



3420U10-1

MONDAY, 19 JUNE 2023 – AFTERNOON

PHYSICS – Unit 1:

**Electricity, Energy and Waves
FOUNDATION TIER**

**1 hour 45 minutes plus your additional
time allowance**

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

(Turn over)

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 5(c).

(Turn over)

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	12	
2.	7	
3.	4	
4.	4	
5.	12	
6.	9	
7.	12	
8.	7	
9.	13	
Total	80	

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EQUATIONS

$$\text{current} = \frac{\text{voltage}}{\text{resistance}}$$

$$I = \frac{V}{R}$$

total resistance in
a series circuit

$$R = R_1 + R_2$$

energy
transferred = power \times time

$$E = Pt$$

power = voltage \times current

$$P = VI$$

% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$

density = $\frac{\text{mass}}{\text{volume}}$

$$\rho = \frac{m}{V}$$

units used (kWh) = power (kW) \times time (h)

cost = units used \times cost per unit

wave
speed = wavelength \times frequency

$$v = \lambda f$$

speed = $\frac{\text{distance}}{\text{time}}$

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

$$p = \frac{F}{A}$$

$$\begin{array}{l} \text{change} \\ \text{in} \\ \text{thermal} \\ \text{energy} \end{array} = \text{mass} \times \begin{array}{l} \text{specific} \\ \text{heat} \\ \text{capacity} \end{array} \times \begin{array}{l} \text{change in} \\ \text{temperature} \end{array}$$

$$\Delta Q = mc\Delta\theta$$

$$\begin{array}{l} \text{thermal} \\ \text{energy for} \\ \text{a change} \\ \text{of state} \end{array} = \text{mass} \times \begin{array}{l} \text{specific} \\ \text{latent} \\ \text{heat} \end{array} \quad Q = mL$$

V_1 = voltage across the primary coil

V_2 = voltage across the secondary coil

N_1 = number of turns on the primary coil

N_2 = number of turns on the secondary coil

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

(Turn over)

SI MULTIPLIERS

Prefix	Symbol	Conversion factor	Multiplier
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}
kilo	k	multiply by 1000	1×10^3
mega	M	multiply by 1 000 000	1×10^6

(Turn over)

Answer ALL questions.

- 1. Students are investigating the properties of series and parallel circuits.**
 - (a) Complete DIAGRAM 1.1 in the separate diagram booklet by DRAWING A STRAIGHT LINE linking the circuit symbol on the left with the name of the component on the right. [3 marks]**

(Turn over)

1 (b) The students set up the circuit shown in DIAGRAM 1.2 in the separate diagram booklet and measure the current in different places.

(i) UNDERLINE words or phrases from the brackets to correctly complete the following sentences. [2 marks]

The circuit is a

(double / series / parallel) circuit.

The current reading on ammeter A_2 is

(less than / the same as /

more than) the reading on ammeter A_1 .

(Turn over)

1 (b)(ii)

The battery voltage in the circuit is 3 V and the current through the lamps is 0.25 A.

I. Use the equation:

power = voltage × current

to calculate the power of the circuit.
[2 marks]

power = _____ W

(Turn over)

1 (b)(ii)

II. Use the equation:

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

to calculate the resistance of the circuit. [2 marks]

resistance = _____

III. **CIRCLE** the correct unit for resistance. [1 mark]

J Ω kg

(Turn over)

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increases decreases

stays the same

1 (c) The students now use the SAME components to make the circuit shown in DIAGRAM 1.3 in the separate diagram booklet.

The students notice that the lamps are BRIGHTER.

SELECT WORDS OR PHRASES FROM THE BOX on the opposite page to correctly complete the sentences below. You may use each word once, more than once or not at all. [2 marks]

The lamps are brighter because the resistance of the circuit

so the current through each lamp

2 **DIAGRAM 2.1** in the separate diagram booklet shows the path of seismic P and S waves through the Earth.

(a)(i) **UNDERLINE** the correct word in the bracket. [1 mark]

The Earth has a liquid

(core / mantle / crust).

(Turn over)

2 (a)(ii)

Tick (✓) the **THREE** correct statements about **P** and **S** waves.
[3 marks]

- P waves are transverse waves.**
- P waves travel faster than S waves.**
- S waves cannot travel in a liquid.**
- P waves cannot travel in a solid.**
- S waves are transverse waves.**
- P waves cannot travel in a liquid.**

(Turn over)

2 (b)(i)

P waves from an earthquake, which are travelling at a mean speed of 8 000 m/s, reach a seismic monitoring station 500 s later.

Use the equation:

distance = speed × time

to calculate the distance travelled by the P waves to the monitoring station. [2 marks]

distance = _____ m

(Turn over)

2 (b)(ii)

Look at DIAGRAM 2.2 in the separate diagram booklet.

A, B and C are monitoring stations in Wales.

They collect data from an earthquake.

The epicentre is located somewhere on the circles shown in the diagram. MARK WITH A CROSS (X) the location of the epicentre. [1 mark]

7

(Turn over)

3 A class investigates the total internal reflection (TIR) of light in a glass block.

They change the angle of incidence, i , of a ray of light and draw in the path of the ray out of the block.

Their results are shown in DIAGRAMS 3.1, 3.2 and 3.3 in the separate diagram booklet.

(a)(i) State in which diagram, 3.1, 3.2 or 3.3, the angle of incidence is equal to the critical angle. [1 mark]

Diagram _____

(ii) State which diagram, 3.1, 3.2 or 3.3, shows total internal reflection. [1 mark]

Diagram _____

(Turn over)

3 (b) Tick (✓) the box next to the condition required for total internal reflection to occur. [1 mark]

Light must be travelling from a less dense to a more dense material.

Light must be travelling from one material to a different material of equal density.

Light must be travelling from a more dense to a less dense material.

(Turn over)

3 (c) State ONE use of total internal reflection. [1 mark]

4

(Turn over)

- 4** **DIAGRAM 4.1** in the separate diagram booklet shows a simple d.c. motor.

The direction of the force on the coil is given by using Fleming's left-hand rule.

- (a)** **COMPLETE** the labels on **DIAGRAM 4.2** in the separate diagram booklet using words from the box below. [2 marks]

CURRENT	MAGNETIC FIELD
FORCE	

(Turn over)

4 (b) State TWO ways of making the motor spin faster. [2 marks]

1.

2.

4

- 5 Smart meters are fitted into some houses to measure how much electricity is used. Householders can monitor and try to reduce their electricity use. In DIAGRAM 5.1 in the separate diagram booklet, a smart meter shows the units used in 10 HOURS from midnight to 10.00 am.**

(a)(i) Use the equation:

$$\text{mean power (kW)} = \frac{\text{units used (kWh)}}{\text{time (h)}}$$

**and information from DIAGRAM 5.1 to calculate the mean power of the appliances used in the 10 hours.
[2 marks]**

mean power = _____ kW

(Turn over)

5 (a)(ii)

- I. State the cost of the electricity used in 10 hours in pence (p). [1 mark]**

cost = _____ p

- II. Use the equation:**

$$\text{cost of 1 unit (p)} = \frac{\text{cost (p)}}{\text{units used (kWh)}}$$

to calculate the cost of 1 unit of electricity. [2 marks]

cost of 1 unit = _____ p

(Turn over)

5 (b) Give ONE reason, OTHER THAN to save money, why householders should be encouraged to reduce their electricity use. [1 mark]

5 (c) Describe the function of an EARTH WIRE, a FUSE and a RESIDUAL CURRENT CIRCUIT BREAKER (rccb).

Include in your answer:

- **what they are each used to protect**
- **the fault that causes each of them to work. [6 marks QER]**

continue on next page

(Turn over)

12

(Turn over)

6 A teacher demonstrates heat transfer by infra-red radiation.

EXPERIMENT 1

Look at DIAGRAM 6.1 in the separate diagram booklet. The teacher places a heater in between a black surface and a silver surface.

After a few minutes the temperature of each surface is recorded using an infra-red thermometer.

EXPERIMENT 2

Look at DIAGRAM 6.2 in the separate diagram booklet. The teacher fills the container with boiling water.

The infra-red thermometer is then used to take readings next to the side of the container which is black and the side which is silver.

question continues

(Turn over)

6 (continued)

The results in TABLE 6.3 in the separate diagram booklet were obtained.

(a) Use the data to complete the following sentences.

(i) The _____ surface is the better emitter of heat as shown by the results for EXPERIMENT _____ because

[2 marks]

(Turn over)

6 (a)(ii)

The _____ surface is the better absorber of heat as shown by the results for **EXPERIMENT** _____ because

[2 marks]

(Turn over)

6 (b) Silver coating can be put on the outside of windows to help to keep houses cool in summer and warm in winter.

Look at DIAGRAM 6.4 in the separate diagram booklet. State why the silver coating helps to keep the house warm in the winter. [1 mark]

6 (c) A family consider different methods of reducing their energy bills. Data about these methods are given in TABLE 6.5 in the separate diagram booklet.

(i) Calculate the payback time for the silver coating. [2 marks]

payback time = _____ years

(Turn over)

6 (c)(ii)

The family can only choose to fit one of the items. Ieuan suggests that it is better to fit cavity wall insulation than loft insulation. Use data from the table to explain whether you agree.

[2 marks]

Space for calculations on the opposite page.

9

(Turn over)

7 Look at DIAGRAM 7.1 in the separate diagram booklet. A teacher uses the apparatus shown to demonstrate the link between the temperature and pressure of a gas.

The metal bulb, which is attached to a pressure gauge, contains a fixed volume of air.

The bulb is placed in a water bath and measurements of pressure for different temperatures are recorded.

(a) State the independent variable in this experiment. [1 mark]

(Turn over)

7 (b)(i)

The teacher obtained the results shown in TABLE 7.2 in the separate diagram booklet.

Plot the data on GRAPH 7.3 in the separate diagram booklet and draw a suitable line. [3 marks]

(ii) Describe the relationship between the temperature and the pressure of the gas. [2 marks]

(Turn over)

7 (b)(iii)

- I. Use information from GRAPH 7.3 or TABLE 7.2 to determine the decrease in pressure for every 10°C decrease in temperature. [2 marks]**

decrease in pressure = _____ units

- II. Use your answer to part I. above to determine the pressure of the gas at -10°C . [1 mark]**

pressure = _____ units

- (iv) State the value of absolute zero in $^{\circ}\text{C}$. [1 mark]**

absolute zero = _____ $^{\circ}\text{C}$

(Turn over)

7 (c) The specific heat capacity of air, c , at constant volume is $720 \text{ J/kg}^\circ\text{C}$.

Use the equation:

heat energy supplied = mass \times specific heat capacity \times change in temperature

$$\Delta Q = mc\Delta\theta$$

to calculate the heat energy required to raise the temperature of 0.05 kg of air FROM 20°C TO 60°C . [2 marks]

heat energy = _____ J

12

(Turn over)

8 **TABLE 8.1** in the separate diagram booklet gives information about four types of power station.

The table ranks the power stations in order from 1 to 4 for three different features.

Rank 1 is best and rank 4 is worst.

(a) Use the information in the table to answer the following questions.

(i) Gareth says that the best type of power station to recommend overall by ranking is **TYPE B**. Explain whether you agree with him. [2 marks]

continue on next page

(Turn over)

(Turn over)

8 (a)(ii)

The energy sources for different types of power station are FOSSIL FUEL, NUCLEAR and HYDROELECTRIC.

COMPLETE TABLE 8.2 in the separate diagram booklet for the energy sources for types A, B, C and D. [3 marks]

Each energy source may be used once, more than once, or not at all.

(Turn over)

8 (b) Use the information below and an equation from pages 4 to 6 to calculate the % efficiency of a TYPE B power station. [2 marks]

Input energy = 200 000 MJ

Heat energy produced = 30 000 MJ

Electrical energy produced = 170 000 MJ

% efficiency = _____

7

(Turn over)

9 Water waves refract when they travel from deep water to shallow water.

Refraction happens because the speed of the wave changes.

The wavelength also changes because the frequency is constant.

Students use a ripple tank to investigate this effect.

(a) COMPLETE DIAGRAM 9.1 in the separate diagram booklet to show the water waves in shallow water. [3 marks]

(Turn over)

9 (b) The depth of the shallow water can be changed by using glass blocks of different thicknesses.

Look at DIAGRAM 9.2 in the separate diagram booklet. Regions A and B are both 15 cm long.

(i) I. How many waves are shown in REGION A? [1 mark]

II. Calculate the wavelength of the waves in REGION A. [1 mark]

wavelength = _____ cm

(Turn over)

9 (b)(ii)

John says that the wave speed in REGION B is greater than the wave speed in REGION A. Explain whether John is correct. [2 marks]

(Turn over)

9 (c) In another experiment using a different tank, students investigate how the depth of water affects wave speed.

They change the depth of the water using different thickness glass blocks.

The water level is kept constant at 10 cm.

TABLE 9.3 in the separate diagram booklet shows their results.

(i) COMPLETE TABLE 9.3. [1 mark]

(Turn over)

9 (c)(ii)

Use the equation:

$$\text{wavelength} = \frac{\text{wave speed}}{\text{frequency}}$$

to calculate the wavelength of water waves of frequency 50 Hz when the thickness of the glass block is 6 cm.
[2 marks]

wavelength = _____ cm

(Turn over)

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9 (c)(iii)

Janet states that when the thickness of the glass block decreases by 2 cm the wave speed increases by a quarter.

Explain to what extent Janet is correct. [3 marks]

Space for calculations on the opposite page.

13

END OF PAPER

(Turn over)

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

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GCSE

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PHYSICS – Unit 1:

**Electricity, Energy and Waves
FOUNDATION TIER**

**1 hour 45 minutes plus your additional
time allowance**

DIAGRAM BOOKLET

**This Diagram Booklet MUST be handed in
to the invigilators and sent for marking.**

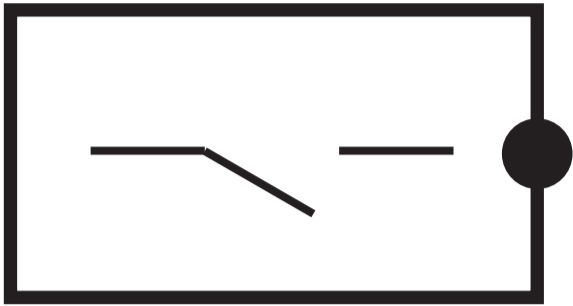
Surname _____

First name(s) _____

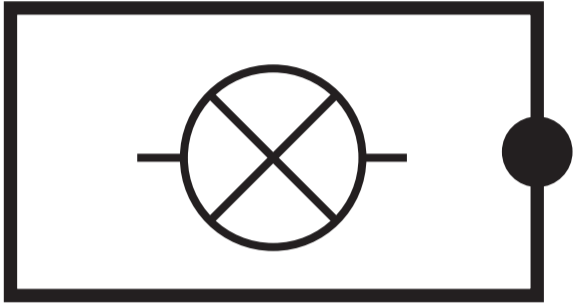
Centre Number _____

Candidate Number 0 _____

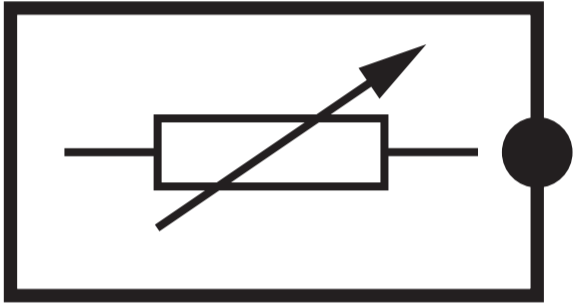
DIAGRAM 1.1



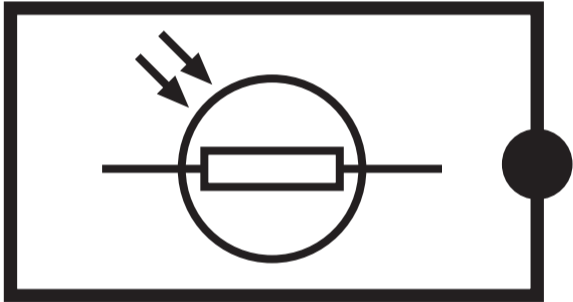
lamp



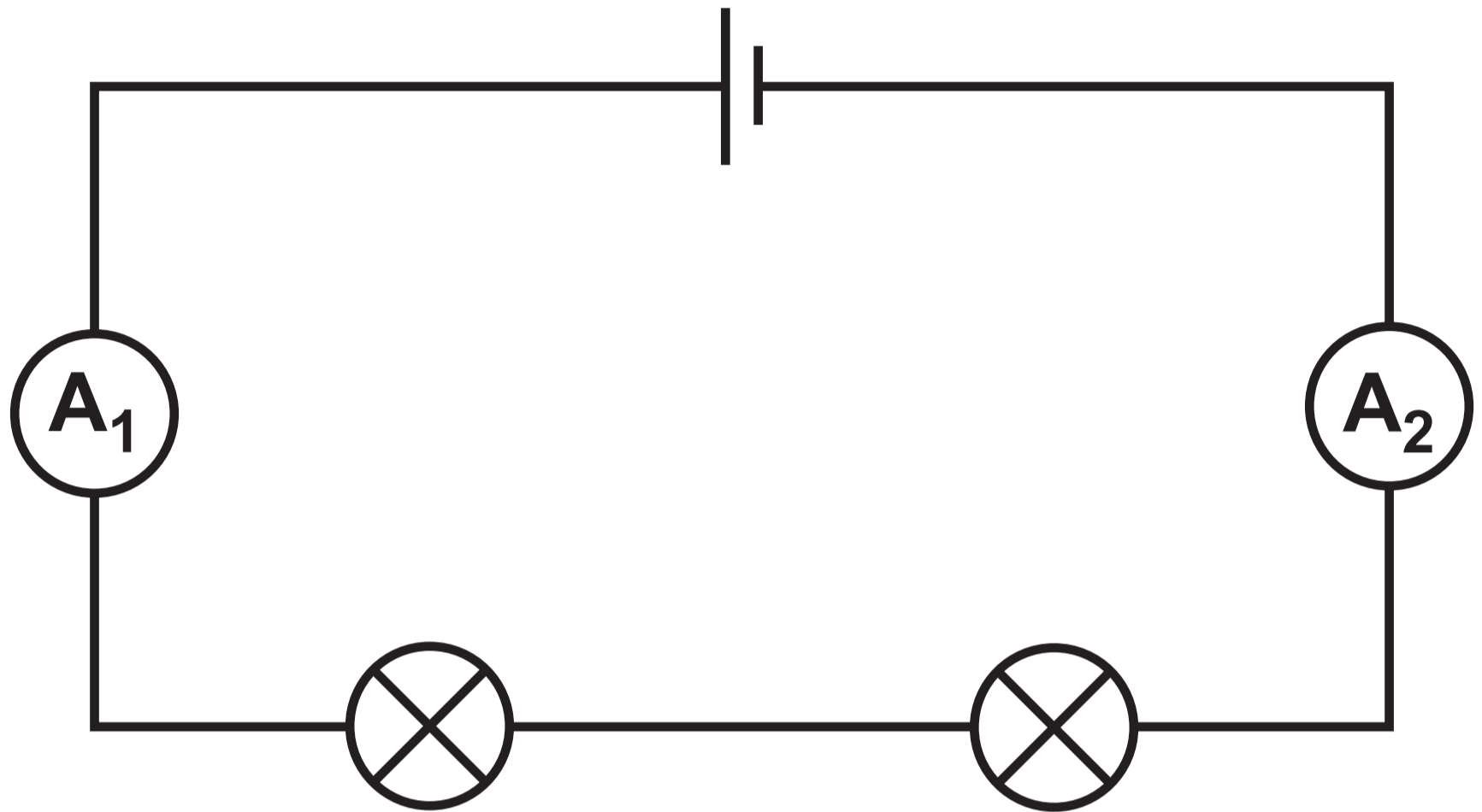
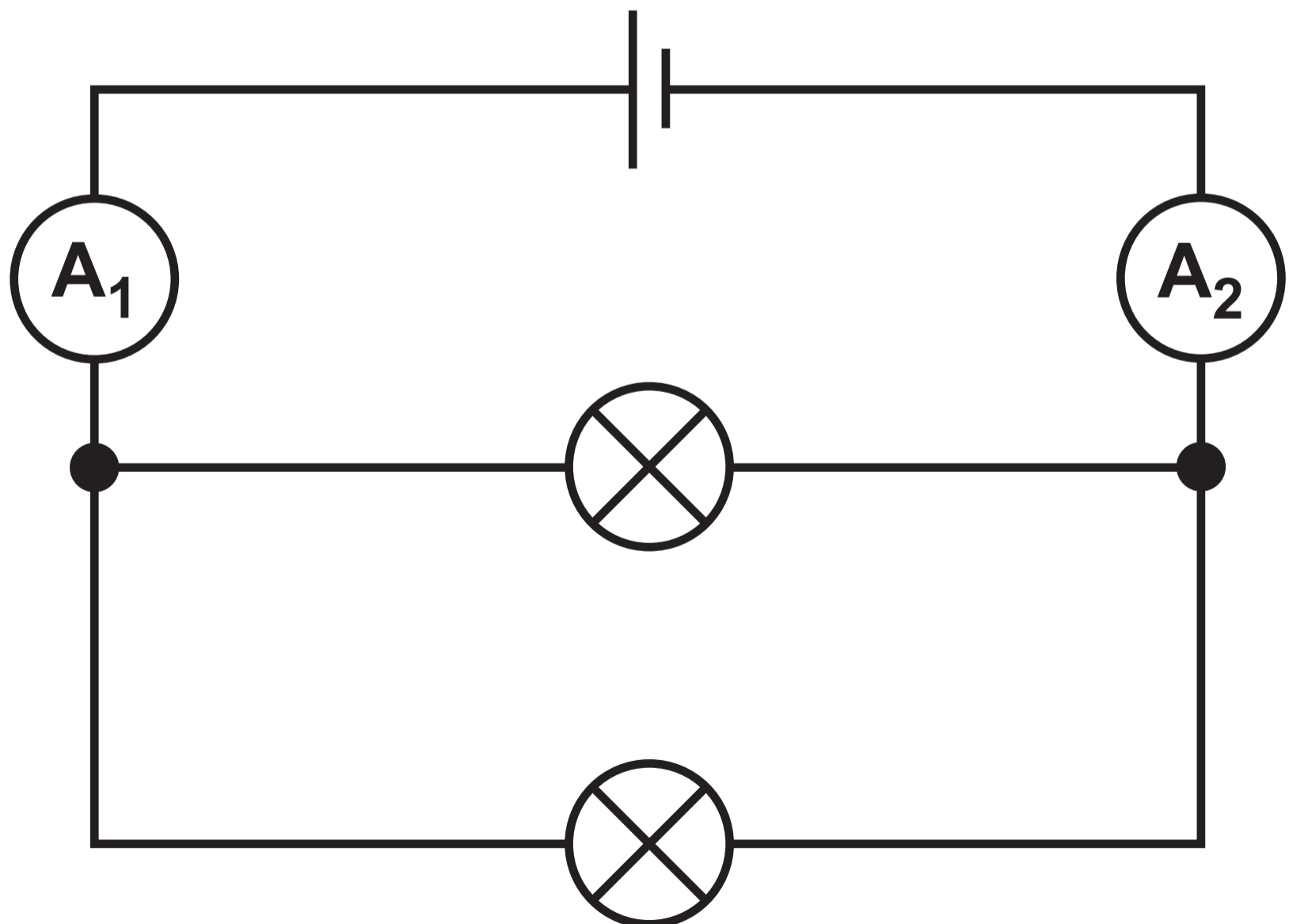
switch



**variable
resistor**



LDR

DIAGRAM 1.2**DIAGRAM 1.3**

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DIAGRAM 2.1

P waves

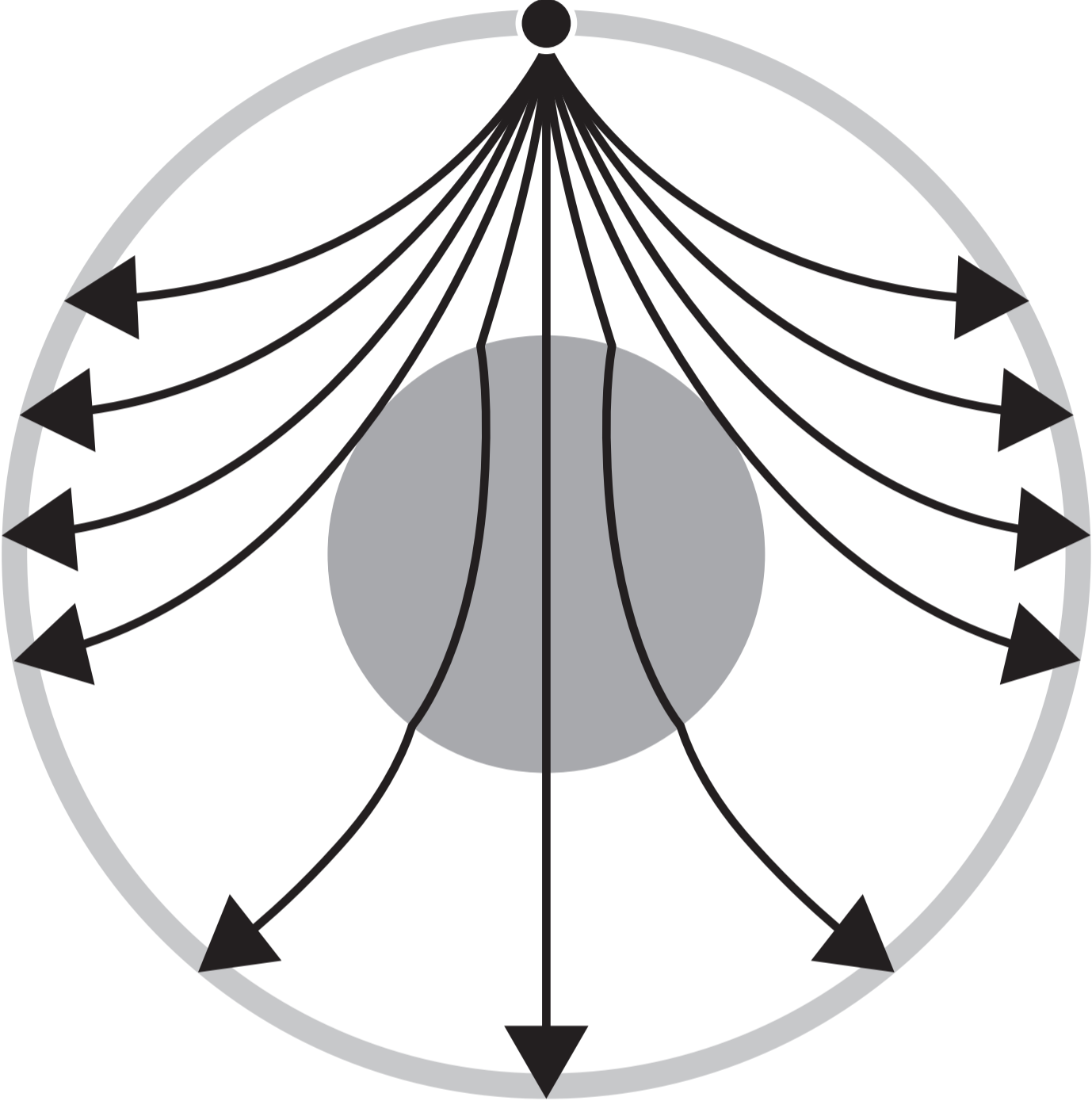
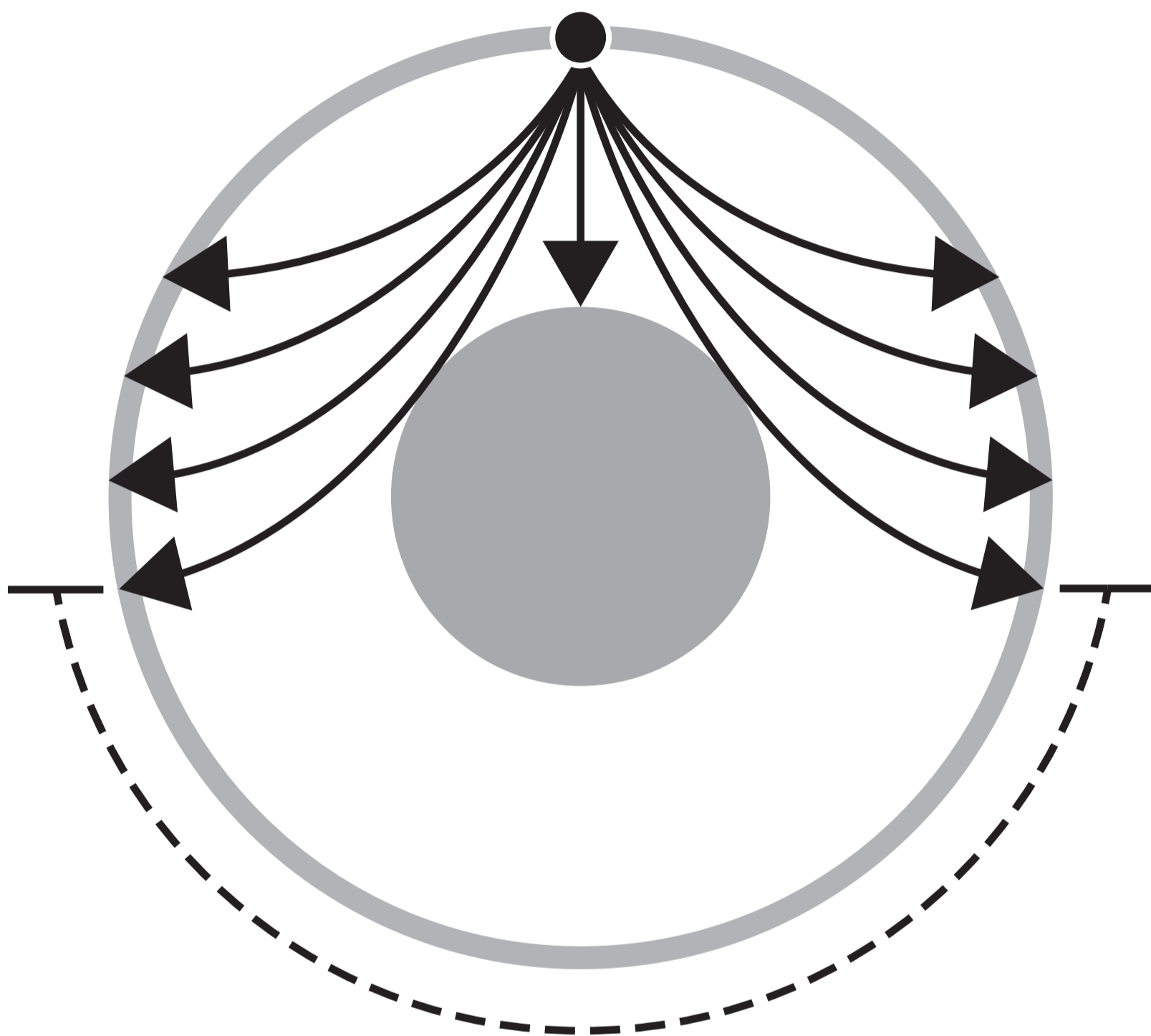


DIAGRAM 2.1 – continued

S waves



S wave shadow zone

DIAGRAM 2.2

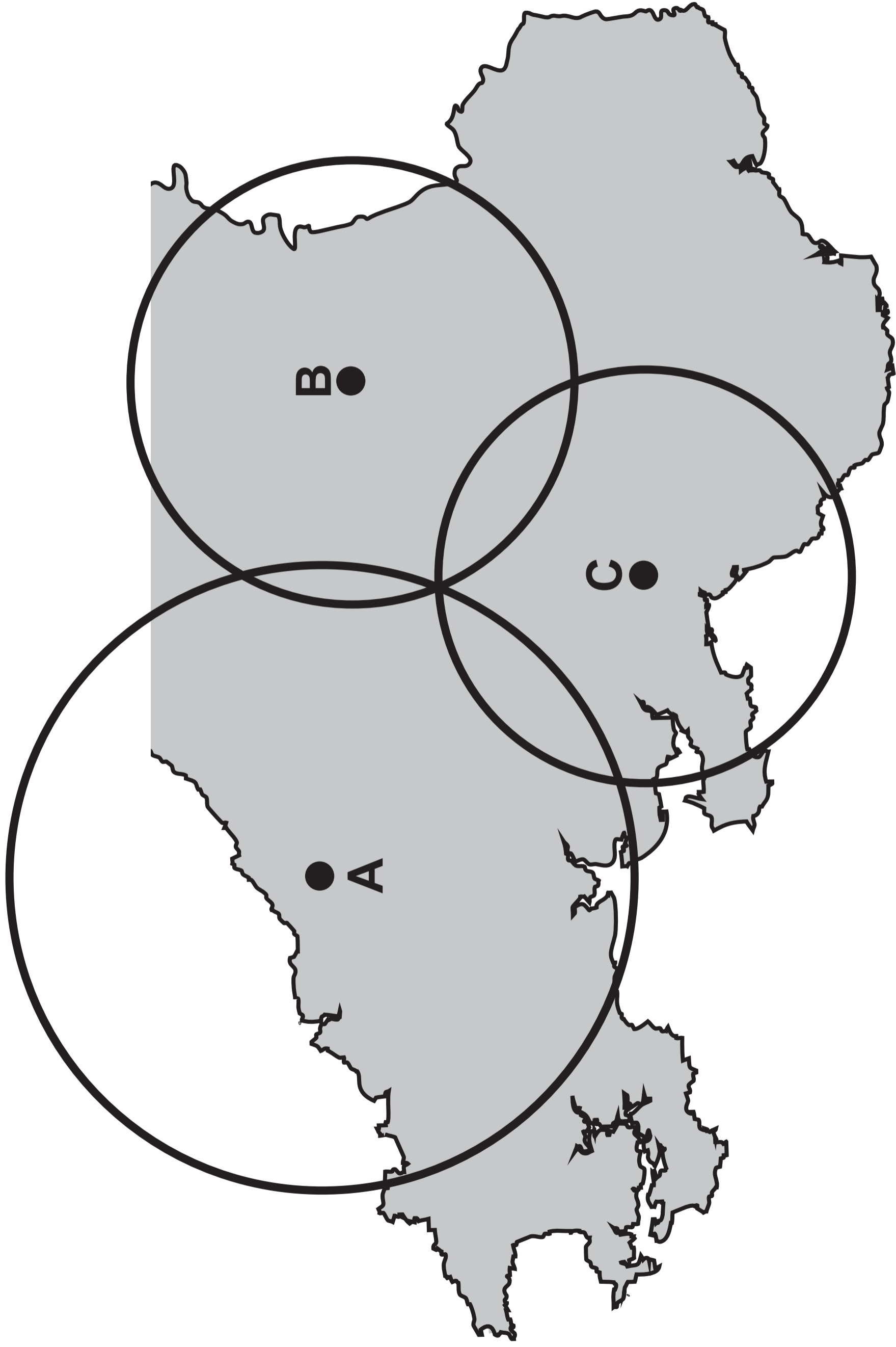


DIAGRAM 3.1

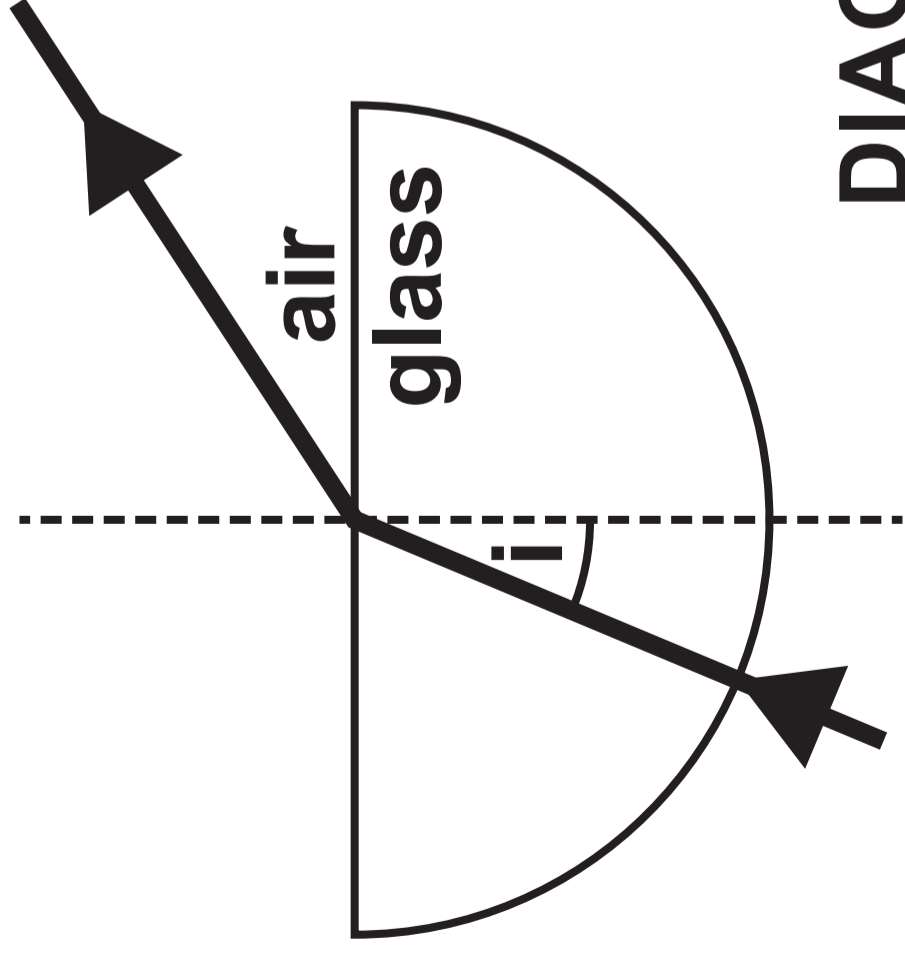


DIAGRAM 3.2

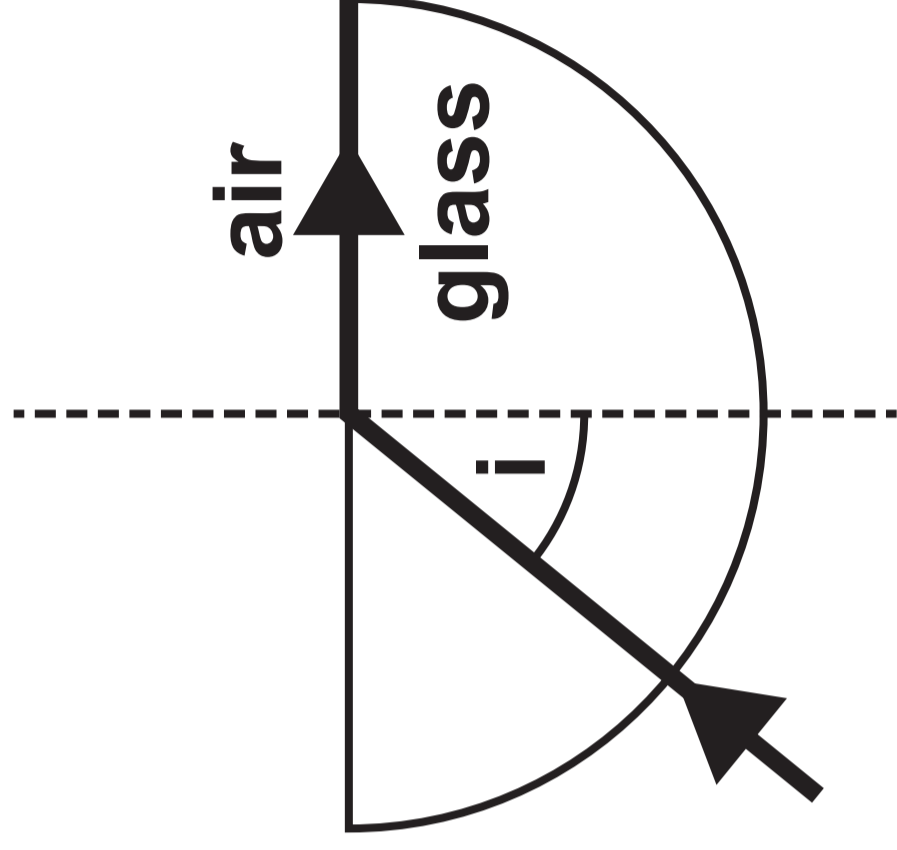
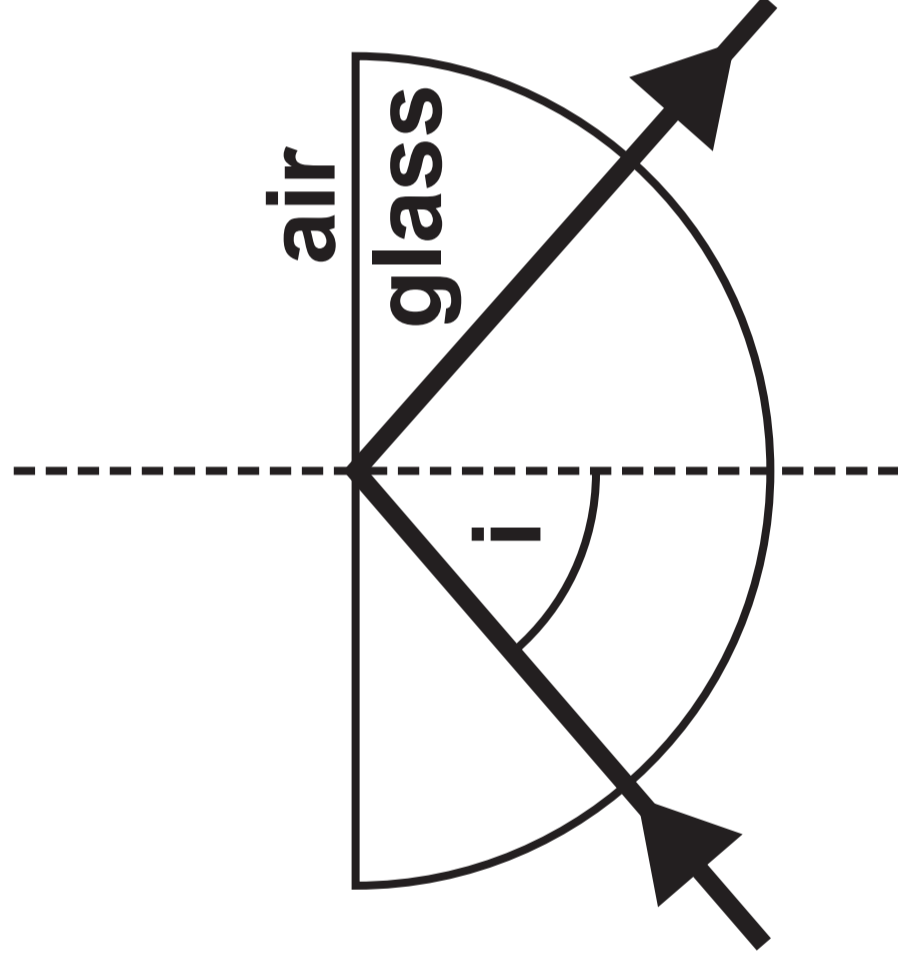


DIAGRAM 3.3



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DIAGRAM 4.1

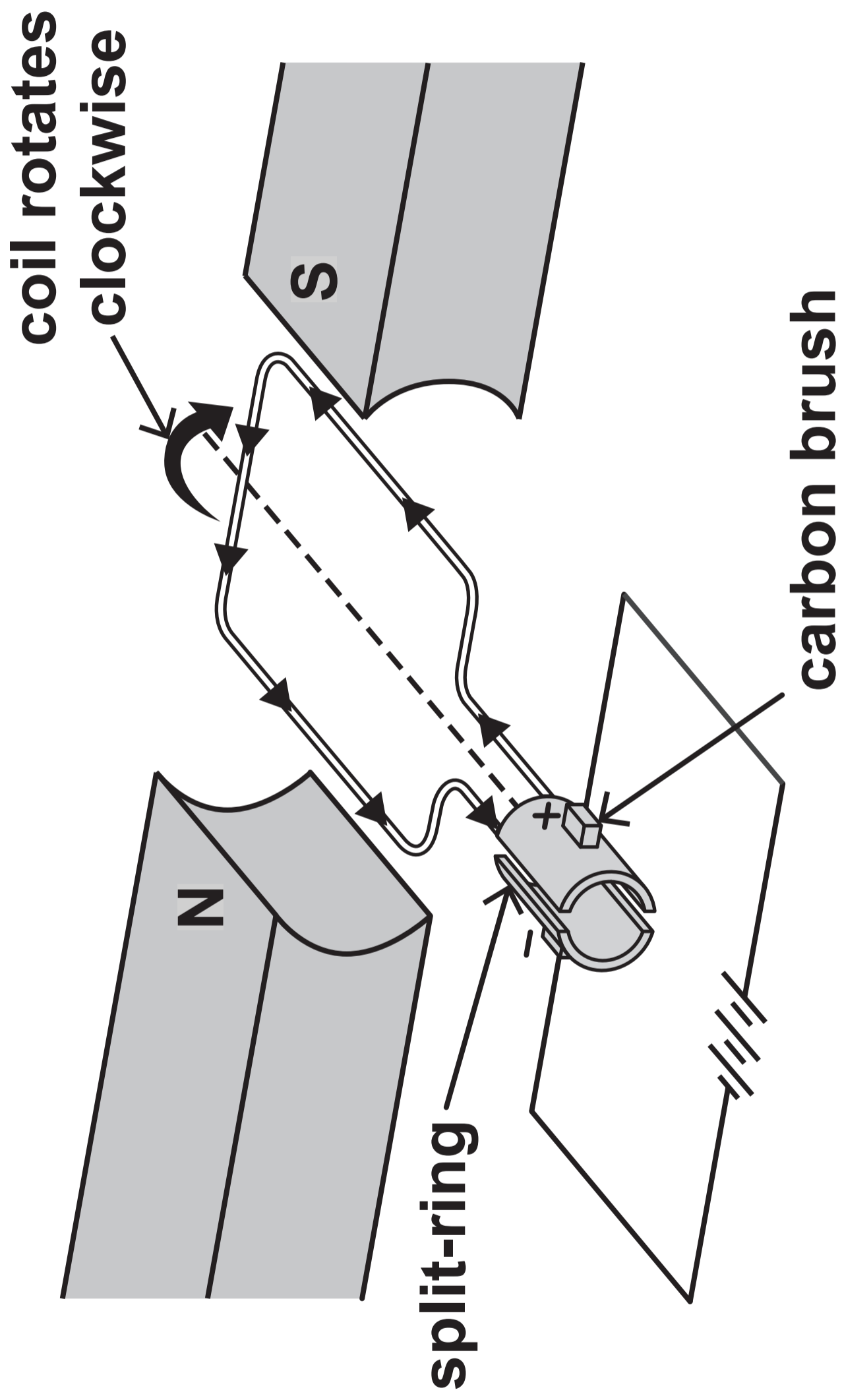
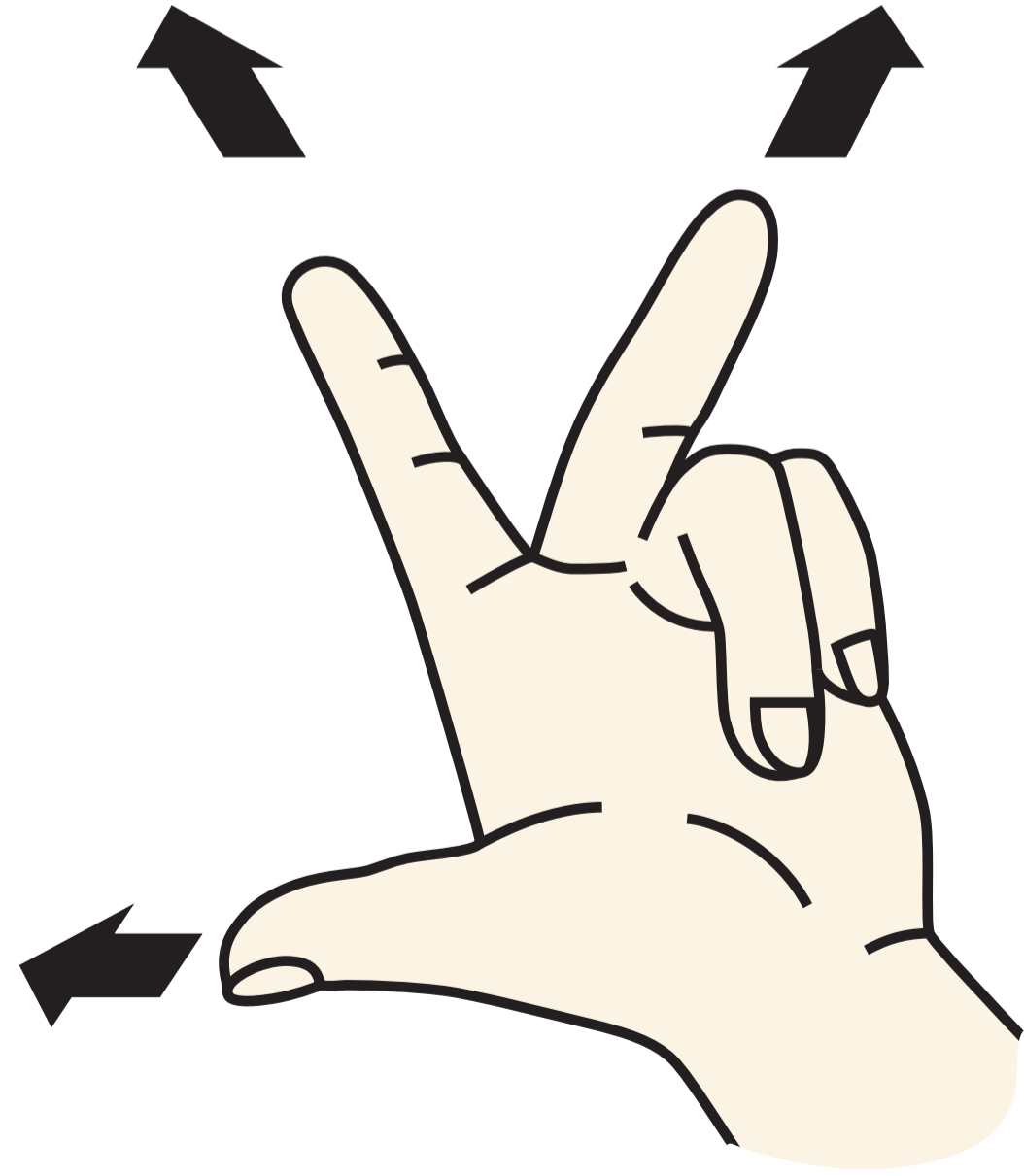


DIAGRAM 4.2

Thumb shows the _____



First finger shows the

8

Second finger shows the

DIAGRAM 5.1



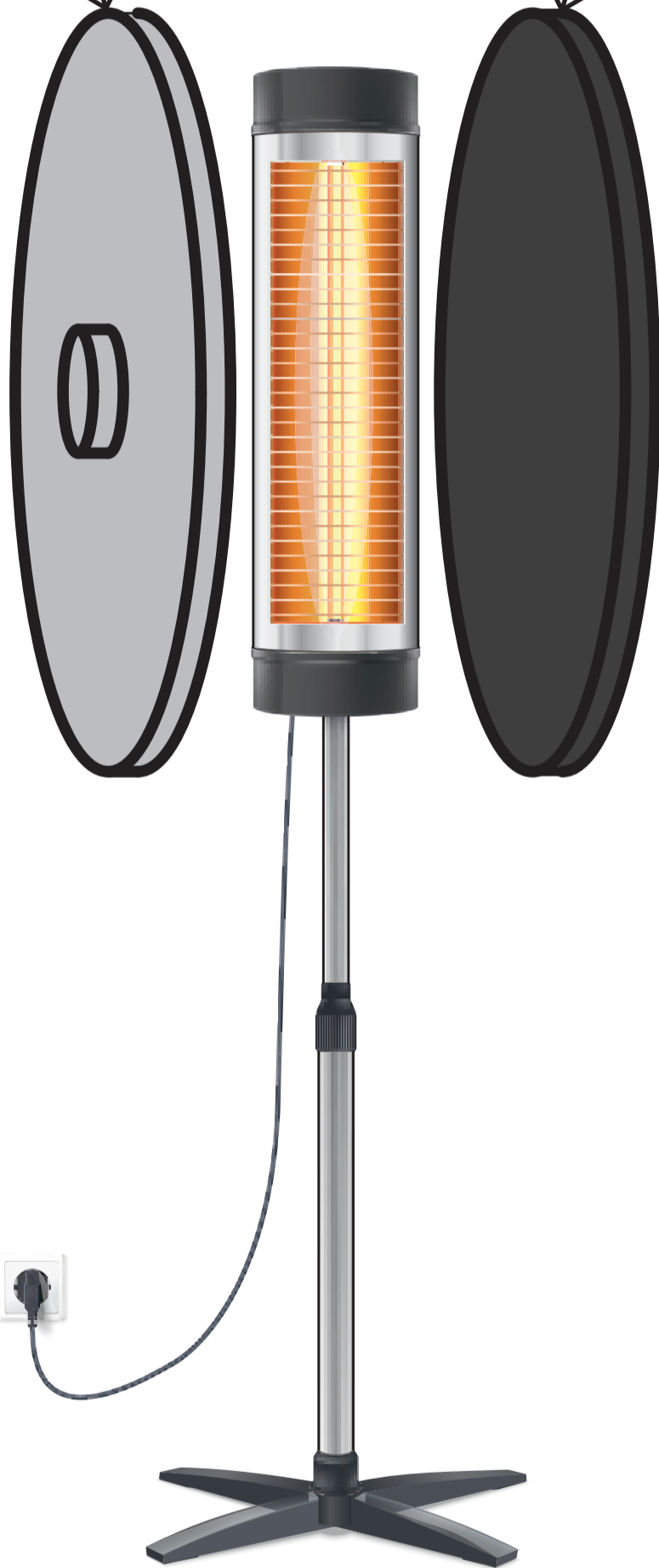
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DIAGRAM 6.1 – EXPERIMENT 1

silver surface

black surface



heater

DIAGRAM 6.2 – EXPERIMENT 2

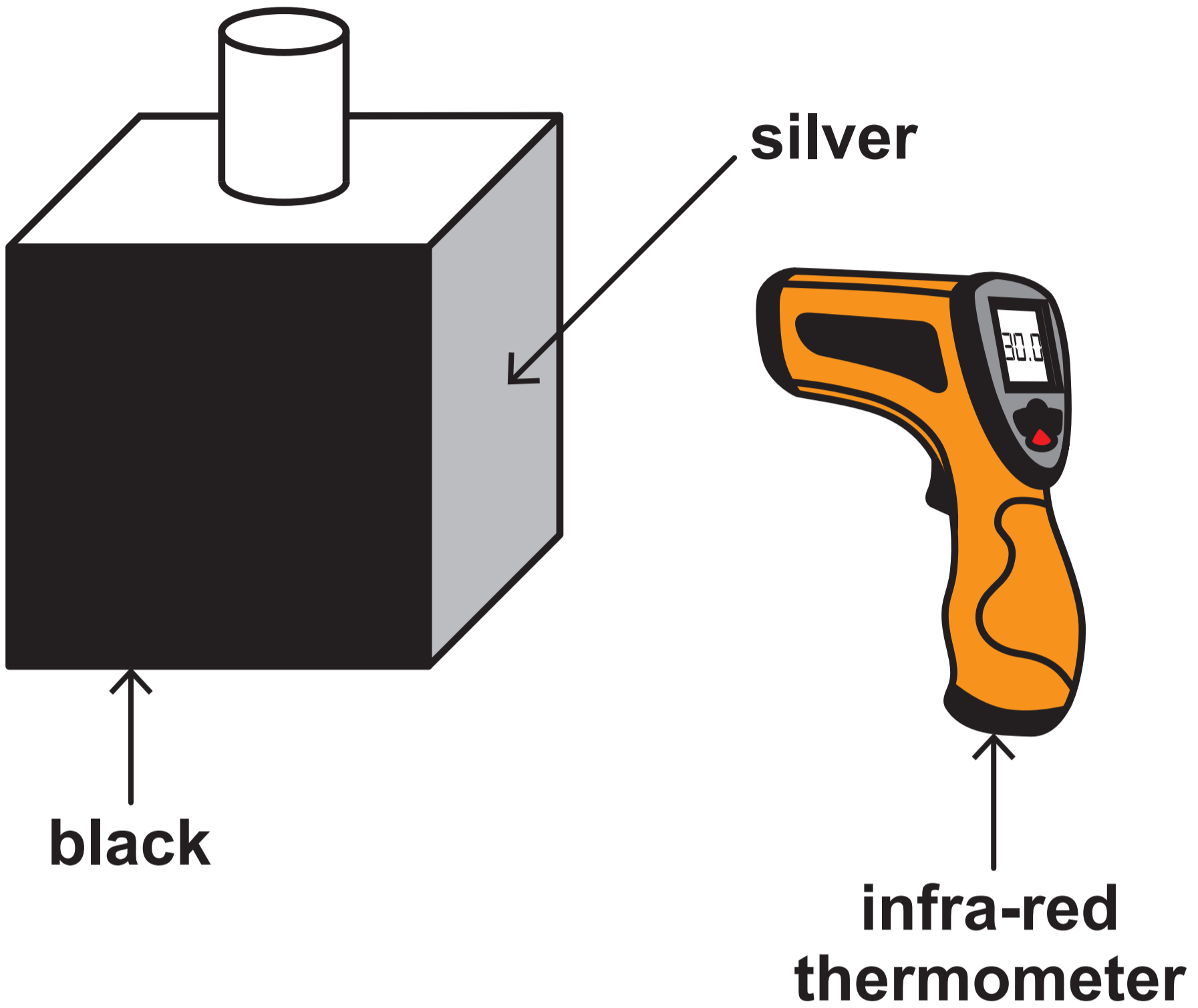
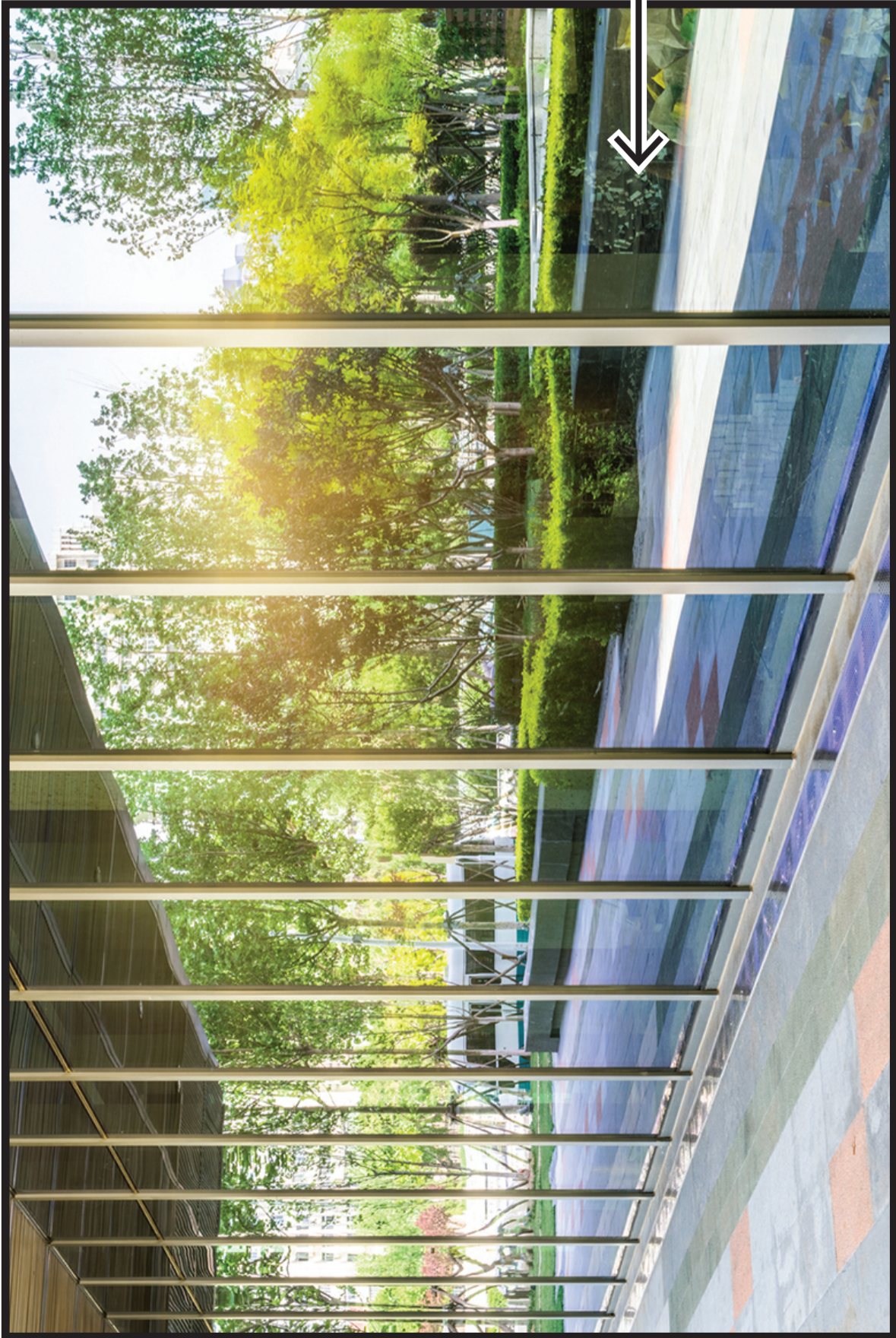


TABLE 6.3

	Temperature (°C)	
	Black surface	Silver surface
EXPERIMENT 1	46	32

	Temperature (°C)	
	Black surface	Silver surface
EXPERIMENT 2	90	65

DIAGRAM 6.4



silver coating

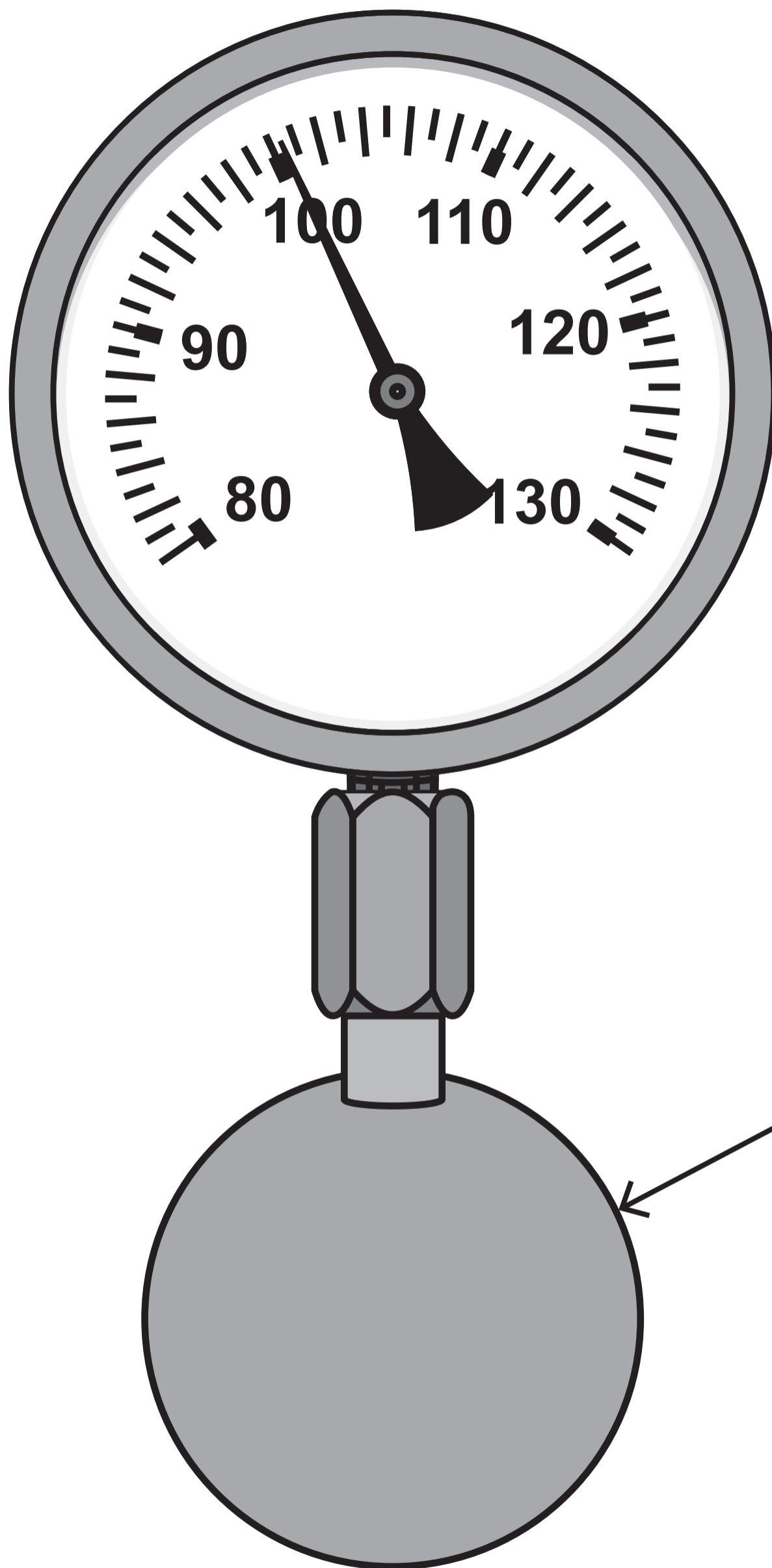
TABLE 6.5

Method	Cost (£)	Yearly savings (£)
Cavity wall insulation	640	160
Loft insulation	480	160
Silver coating	500	25

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DIAGRAM 7.1

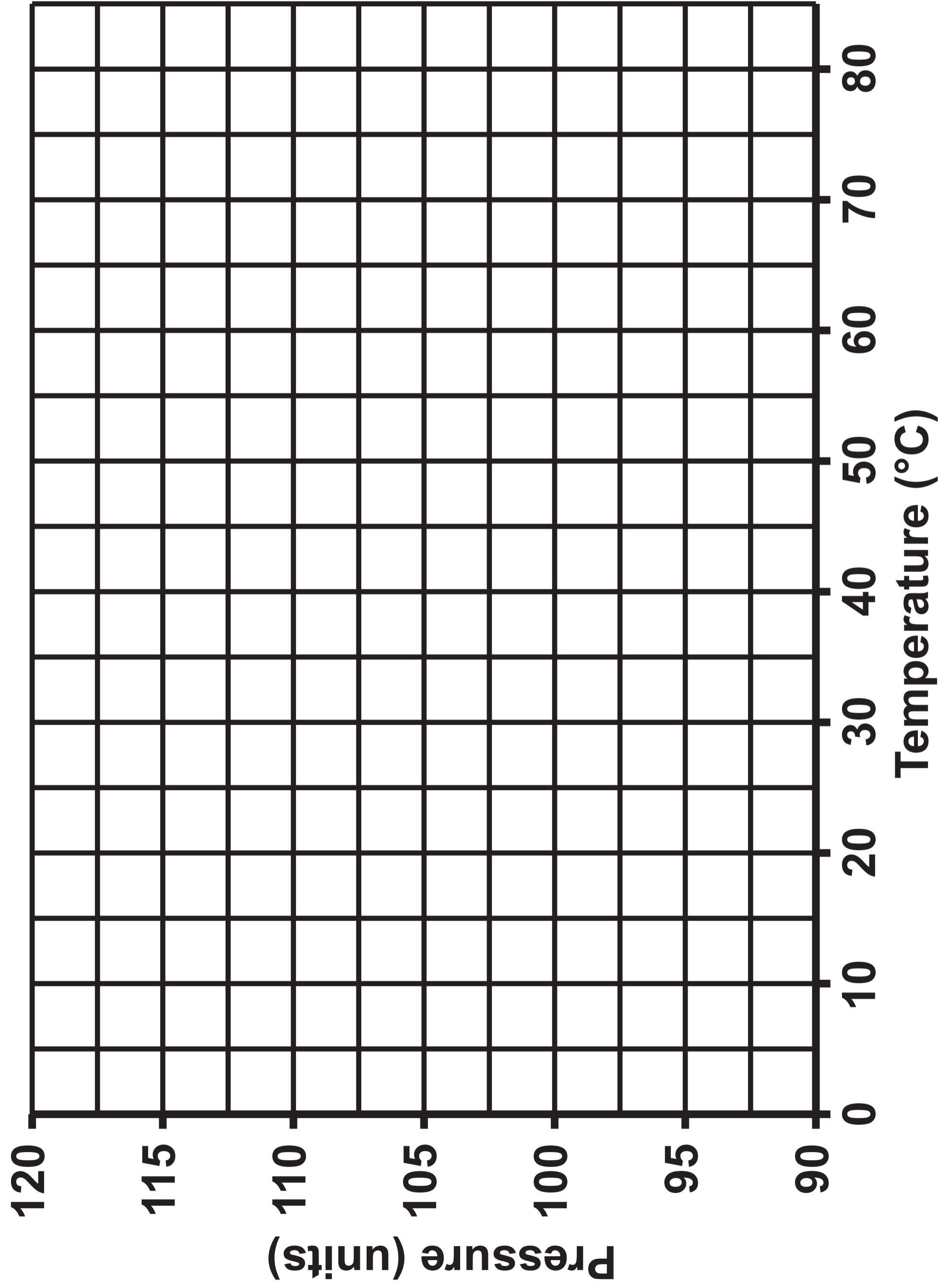


metal bulb

TABLE 7.2

Temperature (°C)	Pressure (units)
0	94
20	100
40	106
60	112
80	118

GRAPH 7.3



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TABLE 8.1

Power station	Type A	Type B
Efficiency	25%	
Rank	4	1
Running cost	Second highest	Practically zero
Rank	3	1
Emissions	Highest polluting emissions	No emissions
Rank	4	1

TABLE 8.1 – continued

Power station	Type C	Type D
Efficiency	35%	40%
Rank	3	2
Running cost	Highest	Second lowest
Rank	4	2
Emissions	Has cleaner emissions than type A power stations	Cleaner emissions than type C power stations but produces radioactive waste
Rank	2	3

TABLE 8.2

Type	Energy source
A	<hr/> <hr/>
B	<hr/> <hr/>
C	<hr/> <hr/>
D	<hr/> <hr/>

DIAGRAM 9.1

wavefronts

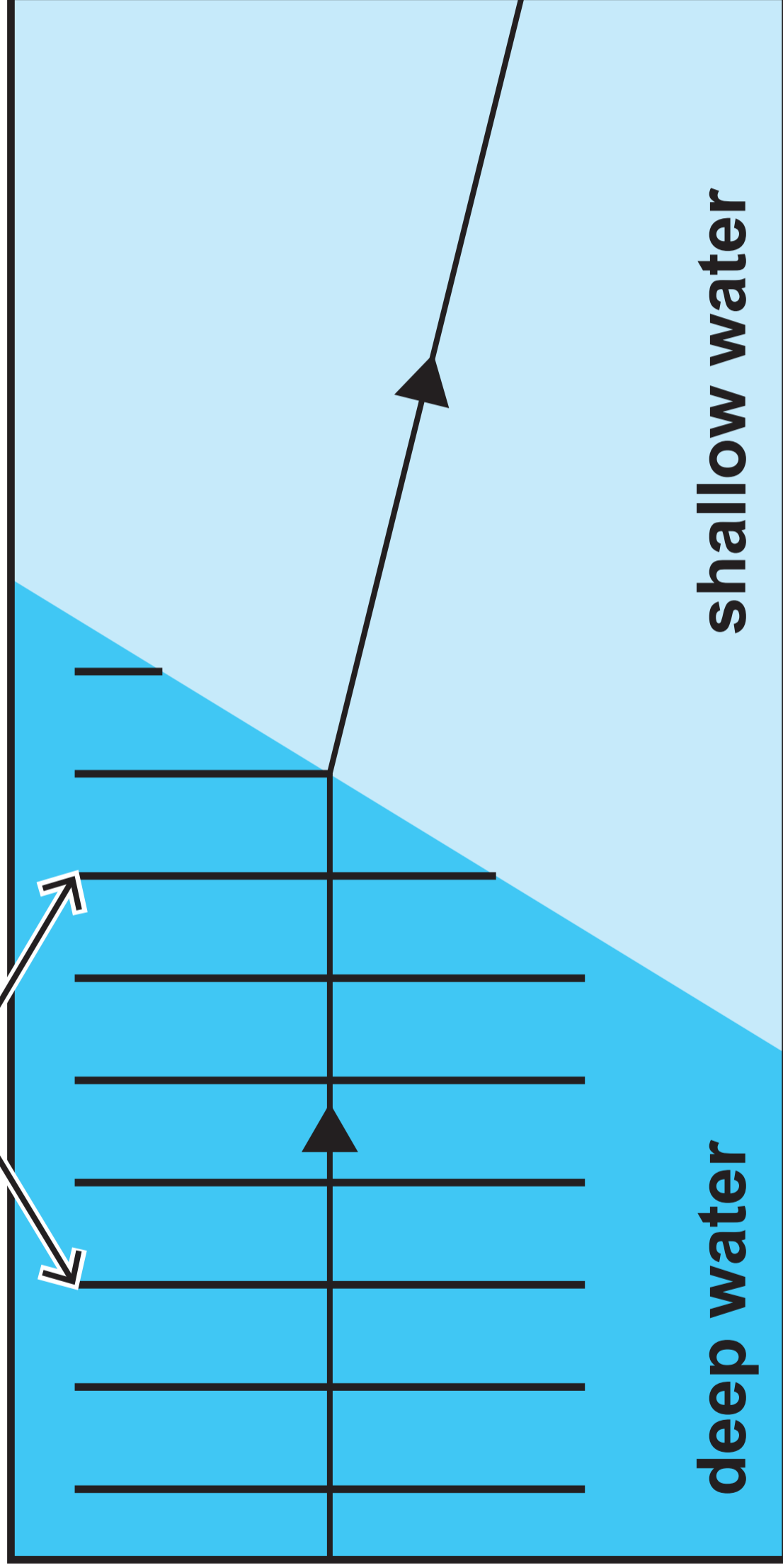
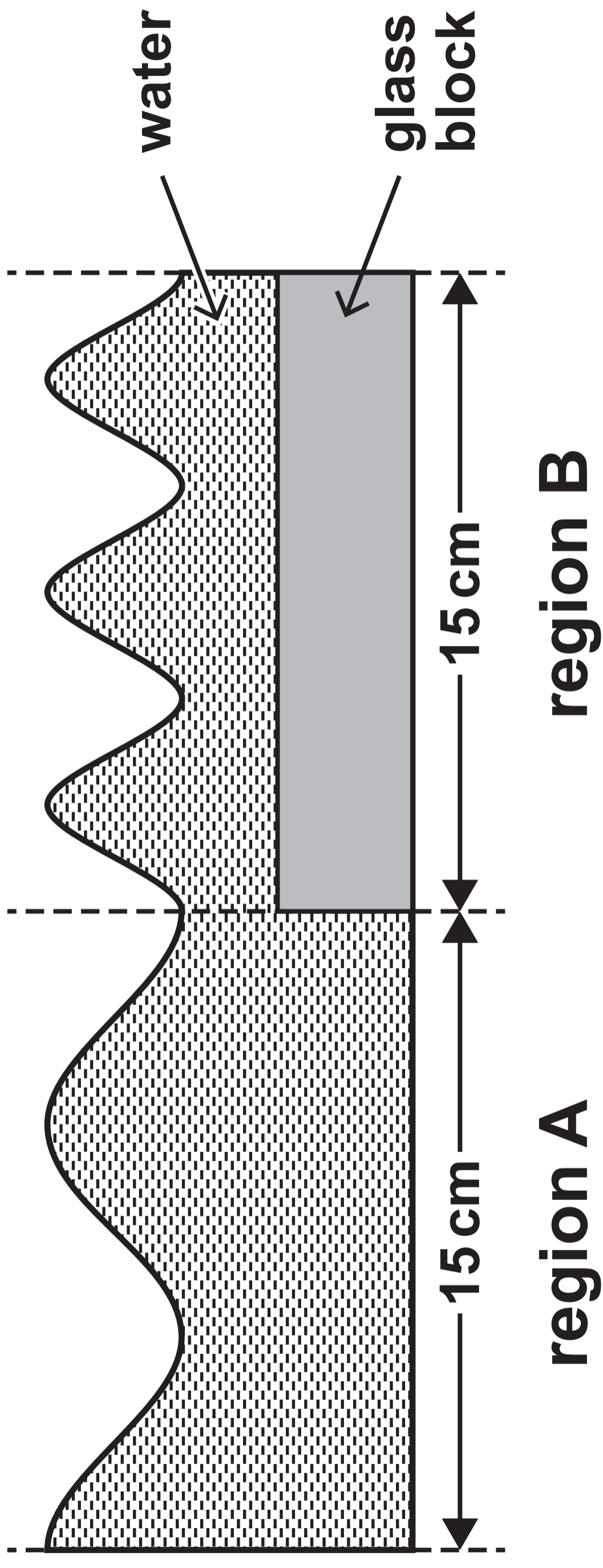


DIAGRAM 9.2



15 cm

15 cm

region A

region B

water

glass
block

TABLE 9.3

Thickness of glass block (cm)	Depth of water (cm)	Wave speed (cm/s)
8	2	60
6	4	75
4		82