Design and Applied Technology
CASE STUDY

Environmental Technology : Hydrogen-powered Car

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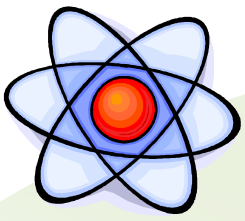
Design and Applied Technology

Students should be made aware of the relevance of the technology they are studying to the real world. Case studies on technology and design enable students to put their learning into an authentic context.

Authentic Context: Students could explore the technological principles as well as environmental responsibilities about the invention of Hydrogen-powered car.

Topics Covered:

Compulsory Part	Strand 2: Technological Principles
	Strand 3: Value and Impact



Environmental Technology: Hydrogen-powered Car

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Background

What causes global warming? Will the Earth extinct one day? Some Hollywood movies filming natural disaster and catastrophe have visual impact to substantiate their concerns or worries about the planet that we live in.

Hydrogen-powered car, the theme of this case study, is an emerging technology that has the potential of curbing the devastating effect of vehicular emission to global warming. However, why the governments of many countries and cities all over the world, including Hong Kong, seem to be slow to respond? Does this emerging technology is still a "specimen" in the laboratory that is not realistic in application? With the learning activities provided by this case study, you will have a chance to investigate the advancement of environmental-friendly technologies and know how we can do to alleviate the problem of global warming.

STOP and THINK : Activity 1

The Story

The US Government has recently spurred investing a huge amount of money for the research on hydrogen cars.

Figure 1. BMW Hydrogen car H_2R:

It's sleek, aerodynamic and environmentally friendly. "H_2 R" stands for "H_2 Race Car", "H_2 Car" or "H_2 Research Car"

In Germany, BMW is expending tremendous amounts of time, money and energy to speed up the production of hydrogen-powered vehicles. BMW's H_2R (Hydrogen-Two Race Car) is powered entirely by the clean-burning process of liquid-hydrogen combustion, and this next-generation racecar has already set speed records in the world. It is sleek, aerodynamic and environmentally friendly.

BMW H_2R Specifications：

- 6-liter, V-12 liquid-hydrogen-powered engine 210kW
- Top speed over 300 km/h
- Aluminum space-frame chassis (generates almost no interior vibration)
- Carbon-fiber-reinforced, Formula 1-style body
- 0 to 100 km/h in 6 seconds
- 1,560 kg with full tank and driver
- 5.4 meters long, 2 meters wide

Its smooth lines, aerodynamic design and gleaming silver body, the *H_2* R appears to

have sprung from the pages of a science fiction novel; It looks like a crossover between a sports car and a futuristic rocket ship. A lightweight aluminum chassis, an aluminum space frame and an outer skin composed of carbon-fiber-reinforced plastic; the H_2 R is designed for high speed and maximum stability under extreme driving conditions.

STOP and THINK : Activity 2

Please find out what are the technical specifications of a Hydrogen Car?

No. of Seats (Capacity): _____

Power Output: _____

0 - 100 km/h Acceleration: _____

Top speed: _____

Dimensions: _____

Overall weight: _____

Why is BMW expending tremendous amounts of time, money and resources to speed up the production of hydrogen-powered vehicles? According to the BMW Web site, the company's long-term goal is to eventually replace the cars that run on atmosphere-polluting fossil fuels with vehicles that use clean-burning, liquid-hydrogen fuel. In this case, you'll learn about the H_2 R and its unique, hydrogen combustion engine.

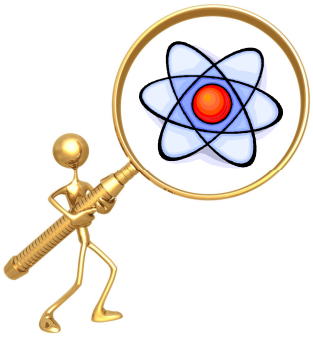
STOP and THINK : Activity 3

What are the advantages of using Aluminum chassis?

The H_2 R's suspension system comprises a double-wishbone, spring-strut front axle, rack-and-pinion steering, forged-aluminum track control arms, a tie bar and an anti-roll bar. These become a stable skeleton with a smooth and vibration-less driving experience.

The H_2 R's race-car-like appearance, high-speed performance and its extreme environmental friendliness is conceived and developed in only 10 months; the H_2 R features a 6.0-liter, V-12 hydrogen-powered engine. BMW has opted for a more traditional-style engine that utilizes a nontraditional fuel. The hydrogen combustion engine operates on the same principle as other internal combustion engines except that liquid hydrogen is used as the fuel source rather than gasoline or diesel oil.

Remarks: The text and pictures used in this case study are mainly quoted from http://auto.howstuffworks.com/bmw-h2r.htm



So far, we cannot look into the details of hydrogen combustion engine of the BMW H_2R Car as it is a secret in commercial confidentiality. However, we take this as a starting point to initiate the investigation of emerging hydrogen fuel cell technology in this case study, using fuel cell technology as a clean, quiet, efficient and pollution-free power has been regarded as the most feasible solution for the foreseeable future.

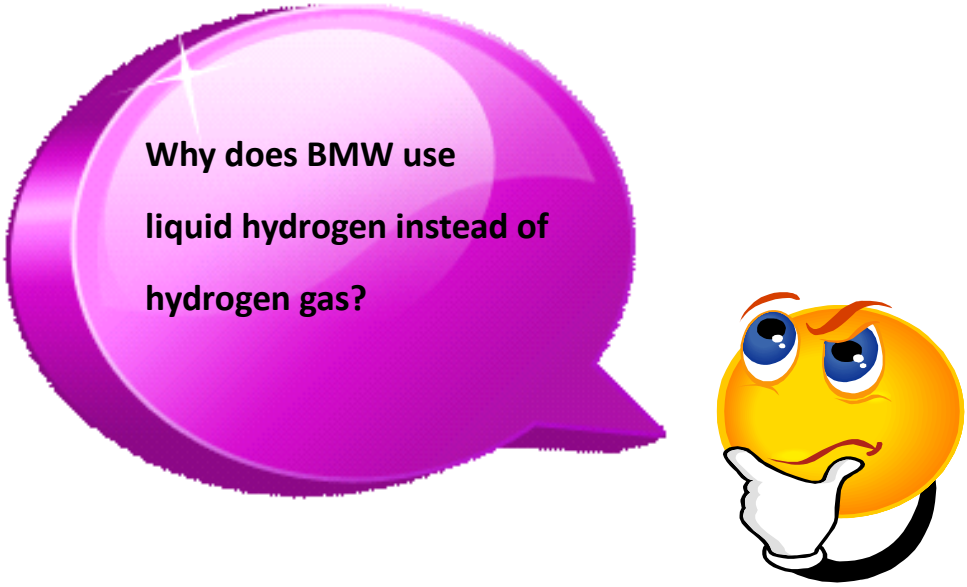
The hydrogen fuel cell has the following advantages:

1. No emission
2. No noise
3. No vibration
4. Increased performance and onboard power
5. Higher reliability
6. Greater design flexibility

The hydrogen fuel cell car likes other traditional car except there is no internal combustion engine inside. It contains a Hydrogen and Compressed Air Fuel Storage device and a Fuel Cell Engine. The Fuel Cell Engine is the core unit that contains the Fuel Cell Module and Proton Exchange Membranes. The Fuel Cell Module contains stacks of fuel cell panes that provide the power requirement. Hydrogen is delivered into the fuel cell module that generates electricity. The electric current

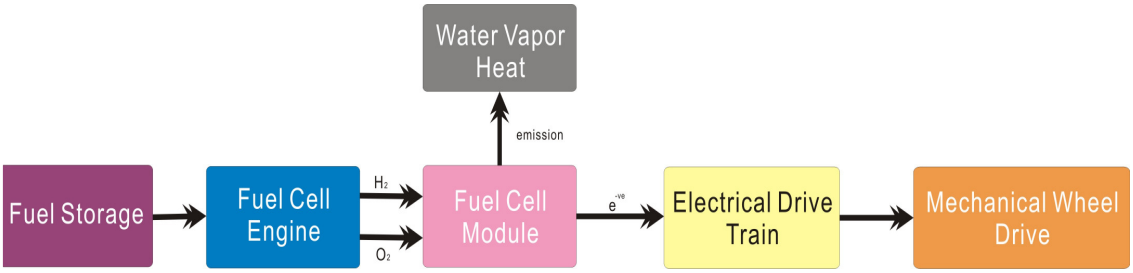
goes into the Electric Drive Train that converts the electrical power to mechanical energy. The mechanical energy makes the wheels turn. The emission or the reactions products are only a small amount of water vapor and heat.

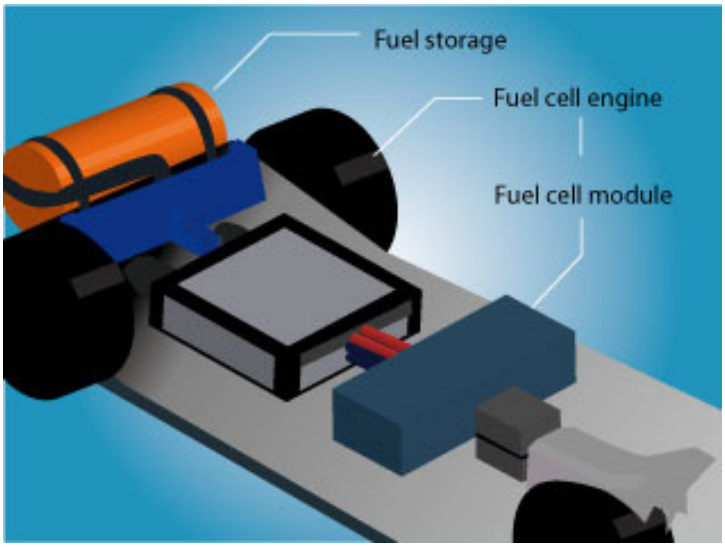
STOP and THINK : Activity 4



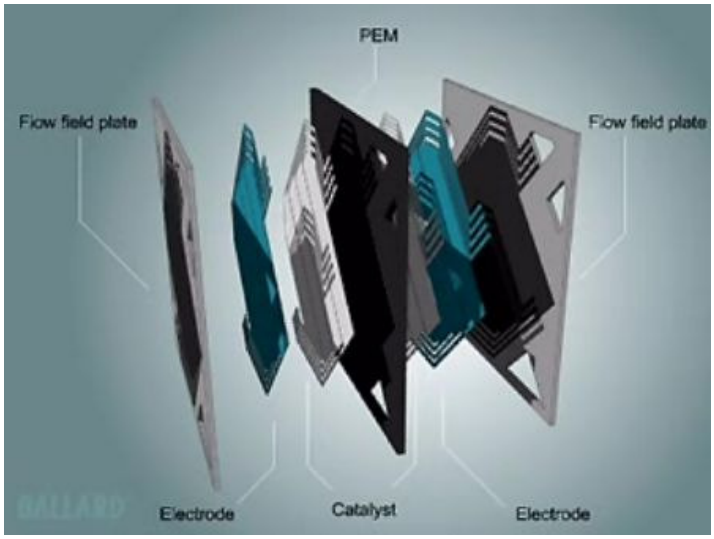
Technological Principle of a typical Hydrogen Car and Fuel Cell

How does a single fuel cell work?

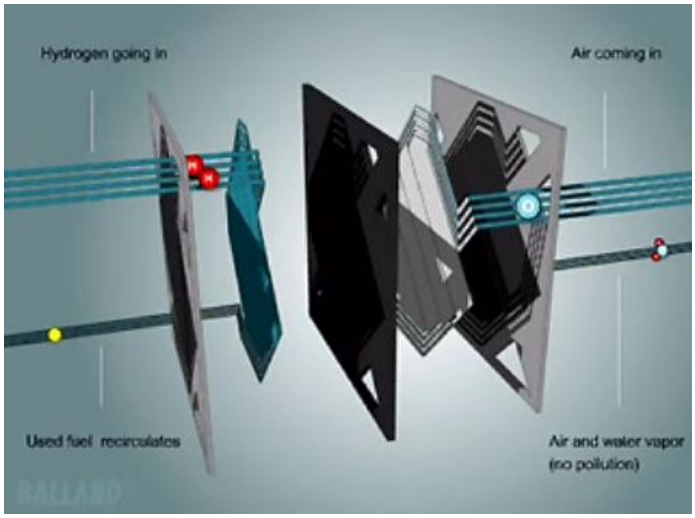




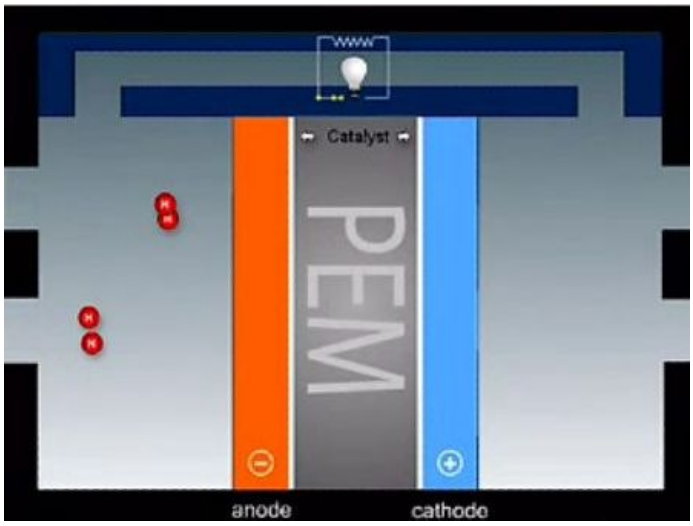
1. The fuel storage tank contains the hydrogen and compressed air.



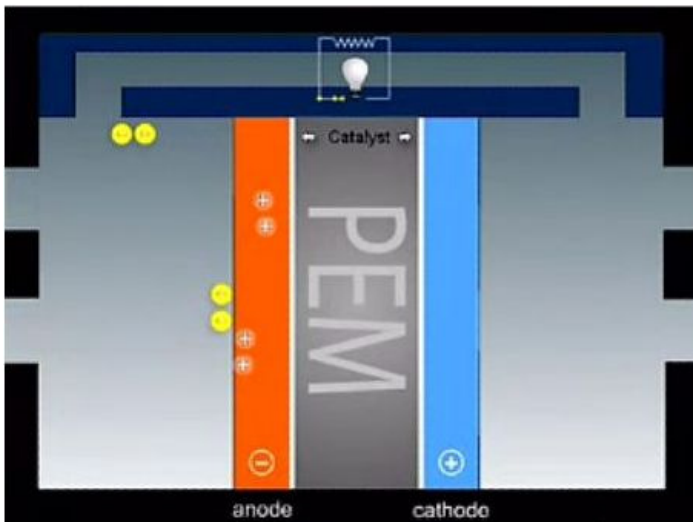
2. A single pane of fuel cell contains 2 pieces of Flow Field Plate, 2 pieces of Electrode, 1 piece of catalyst and I piece of PEM.



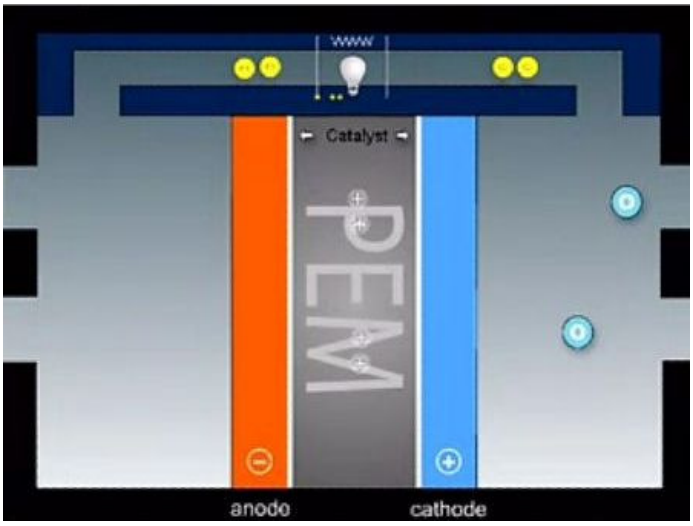
3. Hydrogen going into the Electrode (Anode) and Compressed air going into the Electrode (Cathode).



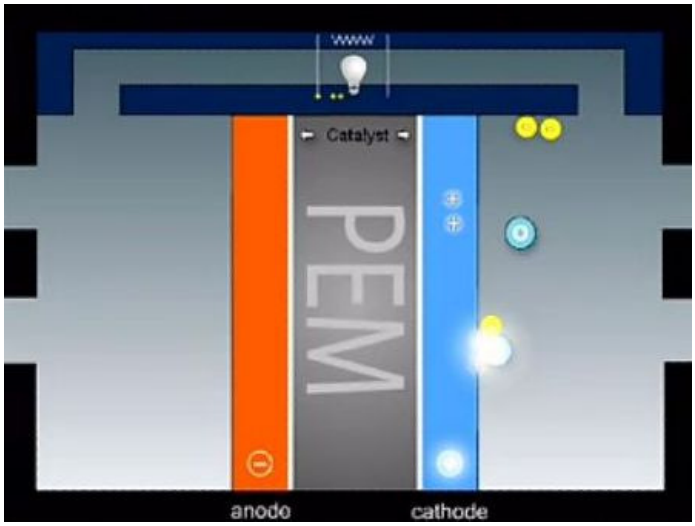
4. Proton can pass through the Anode that is the characteristic of the membrane.



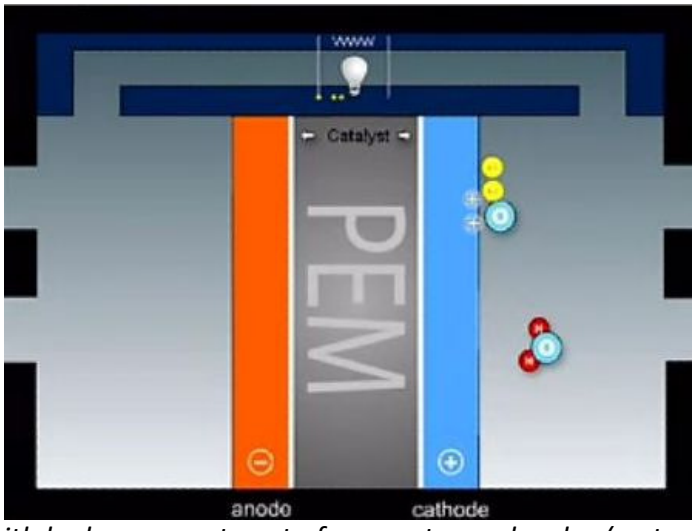
5. Electrons are going through the external electrical circuit.



6. O2 molecules (from compressed air) are going into the cathode.



7. O_2 molecules combine with the electrons on the cathode side.



8. O_2 combines with hydrogen protons to form water molecules (water vapor).

Remarks: Quoted from http://www.youtube.com/watch?v=oy8dzOB-Ykg&mode=related&search=

STOP and THINK : Activity 5

What are the advantages of using hydrogen fuel cell?

Follow up Activity (TV News Broadcast Programme)

We are going to create a more authentic and thematic learning scenario. You are required to produce a 15 minutes TV broadcasting news on a various issues as specified below. A clear definition of role and scope of work can empower you to take greater responsibility of learning. You can also learn how to compromise in taking up roles in according to your interest, strengths and experience.

Responsibility and Duty List

Post	Scope of Work	No. of person needed
Chief producer	1. Monitor the progress; 2. Quality assurance and control of the outcome; 3. Provide facilitation in resources; 4. Provide supervision and guidance; 5. Conduct assessment and feedback; 6. Provide commendation.	1 Teacher and 2 students with leadership.
Anchor person	1. In charge of the live radio broadcast; 2. Communicate with different editorial teams; 3. Prepare their own scripts; 4. Rehearsal and training; 5. Ensure smooth run of programme.	2 students responsible for broadcasting

Graphics Designer	1. Design the pops, backdrop, news logo and name; 2. Communicate actively with different teams and chief producers; 3. Seek consent and approval from the parties concerned. 4. Communicate with the pops-makers.	2 students. (Good at Visual Arts or Graphical Communication)
Pop-makers	1. Prepare all the pops needed for a broadcast room; 2. Follow the instruction from graphics designer; 3. Prepare the bills of materials and budgeting.	4 students. (good at D&T or technical subjects)
PA Technician	1. Prepare the microphones with proper setting; 2. Record the event; 3. Prepare the sound effects, jingles or music as requested; 4. Communicate actively with chief producers and anchorperson.	3 students (interested in PA setting and digital sound mixing)
Videographer	1. Video-taking and sound recording of the broadcast.	2 student (Interested in photography and video-editing)
Editorial team leader	1. Monitor team progress; 2. Ensure quality learning outcome; 3. Communicate actively with other team leaders and chief producers; 4. Give direction to team members	1 per team
Editorial team members	1. Conduct information search; 2. Write the scripts; 3. Work closely with team leader and other members; 4. Design and produce the content, such as sound effect, jingles and narration.	According to the class size, at least 3 is appropriate.

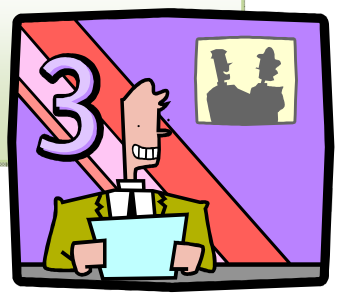
Division of Work

Post	Name of responsible person	
Chief producer	1. _____ 2. _____ 3. _____	
Anchor person	1. _____ 2. _____	
Graphics Designer	1. _____ 2. _____	
Pop-makers	1. _____ 2. _____ 3. _____ 4. _____	
PA Technician	1. _____ 2. _____ 3. _____	
Videographer	1. _____ 2. _____	
Editorial team leader	Team A. _____ Team B. _____ Team C. _____ Team D. _____ Team E. _____	
Editorial team members	Team A： 1. _____ **2.** _____ **3.** _____	Team B： 1. _____ **2.** _____ **3.** _____
	Team C： 1. _____ **2.** _____ **3.** _____	Team D： 1. _____ **2.** _____ **3.** _____
	Team E： 1. _____ **2.** _____ 3. _____	Team F: 1. _____ **2.** _____ 3. _____

TV News Broadcast Programme – Group Presentation Theme 1

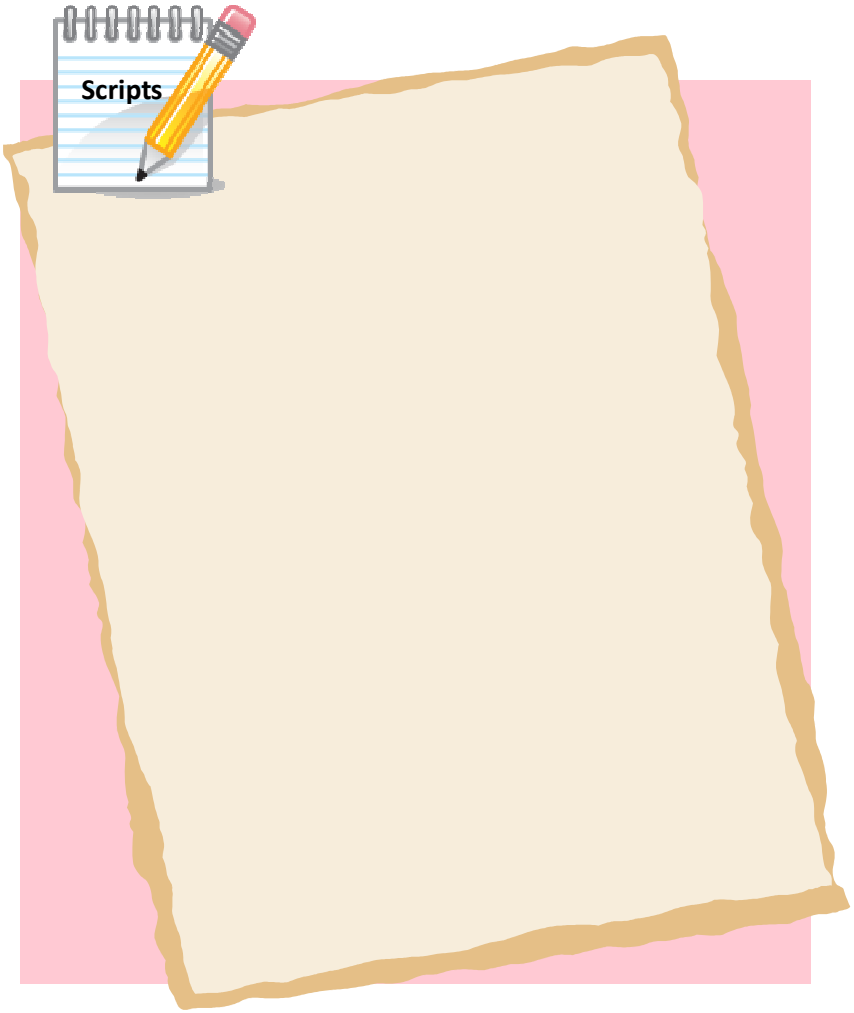
Theme: **Social Issues**

Global warming and vehicular emission



Focus questions:

- What are the causes and effects of global warming to Hong Kong?
- How serious are vehicular emission to pollution in Hong Kong?
- Would you suggest a practical proposal for replacement of conventional vehicle with hydrogen car? Any obstacles you can foresee and overcome?



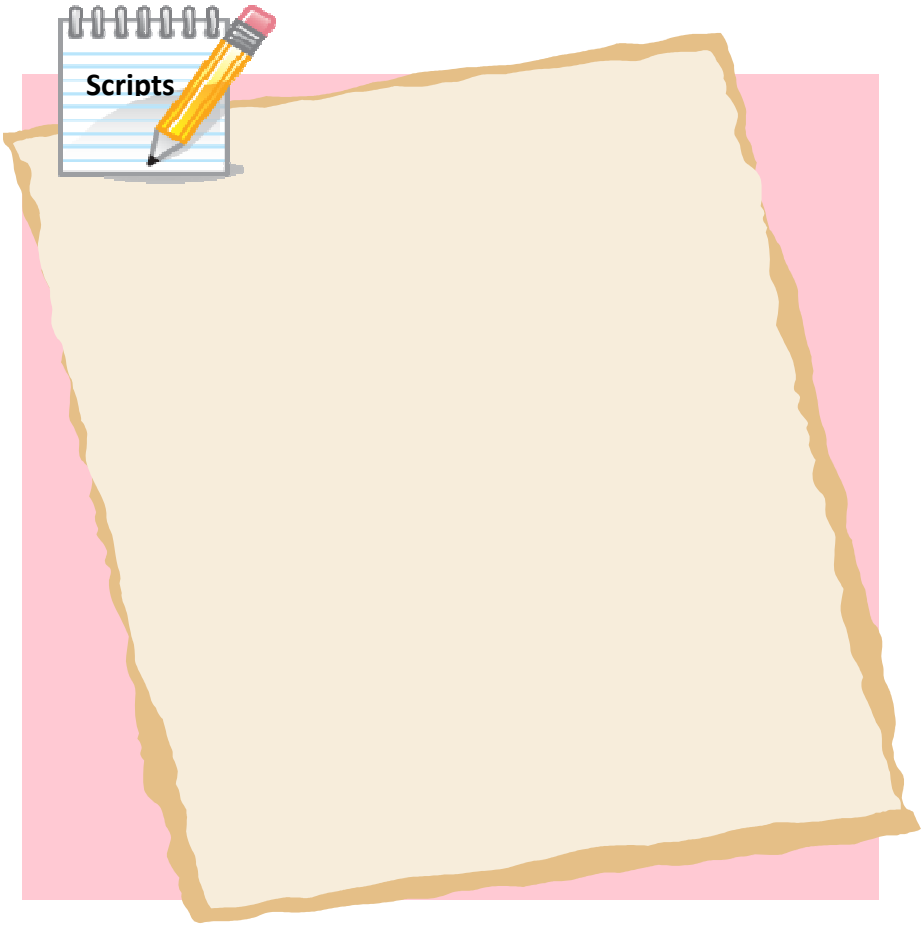
TV News Broadcast Programme – Group Presentation Theme 2

Theme: Economical issues

Putting hydrogen cars onto the road

Focus questions:

- Why many environmental-friendly vehicles, such as hydrogen car, in foreign countries are not yet imported in Hong Kong?
- What infrastructures should be made for the hydrogen cars in Hong Kong?
- Any policies for importing environmental-friendly vehicles to Hong Kong?



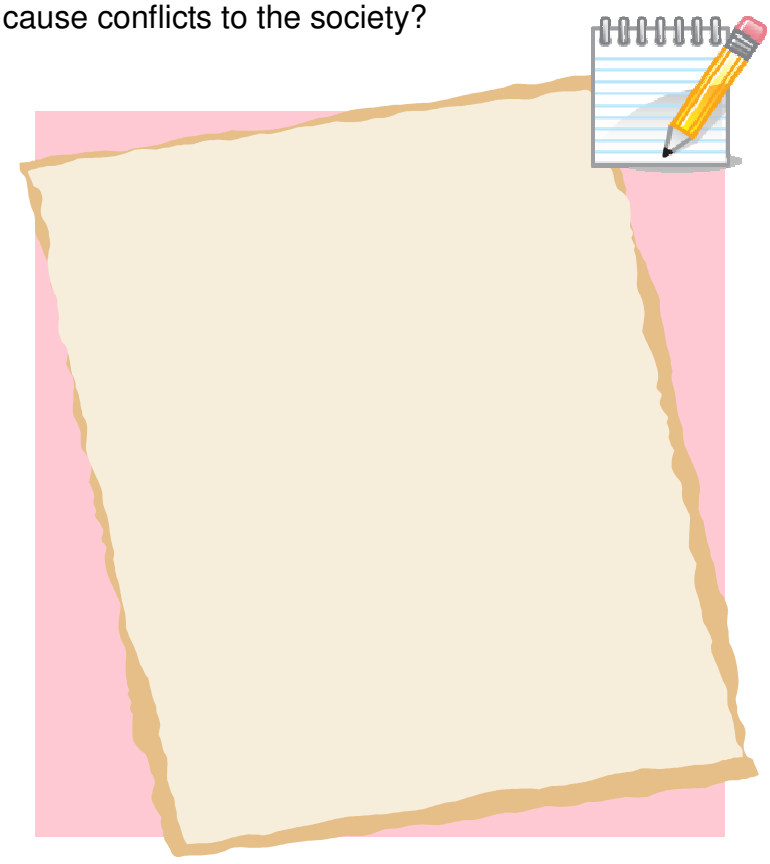
TV News Broadcast Programme – Group Presentation Theme 3

Theme: Value and Impact

Replacing traditional vehicles with hydrogen cars

Focus questions:

- Analysis the statistical data from Hong Kong Observatory and Transport department to find out any correlation between CO2 concentration and total car registration over this 10 years?
- People are getting to know the adverse effect of the vehicular emission to the global warming. However, the number of private car registration is increasing in every year. What is the reason for that?
- Find out the pros and cons of replacing all the conventional vehicles with hydrogen cars? Will it cause conflicts to the society?



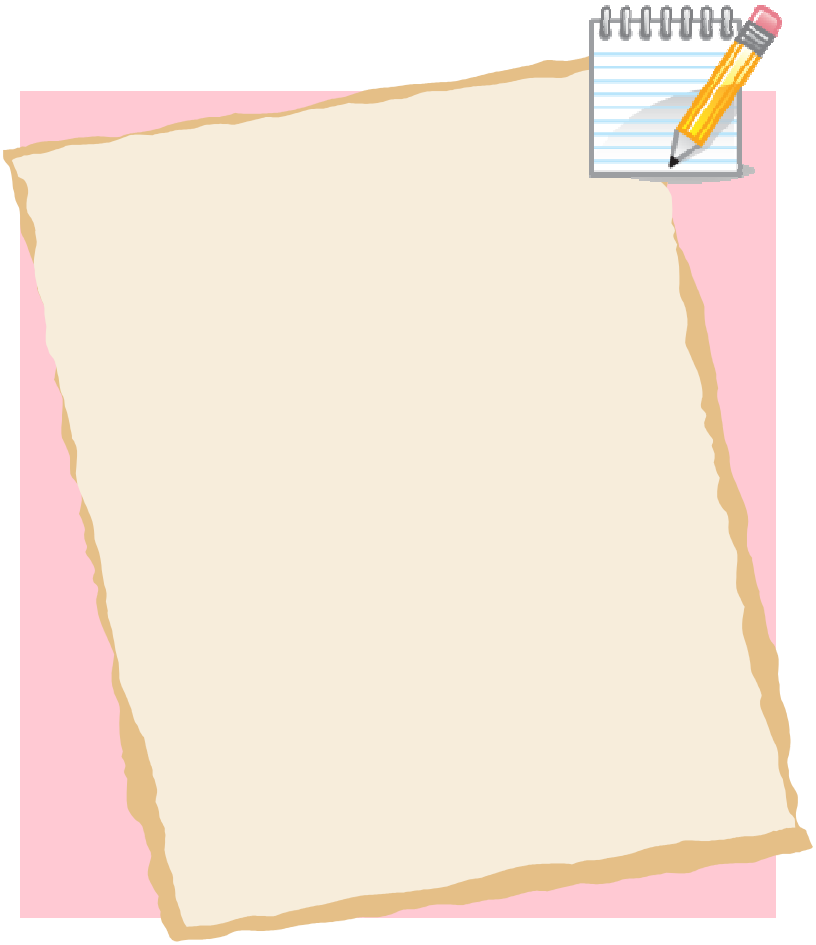
TV News Broadcast Programme – Group Presentation Theme 4

Theme: **Technological Principles**

Emerging environmental friendly vehicle

Focus questions:

- What emerging technologies can replace the use of fossil fuel or rely less on the internal combustion engine?
- What are the performances of environmental-friendly vehicles, such as hybrid-type and hydrogen fuel cell, in comparison with traditional vehicle?
- Find out the possible ways of producing and delivering hydrogen (either gas or liquid) and any safety measures?



Assessment Rubrics for Final Presentation (Live news programme)

We encourage collaborative learning throughout this case study; therefore peer assessment and evaluation on their learning were suggested. It is recommended that you take a minute to evaluate and reflect on your own leaning after each lesson. A simple checklist rubric is provided. You will also take responsibility to assess the performance of other groups during the final presentation with the scored rubrics.

Self / Peer assessment (checklist)

This assessment rubric can be used to keep your learning progress and schedule. Put "Yes" or "No" after each lesson. Teacher can easily check whether you can meet the lesson objectives.

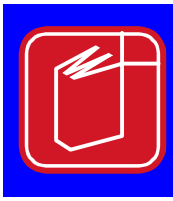
Student Name: _____		***Team:*** _____	
Focus of Assessment: Teamwork		***Date:*** ____/_____/_____	
Criteria	**Self**	**Peer**	**Teacher**
1. I understand the lesson objectives.	Yes / No	Yes / No	Yes / No
2. I work with team members cooperatively.	Yes / No	Yes / No	Yes / No
3. I give my views responsibly.	Yes / No	Yes / No	Yes / No
4. I respect and listen to other members' ideas.	Yes / No	Yes / No	Yes / No
5. I can draw conclusion after this lesson.	Yes / No	Yes / No	Yes / No
6. I am satisfied with my learning today.	Yes / No	Yes / No	Yes / No

Assessment rubrics (Presentation)

Students can use these rubrics for peer assessment of the final presentation. Teacher needs to explain and discuss these criteria with the students.

Peer Assessment for Final presentation														
Team:								***Date:***						___/___/_____
Assessors:								***Class:***						
Focus	**No**	**Scores**					**Assessment Criteria**	**Scores**						
Knowledge	1	1	2	3	4	5	← Understanding of the topic →	6	7	8	9	10	N/A	
	2	1	2	3	4	5	← Content is consistent with the topic →	6	7	8	9	10	N/A	
	3	1	2	3	4	5	← Content is supported with evidence →	6	7	8	9	10	N/A	
	4	1	2	3	4	5	← Content is at appropriate level →	6	7	8	9	10	N/A	
	5	1	2	3	4	5	← Show key concept in content →	6	7	8	9	10	N/A	
Attitude	6	1	2	3	4	5	← Show effort in group discussion →	6	7	8	9	10	N/A	
	7	1	2	3	4	5	← Show effort in information search →	6	7	8	9	10	N/A	
	8	1	2	3	4	5	← Show effort in preparing presentation →	6	7	8	9	10	N/A	
	9	1	2	3	4	5	← Show competency in IT skills →	6	7	8	9	10	N/A	
	10	1	2	3	4	5	← Show organization skills →	6	7	8	9	10	N/A	
Presentation	11	1	2	3	4	5	← Present their views and idea clearly →	6	7	8	9	10	N/A	
	12	1	2	3	4	5	← Logical and consistent flow of ideas →	6	7	8	9	10	N/A	
	13	1	2	3	4	5	← Have interaction with audiences →	6	7	8	9	10	N/A	
	14	1	2	3	4	5	← Show appropriate use of visual aids →	6	7	8	9	10	N/A	
	15	1	2	3	4	5	← Have eye contact with audiences →	6	7	8	9	10	N/A	
Total Scores														

** Performance descriptors: 1 is incomplete; 5 is fair; 7 is good; 8 is very good; 9 is outstanding*



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