Its' wings are shaped so that that air flows slower over the top of the wing and faster underneath.
   d) The high air pressure underneath the wings will therefore push the aircraft up through the lower air pressure.

___ 15. What is Bernoulli's effect?
   a) An application of force.
   b) It is the reduction in pressure that occurs when the fluid speed increases.
   c) A pressure that a fluid exerts when it is not moving caused by the weight of the fluid.
   d) It is the equal to the sum of the free-stream static pressure and the free-stream dynamic pressure.

Additional Activities

Performance Task

Make your own essay about Bernoulli's principle and the continuity equation. Give also an example of their real-life application. You may present your essay in a short bond paper written or printed will do.

3-2-1 JOURNAL WRITING: Make a short reflection on the things that you've learned for today's lesson.

DIRECTION: On the space below, write the following:

Three (3) things you have learned on the topic
Two (2) concepts that are not clear to you.
One (1) question you wanted to ask.

Rubric for the Performance Task

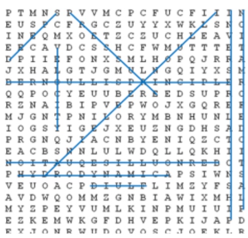
Rubrics			
Criteria	**Excellent**(3)	**Proficient**(2)	**Adequate**(1)
Explanation	Provided a very comprehensive explanation about their presentation.	Provided an explanation about their presentation.	Did not provide a clear explanation about their presentation.
Cleanliness and Orderliness	No mess and erasures that can be seen in their presentation.	There is a slight mess and erasures that can be seen in their presentation.	The presentation contains a lot of erasures.

Answer Key

Pre-Assessment

1. B	6. B	11. A
2. C	7. B	12. D
3. C	8. B	13. B
4. B	9. A	14. A
5. B	10. D	15. A

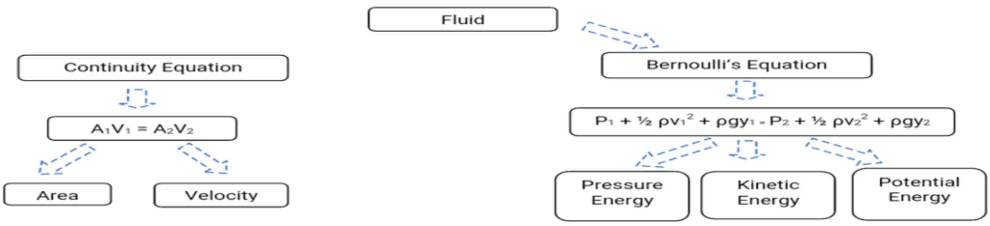
Activity 1: Word Search



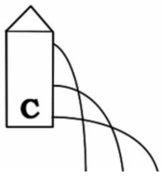
Activity 2 : Guess What

1. Bernoulli's Principle
2. Pressure
3. Daniel Bernoulli
4. Kinetic Energy
5. Velocity

Activity 3: Putting it all Together



Activity 4: Flow Fast



Answers may vary for guide questions 1 and 2.

ACTIVITY 5: MODIFIED TRUE OR FALSE

1. TRUE
2. Flow rate
3. TRUE
4. TRUE
5. Decreases

Activity 7: Complete Me

1. Conservation of energy
2. Velocity
3. Decreases
4. Distance
5. Inviscid
6. Rest
7. Force
8. Fast
9. Decreases
10. Fracture
11. Pressure, density and velocity
12. Gas
13. Fluid Flow
14. Bernoulli's
15. Conserved

Activity 6: Fill Me In

Problem 1:

Given:

P_1 = ?,

v_1 = 2.6 m/s, ,

h_1 = 1.8 m,

P_2 = 128000 Pa ,

v_2 = 3.9 m/s,

h_2 = 3.3 m,

ρ = 1000 kg/m³ ,

g= 9.8 m/s²

Derivation of Formula:

$$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \rho h y_2 \Rightarrow \frac{P1 + \cancel{\tfrac{1}{2}\rho v12} + \cancel{\rho gh1}}{\cancel{\tfrac{1}{2}\rho v12} + \cancel{\rho gh1}} = \frac{P2 + \tfrac{1}{2}\rho v22 + \rho gh2}{\tfrac{1}{2}\rho v12 + \rho gh1} \Rightarrow P_1 = = \frac{P2 + \tfrac{1}{2}\rho v22 + \rho gh2}{\tfrac{1}{2}\rho v12 + \rho gh1}$$

Newly Derived Formula: $P_1 = P_2 + \tfrac{1}{2}\rho[v_2^2 - v_1^2] + \rho g[h_2 - h_1]$

Solution:

$P_1 = P_2 + \tfrac{1}{2}\rho[v_2^2 - v_1^2] + \rho g[h_2 - h_1]$

$\boxed{m^3 - m^1 =}$

$= 128000 \text{ kg/m x s}^2 + [\tfrac{1}{2}(1000 \text{ kg/m}^3)[(3.9 \text{ m/s})^2 -)(2.6 \text{ m/s})^2]] + [(1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(3.3\text{m} - 1.8 \text{ m})]$

$= 128000 \text{ kg/m x s}^2 + [500\text{kg/m}^3 (15.21 \text{ m}^2/\text{s}^2 - 6.76\text{m}^2/\text{s}^2)] + [(9800 \text{ kg/m}^2 \text{ x s}^2)(- 1.5 \text{ m})]$

$= 12800 \text{ kg/m x s}^2 + [500\text{kg/m}^3 (8.45\text{m}^2/\text{s}^2)] + (14700 \text{ kg/m x s}^2)$

$= 128000 \text{ kg/m x s}^2 + (4225 \text{ kg/m x s}^2) + (14700 \text{ kg/m x s}^2)$

$\boxed{P_1 = 146925 \text{ kg/m x s}^2 \text{ or } 146925 \text{ Pa}}$

References

Books

Johnson, John D. Cutnell & Kenneth W. *Physics 7th Edition.* Illonois: John Wiley & Sons, Inc (Asia), 2007.

Jearl Walker, David Halliday & Robert Resnick. *Fundamentals of Physics* 10th edition. John Wiley & Sons, Inc., 2014

Web Links

2020. *ABS Free Pic.* Accessed 26 May , 2020. http://absfreepic.com/free-photos/download/light-bulb-lamp-.

Advameg, Inc. 2020. *Chemistry Explained.* Accessed 26 May, 2020. http://www.chemistryexplained.com/Ar-Bo/Atomic-Nucleus.html.

Asia, The Hive. 2018. *Yahoo.com.* 16 February . Accessed 29 May , 2020. https://ph.news.yahoo.com/sharon-cuneta-shares-details-past-.

Bohr atomic model. (2015). In Encyclopædia Britannica Online. Retrieved October 27, 2015 from http://www.britannica.com/science/Bohratomic-model

Chadwick discovers the neutron. (1998). Retrieved October 27, 2015 from http://www.pbs.org/wgbh/aso/databank/entries/dp32ne.html

Chronology of Discoveries in Atomic Structure. (n.d.) Retrieved October 27, 2015 from http://www.chemteam.info/AtomicStructure/ HistAtomicStructure.pdf

Henry Moseley. (2014, December 29). Retrieved October 27, 2015 from http://www.famousscientists.org/henry-moseley/

Hope, I. 2018. *The Atomic Number and the Synthesis of New Elements.* 18 November

Hope, I. 2018. *The Nuclear Reactions Involved in the Synthesis of New Elements* . 19 November.

Rutherford atomic model. (2015). In Encyclopædia Britannica Online. Retrieved October 27, 2015 from http://www.britannica.com/science/ Rutherford-atomic-model

Thomson atomic model. (2015). In Encyclopædia Britannica Online. Retrieved Octo ber 27, 2015 from http://www.britannica.com/science/ Thomson-atomic-model

Making new elements. (2013). Retrieved May 20, 2016 from http://www.popsci.com/science/article/2013-04/making-new-elements

Discovery of the new chemical elements with numbers 113, 115, 117 and 118. (2016). Retrieved May 20, 2016 from http://www.jinr.ru/posts/ discovery-of-the-new-chemical-elements-with-numbers-113-115-117-and-118-2/

2020. *BC Courier.* Accessed 26 May, 2020. https://www.bccourier.com /%EF%BB%BFglobal-helium-gas-market-report-.

2020. *Butane. Chem.* Accessed 20 May, 2020. http://butane.chem.uiuc.edu/ pshapley/GenChem1/L1/Hcycle.gif.

2020. *Chemistry Learner.* Accessed 26 May, 2020. https://www.chemistrylearner. com/helium.html.

2020. *Courses Lumen Learning* . Accessed 30 May , 2020. https://courses.lumen learning.com/physics/chapter/33-3-accelerators-.

2020. *Cremp Coop.* Accessed 26 May, 2020. https://www.crempcoop.com/ product /jack-n-jill-nova-country-cheddar-.

2020. *Cute Wallpaper.* Accessed 27 May, 2020. https://cutewallpaper.org/ 21/balloon-images-hd/Red-Balloon-Balloon-HD-.

2018. *DL PNG.* Accessed 28 May, 2020. https://dlpng.com/png/494974.

2020. *Dreamstime.* Accessed 26 May, 2020. https://www.dreamstime.com/ camarines-sur-philippines-feb-close-up-.

2017. *Forbes.* 29 July. Accessed 27 May, 2020. https://www.forbes.com/ sites/startswithabang/2017/07/29/ask-ethan-.

2020. *Get Drawings* . Accessed 26 May, 2020. http://getdrawings.com/get-clipart#7-dwarfs-clipart-6.jpg.

2020. *Get Your Image* . Accessed 27 May , 2020. http://getyourimage.club/resize-12-may.html.

2019. *GMA Network.* Accessed 25 May, 2020. https://www.gmanetwork.com/ entertainment/showbiznews/news/46708/.

2020. *History.* Accessed 27 May, 2020. https://www.history.com/news/who-determined-the-speed-of-light.

2020. *HTC Wallpaper.* Accessed 28 May, 2020. http://htc-wallpaper.com/2013 /12/23/sheldon-cooper-big-bang-theory/.

EDITOR'S NOTE

This Self-learning Module (SLM) was developed by DepEd SOCCSKSARGEN with the primary objective of preparing for and addressing the new normal. Contents of this module were based on DepEd's Most Essential Learning Competencies (MELC). This is a supplementary material to be used by all learners of SOCCSKSARGEN Region in all public schools beginning SY 2020-2021. The process of LR development was observed in the production of this module. This is version 1.0. We highly encourage feedback, comments, and recommendations

For inquiries or feedback, please write or call:

Department of Education – SOCCSKSARGEN
Learning Resource Management System (LRMS)

Regional Center, Brgy. Carpenter Hill, City of Koronadal

Telefax No.: (083) 2288825/ (083) 2281893

Email Address: region12@deped.gov.ph