GD: Playing With Thermodynamics 活動單元:熱力學

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在這個活動單元中,你將要用虛擬實驗 來瞭解熱力學現象。在開始回答問題之

前,請大家先玩線上的模擬實驗,並熟悉

模擬系統。玩模擬實驗的時候,可以使用

中文和英文兩種界面,大家就可以學到中

英文關鍵字的對應。在開始本活動的其他

部分之前,請記得要重置所有內容哦。

0. Introduction 簡介

In this activity unit, you will perform virtual experiments with public domain physics simulations dealing with thermodynamics. Before you start answering the questions, play with each simulation. Get Familiar with the simulations. Run the simulations in both Chinese and English so you can be bilingual! Remember to reset everything before you begin the other parts of this activity.

1. States of Matter 物質狀態

- A Play with the PhET Simulation: "States of Matter" 下載並玩 PhET 模擬:「物質狀態」
- B Observe: Three States of Matter. [Left button: "States"] 觀察: 物質的 三個狀態 [左鍵:"狀態"]



1. Compare the solid, liquid and gas states of **argon**. Record your observations. Use pictures. Summarize: What is the same? What is different? 比較氫氣的固態,液態和氣態,並記錄你的觀察結果。使用圖片,並總結: (a) 有什麼相同? (b) 有什麼不同?

Solid 固態	Liquid 液態	Gas 氣態

2. Compare the **solid** state of oxygen, neon, argon and water. Record your observations. Use pictures. Summarize: 比較氧氣,気氣,氫氣和水的固態,並記錄你的觀察結果。使用圖片,並總結:

What is the same? 有什麼相同?	What is different? 有什麼不同?
	1

3. Compare the **liquid** state of oxygen, neon, argon and water. Record your observations. Use pictures. Summarize: 比較氧氣, 氖氣, 氩氣和水的液態, 並記錄你的觀察結果。使用圖片, 並總結:

What is the same? 有什麼相同?	What is different? 有什麼不同?

4. Compare the **gas** state of oxygen, neon, argon and water. Record your observations. Use pictures. Summarize: 比較氧氣, 氖氣, 氫氣和水的氣態, 並記錄你的觀察結果。使用圖片, 並總結:

What is the same? 有什麼相同?	What is different? 有什麼不同?
5. Summarize your results and make conclusions.	

- C Observe: Transition between States of Matter. 觀察:物質狀態之間的過渡
 - 1. Reset the Simulation. Cool Neon to 1 K. Heat until you reach the gas state. Then cool the Neon back down to 1 K. Summarize in diagrams the changes that occur 重置模擬,並將氖氣冷卻至 1K。加熱 直到達到氣態,然後將氖氣冷卻回 1K。在圖表中總結發生的變化。

且却是均小心				
Solid 固態	Liquid 液態	Gas 氣態	Liquid 液態	Solid 固態

2. Reset the Simulation. Cool Water to 1 K. Heat until you reach the gas state. Then cool the Water back down to 1 K. Summarize in diagrams the changes that occur. 重置模擬,並將水冷卻至 1K。加 執 百到達到氫能, 然後將水冷卻回 1K。在圖表中總結發生的戀化。

が且り住り示応				
Solid 固態	Liquid 液態	Gas 氣態	Liquid 液態	Solid 固態

D Interpret: Discuss the differences between water and Neon (other molecules). Consider differences occurring between the liquid and solid state. 解釋:討論水和氖氣(其他分子)之間的區別,記得考慮液態和固態之間的差異。

E Apply: Why is this difference important in nature? 應用:為什麼這種差異在自然界中很重要?

2. Phase Diagrams 相圖

- A View the Video "Animation Phase Diagram" (<u>https://youtu.be/ejg27ozbPA8</u>) 觀看視頻 "動畫 相圖"
- B Summarize the Information Presented by the Video. 總結視頻介紹的信息

1. For what is the diagram used? 該圖用於什麼?	
2. What are the 2 axis? 兩軸是什麼?	
3. What do the three areas in the diagram represent? 圖中的三個區域代表什麼?	
4. What do the lines in the diagram represent? 圖中的線代表什麼?	
5. What "Phase" is in the upper left part of the diagram? 圖 的左上方是什麼 "相位"?	
6. What "Phase" is in the lower right part of the diagram? 圖的右下方是什麼"相位"?	
7. What is the "Critical point"? 什麼是"臨界點"?	
8. What is the "Triple Point"?什麼是"三相點"?	

- C Application: Making a Phase Diagram to Explain Transitions. 應用:製作相圖以解釋過渡
 - 1. Draw a Simple Phase Diagram (for H₂O). 繪製一個簡單的相圖(為水)。
 - Add a horizontal line on the diagram at atmospheric pressure. 在大氣壓力 下,在圖中添加一條水平線。
 - 3. Add two vertical lines: one at 0 C and the other at 100 C. 添加兩條垂直線: 一個在 0°C,另一個在 100°C。
 - It is snowing on the top of the Mount He Huan (合歡山). But it is raining in the valley below the mountain. Draw a line on the phase diagram to show what is happening as H₂O falls to the ground. 合歡山山頂正在下雪,但山 下的山谷正在下雨。在相圖上畫一 條線,以顯示當水落在地上時發生 了什麼。

3. Gas Properties 氣體性質

- A Run and Play with the PhET Simulation: "Gas Properties" Choose: Explore 下載並玩 PhET 模擬:「氣體性質」, 選擇: 探索
- B Preliminary Question 初步問題:
 - What is the mathematical conversion factor between the units of pressure atm and kPa? 壓力單位 atm 和 kPa 之間的數學轉換 係數是多少?



C Observe: Change one parameter at a time and fill in the effect of the change on the temperature (T) and pressure (P) of the gas. 觀察:一次更改一個參數,並填寫改變它對氣體的溫度(T)和壓力(P)的影響。

Parameter 參數	Temperature 溫度 (T)	Pressure 壓力 (P)
Increase Volume (V↑) 増加體積		
Decrease Volume (V↓) 減少體積		
Add Heat (Q↑) 加熱		
Remove Heat (Q↓) 散熱		
Add Molecules (N↑) 填加分子		
Decrease Molecules (N↓) 減少分子		
Replace Light with Heavy Molecules 用重分子取代輕分子		

D Quantify 量化

For each of the following questions: (a) First take experimental data, (b) Graph the data using a spreadsheet, and finally (c) fit your data to a mathematical equation using your spreadsheet as discussed earlier in the course. 對於以下每個問題: (a) 首先獲取實驗數據, (b) 使用電子表格繪製數據圖, 最後(c) 如本課程前面所述,使用電子表格將你的數據擬合成數學方程式。

Find the relationship between the number of gas molecules (N) in the container and the change in pressure (P) of gas in the chamber for heavy molecules. Keep volume (V) constant. Keep temperature (T) constant. 找到容器中氣體分子數(N)與腔室中重分子的氣體壓力變化(P)之間的關係。 維持體積(V)和溫度(T)的恆定。

Experimental Data 實驗數據 (a)		Graph 圖表 (b)	Curve Fit 曲線擬合 (c)
Number Heavy Molecules 重 分子數 (-)	Pressure 壓力 (kPa)		

2. Find the relationship between the temperature (T) in the container and the pressure (P) of gas in the chamber. Keep the volume (V) constant. 找到容器中的溫度(T)和腔室內的氣體壓力(P)之間的關係。維持體積(V)恆定。

(a) Data 🛱	驗數據	(b) Graph 圖表	(c) Curve Fit 曲線擬合
Temperature 溫度 (K)	Pressure 壓力 (kPa)		

3. Find the relationship between the volume (V) of the container and the pressure (P) of gas in the chamber. Keep temperature (T) constant. (Note: One has to remove or add heat to the system.) 找出 容器體積(V)和腔室內氣體壓力(P)之間的關係。維持溫度(T)恆定。(注意:必須散發 或增加系統的熱量)

(a) Data 🛱	驗數據	(b) Graph 圖表	(c) Curve Fit 曲線擬合
Volume 體積 (V)	Pressure 壓力(kPa)		

4. Find the relationship between the temperature(T) in the container and the volume (V) of gas in the chamber. Keep pressure (P) constant. (Note: One has to remove or add heat to the system.) 找到容器中的溫度(T)與腔室中的氣體體積(V)之間的關係。維持壓力(P)恆定。(注意:必須散發或增加系統的熱量)

(a) Data 實驗數據		(b) Graph 圖表	(c) Curve Fit 曲線擬合
Temperature 溫度(T)	Pressure 壓力 (kPa)		

E Combine the equations to make a single general equation relate all the quantities to each other., i.e. Your equation should include N, P, V, T and a constant. 合併這些方程以使一個通用方程將所有量相互關聯, i.e. 你的方程應包括N, P, V, T和一個常數。

4. Energy Forms	& Conversion	能量的形式和轉	換 🔗	Energy Symbols				
A Play with the Ph Conversion". 下責	ET Simulation: "E 貮並玩 PhET 模擬	Energy Forms & 注「能量的形式和轉	换」					
B Use the right Bu	tton "Systems"	ē用右側按鈕 "系統						
1. Using the teapot, Follow the conve needed to create 燈泡工作所需的	make the incander rsion between for light. 使用茶壺, D能量形式之間的	scent light bulb to we ms of energy that are 讓燈泡工作。跟隨 轉換。	ork. 运行 到	e e e e e e e e e e e e e e e e e e e				
\rightarrow	\rightarrow	\rightarrow	\rightarrow	\rightarrow Light (EM)				
 Using the teapot energy that are n 式之間的轉換。 	, make the fluoreso eeded to create ligh	cent light bulb to wo ht. 使用茶壺,讓燈	rk. Follow the con 泡工作。跟隨熒	nversion between forms of 光燈泡工作所需的能量形				
\rightarrow	\rightarrow	\rightarrow	\rightarrow Light((EM)				
3. What is different between the operation of the two types of bulbs? 兩種燈泡的工作方式有何不同?								
5. Heat Engines — A brief Introduction 熱機一簡介								
A Learn a little abo 網站了解有關熱 https://www.mpo	ut heat engines f 幾的一些信息: weruk.com/heat_	from 從以下 <u>_engines.htm</u>						
B On a single P-V cycles 在單個 P-	graph, plot the fc V 圖上,繪製以T	bllowing ▽循環:						
1. Carnot Cycle 卡	諾循環							
2. Otto Cycle 奧托	循環							
3. Brayton Cycle 有	1笛唄循環							
6. Student Comm	ients 學生評論							

A Did you enjoy the activity? Choose one 你喜歡這個活動嗎? 選一個

□ LOVED 喜爱	□ 75%	□ OK 馬馬虎虎	□ 25%	□ HATED 討厭
Why? 為什麼?				

B Suggest one or two additional questions that could be asked concerning any of the simulations you played with. (If we add your question, you will get 1% bonus marks for the course!) 提出一個或兩個補充問題,這些問題可以與你玩過的任何模擬遊戲有關。(如果你的問題被採用,你將獲得該課程 1%的加分!)

 Activity
 Suggested Question
 Answer to suggested question

 活動
 建議的問題
 對建議問題的答覆

C Any suggestions to improve this guided discovery module? 有沒有別的建議?