Absorption of thermal radiation (Item No.: P1043500)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Thermal physics
Subtopic: Heat transfer and thermal insulation
Experiment: Absorption of thermal radiation

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- Butane burner, Labogaz 206 type 32178-00
- Butane cartridge C206, without valve 47535-00
- Glycerol, 250 ml 30084-25
- Matches

Experiment Variations:

- Demonstration experiment with a radiation sensitive thermo column and Leslie radiation cube

Keywords:

Task and equipment

Information for teachers

Additional Information

A polished and a black beaker are heated by radiation. Instead of solar radiation a bright flame located in front of the two beakers is used.
Both beakers are filled with air since the heat capacity of water is very large and it would be too slowly heated.

Remarks

The flame must be in front of the two beakers so that they are primarily warmed by radiation and not by convection flow.

The inverse physical statement, i.e. "black surfaces radiate heat energy better than polished ones", cannot be conclusively proven with the temperature measurements. If both beakers are filled with hot water having the same temperature, in both cases the temperature decrease is of nearly the same magnitude. The difference would have to be very much larger if the heat loss was only the result of radiation. Since the experiment does not take place in a vacuum, the largest part of the heat is lost by heat conduction through the walls and heat emission of the surrounding air.
The proof of the differing heat dissipation should be better conducted in a demonstration with the aid of the Leslie radiation cube (Order No. 04555-00) and a radiation sensitive thermo column (Order No. 08479-00).

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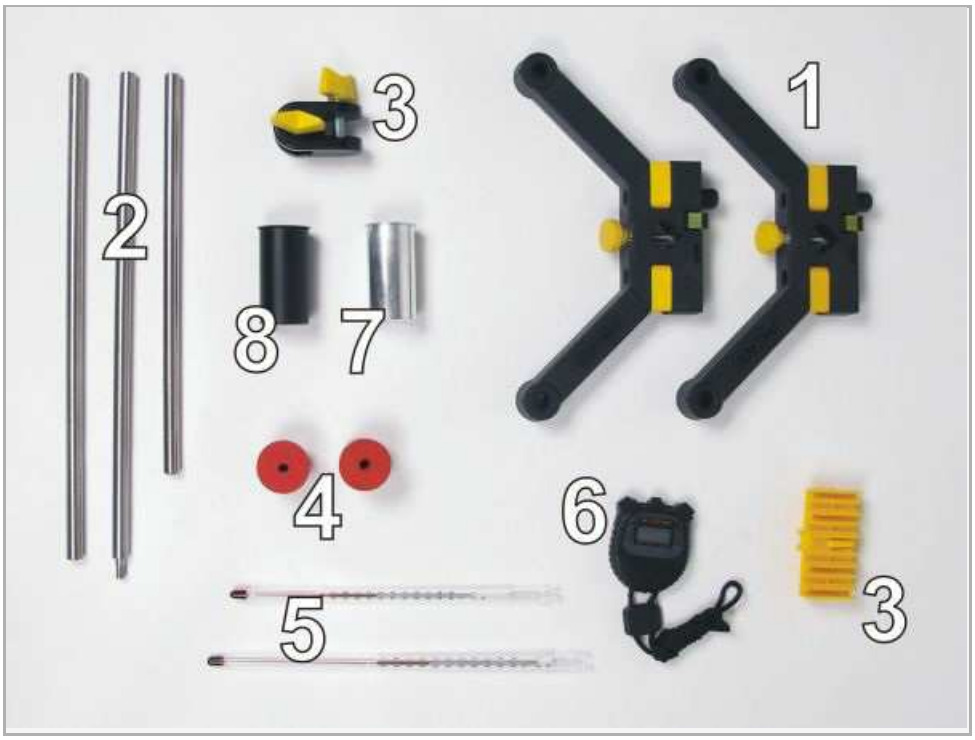
Task and equipment

Task

What kind of bodies are best warmed by the sun?

Investigate the heat absorption of a polished and a black surface.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
3	Boss head	02043-00	1
3	Glass tube holder with tape measure clamp	05961-00	1
4	Rubber stopper 26/32, 1 hole 7 mm	39258-01	2
5	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
5	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
6	Stop watch 4	03078-00	1
7	Beaker, aluminum, polished	05903-00	1
8	Beaker, black	05904-00	1
	Butane burner, Labogaz 206 type	32178-00	1
	Butane cartridge C206, without valve	47535-01	1
	Glycerol, 250 ml	30084-25	1
Additional material			
	Matches		
As an alternative	(Additional Information on the Task page)		
	Leslie radiation cube	04555-00	1
	Thermopile, Moll type	08479-00	1
	Moving-coil meter	11100-00	1
	Measuring range 30 µV...10 mV (with amplifier)	11110-01	1

Set-up and procedure

Set-up

Attention!

Always insert the thermometer in the rubber stoppers using glycerol.

Setup

- Set up the support stand according to the following pictures.

Fig. 1

Fig. 2

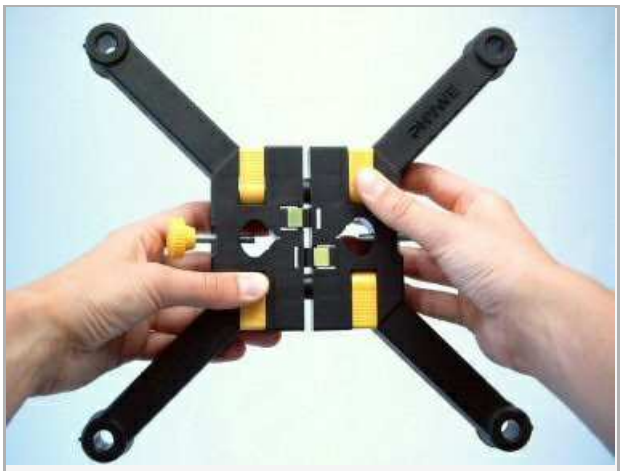


Fig. 3

Fig. 4a

Fig. 4b

Fig. 5

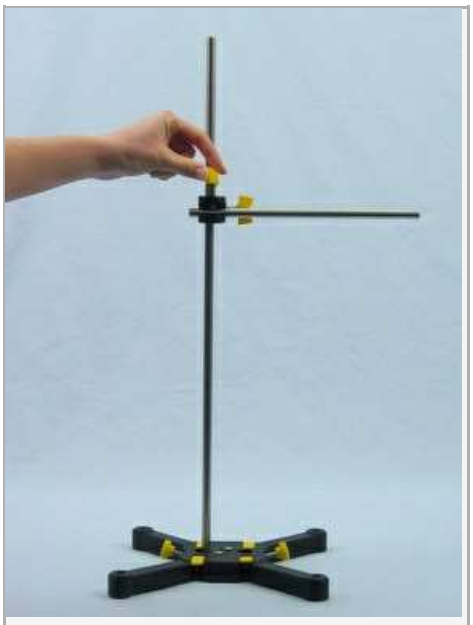


Fig. 6

- Insert both thermometers into the rubber stoppers so that they extend about 3 cm through the stoppers; insert the rubber stoppers firmly into the metal beakers.

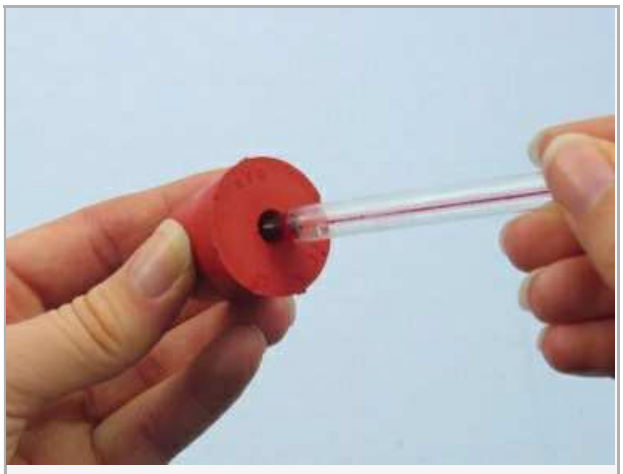


Fig. 7

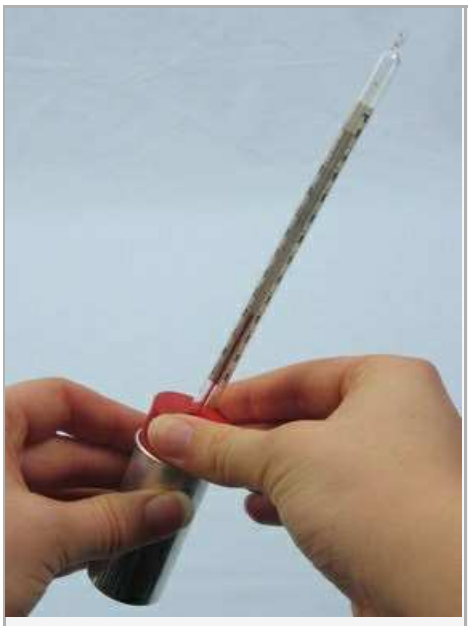


Fig. 8

- Fix the thermometers in the glass tube holder; adjust the height of the two beakers so that they are at the height of the burner's flame.


Fig. 9


Fig. 10

Procedure

- Read the beginning temperature of both thermometers and record it in the table in the report (time $t = 0$).
- Place the burner with a bright flame about 5 cm in front of (not under!) and centered on the two beakers.
- Start the stop watch and read the temperature at 1 min intervals.

Report: Absorption of thermal radiation ung

Result – Table 1

Enter the temperature of both beakers in the table.

	polished	black
t in min	ϑ_1 in °C	ϑ_2 in °C
0	1 ±0	1 ±0
1	1 ±0	1 ±0
2	1 ±0	1 ±0
3	1 ±0	1 ±0
4	1 ±0	1 ±0
5	1 ±0	1 ±0
6	1 ±0	1 ±0
7	1 ±0	1 ±0
8	1 ±0	1 ±0
9	1 ±0	1 ±0
10	1 ±0	1 ±0

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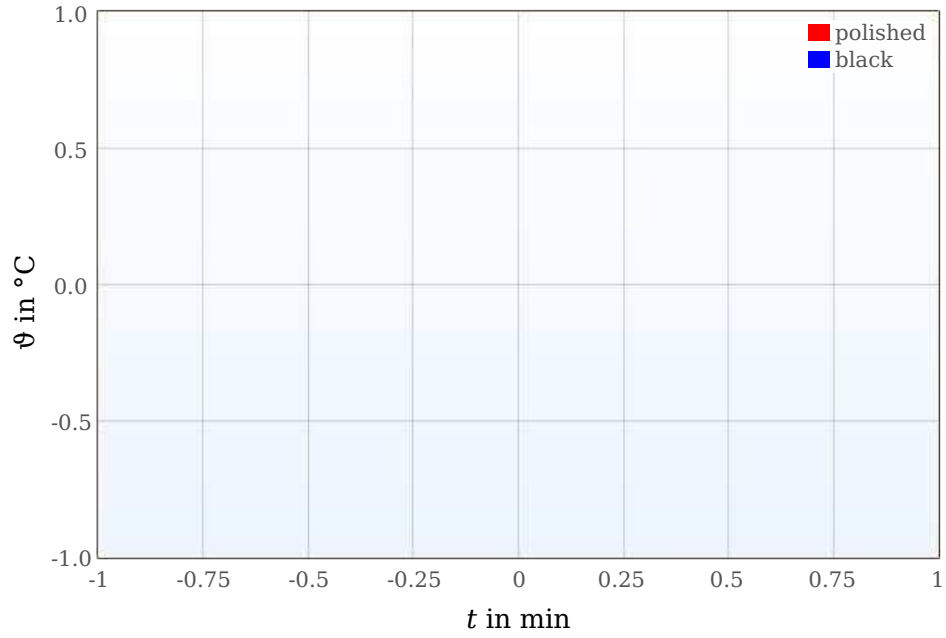
Number1



Evaluation – Question 1

Which body absorbs heat radiation better?

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Evaluation – Question 2

Give further examples which confirm this observation.

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