

### Heat Transfer – Radiation (Physics)

Level: S3

Subject: Physics

Topic: Heat Transfer – Radiation

Introduction:

This set of ELA materials is developed for S3 Physics. The materials, consisting of a lesson plan, a worksheet and a word game, are designed for a double lesson of 70 minutes.

The topic, namely ‘Heat Transfer – Radiation’ has been taught in previous lessons, using Chinese as the medium of instruction. During these lessons, the concept terms in English relevant to the topic may also have been introduced. In this ELA lesson, an experiment for examining the surface properties of good and poor absorbers/radiators of heat is conducted through the medium of English based on students’ understanding of radiation.

The ELA aims to help students verify that dull black surfaces radiate/absorb heat faster than shiny/silvery surfaces. Through an experiment, students will learn the names of apparatus and measuring variables in English. Besides, through completing a worksheet, they will learn how to write a simple laboratory report in English, focusing on the language features commonly used in writing laboratory reports. The ELA includes a crossword puzzle which helps students to revise the key terms introduced in the lesson and a short quiz to assess students’ knowledge of the simple format of a laboratory report.

#### *Acknowledgement*

This set of materials was produced jointly by the teachers of Tang Shiu Kin Victoria Government Secondary School and the ELA research team.

## ELA Lesson Plan – Heat Transfer - Radiation

**Description:** This ELA involves the basic knowledge of heat transfer by radiation, which is covered in Section 1 Heat of the CDC S.4 – 5 Physics syllabus. The students have learned the concepts relevant to this topic, using Chinese as the medium of instruction. In most CMI classes, some English key terms relating to the topic will have been introduced. In this ELA, students compare the heat absorption and radiation of different surfaces experimentally. Based on a worksheet, students will complete a simple laboratory report. They are also introduced to the language features, such as vocabulary and tenses, commonly used in writing such reports. During the waiting time in Part B of the experiment, students review the English terms introduced in the lesson by completing a crossword puzzle.

**Content Objectives:** After completing the activity, students should be able to distinguish good and poor absorbers/radiators of heat according to their surface properties.

**Language Objectives:** After completing the activity, students should be able to:

- understand and use the English terms related to heat transfer and radiation (e.g., *radiation, objective, compare, absorption, radiation, different surfaces, silvery surface, dull black surface, good absorber, poor absorber, good radiator, poor radiator, heat, aluminum foil, thermometers, heat insulating gloves*);
- understand and use the English expressions for stating the surface properties of good and poor absorbers/radiators of heat, e.g.,
  - *Dull black surfaces are good absorbers and good radiators of heat.*
  - *Shiny/silvery surfaces are poor absorbers and poor radiators of heat.*
- state in English the format of a simple laboratory report, e.g.,
  - *A simple laboratory report contains five sections: Objective, Apparatus, Procedure, Result, and Conclusion.*
- name correctly in English the apparatus commonly used in studying heat (e.g., *heater, aluminium foil, thermometers, boiling tubes, lamp, rubber stoppers, hot water, heat insulating gloves*)

**Activities:**

1. Introducing Report Format – whole-class activity (10 min)
2. Experiment (Part A) – student demonstration (20 min)
3. Experiment (Part B) and Revision of Vocabulary – student demonstration and individual work (20 min)
4. Discussion on the Results of the Experiment – whole-class activity (10 min)
5. Round-up and Short Quiz – whole-class activity (10 min)

**Materials:**

- 1 worksheet (WS: Experiment 3C Radiation)
- 1 word game (WG: Crossword Puzzle)
- 1 Quiz

*(Apparatus for the experiment: please refer to WS)*

Steps:

**Introducing Report Format** – whole-class activity (10 min)

*Refer to Teacher's note (TNI)*

1. The teacher should first explain the learning objectives of the lesson – studying the properties of good and poor absorbers/radiators of heat by doing experiments, and writing a simple laboratory report.
2. The teacher should then distribute the worksheet WS.
3. The experiment to be conducted in this lesson should be briefly explained and the teacher should show how it is related to what they have learned in previous lessons.
4. The teacher should introduce the main purposes of writing a laboratory report, which include telling people
  - (i) why you did the experiment
  - (ii) how you carried out the experiment
  - (iii) what you found in the experiment.

A laboratory report has a typical format that provides a systematic and effective presentation of information to fulfill these purposes.

5. Finally, the teacher should introduce a simple format with the following 5 sections:

<b>Objective:</b>	state the tasks to be achieved in the experiment	for purpose (i)
<b>Apparatus :</b>	put down the list of the materials and tools that are necessary for conducting the experiment	for purpose (ii)
<b>Procedure :</b>	present a series of ordered steps in carrying out the experiment	for purpose (ii)
<b>Results :</b>	record the findings of the experiment	for purpose (iii)
<b>Conclusion :</b>	tell what is deduced from the findings in reference to the objectives of the experiment.	for purpose (iii)

In this lesson, students will learn about this format and the way to write the report.

**Experiment (Part A)** – group work (20 min)

6. The teacher should first, introduce the objective of the experiment.
  - 6.1 He or she should highlight the pattern “To *verb* (in base form).....” to introduce a simple way of stating the objective of an experiment.
7. The names of the apparatus should be introduced and the procedure of the experiment should be explained step by step, through the medium of English. Students should be reminded to pay attention to what the teacher is going to do and say since they are going to record these in the report.
8. The teacher should let students complete the **Apparatus** and **Procedure** tasks. Then, check answers.

(Students’ attention should be drawn to the main verb (usually the first word) in each step. These steps are instruction which usually start with an action verb in base form.)
9. Before starting the experiment, the teacher should ask students to predict the result of the experiment and conduct a survey of class predictions.
10. The teacher should ask students to record the finding in the **Result** section.

(Students’ attention should be drawn to the tense of the verb. In reporting results, past tense is used.)

**Experiment (Part B)** – group work **and Revision of Vocabulary** – individual work (20 min)

11. The students should be asked to fill in the heading of each section in Part B. Then, the teacher should check their answers.
12. The names of the apparatus should be introduced and the procedure of the experiment should be described step by step, through the medium of English. Then, students should be asked to complete the **Apparatus** and **Procedure** tasks before the teacher checks their answers.
  - 13.1 In the demonstration, the temperatures of one boiling tube should be taken and put on the board to illustrate the meaning of the terms ‘initial temperature’, ‘final temperature’ and ‘temperature drop’.
  - 13.2 Student attention should be drawn to the **Precaution** for handling hot water.

*Refer to Teacher's note (TN2)*

13. Before starting the experiment, the teacher should ask students to predict the result of the experiment (Which boiling tube will lose heat faster?) and conduct a survey of class predictions.
14. Students should be asked to record the temperature readings in the **Result** section.
15. During the waiting time of 10 minutes for taking the final temperatures of the boiling tubes, the word game WG should be distributed and students asked to complete the cross-word puzzle as far as they can. (Remark: The answers to Item 4 and 10 will not have been covered yet.)

*Refer to Teacher's note (TN3)*

16. The teacher should ask students to complete the statement in the Result section according to the temperature readings recorded and compare it with their prediction.

#### **Discussion on the Results of the Experiment** – whole-class activity (10 min)

17. The teacher should compare the results obtained in Part A and B of the experiment and students should be asked if they can tell from the results that which surfaces are good radiators and absorbers of heat.
18. Students should be asked to complete the statement in the **Conclusion** section.

#### **Round-up and Short Quiz** – whole-class activity (10 min)

19. The teacher should let students complete WG (Item 4 and 10) if necessary.
20. After checking the answers to the WG, students should be invited to read the clues and their answers.
21. Selected students should be asked orally to name the five sections of a simple laboratory report and arrange their order.
22. After collecting all the worksheets, a short quiz should be distributed to the class.
23. When students have finished the quiz, the teacher should check the answers they have given.

### **Teacher's notes**

TN1: The teacher may conduct this briefing session in CMI if necessary.

TN2: To save time, the teacher may measure the initial and the final temperature of the boiling tube with a time interval of about 1 minute, rather than 10 minutes.

TN 3: Answers of WG will be checked in the Round-up session.

## Experiment: Radiation

WS: Experiment: Radiation

### Objective

To *compare* a silvery surface and a dull black surface, and *find out* which is a *good* absorber and radiator of heat.

Part A Absorption of radiation by different surfaces

### Apparatus

*\*Circle the ones needed in this experiment.*

Aluminium foil, *thermometers*, *boiling tubes*, heater, lamp, *rubber stoppers*, hot water (~70 °C), heat insulating gloves

### Procedure

*\*Put down numbers to show the steps in order.*

	<i>Find out</i> which foil becomes hot first.
	Cover the back of your right hand with a square of blackened aluminium foil.
	Hold your hands at about 10 cm from a heater.
	Cover the back of your left hand with a square of plain aluminium foil.

### Result

The \_\_\_\_\_ (plain / blackened) aluminium foil got hotter first.

Part B Radiation of heat from different surfaces

\_\_\_\_\_  
*\*Circle the ones needed in this experiment.*

Aluminium foil, *thermometers*, *boiling tubes*, heater, lamp, *rubber stoppers*, hot water (~70 °C), heat insulating gloves

\_\_\_\_\_  
*\*Put down numbers to show the steps in order.*

	Put on stoppers and <i>thermometers</i> for the <i>boiling tubes</i> .
	Take the <i>temperature</i> of the water in the two <i>boiling tubes</i> .
	Pour same amount of hot water (~70 °C) into two <i>boiling tubes</i> , one covered with dull black paper and the other covered with silvery aluminium foil.
	After 10 minutes, take the <i>temperature</i> again.

*\* Precaution: Wear heat insulating gloves when handling hot water.*

\_\_\_\_\_  
*Boiling tube* covered with dull black paper :

*Initial temperature* =                      *Final temperature* =                      *Temperature drop* =

*Boiling tube* covered with silvery aluminium foil:

*Initial temperature* =                      *Final temperature* =                      *Temperature drop* =

The *boiling tube* covered with \_\_\_\_\_ lost heat faster.

\_\_\_\_\_  
Dull black surfaces are \_\_\_\_\_ (*good / poor*) absorbers and \_\_\_\_\_ (*good / poor*) radiators of heat; shiny/silvery surfaces are \_\_\_\_\_ (*good / poor*) absorbers and \_\_\_\_\_ (*good / poor*) radiators of heat.

### Crossword Puzzle

1F			2A													
					4P											
									5T						9C	
3T													10G			
											8C					
													12R			
	6R							7P								
	14D				16P			13I								
	11O															

1. At the end.
2. The section of a laboratory report where you put down the list of materials and tools used.
3. You read temperature with this.
4. Silvery surfaces are \_\_\_\_\_ absorbers of heat.
5. The degree of hotness of an object.
6. The section of a laboratory report in which you write down what you have found out.
7. The section of a laboratory report in which you write down the steps for carrying out the experiment.
8. The last section of a laboratory report.
9. You \_\_\_\_\_ two things to find out how different and similar they are.
10. Black surfaces are \_\_\_\_\_ radiators of heat.
11. The section of a laboratory report in which you write down why you did that experiment.
12. \_\_\_\_\_ carries heat from the sun to the earth.
13. At the beginning.
14. When an object cools down, it has a temperature \_\_\_\_\_.
15. To \_\_\_\_\_ the temperature means to obtain the temperature through measurement.
16. \_\_\_\_\_ is what people should do to protect themselves against possible dangers.



**Experiment: Radiation****Objective**

To *compare* a silvery surface and a dull black surface, and *find out* which is a *good* absorber and radiator of heat.

Part A Absorption of radiation by different surfaces

**Apparatus**

*\*Circle the ones needed in this experiment.*

Aluminium foil, *thermometers*, *boiling tubes*, heater, lamp, *rubber stoppers*, hot water (~70 °C), heat insulating gloves

**Procedure**

*\*Put down numbers to show the steps in order.*

4	Find out which foil becomes hot first.
1 or 2	Cover the back of your right hand with a square of blackened aluminium foil.
3	Hold your hands at about 10 cm from a heater.
2 or 1	Cover the back of your left hand with a square of plain aluminium foil.

**Result**

The blackened (plain / blackened) aluminium foil got hotter first.

## Part B Radiation of heat from different surfaces

### Apparatus

\*Circle the ones needed in this experiment.

Aluminium foil,	thermometers,	boiling tubes,	heater,	lamp,	rubber stoppers,
hot water (~70 °C),	heat insulating gloves				

### Procedure

\*Put down numbers to show the steps in order.

2	Put on stoppers and <i>thermometers</i> for the <i>boiling tubes</i> .
3	Take the <i>temperature</i> of water in the two <i>boiling tubes</i> .
1	Pour same amount of hot water (~70 °C) into two <i>boiling tubes</i> , one covered with dull black paper and the other covered with silvery aluminium foil.
4	After 10 minutes, take the <i>temperature</i> again.

\***Precaution:** Wear heat insulating gloves while handling hot water.

### Result

Boiling tube covered with dull black paper :

Initial temperature =                      Final temperature =                      Temperature drop =

Boiling tube covered with silvery aluminium foil:

Initial temperature =                      Final temperature =                      Temperature drop =

The boiling tube covered with dull black paper lost heat faster.

### Conclusion

Dull black surfaces are good (*good / poor*) absorbers and good (*good / poor*) radiators of heat; shiny/silvery surfaces are poor (*good / poor*) absorbers and poor (*good / poor*) radiators of heat.

## Crossword Puzzle

<sup>1</sup> F	I	N	<sup>2</sup> A	L													
			P														
			P		<sup>4</sup> P												
			A		O				<sup>5</sup> T						<sup>9</sup> C		
<sup>3</sup> T	H	E	R	M	O	M	E	T	E	R			<sup>10</sup> G	O	O	D	
			A		R				M			<sup>8</sup> C			M		
			T						P			O		<sup>12</sup> R		P	
			U						E			N		A		A	
	<sup>6</sup> R	E	S	U	L	T			<sup>7</sup> P	R	O	C	E	D	U	R	E
									A		L		I		E		
									T		U		A				
	<sup>14</sup> D				<sup>16</sup> P				<sup>13</sup> I	U		S		T			
	R				R				N	R		I		I			
	<sup>11</sup> O	B	J	E	C	T	I	V	E			O		O			
	P			C			T					N		N			
				A			I										
				U		<sup>15</sup> T	A	K	E								
				T			L										
				I													
				O													
				N													

- At the end.
- The section of a laboratory report where you put down the list of materials and tools used.
- You read temperature with this.
- Silvery surfaces are \_\_\_\_\_ absorbers of heat.
- The degree of hotness of an object.
- The section of a laboratory report in which you write down what you have found out.
- The section of a laboratory report in which you write down the steps for carrying out the experiment.
- The last section of a laboratory report.
- You \_\_\_\_\_ two things to find out how different and similar they are.
- Black surfaces are \_\_\_\_\_ radiators of heat.
- The section of a laboratory report in which you write down why you did that experiment.
- \_\_\_\_\_ carries heat from the sun to the earth.
- At the beginning.
- When an object cools down, it has a temperature \_\_\_\_\_.
- To \_\_\_\_\_ the temperature means to obtain the temperature through measurement.
- \_\_\_\_\_ is what people should do to protect themselves against possible dangers.

Short Quiz

**Write down the five sections of a simple laboratory report in correct order.**

1.
2.
3.
4.
5.

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Short Quiz

**Write down the five sections of a simple laboratory report in correct order.**

1.
2.
3.
4.
5.