

Applications of air pressure

Integrated Science

St Francis Xavier's School, Tsuen Wan

13 December 2014



Developing Cycles of Teaching and Learning

SETTING THE CONTEXT

- Working with prior knowledge:
 - Particle theory
 - Concept of gas pressure
 - How a force is set up from gas pressure
- Informing what the new knowledge is:
 - Explaining how gas pressure difference results in a net force, which is applied in various ways in our lives.

Suggested Cycle of Teaching



EXPLAINING
how a balloon
in a bottle
behaves
*Modelling and
Deconstruction*

EXPLAINING
why a rubber
sucker works
*Guided
Construction*



EXPLAINING
why a can
gets crushed
*Independent
Construction*

EXPLAINING
why a drink
box collapses
Assessment

EXPLAINING
why a vacuum
plastic bag
works
Homework



Break up the content into manageable bits and make the thinking visible

When we teach new knowledge, we break it up into manageable bits by asking sets of content-specific **guiding questions**, which construct the knowledge for the students.

In other words, there is **pedagogical resonance** because the way that the teaching unfolds resonates with the unfolding of the knowledge.

By doing this—asking the **same set** of knowledge-specific guiding questions repeatedly over the teaching and learning cycle—we **scaffold** the students' learning.

Provide multiple ways of making meaning and a sequence that provides a macro-scaffold

We provide **multiple ways of making meaning** such as: experiments, simulations, diagrams, videos, sequences of spoken and written guiding questions.

We make sure the **sequence of activities and knowledge** move from the simple to the complex, the concrete to the technical and abstract—in this way, the students' are **scaffolded in both their language and their learning**.

St Francis Xavier's School, T.W.
Science Learning Circle — Lesson Plan

Teacher: LAM **Class:** 1B **Venue:** IS Lab (2/F) **Subject:** I.S. **Date:** 25 March 2014

Topic: Application of gas pressure

Content objectives:

1. Students understand the size of the “force” given by the atmospheric pressure (Magdeburg Hemisphere, rubber sucker)
2. Students can apply the particle theory and their knowledge of air pressure to explain an interesting phenomenon, e.g. The inflation of a balloon in a bottle by sucking out air from the bottle.
3. Students can apply the particle theory and their knowledge of air pressure to explain the working principle of some common tools, eg: a rubber sucker, a vacuum plastic bag

Language objectives :

1. Students are familiar with the technical and abstract terms used to explain gas pressure experiments.
2. Students learn the language resources needed to explain cause and effect.
3. Students can write a sequential explanation for the change in gas pressure.

OBJECTIVES	TEACHING FLOW	REMARKS
Motivation	1. Pressure gun demonstration [5 min]	Modelling
Development [~ 53 min]	1. Magdeburg Hemisphere [20 min] a. Video [2 min] http://www.youtube.com/watch?v=9iRkPiaFmVs b. Demonstration [inviting Ss to be involved; 5 min] c. Detailed explanation of Magdeburg Hemisphere: 13 min, with Q&A]	Modelling & deconstruction
	2. Balloon in a bottle expt. [8 min] ; WS 1: Filling the keywords a. Demonstration [3 min], one with a hole; the other without a hole b. Finding out the causes and effects [2 min] c. Group presentation (1-2 groups) [3 min]	Guided construction
	3. Rubber sucker [9 min]; WS 2 : Sequencing the explanation a. Student experiment [3 min] b. Sequencing the causes and effects (Group discussion) [3 min] c. Group presentation (1-2 groups) [3 min] (with support)	Guided construction
	4. Vacuum Plastic bag [16 min] ; WS 3 : Writing their own explanation a. Demonstration or video show [1 min] b. Finding the causes and effects (Group discussion) [3 min] c. Group presentation (1-2 groups) [12 min] (without support, A3 sheet per gp)	Independent construction
Consolidation [~20 min]	1. Writing an explanation for the working principle of a rubber sucker. 2. Writing an explanation for the working principle of a vacuum plastic bag.	1. Guided construction 2. Independent construction
Homework	Passage writing for the working principle of the pressure gun. Show the diagram of the internal structure of the pressure gun [2 min]	Independent construction

Please refer to
the last page

Language objectives

1. Students are familiar with the technical and abstract terms used to explain gas pressure experiments.
2. Students learn the language resources needed to explain cause and effect.
3. Students can write a sequential explanation for the change in gas pressure.

Motivation

Visible language

Example 1: Magdeburg Hemispheres

Questioning based on a set of guiding questions

Resonance and consolidation

Students' work

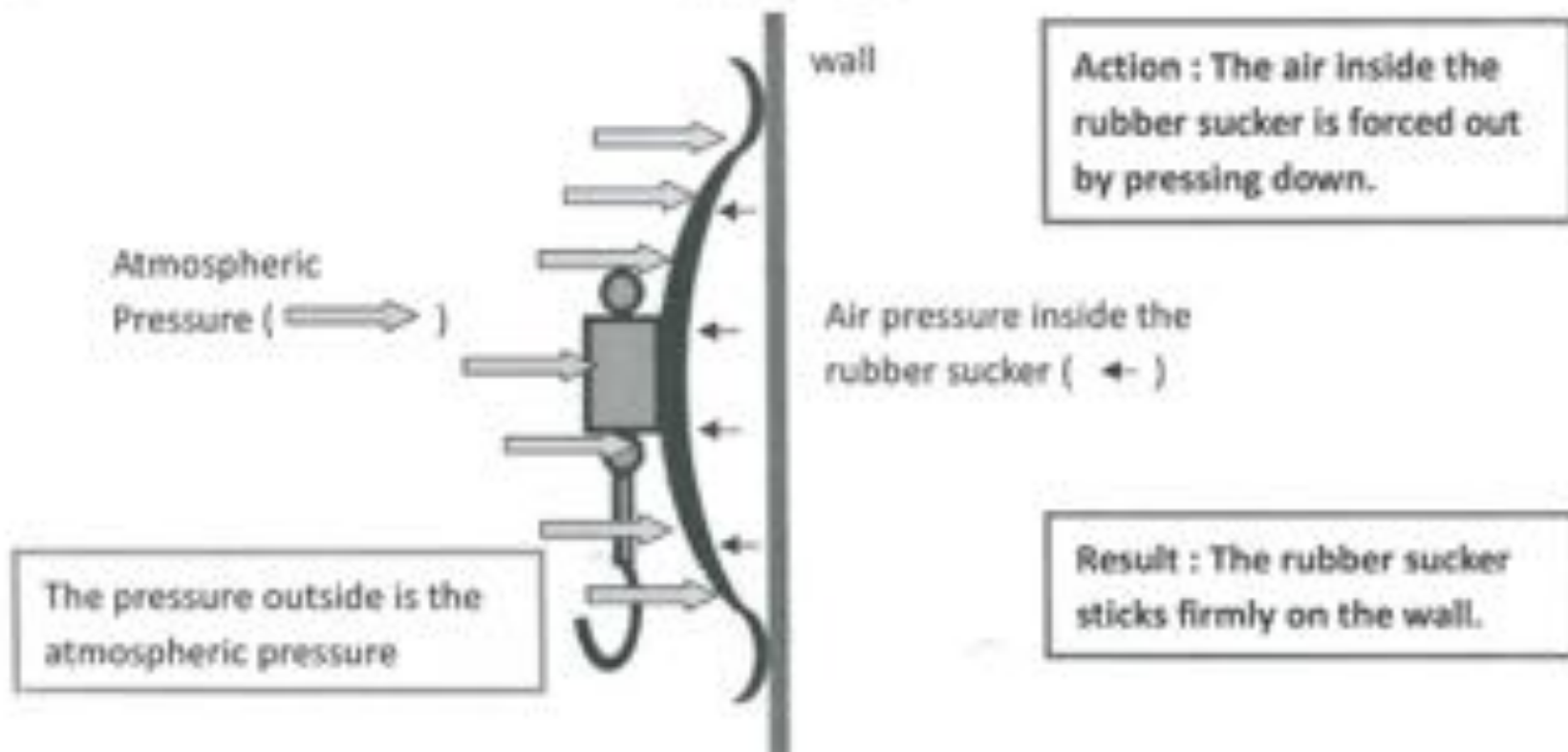
WS 2:

How to explain the working principle of everyday tools

(With hints for the guiding questions)

Sequencing 1B-S

1. Rubber sucker : used to hang light objects on a wall



Working principle of a rubber sucker :

Events	Descriptions of events	Guiding questions
Cause	We <u>force out the air</u> inside the rubber sucker by pressing it down.	What is the action?

Working principle of a rubber sucker :

Guiding questions

Events	Descriptions of events	Guiding questions
Cause	We <u>force out the air</u> inside the rubber sucker by pressing it down.	What is the <u>action</u> ?
Effect 1	The number of air particles inside the rubber sucker <u>decreases</u> .	What is the <u>change</u> in the <u>number of air particles</u> inside the rubber sucker? (increase or decrease ?)
Effect 2	The air pressure inside the sucker <u>decreases</u> .	What is the <u>change</u> in the <u>air pressure inside the sucker</u> ? (increase or decrease ?)
Effect 3	The air pressure outside the rubber sucker is <u>higher than</u> that inside.	Try to <u>compare</u> the <u>air pressure inside and outside the rubber sucker</u> . (Is the air pressure outside the sucker <u>higher than or lower than</u> that inside ?)
Result	The rubber sucker <u>"sticks"</u> firmly on the wall .	What will happen <u>due to</u> the <u>air pressure difference</u> ?

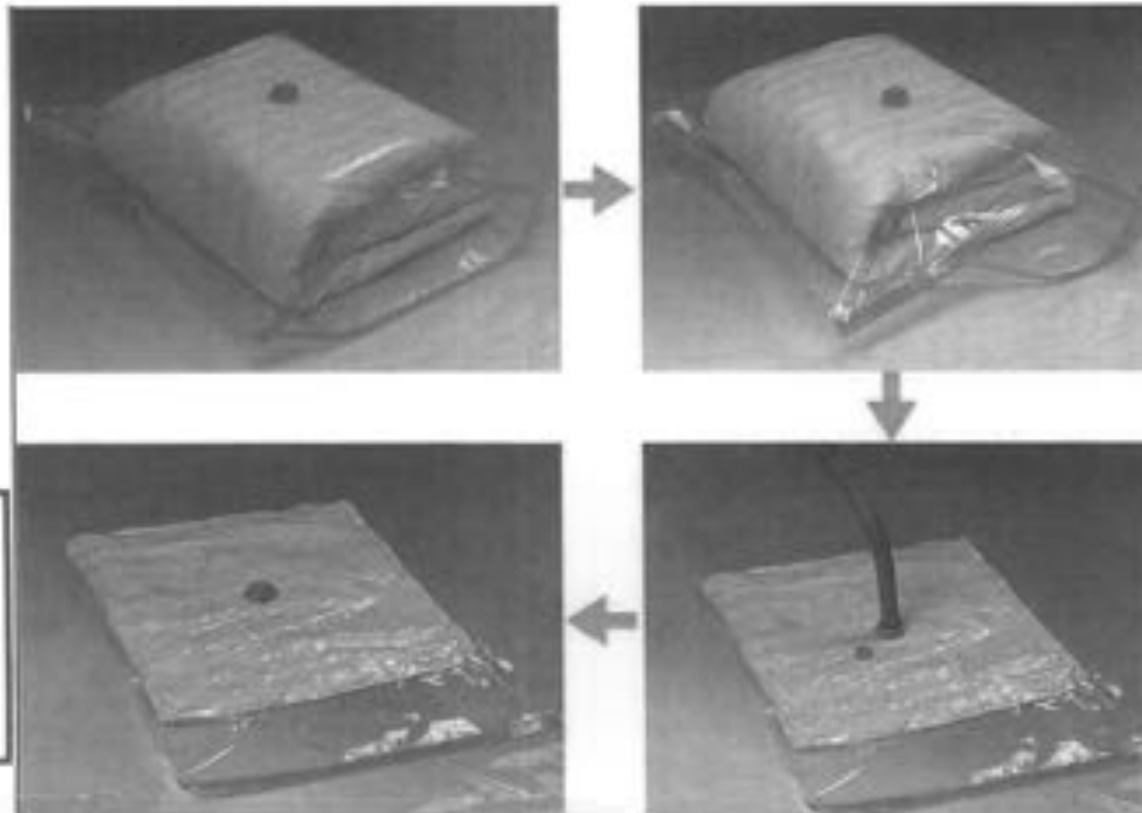


Name: _____ () Class: 1B Group: 6 Date: _____

WS 3:

How to explain the working principle of everyday tools
(Without hints for the guiding questions) 1B-S

2. Vacuum plastic bag : used to reduce the space occupied by a blanket



Result:

The space occupied by the blanket reduces.

Action:

We suck out the air inside the bag by a vacuum pump.

Working principle of a vacuum plastic bag :

Events	Descriptions of events	Guiding questions
Cause	Suck out the air inside the bag	What is the action?
Effect 1	The number of air particles will decrease	What is the <u>change</u> in the <u>number of air particles</u> inside the plastic bag?
Effect 2	The air pressure inside the bag will also decrease	What is the <u>change</u> in the <u>air pressure inside the plastic bag</u> ?
Effect 3	outside > inside The air pressure inside the bag is lower than outside	Try to <u>compare</u> the <u>air pressure inside and outside the plastic bag</u> .
Result	The bag will become smaller and smaller / contract	What will happen <u>due to</u> the <u>air pressure difference</u> ?

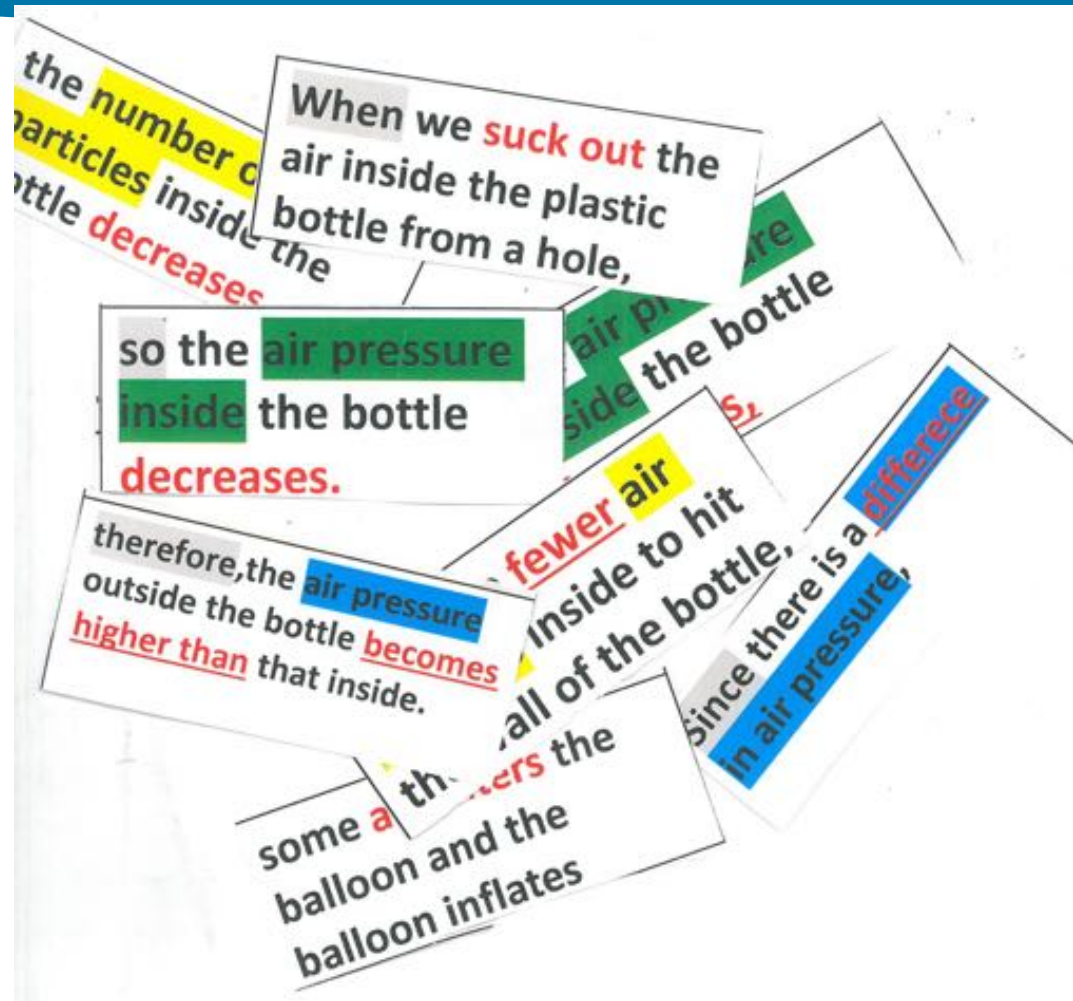
Working principle of a vacuum plastic bag :

Events	Descriptions of events	Guiding questions
Cause	We suck out the air air inside the bag by a vacuum pump ✓	What is the action?
Effect 1	The number of air particles inside the plastic bag is decreases. ✓	What is the <u>change</u> in the <u>number of air particles</u> inside the plastic bag?
Effect 2	The air pressure inside the bag plastic plastic bag decreases ✓	What is the <u>change</u> in the <u>air pressure inside the plastic bag</u> ?
Effect 3	The air pressure outside the plastic bag is higher than that that inside ✓	Try to <u>compare</u> the <u>air pressure inside and outside the plastic bag</u> .
Result	Some air enters leaves the plastic bag and so it contracts <u>inflates</u> becomes smaller ✓	What will happen <u>due to</u> the <u>air pressure difference</u> ?

~~it contracts~~

it reduces in size.

Sequencing using the guiding questions

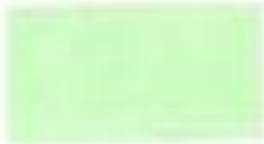







WS 1:

How to explain the inflation of the balloon in a bottle by sucking



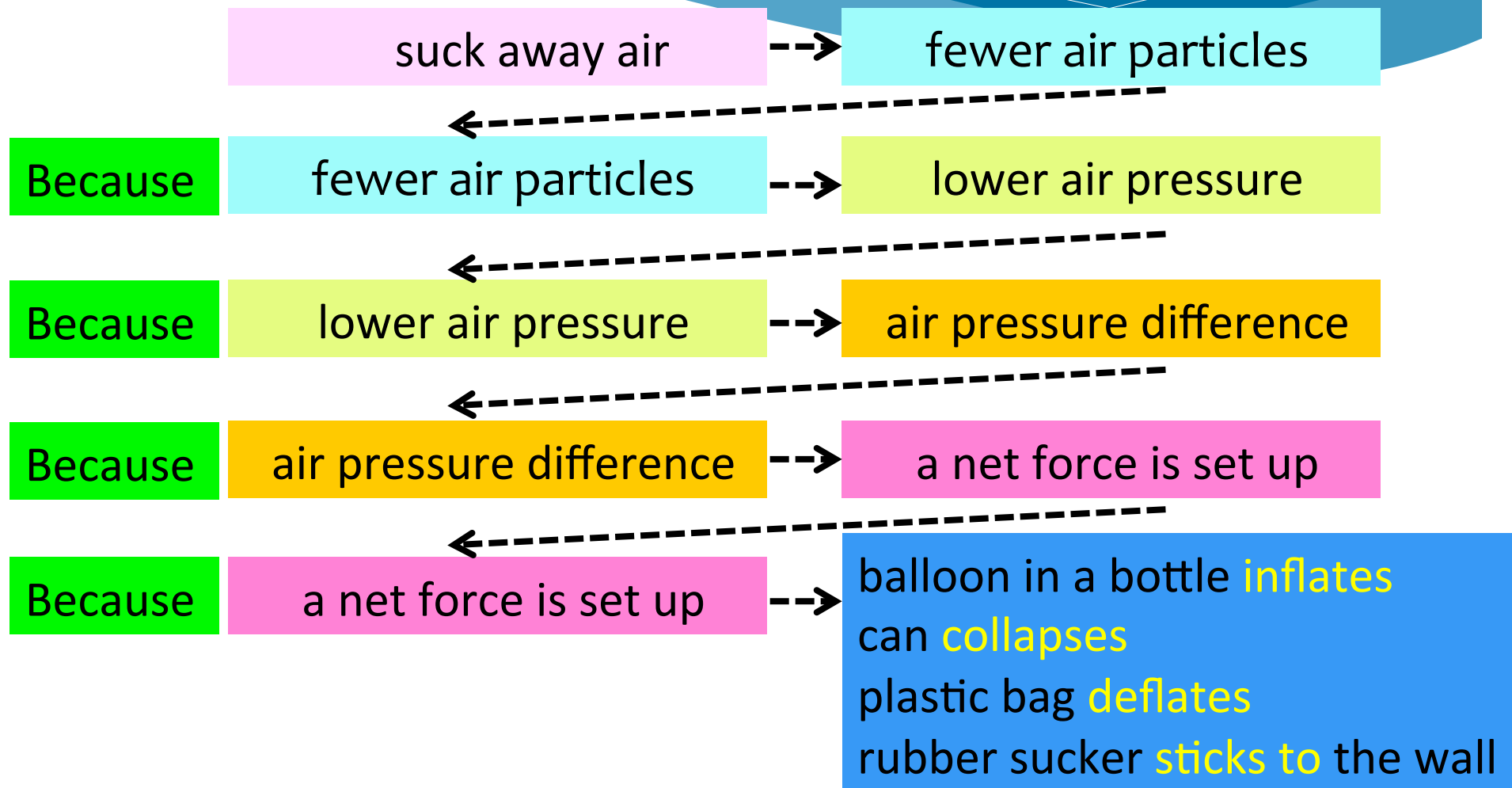
Explanation of the inflation of the balloon:

Descriptions of events		
1 st Event (Cause1)		(Effect 1)
	What is the change in the no. of air particles inside the bottle?	
		
Cause 2 (Effect 1)		(Effect 2)
	What is the change in the air pressure inside in bottle?	
		

Explanation of the inflation of the balloon:



More everyday language resources at the start



Individual work

WS 3: Invent to explain the working principle of a vacuum bag!

1. Vacuum plastic bag: used to reduce the space occupied by objects



When the air is removed, the bag collapses and holds the object tightly.

When the storage bag is removed...

Working principle of a vacuum plastic bag:

Description of action		Justifying sentence
Effect 1 (Cause): The object is placed inside the storage bag.	Effect 2:	When the object is placed inside the storage bag, the air is pushed out.
Effect 1 (Cause):	Effect 2:	When the object is placed inside the storage bag, the air is pushed out.
Effect 1 (Cause):	Effect 2:	When the object is placed inside the storage bag, the air is pushed out.
Effect 1 (Cause):	Effect 2: The storage bag collapses.	When the air is removed, the storage bag collapses.

Group work

Group work writing:
 1. Drawing out the relationship between cause and effect.
 2. Adding suitable connections to show the 'cause and effect'.
 Type 1 connection: Effect 1
 Type 2 connection: Effect 2
 Type 3 connection: Because / Since / As

Description of action	Justifying sentence
	Effect 1 ↓ Effect 2
	Effect 1 ↓ Effect 2
	Effect 1 ↓ Effect 2
	Effect 1 ↓ Effect 2
	Effect 1 ↓ Effect 2

Group writing

Descriptions of events	Events
<p>While <u>When</u> we use a vacuum pump to suck out the air inside the storage bag, the <u>number of air particles</u> inside the storage bag ^v decrease.</p>	<p>1st Event ↓ (Effect 1)</p>
<p>There are fewer <u>air particles</u> inside to hit the wall of the storage bag, <u>so the air pressure</u> inside the storage bag decrease.</p>	<p>2nd Event Effect 1 ↓ (Effect 2)</p>
<p>The <u>air pressure</u> inside the storage bag decreases, <u>therefore</u>, the air pressure outside the storage becomes <u>higher than</u> that inside.</p>	<p>3rd Event Effect 2 ↓ (Effect 3)</p>
<p><u>There</u> is <u>is</u> a <u>difference in</u> the <u>air pressure</u>. <u>as a result</u>, the <u>storage bag</u> collapses.</p>	<p>4th Event Effect 3 ↓ (Result)</p>

When we use the vacuum pump to suck out the air inside the strong bag, the number of air particles inside the strong bag decreases.

There are fewer air particles inside to hit the wall of the strong bag, So the air pressure inside the ~~soft drink~~ ^{strong} strong bag decreases.

The air pressure inside the strong bag becomes \neq lower than that outside.

The ~~soft~~ strong bag collapses for there is a difference in air pressure.

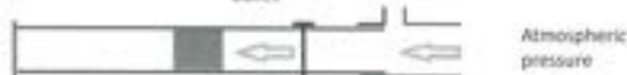
HW : How to explain the working principle of an air pressure gun
(Without hints for the guiding questions)

Air Pressure Gun

Preparatory Mode :



Firing Mode :



Action 3: Card is removed

Working principle of an air pressure gun :

Events	Descriptions of events	Guiding questions
Preparation	We <u>insert</u> a wooden bullet <u>into</u> the tube of the gun. We <u>place</u> a card <u>at</u> the end of the gun.	
Cause (Action 1)	We suck out (draw out) air inside the pressure gun by a vacuum pump.	What is the action?
Effect 1	The bullet <u>goes into</u> the tube and reach the position of the pin.	
Cause (Action 2)	We <u>place</u> another card <u>at</u> the front end of the gun. We <u>draw out</u> the air inside the pressure gun <u>continuously</u> by a vacuum pump.	
Effect 2	The number of air particles are decreased in air pressure gun.	What is the <u>change</u> in the number of air particles inside the pressure gun?
Effect 3	The air pressure inside the air pressure gun are decreased.	What is the <u>change</u> in the air pressure inside the pressure gun?
Effect 4	The air pressure inside the gun is lower than that outside.	Try to <u>compare</u> the air pressure inside and outside the pressure gun.
Cause (Action 3)	We <u>remove</u> the card covering the end position.	What is the action?
Effect 5	Air particles outside will quickly go into air pressure gun and push the bullet.	What will happen due to the air pressure difference?
Result	The bullet "fires out".	What will happen <u>due to</u> the air pressure difference?

B+

HW : Passage writing

Steps in passage writing :

1. Write down the causes and effects step by step.
2. Add suitable connectives to link the "cause and effect":
 - Type I : When/If.....(Cause).....,(Effect).....
 - Type II : (Cause)....., so/ thus / hence.....(Effect).....
.....(Cause)....., therefore / as a result.....(Effect).....
 - Type III :(Effect)....., because(Cause).....
Since/As..... (Cause).....,.....(Effect).....

Instructions : Starting with the action 2 on the table of the working principle on the previous page, write a short passage about the working principle of a air pressure gun.

We draw out the air inside the pressure gun continuously by a vacuum pump,

so, the number of air particles inside decreased. Hence, the air pressure decreased. Therefore, the air pressure inside is lower than that outside.

Then, we remove the card covering the end of the position. Therefore, air particles outside will quickly go into air pressure gun and pushes the bullet.

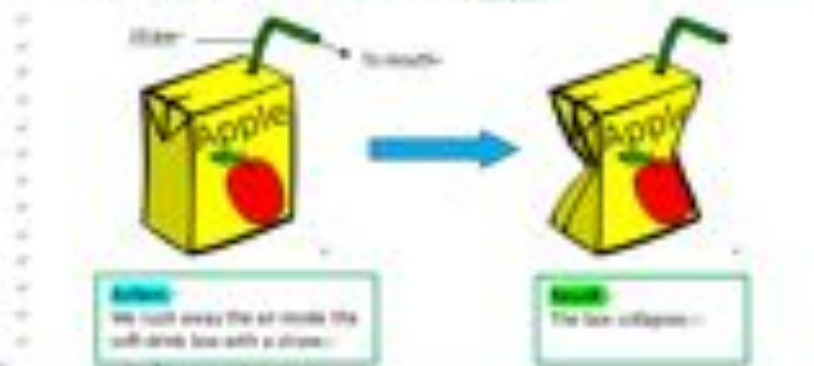
As the result, the bullet "fires out"

good!

A

Test: How to explain the collapse of a drinking box
 Without form for the possible answers
 An open ended question. You are required to write a whole sentence.
 For example: "As the air inside the soft-drink box is sucked away, the air pressure inside the soft-drink box is lower than the air pressure outside the soft-drink box, so the box collapses."

Sucking away air from a soft-drink box :



Event	Description of event	Guiding questions
Cause	We suck away the air inside the soft-drink box with a straw.	What is the cause?
Effect 1	The number of air particles inside the soft-drink box decreases .	What is the change in the number of air particles inside the soft-drink box?
Effect 2	The air pressure inside the soft-drink box decreases .	What is the change in the air pressure inside soft-drink box?
Effect 3	The air pressure inside the soft-drink box is lower than that outside. (Note: as there is no change of the outside pressure) OR The air pressure outside the soft-drink box is higher than that inside.	Try to postulate the air pressure inside and outside soft-drink box.
Effect 4	A net force pointing inward is set up by the air pressure difference between inside and outside the soft-drink box.	What is the direction of the net force set up by the air pressure difference?
Result	The soft-drink box collapses.	What will happen due to the net force?

Exam Question :

The following diagram shows that a ping-pong ball inflates after being up in water.
 By using the kinetic theory and the concept about air pressure, try to explain the phenomenon.
 Write the suitable words to complete the explanation and the questions.



Event	Description of event
Cause	We put the collapsed ping-pong ball in the hot water.
Effect 1	The air particles are moving more and it is more energetic .
Effect 2	The air pressure inside the ping-pong ball increases .
Effect 3	The air pressure inside the ping-pong ball is higher than that outside.
Effect 4	A net force acting outward towards it set up by the air pressure difference.
Result	The ping-pong ball inflates again.

Do you think, when we put the collapsed ping-pong ball into the hot water, both energy transfer and energy conversion will take place, as there is a change in the movement of the air particles.

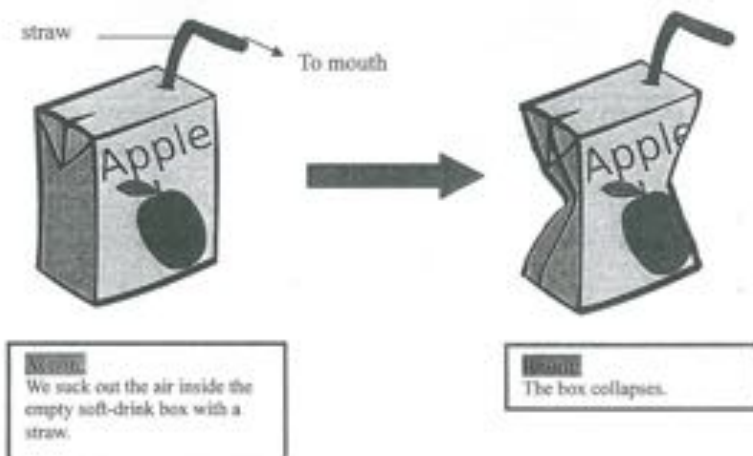
(a) What is the energy transfer? (2 marks)

Yes, kinetic energy is transferred from the hot water to the air particles in the ping-pong ball.

(b) What is the energy conversion? (2 marks)

The **kinetic** energy gained by the air particles is converted into the **heat** energy.

4. When we suck out the air from an empty soft-drink box, it collapses.

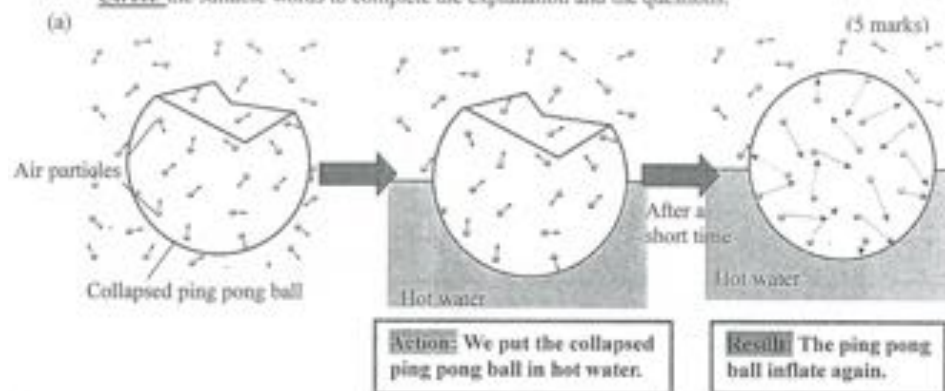


*Complete the following table on the principles of this event (add suitable connectives) : (10 marks+ 2 marks)

Events	Descriptions of events	Guiding questions
Cause	<i>When we suck out the air inside the empty soft-drink box with a straw.</i>	What is the action?
Effect 1	<i>The number of air particles inside the soft-drink box decrease.</i>	What is the change in the number of air particles inside the soft-drink box?
Effect 2	<i>The air pressure inside the soft-drink box decrease.</i>	What is the change in the air pressure inside soft-drink box?
Effect 3	<i>The air pressure inside is lower than outside.</i>	Try to compare the air pressure inside and outside soft-drink box.
Effect 4	A net force pointing inward is resulted from the difference in air pressure between inside and outside.	What is the direction of the net force resulted from the air pressure difference? (Pointing inward or pointing outward)
Result	<i>As the result, the box collapses.</i>	What will happen due to the net force?

2. The following diagrams show that a ping pong ball inflates after heating up in water. By using the *kinetic theory and the concepts about air pressure*, we can explain this phenomenon.

Circle the suitable words to complete the explanation and the questions.



Events	Descriptions of events
Cause	We put the collapsed ping pong ball in the hot water.
Effect 1	The air particles move faster slower and in a greater lesser extend.
Effect 2	The air pressure inside the ping pong ball increases decrease.
Effect 3	The air pressure inside the balloon is lower higher than that outside.
Effect 4	A net force pointing outwards inwards is resulted from the air pressure difference.
Result	The ping pong ball inflates again.

- (b) In fact, when we put the collapsed ping-pong ball into the hot water, both energy transfer and energy conversion will take place, so that there is a change in the movement of the air particles.

- (i) What is the energy transfer? (3 marks)

~~Heat~~ kinetic energy is transferred from the ~~hot water~~ air particles to ~~hot water~~ air particles.

- (ii) What is the energy conversion? (2 marks)

The ~~heat~~ kinetic energy gained by the air particles is converted into their ~~heat~~ kinetic energy.

Thank you



Happy SFXS teachers and students