

自然領域教學單元案例

領域	自然科學領域		設計者	林雨慶、林怡伶、陳美卿
實施年級	六年級		總節數	5
單元名稱	第二單元活動 1 物質受熱的變化		教材來源	南一版
教學內容				
第一節	物質受熱後形態的變化			
第二節	液體熱漲冷縮的變化			
第三節	氣體受熱後體積的變化			
第四節	固體受熱後的體積變化			
第五節	了解日常生活中熱脹冷縮的例子			
設計依據				
學習 重點 Learning focus	學習 內容 Learning content	INa-III-2 物質各有不同性質， 有些性質會隨溫度 而改變。	核心 素養	自-E-A3 具備透過實地操作探究活動探索科學 問題的能力，並能初步根據問題特性、資源 的有無等因素，規劃簡單步驟，操作適合 學習階段的器材儀器、科技設備及資源，進 行自然科學實驗。
	學習 表現 Learning behavior	pa-III-2 能從（所得的）資訊 或數據，形成解釋、 發現新知、獲知因果 關係、解決問題或是 發現新的問題。並能 將自己的探究結果 和他人的結果（例如 來自同學）比較對 照，檢查相近探究是 否有相近的結果。		
跨域連結	英文領域			
學習目標 Learning objectives	<p>By the end of the course, students will be able to</p> <p>2-1 能說出物體受熱前、後形態(性質)的變化情形 Explain the changing situation of the substance before getting heating up and after heating up.</p> <p>2-2 藉由實驗，觀察熱漲冷縮的現象 Operate the experiment of Thermal expansion and contraction and observe the phenomenon.</p> <p>2-3 探討和理解生活中熱漲冷縮的應用實例 Discuss and understand the daliy life examples of Thermal expansion and contraction</p>			
教學設備／資源	videos			



<p>Through experiments, observe the phenomenon of thermal expansion and contraction</p>	<p>Eggs are liquid when they are uncooked, then they become hard solid forms after cooking. Vegetables are hard before cooking, then they become soft after cooking</p> <p>◇ 大部分的食物加熱前、後的顏色和外觀都會改變，但可能也有不會改變的例子 Most of the foods' colors and appearances change after heating up, but there are some examples that don't have any change.</p> <p>◇ 食物受熱後，顏色、形狀、軟硬.....會改變 The color, shape and hardness of foods will change after heating up.</p> <p>◇ 有些物質受熱後的性質會改變且無法再變回原來的模樣，屬於化學變化，例如雞蛋 Some substances' natures will change after heating up and could never return to original appearance, which is chemical reaction. For example: egg.</p> <p>◇ 有些物質受熱後的性質不會改變，還可以再變回原來的樣子，屬於物理變化，例如巧克力、冰塊 Some substances' natures will not change after heating up and could recover to original appearance, which is physical change. For example: chocolate and ice.</p>	<p>10'</p> <p>10'</p>	<p>before getting heating up and after heating up.</p>
	<p style="text-align: center;">【Second class】</p> <p>1-2 物質受熱後體積的變化 The changes of substance's volume after heating</p> <p style="text-align: center;">【Explore 探索】</p> <p>物質的熱脹冷縮:液體 Thermal expansion and contraction of substance: liquid</p> <p>◇ 生活中常見的物質受熱後，體積會有變化嗎? 有什麼方法可以知道? (1)溫度計內的酒精好像會因為溫度的不同，體積有所變化 (2)把酒精溫度計放入熱水時，溫度計的酒精柱高度會上升；放入冷水時，溫度計的酒精柱高度會下降 →溫度的高低使得液體的體積改變了</p> <p>In our daily lives, does the substance's volume have any change after heating up? What ways can we know about that? (1) The alcohol's volume of thermometer may change due to the temperature's difference. (2) When putting thermometer into hot water, the alcohol column of thermometer will rise. When putting thermometer into cold water, the alcohol column of thermometer will decline.</p>	<p>10'</p>	<p>2-2 藉由實驗，觀察熱漲冷縮的現象 Operate the experiment of Thermal expansion and contraction and observethe phenomenon.</p>


	<p>實驗操作</p> <ul style="list-style-type: none"> ◆ 實驗器材： 250ml 錐形瓶、橡皮塞、玻璃管、公升盒、冰水、熱水 ◆ 操作步驟： <ol style="list-style-type: none"> 1. 在錐形瓶裡裝滿染色的水 2. 玻璃管插入橡皮塞後，再塞入錐形瓶口 3. 在玻璃管上標示實驗前的水位 4. 將錐形瓶浸入冰水中一段時間，紀錄玻璃管中的水位 5. 在將瓶子浸入熱水中，觀察並記錄玻璃管中水位的變化 ◆ 注意事項： <ol style="list-style-type: none"> 1. 我們可以用一根細長的玻璃管來代替溫度計的玻璃管 2. 將水染色，是為了容易看清楚水位的變化 3. 熱水的溫度不要超過 60°C <p>Experimental operation</p> <ul style="list-style-type: none"> ◆ Experiment equipment: Erlenmeyer flask of 250 ml, Rubber stopper, stir rods, Liter box, ice water, hot water ◆ Operating steps: <ol style="list-style-type: none"> 1. Fill up the Erlenmeyer flask with stained water 2. Put the stir rods in the Rubber stopper, and then put them into the Erlenmeyer flask 3. Mark the water level on the stir rods before the experiment 4. Dip the Erlenmeyer flask into cold water for a while and record the water level in the stir rods 5. Then dip the stir rods into hot water. Observe and record the change of water level in the stir rods. ◆ Points for attention: <ol style="list-style-type: none"> 1. We can use a long and thin glass tube instead of the stir rods of the thermometer. 2. Dye/ stain the water in order to see the changes of water level clearly. 3. The temperature of hot water should be lower than 60 °C. <p style="text-align: center;">【Explain 解釋】</p> <ul style="list-style-type: none"> ◆ 討論： <ol style="list-style-type: none"> 1. 錐形瓶浸入冰水時，玻璃管的水位有什麼變化? 水位下降 2. 錐形瓶浸入熱水時，玻璃管的水位有什麼變化? 水位上升 	20'	
		10'	

<p>Through experiments, observe the phenomenon of thermal expansion and contraction</p>	<p>3. 玻璃管裡藍色液體的體積和溫度的高低有什麼關係? 溫度增加時，體積增加→玻璃管中水位上升 溫度降低時，體積減少→玻璃管中水位下降 →液體也會熱脹冷縮</p> <p>4. 溫度計裡紅色液體的升降和這個實驗有什麼相同的地方? 利用液體熱脹冷縮的特性，溫度計內的紅色液體遇熱會上升、遇冷會下降來測量溫度</p> <p>◆ Discussion:</p> <p>1. What changes do the water level of stir rods have when the Erlenmeyer flask is dipping in the ice water? The water level declines.</p> <p>2. What changes do the water level of stir rods have when the Erlenmeyer flask is dipping in the hot water? The water level rises.</p> <p>3. What relationship does the blue liquid's volume in the stir rods and the temperature have? -volume will increase when the temperature raise→the water level in the stir rods raises - volume will decrease when the temperature decline→the water level in the stir rods declines</p> <p>4. What is the same of the red liquid's water lever of the temperature and this experiment? By the characteristic of Thermal expansion and contraction, the red liquid of the temperature will raise when it getting hot. And it will decline when it getting cold for measuring temperature.</p> <p style="text-align: center;">【Third class】</p> <p>物質的熱脹冷縮:氣體 Thermal expansion and contraction of substance: gas</p> <p>◇ 錐形瓶內的空氣受熱後，如果體積改變，看得出來嗎? 空氣無色無味，需借助其他物品的變化來觀察。 After heating up the air in the Erlenmeyer flask, can we find if the volume change? Air has no color and odor. It needs to observe other objects' change to see.</p> <p style="text-align: center;">【Explore 探索】</p> <p>實驗操作</p> <p>◆ 實驗器材： 公升盒、250ml 錐形瓶、氣球、熱水、冰水</p>	<p>10'</p> <p>20'</p>	<p>2-2 藉由實驗，觀察熱脹冷縮的現象</p> <p>Operate the experiment of Thermal expansion and contraction and observethe phenomenon.</p>
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	<p>◆ 操作步驟：</p> <ol style="list-style-type: none"> 1. 把汽球套在錐形瓶的瓶口 2. 將錐形瓶依次浸入熱水與冰水中 3. 觀察瓶口氣球的變化 <p>Experimental operation</p> <p>◆ Experiment equipment: Liter box, Erlenmeyer flask of 250 ml, balloon, hot water, ice water</p> <p>◆ Operating steps:</p> <ol style="list-style-type: none"> 1. Put the balloon on the top of the Erlenmeyer flask 2. First put the Erlenmeyer flask into the hot water. Then move the Erlenmeyer flask into ice water 3. Observe the changes of balloon <p style="text-align: center;">【Explain 解釋】</p> <p>◆ 討論：</p> <ol style="list-style-type: none"> 1. 將錐形瓶浸入熱水中，瓶口的氣球有什麼變化？氣球膨脹 2. 將錐形瓶浸入冰水中，瓶口的氣球有什麼變化？氣球會縮進錐形瓶中 3. 錐形瓶口的氣球形狀為什麼會改變？氣球會膨脹或縮小，是錐形瓶中的空氣受到溫度的影響 4. 氣體的體積變化和溫度的高低有什麼關係？ <p style="color: red;">歸納：氣體遇熱後，體積會膨脹；遇冷時，體積會縮小</p> <p>◆ Discussion:</p> <ol style="list-style-type: none"> 1. What changes will the balloon have when the Erlenmeyer flask is dipping in the hot water? The balloon inflates 2. What changes will the balloon have when the Erlenmeyer flask is dipping in the ice water? The balloon shrinks/deflates into the Erlenmeyer flask 3. Why does the balloon's shape on the top of the Erlenmeyer flask change? Balloon will inflate or shrink due to the temperature in the Erlenmeyer flask. 4. What relationship do the volume change of gas and the temperature have? Conclusion: when gas getting hot, its volume will inflate ; When gas getting cold, its volume will shrink <p style="text-align: center;">【Fourth class】</p> <p>物質的熱脹冷縮:固體</p>	<p>10'</p> <p>10'</p> <p>20'</p>	<p>2-2 藉由實驗，觀察熱漲冷縮的現象</p> <p>Operate the experiment of Thermal expansion and contraction and observethe phenomenon.</p>
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<p>Through experiments, observe the phenomenon of thermal expansion and contraction</p>	<p>Thermal expansion and contraction of substance: solid ◇ 固體受熱後，體積會改變嗎? Will solid's volume change after being heating up?</p> <p style="text-align: center;">【Explore 探索】</p> <p>實驗操作</p> <p>◆ 實驗器材： 冷水、銅球、金屬環和酒精燈</p> <p>◆ 操作步驟：</p> <ol style="list-style-type: none"> 1. 將未加熱的銅球試著穿過金屬環 2. 將銅球放置於酒精燈上加熱約 2 分鐘 3. 將加熱後的銅球試著穿過金屬環 <p>Experimental operation</p> <p>◆ Experiment equipment: ice water, copper ball, metal ring, spirit lamp/alcohol burner</p> <p>◆ Operating steps:</p> <ol style="list-style-type: none"> 1. Try to make the copper ball pass through the metal ring before it gets heating up 2. Put the copper ball on the spirit lamp to heat up for 2 minutes 3. Try to make the copper ball pass through the metal ring again after it gets heating up <p style="text-align: center;">【Explain 解釋】</p> <p>◆ 討論：</p> <ol style="list-style-type: none"> 1. 未加熱和加熱後的銅球，哪一個可以通過金屬環? 未加熱的銅球因體積不變，可以通過金屬環； 加熱後的銅球因體積變大，不能通過金屬環 2. 有什麼方法可以讓加熱後的銅球再穿過金屬環呢? 加熱的銅球進入冰水中，銅球體積變小，就可以通過金屬環 3. 比較加熱前和加熱後的銅球，有什麼變化? 歸納：溫度增加，銅球體積增加； 溫度降低，銅球體積減少 → 固體也會熱脹冷縮 <p>◆ Discussion:</p> <ol style="list-style-type: none"> 1. Which copper ball can pass through the metal ball, the original one or the one being heating up? The original copper ball could pass through the metal ring because its volume keeps the same. The copper ball being heating up could not pass through the metal ball because its volume become bigger. 	<p style="text-align: center;">10'</p>	<p>2-2 藉由實驗，觀察熱漲冷縮的現象 Operate the experiment of Thermal expansion and contraction and observethe phenomenon.</p>
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<p>Explore and understand the application examples of thermal expansion and contraction in life</p>	<p>2. What can we do to let the copper ball pass through the metal ring again after it got heat up? We could put the copper ball into the ice water to make its volume become smaller, then it can pass through the metal ring.</p> <p>3. Compare the copper balls of being non-heating up and heating up, what are the changes? Conclusion: The copper ball's volume increase when the temperature increase. The copper ball's volume decrease when the temperature decline. →Solid also has the situation of Thermal expansion and contraction</p> <p>[Thermal Expansion and Contraction of Solids, Liquids and Gases] https://www.youtube.com/watch?v=9UtfegG4DU8</p>  <p>[The Uses of Expansion and Contraction of Matter in Daily Life] (0:00-0:44 table tennis)(後面也有例子，小難) https://www.youtube.com/watch?v=T1zFwgj2mZ4</p>  <p>【 Fifth class 】 【 Evaluate 評量 】</p> <p>[Thermal Expansion - Why are gaps left between railway tracks?]</p>	<p>20'</p> <p>20'</p>	<p>2-3 探討和了解生活中熱漲冷縮的應用實例</p> <p>Discuss and understand the dailiy life examples of Thermal</p>
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	<p>https://www.youtube.com/watch?v=9JuKqkZVgTU</p>  <p>◇ 仔細觀察，生活中還有哪些物品也是利用熱脹冷縮的原理設計的？</p> <p><u>熱氣球</u>：利用火將氣球中的氣體加熱，球內的氣體因受熱後而膨脹</p> <p><u>溫度計中的酒精</u>：遇到高溫會膨脹上升；遇到低溫會收縮下降</p> <p><u>火車鐵軌</u>：鐵軌之間會保留縫隙，避免熱漲冷縮使鐵軌變形</p> <p>Observing carefully, what objects also use the theory of Thermal expansion and contraction to design in our daily lives?</p> <p>-<u>hot air balloon</u>: using fire to heat up the air in the balloon to inflate the gas in the balloon.</p> <p>-<u>the alcohol in the thermometer</u>: it will inflate and raise when it getting hot. On the other hand, it will shrink and decline when it getting cold</p> <p>-<u>train tracks</u>: there're some small cracks/gaps left between rails in order to prevent Thermal expansion and contraction deforms the tracks.</p>	<p>expansion and contraction</p>
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參考資料

[Thermal Expansion - Why are gaps left between railway tracks?]

<https://www.youtube.com/watch?v=9JuKqkZVgTU>

[Thermal Expansion and Contraction of Solids, Liquids and Gases]

(較難)

<https://www.youtube.com/watch?v=9UtfegG4DU8>

[The Uses of Expansion and Contraction of Matter in Daily Life]

(0:00-0:44 table tennis)(後面也有例子，小難)

<https://www.youtube.com/watch?v=T1zFwgj2mZ4>

