



3420U10-1

MONDAY, 16 JUNE 2025 – MORNING

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.

A separate Data Booklet.

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

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 6.

(Turn over)

For Examiner’s use only		
Question	Maximum Mark	Mark Awarded
1.	5	
2.	9	
3.	6	
4.	11	
5.	6	
6.	6	
7.	6	
8.	11	
9.	11	
10.	9	
Total	80	

Answer ALL questions.

- 1 Electromagnetic induction takes place in generators and transformers.**
DIAGRAM 1.1 in the separate diagram booklet shows a simple generator of electricity.

The coil spins at a steady speed in the direction shown.
The voltage produced is shown in GRAPH 1.2 in the separate diagram booklet.

- (a)(i) Write down the maximum voltage produced. [1 mark]**

_____ V

(Turn over)

1 (a)(ii)

Tomos says the coil spins once in 0.1 seconds.

Complete the following sentence by UNDERLINING the correct answers in the brackets. [1 mark]

I (agree / disagree) with Tomos because the coil spins once in (0.1 / 0.2) seconds.

1 (b) CIRCLE the direction of the current in the coil when it is in the position shown in the diagram. [1 mark]

A to B / C to B / D to C

(Turn over)

1 (c) GRAPHS B-E in GRAPH 1.3 in the separate diagram booklet show the voltages produced after making changes to the coil.

(i) State which graph, B, C, D or E, would be produced if the number of turns of wire on the coil were doubled. [1 mark]

(ii) State which graph, B, C, D or E, would be produced by the original coil if it were spun twice as fast. [1 mark]

- 2** **DIAGRAM 2.1** in the separate diagram booklet shows apparatus that can be used to investigate transformers.
- (a)** **UNDERLINE** the words in brackets to correctly complete the sentences about how a transformer works.
[3 marks]

**A transformer works because
(an alternating / a direct /
a constant) current in the
primary coil produces a changing
(magnetic / electric /
gravitational) field in the
(iron / copper / aluminium)
core. This induces an alternating
voltage across the secondary coil.**

(Turn over)

2 (b) A 200-TURN coil is used as the primary coil and remains in place throughout the investigation.

(i) The secondary coils available to fit the transformer have the following number of turns.

100	200	400	800	1 200
------------	------------	------------	------------	--------------

They are used to investigate how the number of turns in the secondary coil affects the output voltage.

**I. State which of the above coils would be used so the output voltage is smaller than the input voltage.
[1 mark]**

_____ turns

(Turn over)

2 (b)(i)

II. State which of the coils in the box on page 8 would be used to give the maximum output voltage. [1 mark]

_____ turns

**(ii) Different secondary coils (A, B and C) are used.
The results are shown on
GRAPH 2.2 in the separate diagram
booklet.**

(Turn over)

2 (b)(ii)

- I. Complete the following sentence by underlining the correct words or phrases in the brackets. [2 marks]**

As the input voltage increases, the output voltage

(increases / decreases /

stays the same) at

(an increasing / a decreasing / a constant) rate.

- II. A 10 V lamp needs a 10 V supply to operate at normal brightness. State which secondary coil, A, B or C, would be used to operate a 10 V lamp at normal brightness from a 5 V input voltage. [1 mark]**
-

(Turn over)

2 (b)(ii)

III. State which secondary coil, A, B or C, has an output which is always double the input voltage. [1 mark]

9

(Turn over)

3 **DIAGRAM 3.1** in the separate diagram booklet shows three experiments (A, B and C) used to demonstrate methods of heat transfer.

(a)(i) State which experiment A, B or C demonstrates convection. [1 mark]

(ii) State which experiment A, B or C demonstrates radiation. [1 mark]

(Turn over)

3 (b)(i)

In experiment B, the time for the match to drop off each metal is measured.

The results are shown in TABLE 3.2 in the separate diagram booklet.

Use the results to arrange the 4 metals in order starting with the best conductor. [1 mark]

best

worst

(Turn over)

3 (b)(ii)

TABLE 3.3 in the separate diagram booklet shows the thermal conductivity of metals.

The larger the number the better the conductor.

**Explain whether the results from experiment B in TABLE 3.2 agree with the data in TABLE 3.3.
[2 marks]**

(Turn over)

3 (c) Complete the following sentence.

Heat energy transfers along the metal rods in experiment B because the end of each rod in the middle of the ring is _____

**than the end that holds the match.
[1 mark]**

6

(Turn over)

4 This question is about lamps connected in a circuit.

(a) DIAGRAM 4.1 in the separate diagram booklet shows the current in lamps L_1 and L_3 .

State the currents in lamps L_2 and L_4 . [2 marks]

$L_2 =$ _____ **A**

$L_4 =$ _____ **A**

(Turn over)

4 (b) DIAGRAM 4.2 in the separate diagram booklet is the same circuit as DIAGRAM 4.1 but it shows the voltages across lamps L_1 , L_3 and the battery.

State the VOLTAGES across lamps L_2 and L_4 . [2 marks]

$L_2 =$ _____ V

$L_4 =$ _____ V

(Turn over)

4 (c) Use information from both circuit diagrams and the equation:

$$\text{power} = \text{voltage} \times \text{current}$$

**to calculate the power of lamp L₁.
Give the unit for power. [3 marks]**

power = _____

unit = _____

(Turn over)

4 (d)(i)

Use information from both circuit diagrams and the equation:

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

to calculate the resistance of lamp L₁. [2 marks]

resistance = _____ Ω

(Turn over)

4 (d)(ii)

Owain says that setting up the circuit without lamp L_1 will not affect the current through the battery.

Explain whether you agree. [2 marks]

- 5** **DIAGRAM 5.1** in the separate diagram booklet is an experiment to determine how the speed of water waves depends on depth. The experiment is described below.
- 1.** **Measure the length of the tray and record the result.**
 - 2.** **Add water to the tray to give a depth of 0.5 cm.**
 - 3.** **Lift the end of the tray up a few cm and gently drop on the desk.**
 - 4.** **Start the stopwatch when the wave produced hits the end of the tray.**
 - 5.** **Record how long it takes the waves to travel 3 lengths of the tray.**
 - 6.** **Repeat steps 3–5 four more times.**

continued on the next page

(Turn over)

Question 5 continued

- 7. Repeat steps 2–6, increasing the depth each time by 0.5 cm up to 3.0 cm.**

5 (a)(i)

**Explain why step 5 helps to improve the accuracy of the experiment.
[1 mark]**

(Turn over)

5 (a)(ii)

**Explain why step 6 helps to improve the accuracy of the experiment.
[2 marks]**

(Turn over)

5 (b) The length of the tray is 40 cm.

At one depth, the time for the wave to travel 3 LENGTHS is 2.4 s.

- (i) Calculate the distance travelled by the wave in 3 LENGTHS of the tray.
[1 mark]**

distance = _____ cm

(Turn over)

5 (b)(ii)

Use the equation:

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

to calculate the speed of the water wave. [2 marks]

speed = _____ cm/s

6

(Turn over)

- 6** **DIAGRAM 6.1** in the separate diagram booklet shows how light passes through an optical fibre.

**Explain how optical fibres transmit information in this way AND describe their advantages over satellites for long distance communication.
[6 marks QER]**

continue answer on the next page

(Turn over)

continue answer on the next page

(Turn over)

6

- 7** **DIAGRAM 7.1** in the separate diagram booklet shows shows a cut away section of the Earth.

Four monitoring stations A, B, C and D are shown.

The path of earthquake (seismic) waves to B and C are shown spreading out from an earthquake at X.

- (a) ADD LINES WITH ARROWS to DIAGRAM 7.1 to show the paths of the earthquake waves to A and D.**
[2 marks]

(Turn over)

7 (b) The type of earthquake waves detected at **A and **B** are different from the ones arriving at **C** and **D**.**

(i) Name the type of earthquake waves detected at **C but not at **A**. [1 mark]**

7 (b)(ii)

Geologists used seismic records to develop a model of the structure of the Earth.

Describe what these seismic records tell us about the structure of the Earth. [3 marks]

continue answer on the next page

(Turn over)

6

- 8 GRAPH 8.1 in the separate diagram booklet shows how air pressure varies with height above sea level.**
- (a) Passenger jets fly 12 000 m above sea level.**
- (i) Use the graph to find the air pressure at this height. [1 mark]**

pressure = _____ kPa

- (ii) Calculate the difference in air pressure between the inside and outside of the jet.**
Assume the air pressure in the cabin of the jet is the same as the air pressure at sea level. [2 marks]

pressure difference = _____ kPa
(Turn over)

8 (b) A window in a passenger jet is 0.40 m wide and 0.25 m high.

(i) Calculate the area of the window (assume it is a rectangle). [2 marks]

area = _____ m²

(Turn over)

8 (b)(ii)

Use the equation:

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

to calculate the force on the window due to the pressure difference when flying at a height of 12 000 m above sea level. [3 marks]

force = _____ N

(Turn over)

8 (c) Information shown on a screen during the flight is given below.

Use the information below and in GRAPH 8.1 to explain the change in air pressure with height in terms of molecules. [3 marks]

Height above sea level = 12 000 m

Aircraft speed = 900 km/h

Temperature at sea level = 17 °C

Outside temperature = –55 °C

continue answer on the next page
(Turn over)

11

9 In the UK, domestic electricity has a voltage of 230 V and a frequency of 50 Hz.

It is an alternating current (a.c.) supply, rather than a direct current (d.c.) supply.

(a) State the difference between a.c. and d.c. [1 mark]

9 (b) A science class investigates the cost and efficiency of different kettles. They collect and compare data for two different kettles as shown in TABLE 9.1 in the separate diagram booklet.

(i) Not all of the heat energy transferred by the kettle is transferred to the water.

**I. Use data from TABLE 9.1 and an equation from the separate data booklet to calculate the total electrical energy transferred by kettle X when it is boiled ONCE.
[2 marks]**

**total electrical energy
transferred by kettle X = _____ J
(Turn over)**

9 (b)(i)

- II. Use data from TABLE 9.1, an equation from the separate data booklet and your answer to part (i) I to determine the % efficiency of kettle X. [2 marks]**

% efficiency = _____

(Turn over)

9 (b)(ii)

The students compare the cost of using each of the kettles.

They estimate that each kettle will be boiled 10 times per day.

I. Calculate the time that each kettle is used per day in hours. [1 mark]

time = _____ hours

(Turn over)

9 (b)(ii)

II. Use equations from the separate data booklet to calculate the cost of using kettle Y per day if 1 unit of electricity costs 30 p. [3 marks]

cost per day = _____ p

(Turn over)

9 (b)(iii)

It is suggested that kettle X will cost more to use per day, than kettle Y, when used for the same time.

Explain whether you agree with this suggestion. [2 marks]

- 10 Drax power station is a fuel-burning power station.
In 1986, Drax was the largest power station in the UK.
It consisted of 6 coal-fired generators with a total capacity of about 4000 MW, powering millions of homes.
By 2018, Drax had converted four of the coal-fired generators to run on biomass, producing 70% of its electrical power through burning compressed wood pellets.**

- (a) DIAGRAM 10.1 in the separate diagram booklet is a simplified diagram of a fuel-burning power station.**

Describe the processes involved in producing electrical power from a fuel. [3 marks]

**continue answer on the next page
(Turn over)**

45

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Turn over)

10 (b)

Burning biomass does not produce sulfur dioxide.

State AND explain another environmental advantage of burning biomass rather than coal. [2 marks]

(Turn over)

10 (c)

The demand for electricity depends on the weather.

In the winter, demand increases by 750 MW for every degree the temperature drops below 14 °C.

In the summer, demand increases by 350 MW for every degree rise over 20 °C, from a mean demand of 40 000 MW.

- (i) Suggest why demand for electricity increases as the temperature increases above 20 °C in the summer.**
[1 mark]

(Turn over)

10 (c)(ii)

On one summer's day, the demand for electricity increased to 45 600 MW. Chris suggests that the temperature must have risen to 30 °C, but Ella states that it must be 36 °C.

**Determine who is correct. [3 marks]
Space for calculations.**

9

END OF PAPER

[illegible]

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

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

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

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



GCSE

3420U10-1

MONDAY, 16 JUNE 2025 – MORNING

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 _____

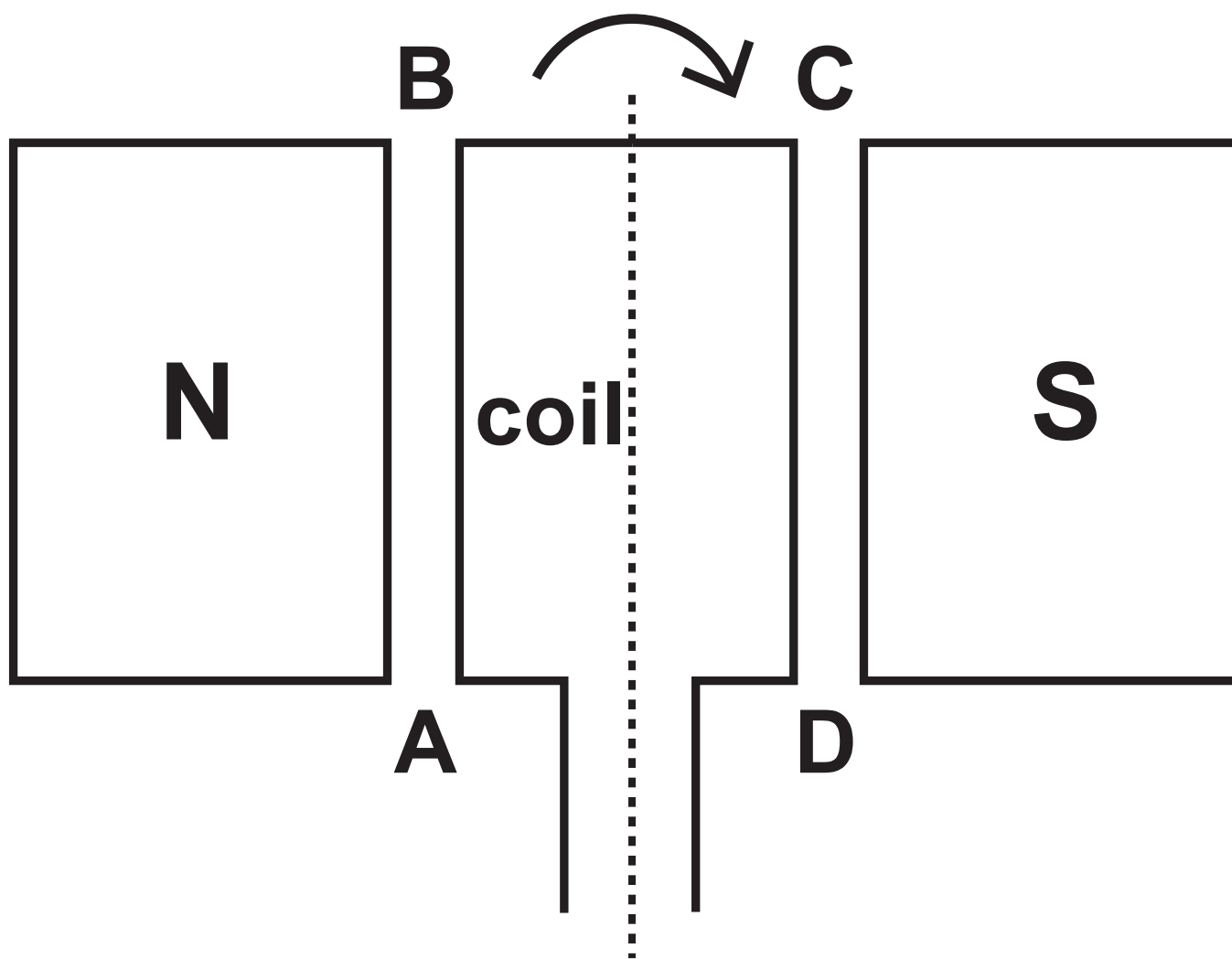
First name(s) _____

Centre Number _____

Candidate Number 0 _____

DIAGRAM 1.1

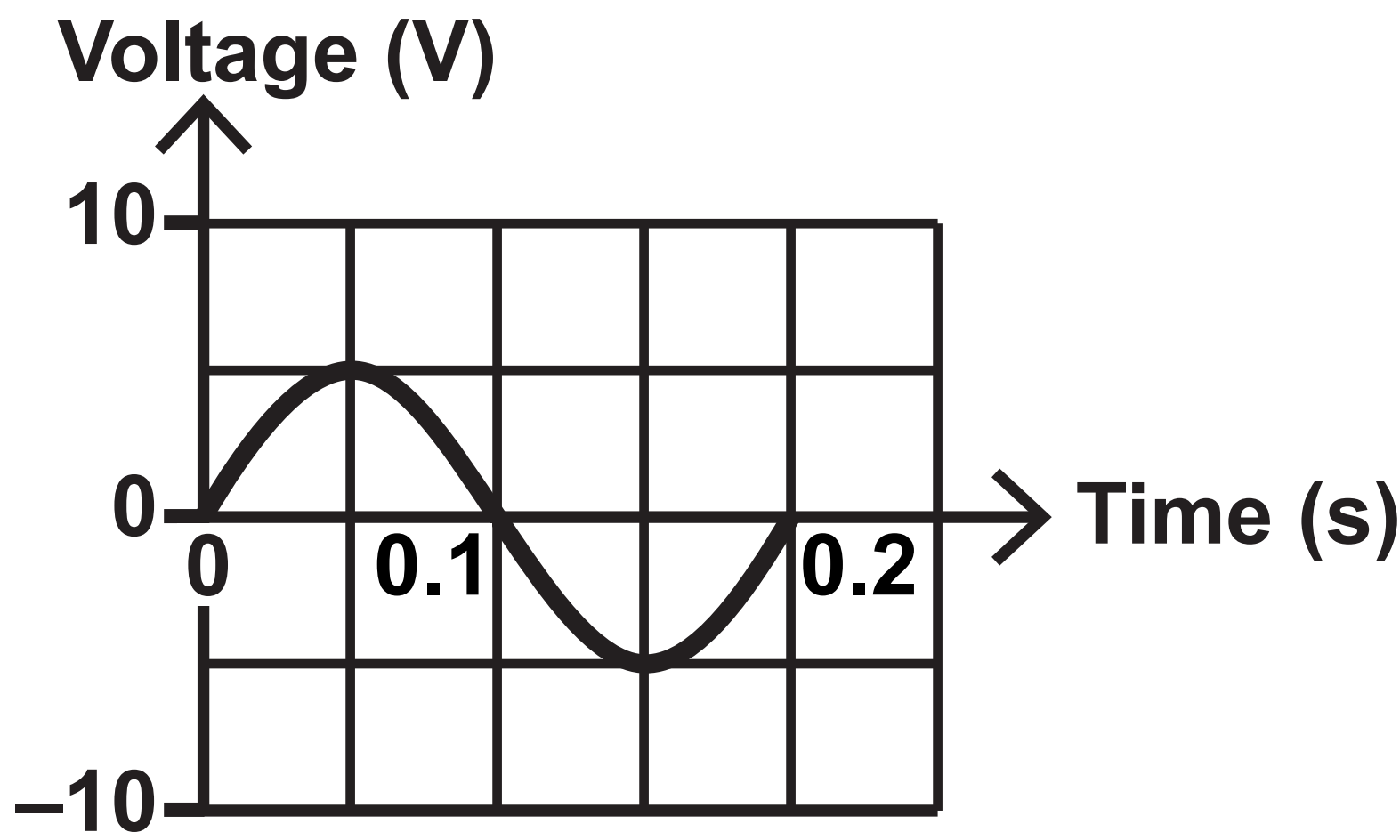
direction of rotation



THIS IS A BLANK PAGE

TURN OVER

GRAPH 1.2



GRAPH 1.3

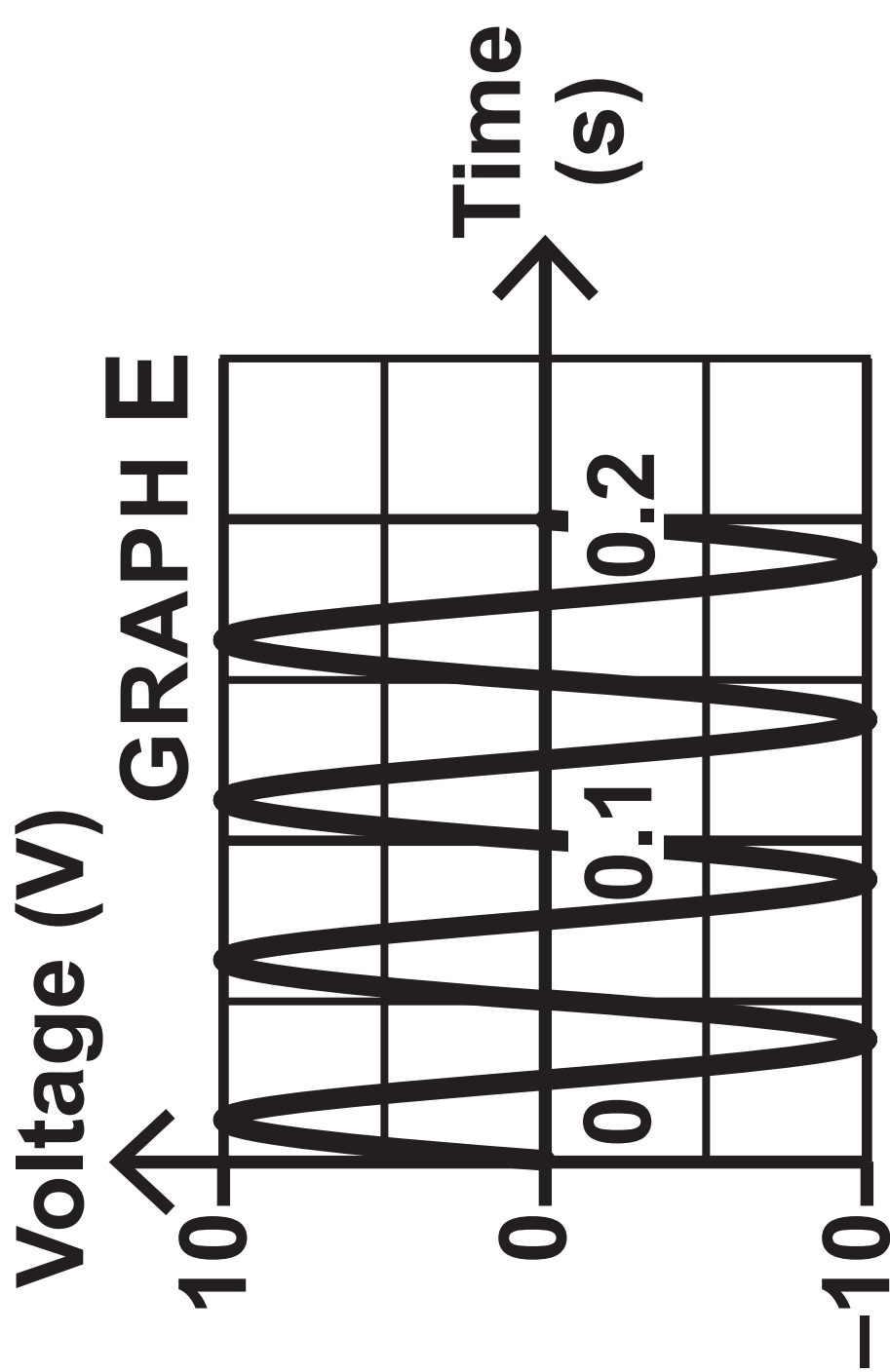
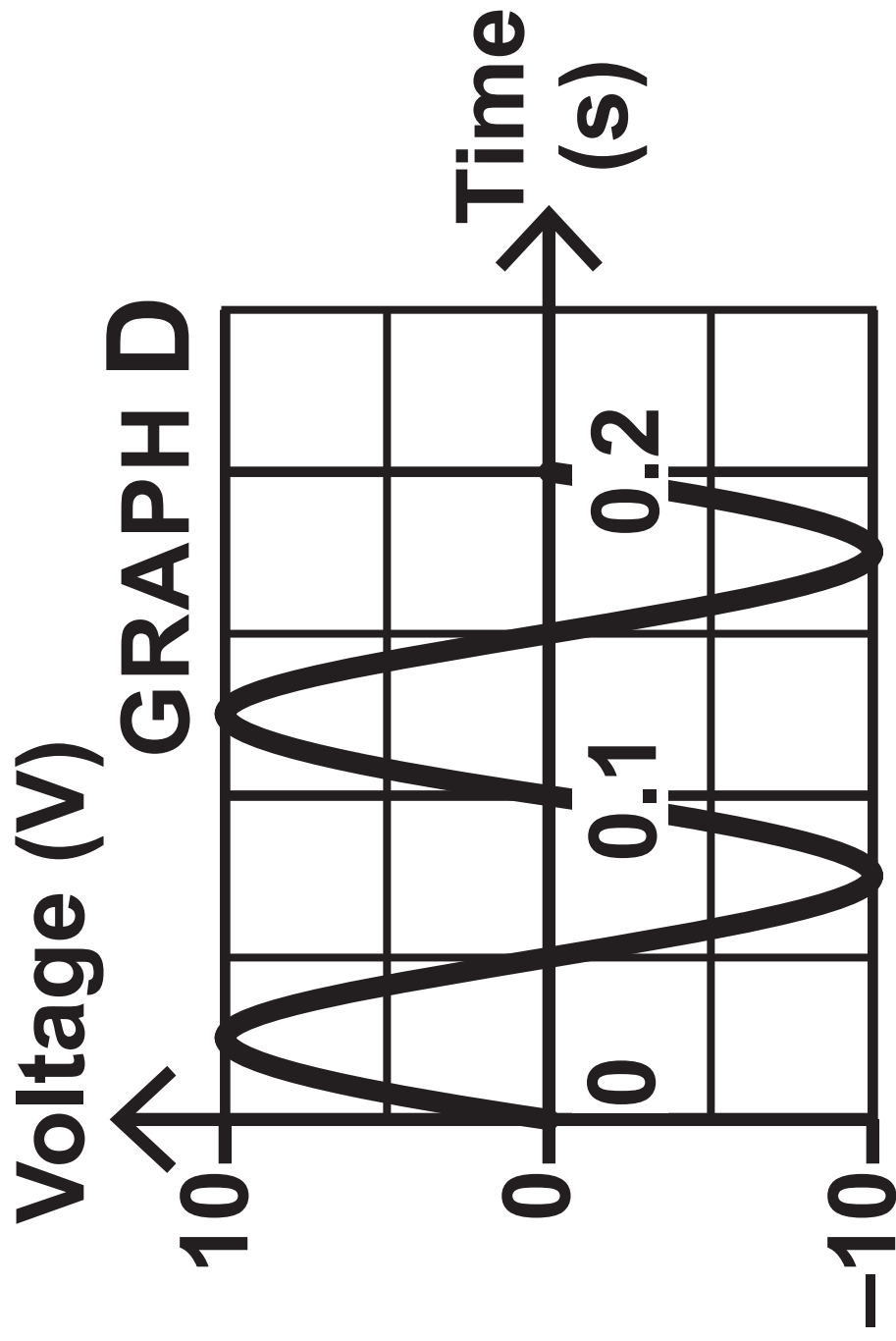
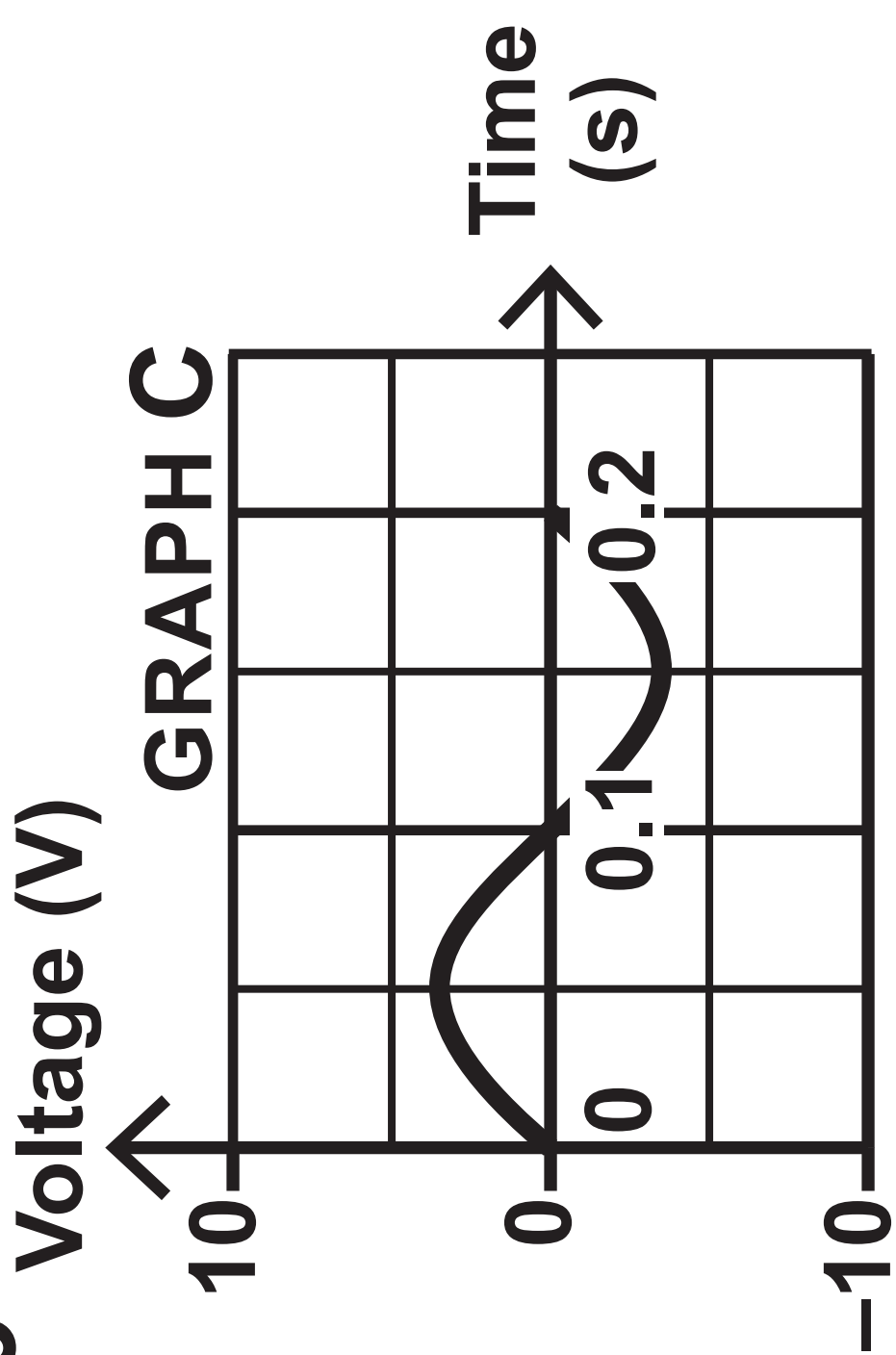
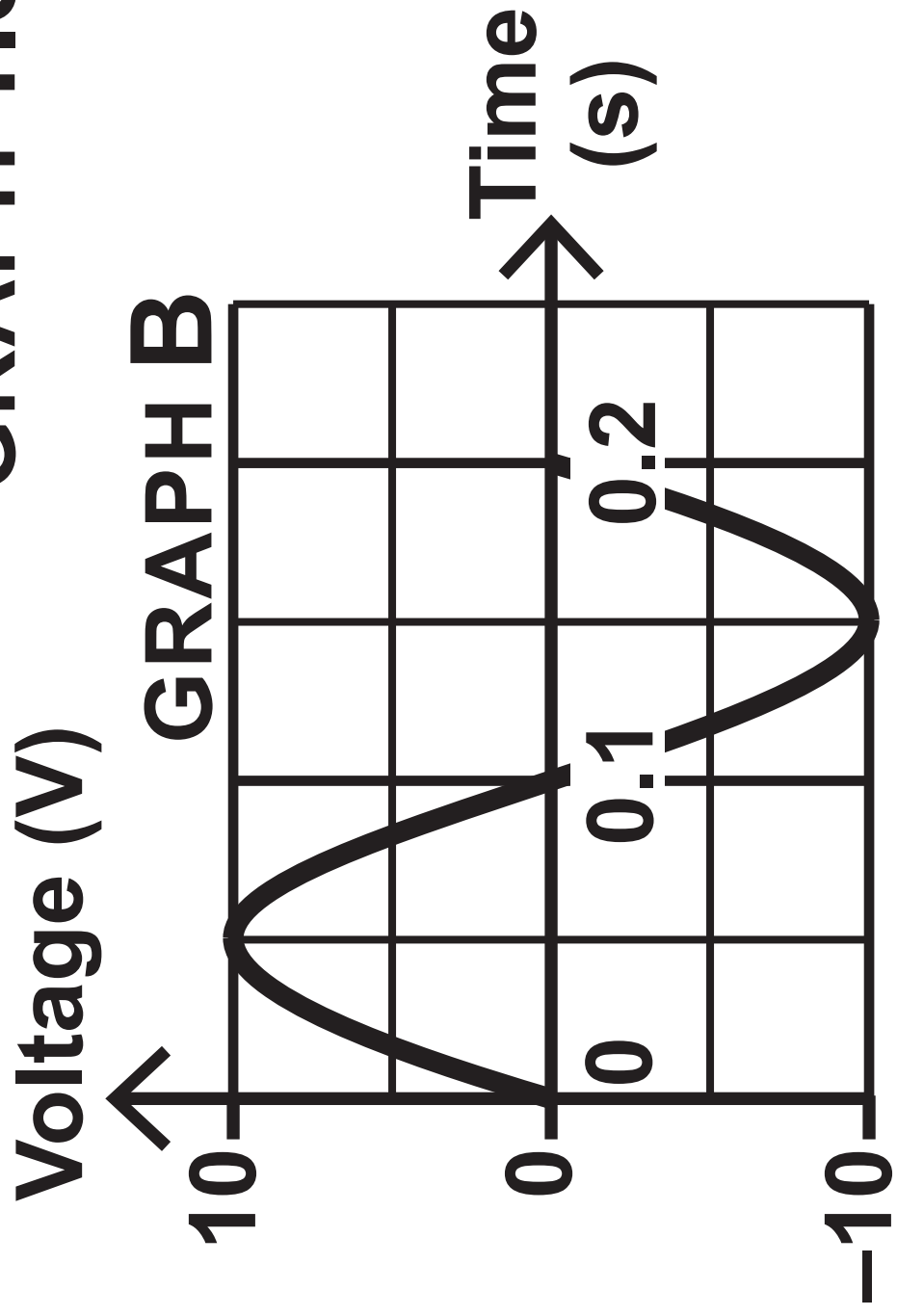
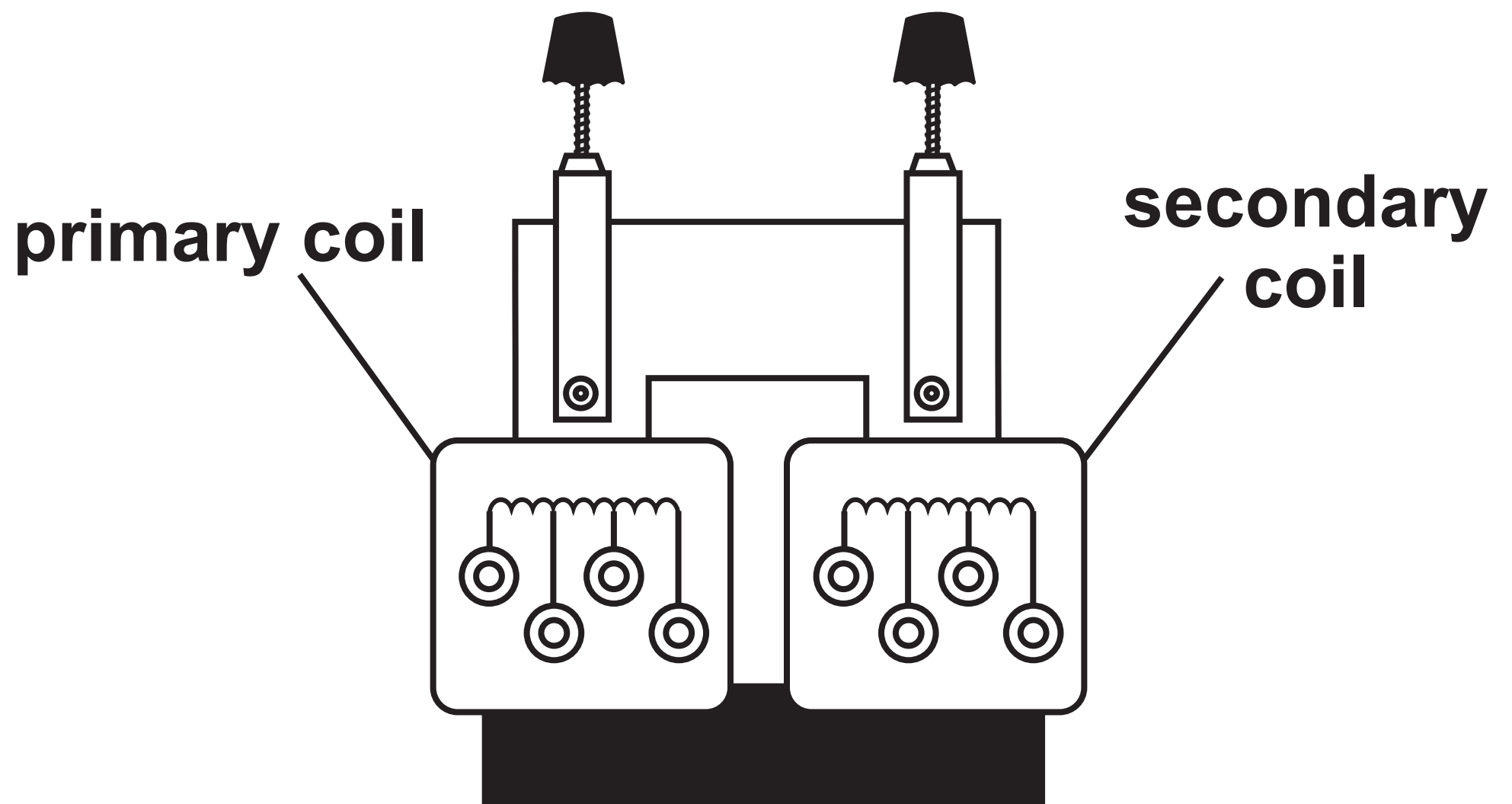
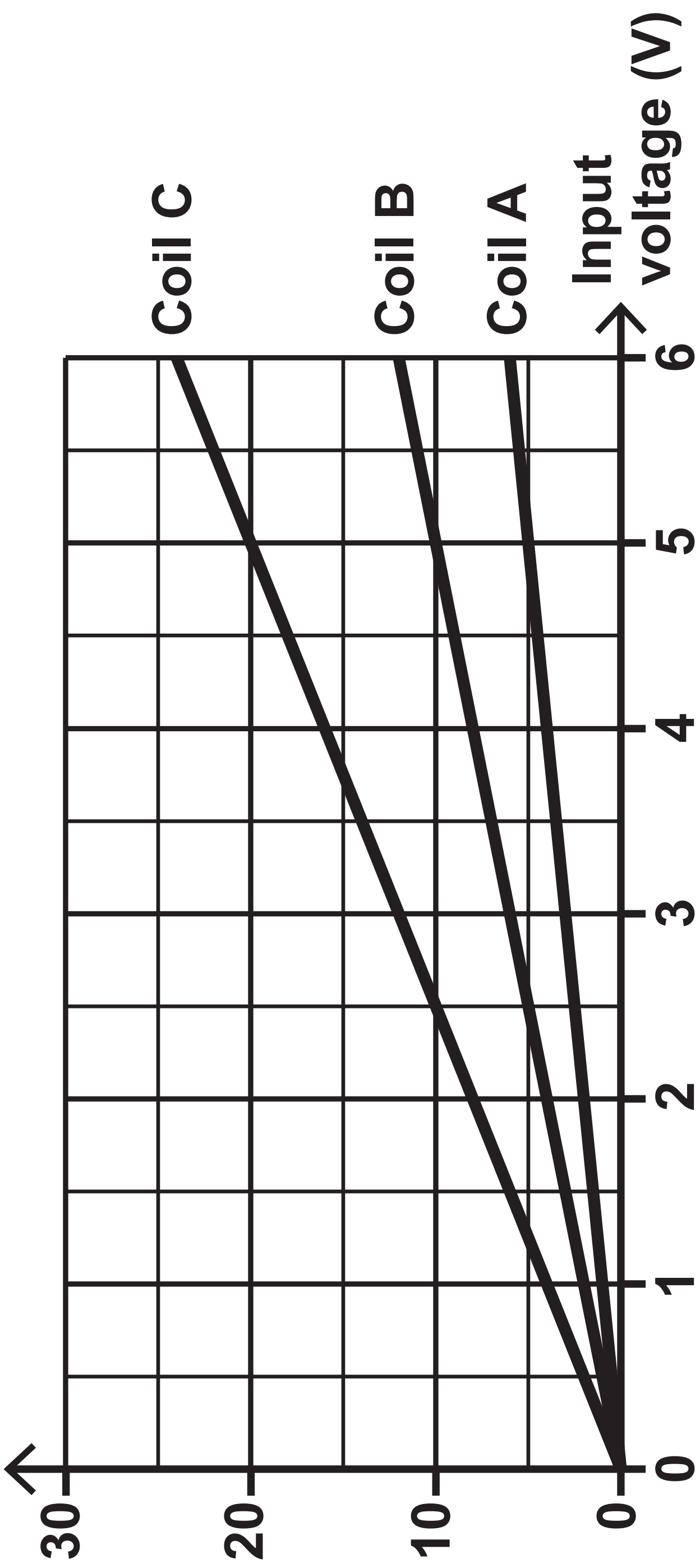


DIAGRAM 2.1



GRAPH 2.2

Output voltage (V)



THIS IS A BLANK PAGE

TURN OVER

DIAGRAM 3.1

EXPERIMENT A

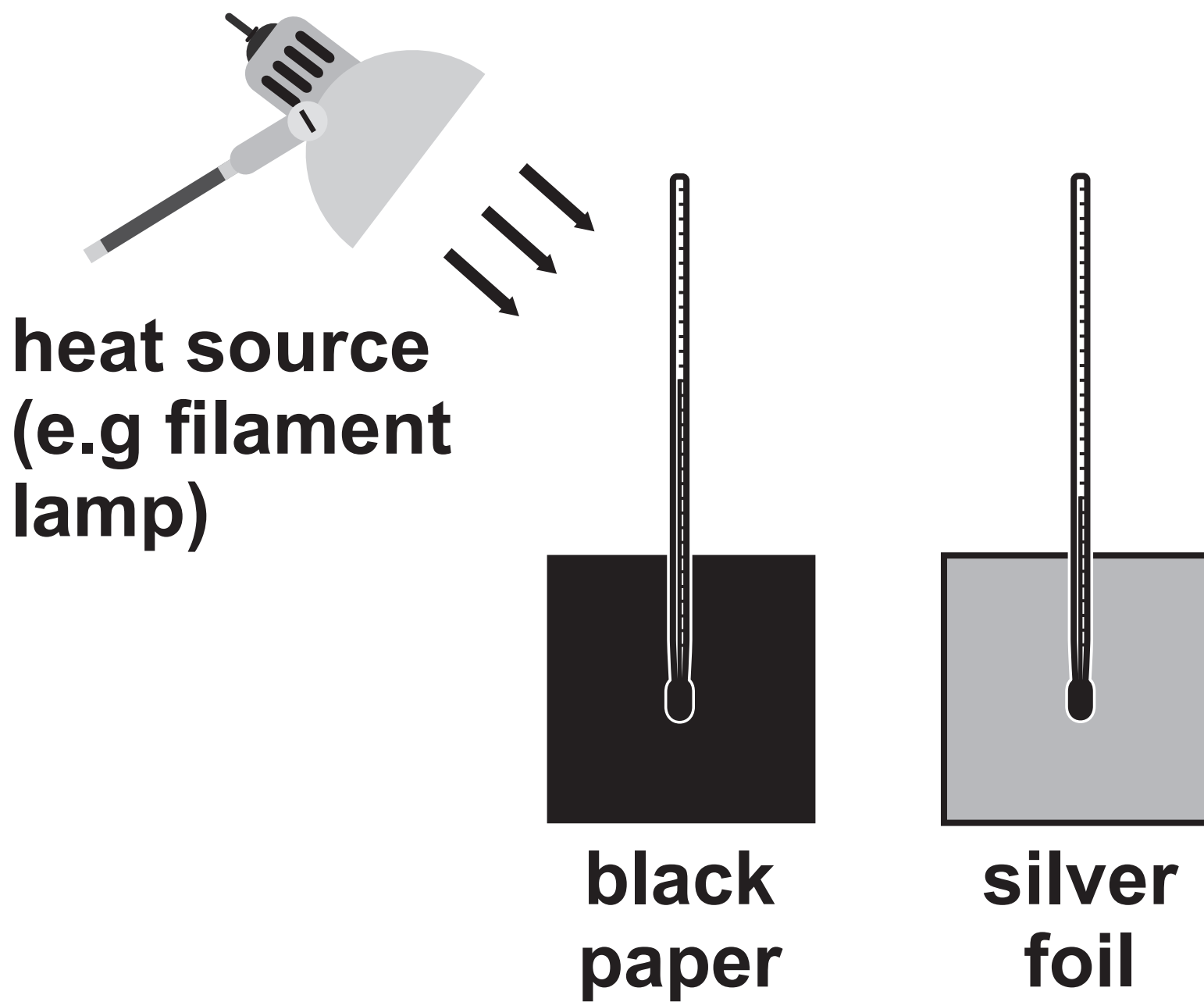
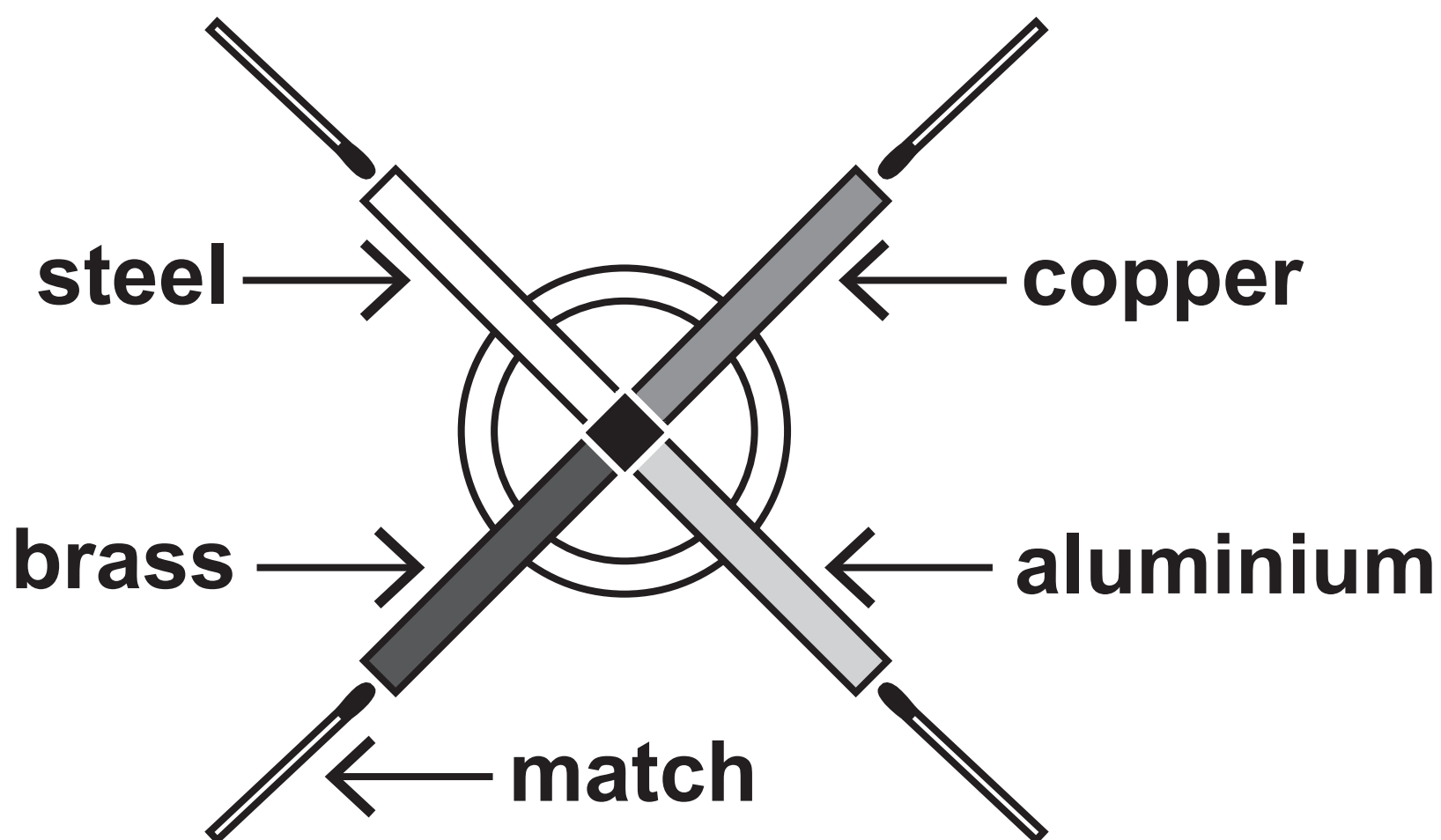


DIAGRAM 3.1 – continued

EXPERIMENT B

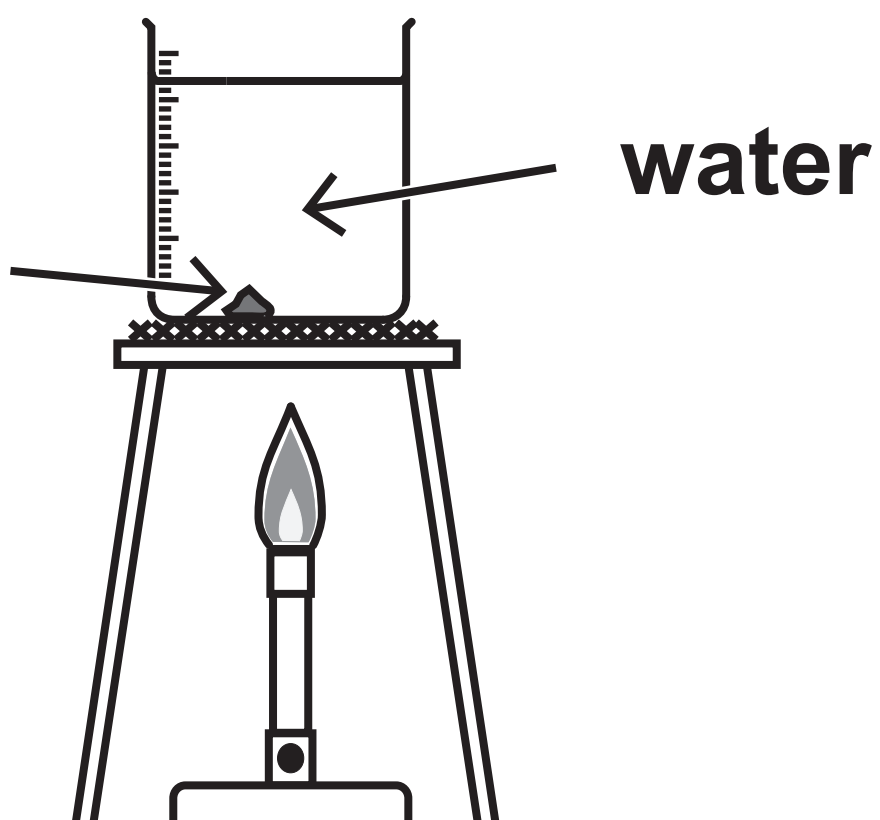
Key:

◆ Heat source



EXPERIMENT C

crystal of
potassium
permanganate(VII)



THIS IS A BLANK PAGE

TURN OVER

TABLE 3.2

Metal	Time taken to drop off (s)
aluminium	13
brass	18
copper	15
steel	20

TABLE 3.3

Metal	Thermal conductivity (units)
aluminium	205
brass	109
copper	385
steel	50

THIS IS A BLANK PAGE

TURN OVER

DIAGRAM 4.1

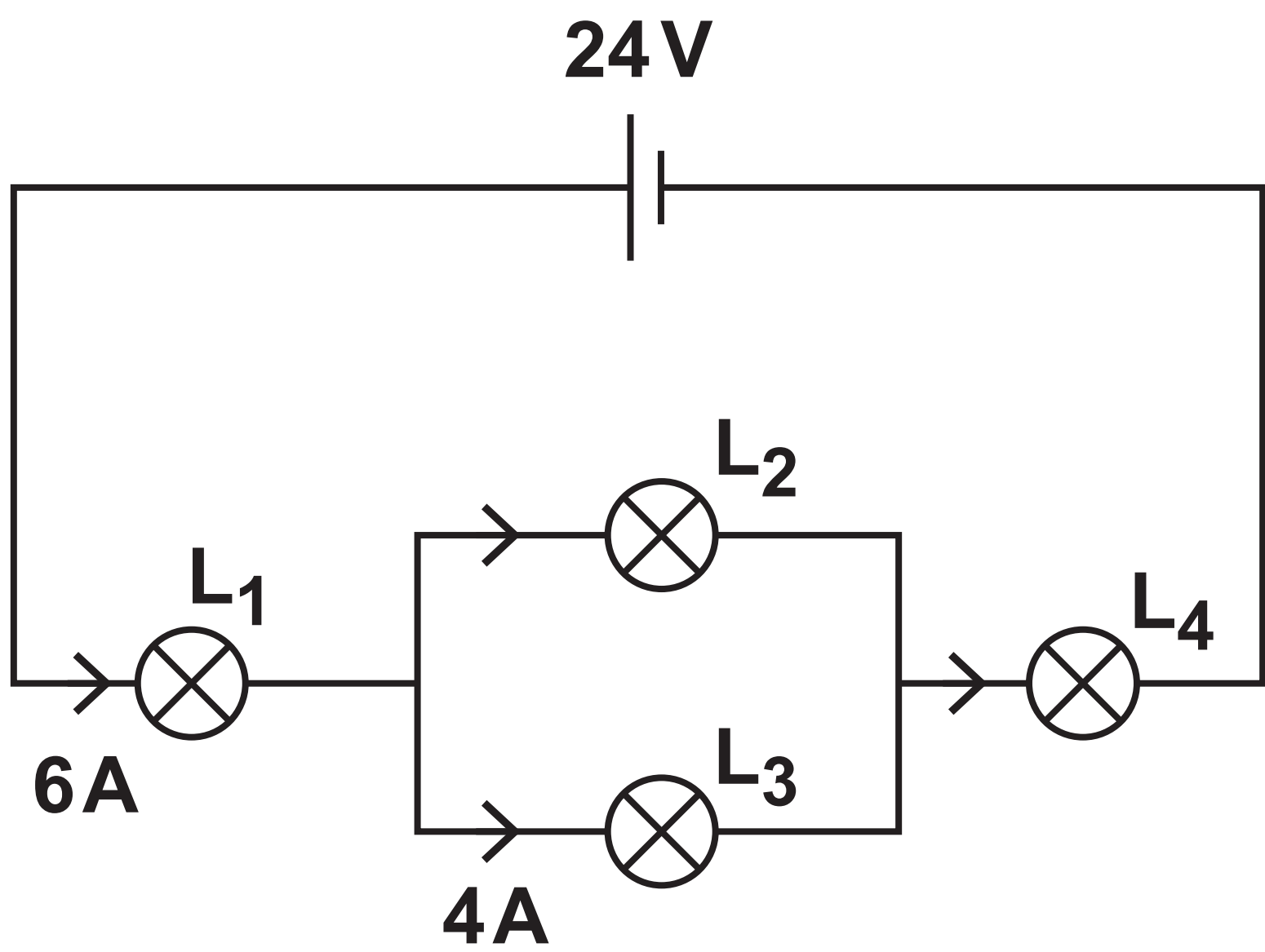


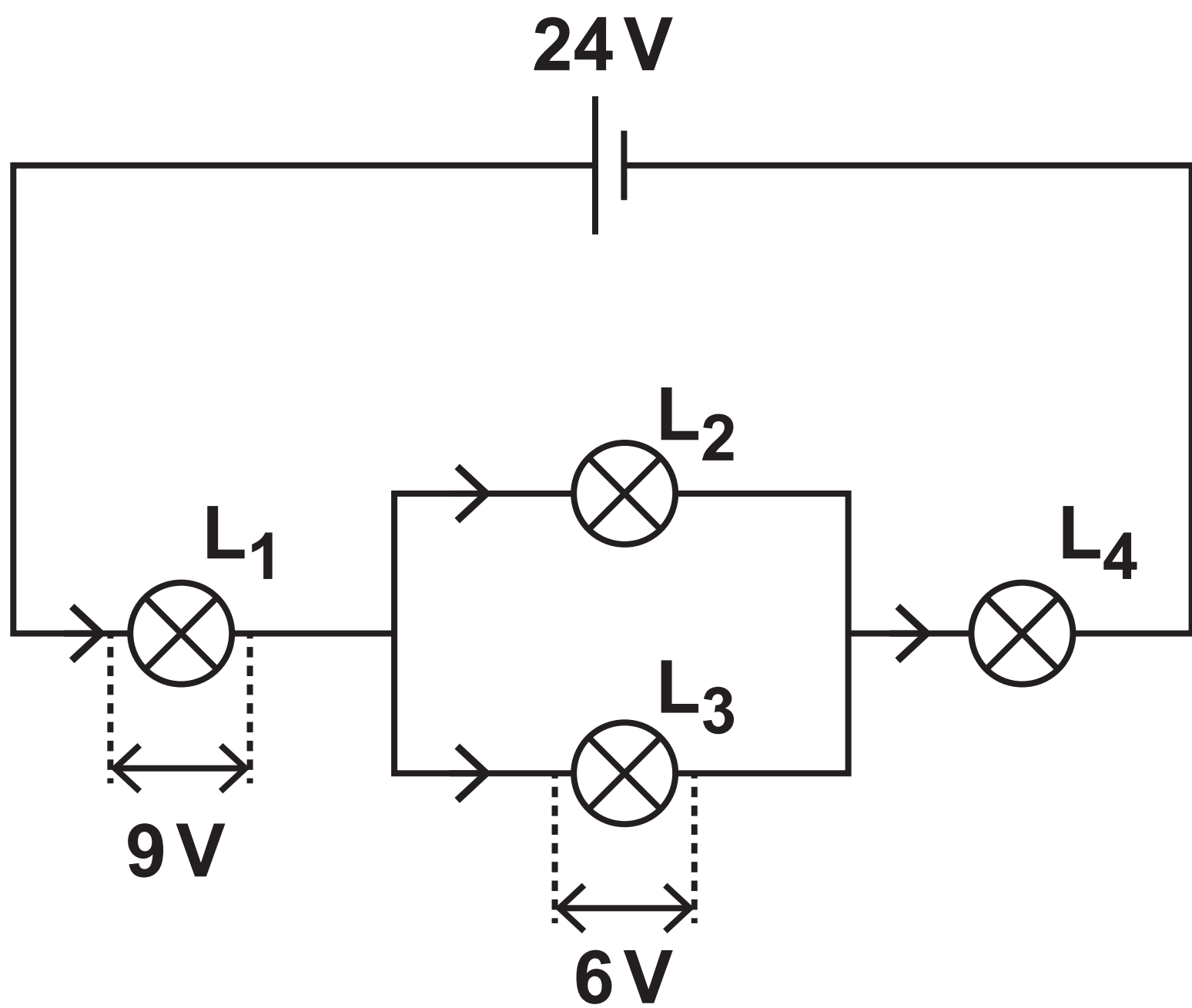
DIAGRAM 4.2

DIAGRAM 5.1



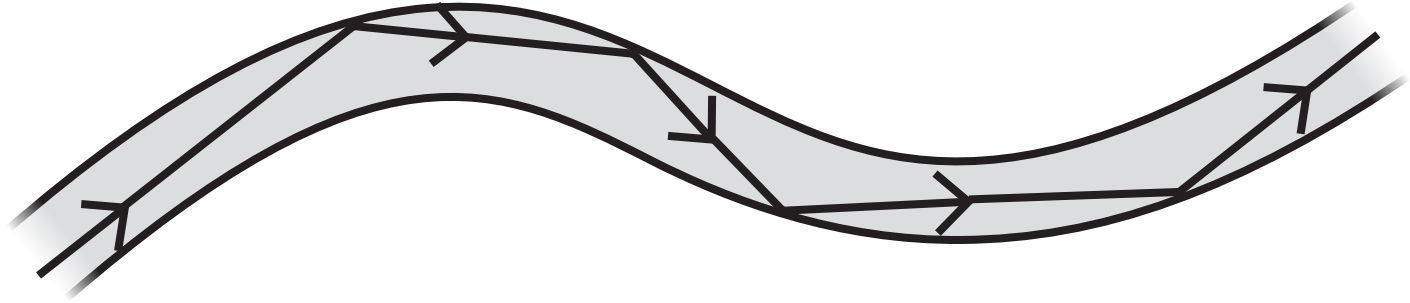
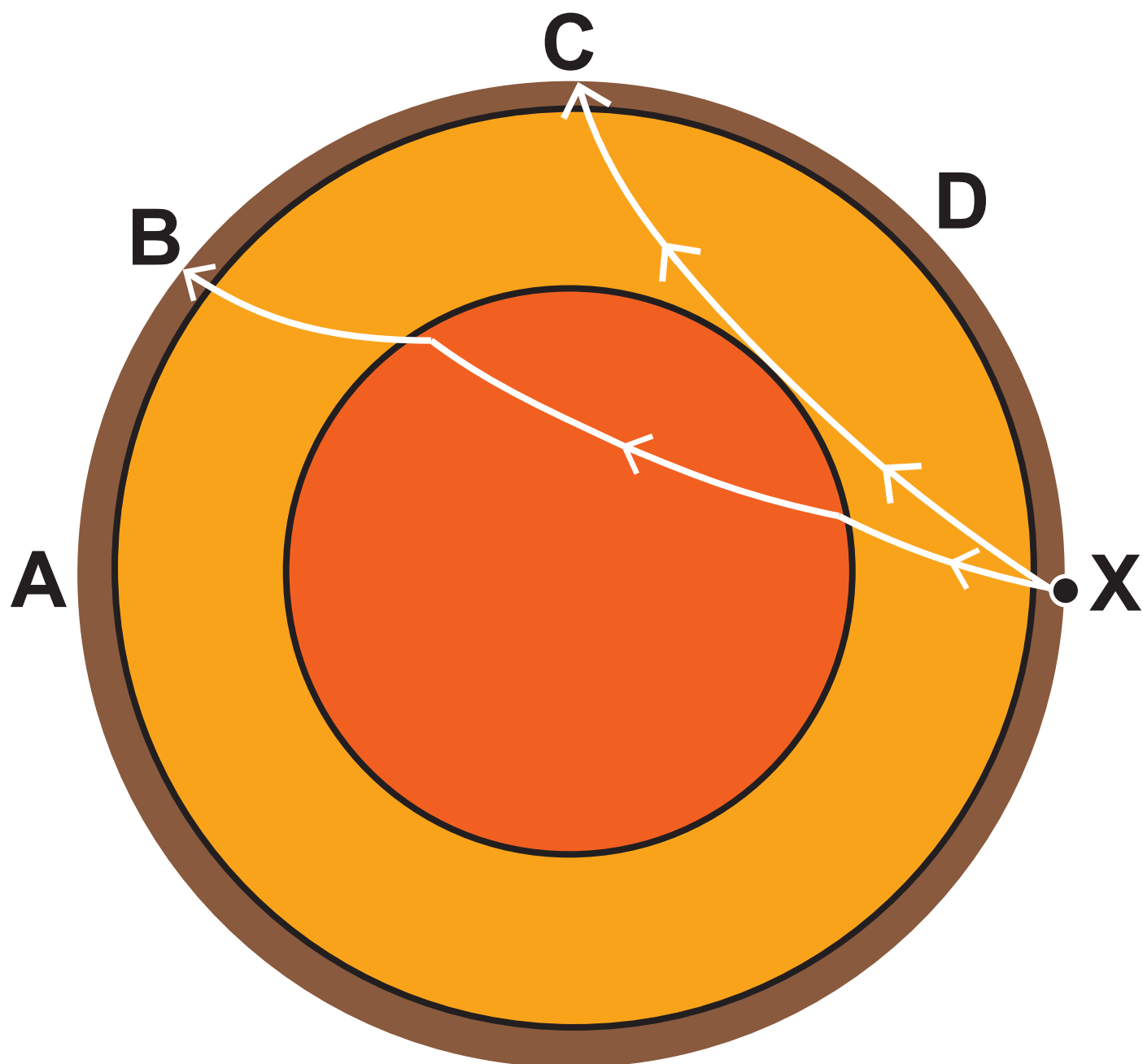
DIAGRAM 6.1

DIAGRAM 7.1



GRAPH 8.1

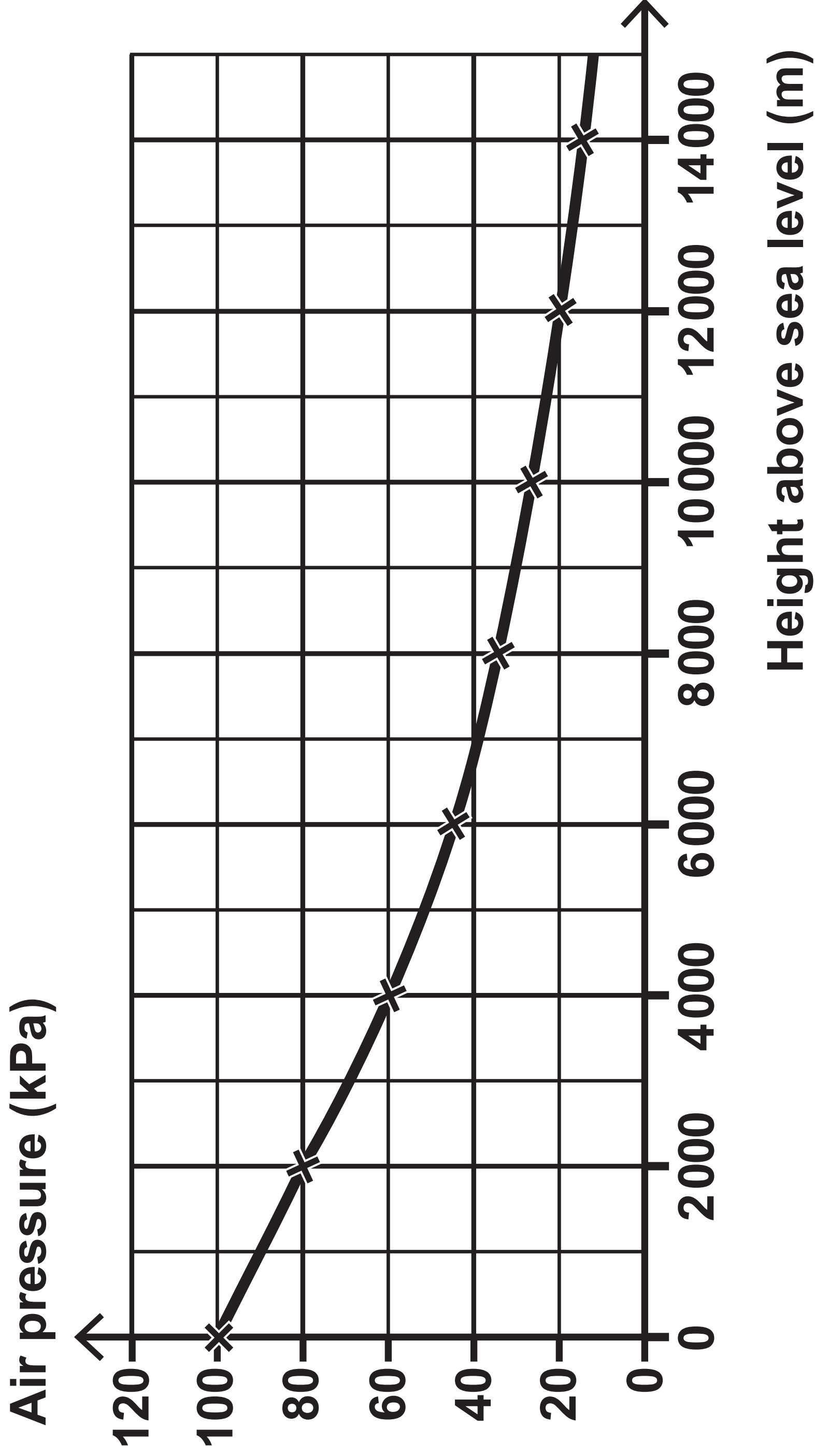
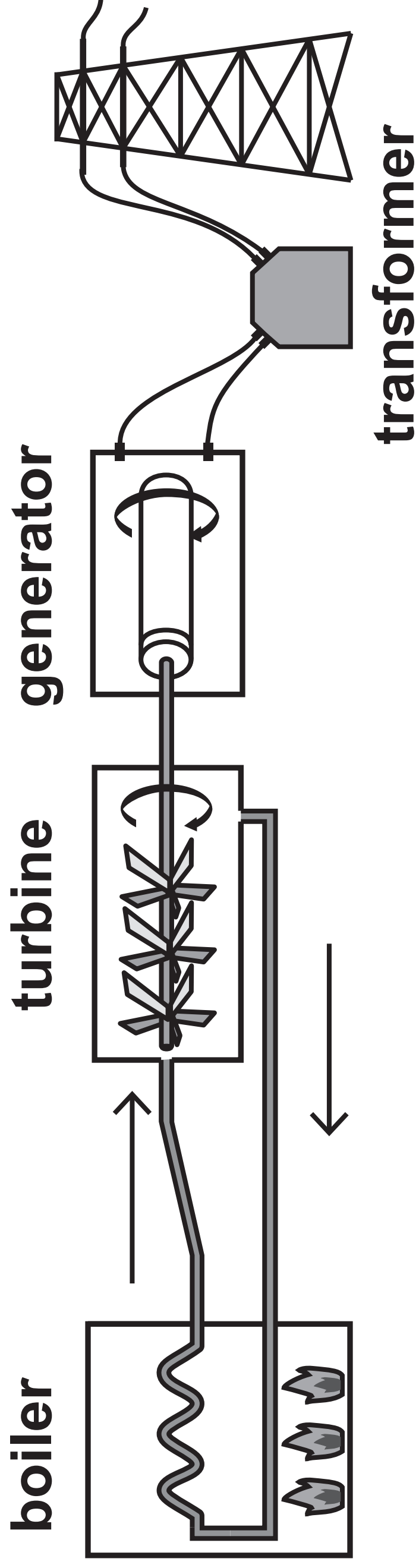


TABLE 9.1

	Kettle X	Kettle Y
Power	2200 W	2.4 kW
Time to boil (s)	90	90
Mass of water (kg)	0.6	0.6
Heat energy transferred to the water (J)	188 100	

DIAGRAM 10.1





3420U10-1

MONDAY, 16 JUNE 2025 – MORNING

**PHYSICS – Unit 1:
Electricity, Energy and Waves**

FOUNDATION TIER

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

Data Booklet

Equations and SI multipliers

THIS IS A BLANK PAGE

TURN OVER

EQUATIONS

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

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

total resistance
in a series circuit

$$R = R_1 + R_2$$

$$\begin{array}{l} \text{energy} \\ \text{transferred} \end{array} = \text{power} \times \text{time} \quad E = Pt$$

$$\text{power} = \text{voltage} \times \text{current} \quad P = VI$$

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

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

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

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

$$\text{cost} = \text{units used} \times \text{cost per unit}$$

wave

$$\text{speed} = \text{wavelength} \times \text{frequency} \quad v = \lambda f$$

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

$$\text{pressure} = \frac{\text{force}}{\text{area}} \quad p = \frac{F}{A}$$

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

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

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

$$Q = mL$$

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

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

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