wjec cbac GCSE

3420U10-1

MONDAY, 17 JUNE 2024 – 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 may 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.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	3	
2.	7	
3.	10	
4.	10	
5.	13	
6.	6	
7.	5	
8.	6	
9.	8	
10.	12	
Total	80	

Answer ALL questions.

1 **Complete TABLE 1 in the separate diagram booklet about seismic waves by placing ONE tick (✓) in each row. [3 marks]**

3

2 A 30 kW gas boiler is used for 700 HOURS in 1 year.

(a)(i) Use the equation:

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

to calculate the units used in 1 year.
[2 marks]

units used = _____ kWh

2 (a)(ii)

Use the equation:

cost = units used × cost per unit

to calculate the cost of using the boiler for 700 hours. [2 marks]

One unit of gas costs £0.12.

cost = £ _____

2 (a)(iii) Use your answer in (a)(ii) to calculate the cost of using the boiler for 1 HOUR. [1 mark]

cost = £ _____

2 (b) A solar water heating system costs £3600.

It is estimated to reduce gas consumption so that the boiler is used for only 650 hours instead of 700 hours.

(i) Calculate the saving made in 1 year by using the boiler for 50 hours less. [1 mark]

saving = £ _____

2 (b)(ii)

Calculate the payback time of the cost of the solar water heating system. [1 mark]

payback time = _____ years

7

3 (a) DIAGRAM 3.1 in the separate diagram booklet shows three resistors connected in series.

(i) Use an equation from the separate data booklet to calculate the total resistance of the circuit. [1 mark]

total resistance = _____ Ω

(ii) The battery voltage is 12 V.
Use an equation from the separate data booklet to calculate the current in the circuit. [2 marks]

current = _____ A

3 (a)(iii)

Use an equation from the separate data booklet to calculate the power produced by the battery. [2 marks]

power = _____ W

3 (b) The circuit in DIAGRAM 3.2 in the separate diagram booklet contains three IDENTICAL components, L_1, L_2 and L_3, connected to a battery.

(i) Tick (✓) the box next to the name of these components. [1 mark]

☐ Lamp

☐ LED

☐ LDR

(ii) The current in L_2 is 8 mA.

I. Write down the current in L_3. [1 mark]

current = _____ mA

II. Write down the current in L_1. [1 mark]

current = _____ mA

3 (b)(iii)

I. State which TWO components (L_1, L_2 or L_3) have the same voltage across them. [1 mark]

_____ and _____

II. State which TWO components (L_1, L_2 or L_3) have voltages that add up to the battery voltage. [1 mark]

_____ and _____

10

4 The apparatus used by a group of students to determine the specific heat capacity of copper is shown in DIAGRAM 4 in the separate diagram booklet.

(a)(i) The immersion heater has a power of 50 W.
It heats the copper block for 150 s.
Use the equation:

energy transferred = power × time

to calculate the energy transferred by the heater. [2 marks]

energy transferred = _____ J

4 (a)(ii) The temperature of the copper block at the start of the experiment is 20 °C. Its temperature after heating is 35 °C. Calculate the change in temperature of the copper block. [1 mark]

change in temperature = _____ °C

4 (a)(iii) The mass of the copper block is 1 kg.

Use the answers in parts (i) and (ii) and the equation:

$$\text{specific heat capacity} = \frac{\text{energy transferred}}{\text{mass} \times \text{change in temperature}}$$

to calculate the specific heat capacity of copper. [2 marks]

specific heat capacity, c = _____ J/kg °C

4 (a)(iv)

Another group of students get a value for the specific heat capacity of 455 J / kg °C.

The true value of the specific heat capacity of copper is 385 J / kg °C.

I. Calculate the difference between this group's value and the true value. [1 mark]

difference = _____ J/kg °C

4 (a)(iv) continued

II. Use the equation:

$$\% \text{ difference} = \frac{\text{difference}}{\text{true value}} \times 100$$

to calculate the % difference between this group's value and the true value. [2 marks]

% difference = _____

4 (b) Tick (✓) the boxes next to TWO improvements that could be made to this experiment that would lead to a more accurate value for the specific heat capacity of copper. [2 marks]

- ☐ Use a heater with a larger power
- ☐ Heat the block for longer
- ☐ Wrap the block in insulating material
- ☐ Push the heater fully into the block

10

5 The operation of electric generators can be explained by electromagnetic induction.

(a) DIAGRAM 5.1 in the separate diagram booklet shows part of an a.c. generator.

(i) State the direction (A, B, C, D, E or F) in which the magnetic field acts. [1 mark]

Direction = _____

(ii) State the direction (A, B, C, D, E or F) in which the right hand side of the coil moves. [1 mark]

Direction = _____

5 (a)(iii) Use Fleming's right hand rule (shown in DIAGRAM 5.2 in the separate diagram booklet) to determine the direction (A, B, C, D, E or F) of the induced current in the right hand side of the coil. [1 mark]

Direction = _____

(iv) When the coil spins, a voltage is produced.

This is shown on GRAPH 5.3 in the separate diagram booklet.

I. Use the graph to find the maximum voltage produced by the generator. [1 mark]

maximum voltage = _____ V

5 (a)(iv) continued

II. Use the graph to find the time for one rotation (spin) of the coil. [1 mark]

time = _____ s

III. Complete TABLE 5.4 in the separate diagram booklet to show the effect of each change made.
Use the words INCREASES, DECREASES or NO EFFECT.
Three boxes have been completed for you. [3 marks]

5 (b) Transformers also work by electromagnetic induction.

(i) Tick (✓) the boxes next to the THREE correct statements about transformers. [3 marks]

☐ Transformers change a.c. to d.c.

☐ Transformers change d.c. voltages.

☐ The core is made from iron.

☐ There is an electric current in the core.

☐ The primary coil creates an alternating magnetic field.

☐ Transformers can increase or decrease voltages.

5 (b)(ii)

A transformer increases voltage from 12 V to 36 V.

The primary coil contains 20 turns of wire.

Use the equation:

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

to calculate the number of turns in the secondary coil, N_2. [2 marks]

N_2 = _____

13

6 Radio waves is one region of the electromagnetic spectrum.

List the other regions of the electromagnetic spectrum and describe their similarities and differences.

DESCRIPTION OF USES IS NOT REQUIRED. [6 marks QER]

continue answer on next page

continue answer on next page

6

(Turn over)

7 Communication between the UK and USA can be made by optical fibres or by geostationary satellites.

TABLE 7.1 in the separate diagram booklet shows the time taken by infra-red waves to travel different distances through an optical fibre.

(a) Use the data from TABLE 7.1 to plot a graph on the grid in GRAPH 7.2 in the separate diagram booklet and draw a suitable straight line. [3 marks]

7 (b) An infra-red signal sent from the UK to the USA by optical fibre travels 9000 km.
A microwave signal sent from the UK to the USA by geostationary satellite travels 72 000 km and takes 0.24 s.
Chris thinks it is quicker to send signals by geostationary satellite.

USE A VALUE FROM GRAPH 7.2 to explain whether you agree with Chris. [2 marks]

8 DIAGRAM 8 in the separate diagram booklet shows a hydraulic jack system.
The pressure in the fluid throughout the system is constant.

(a) A force F_1 of size 25 N is applied to a piston of area A_1 equal to 10 cm^2.
Use an equation from the separate data booklet to calculate the pressure created in the fluid.
[2 marks]

pressure = _____ N/cm^2

8 (b) Use the equation:

force = pressure × area

to calculate the force F_2 if the area A_2 equals 4000 cm^2. [2 marks]

force = _____ N

8 (c) The jack works because hydraulic fluids cannot be compressed. Explain, IN TERMS OF MOLECULES, why the jack will not work if it contains air. [2 marks]

(Turn over)

9 (a) A group of students was asked to find the density of an object. They made the following measurements.

mass of the object = 15 g
volume of water in measuring cylinder = 20 cm^3
volume of water and object = 25 cm^3

Use the results to answer the following questions.

(i) Calculate the volume of the object. [1 mark]

volume = _____ cm^3

9 (a)(ii) Use an equation from the separate data booklet to calculate the density of the object. [2 marks]

density = _____ g/cm^3

9 (a)(iii)

The teacher said the object was made from one of the materials in TABLE 9 in the separate diagram booklet.

Ffion thought the object was made of aluminium.
Use the data in the table to explain whether you agree with Ffion.
[2 marks]

9 (b) The group is given a solid object that floats on water.
Describe how they would change the experiment to find the density of this object.
They still use the measuring cylinder partly filled with water. [3 marks]

continue answer on next page

8

(Turn over)

10 **BLOCK DIAGRAM 10.1 in the separate diagram booklet represents a fossil fuel power station.**

(a)(i) **Use the words in the block diagram to explain how electricity is generated in a fossil fuel power station. [3 marks]**

continue answer on next page

(Turn over)

10 (a)(ii)

Neve says that fossil fuel power stations are about 35% efficient.
Jacob says they are less than 30% efficient.
Use the information in SANKEY DIAGRAM 10.2 in the separate diagram booklet and an equation from the separate data booklet to explain whether you agree with Neve or Jacob. [3 marks]

Space for calculation.

10 (b) Power stations are connected to the National Grid.

The power demand on a particular day is shown in GRAPH 10.3 in the separate diagram booklet.

(i) The graph shows that the base load is 25 GW. State what is meant by this. [1 mark]

10 (b)(ii) State the peak power demand on the National Grid on the day shown in the graph. [1 mark]

peak power demand = _____ GW

10 (b)(iii)

The Dinorwig power station is a pumped storage hydro-electric scheme.

Dinorwig has six 0.3 GW generators. It is used to provide additional power once demand rises above 35 GW. Once operating at maximum output, it can provide power for 6 hours before running out of water.

Rowan says that Dinorwig can provide power for the whole time that demand is over 35 GW.
However, he says that it will not be able to supply enough power to meet all the demand above 35 GW shown in GRAPH 10.3.
He also says that about 3 GW will need to be imported from overseas.

question continues

10 (b)(iii) continued

Explain whether you agree with Rowan.

Include data in your answer.

[4 marks]

continue answer on next page

45

12

END OF PAPER

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

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MONDAY, 17 JUNE 2024 – 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 _____

TABLE 1

Property	P waves	S waves	Surface waves
These waves travel the fastest.			
These waves are longitudinal.			
These waves cannot travel through liquids.			

DIAGRAM 3.1

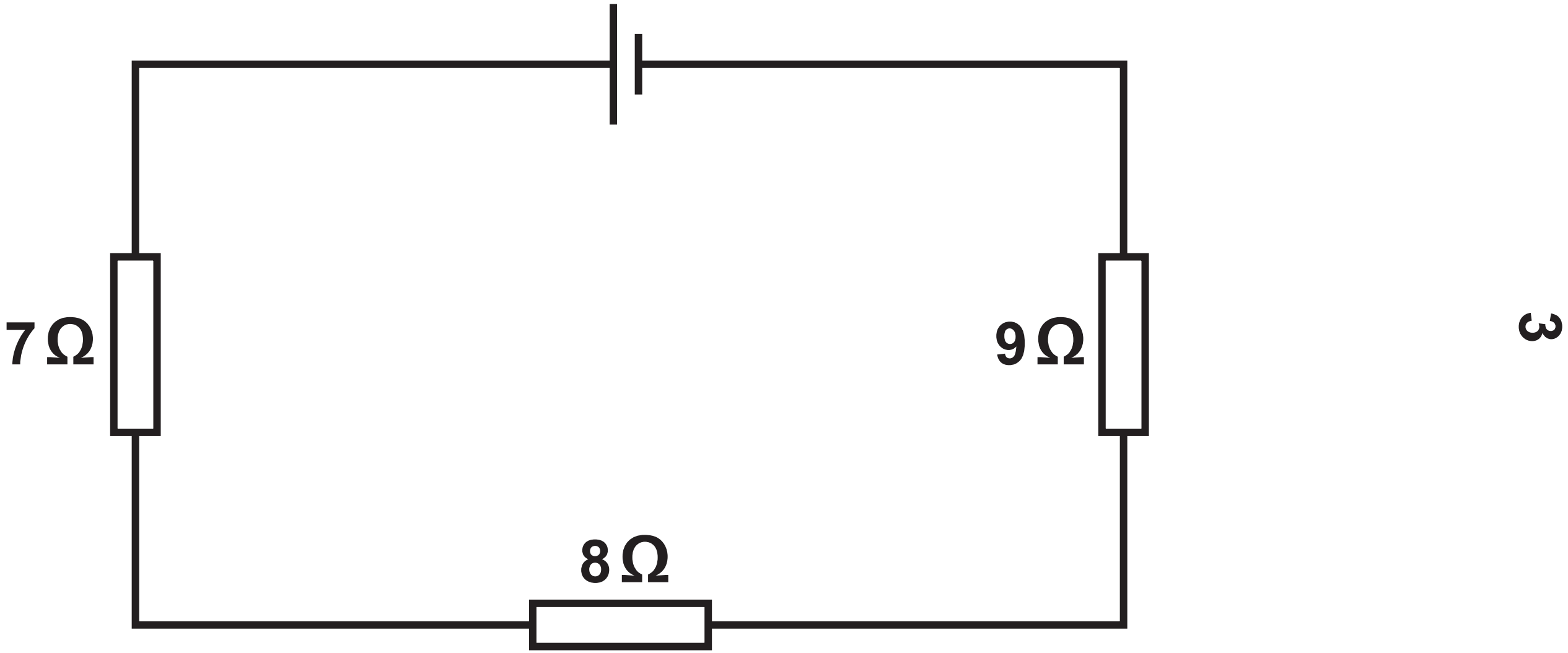


DIAGRAM 3.2

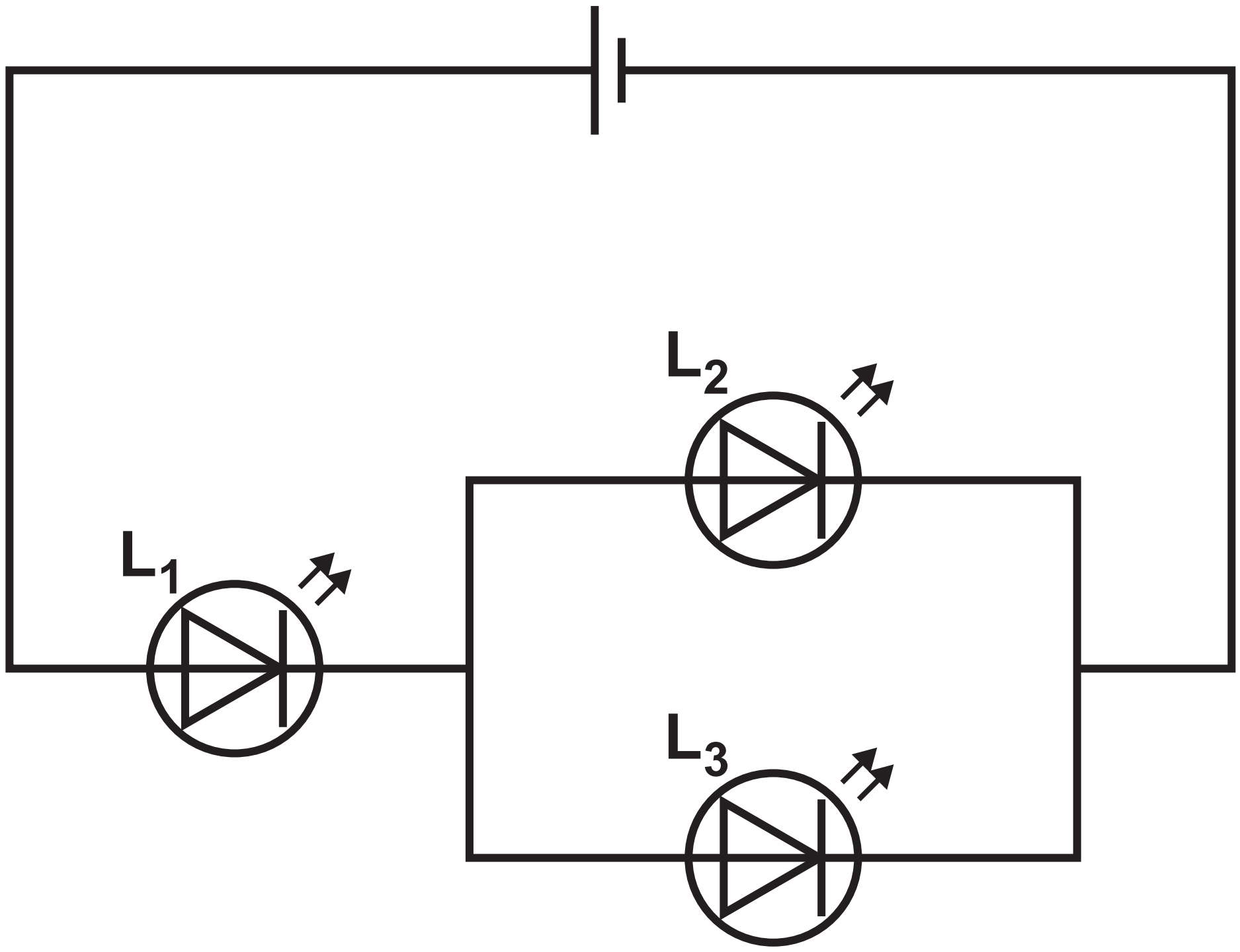


DIAGRAM 4

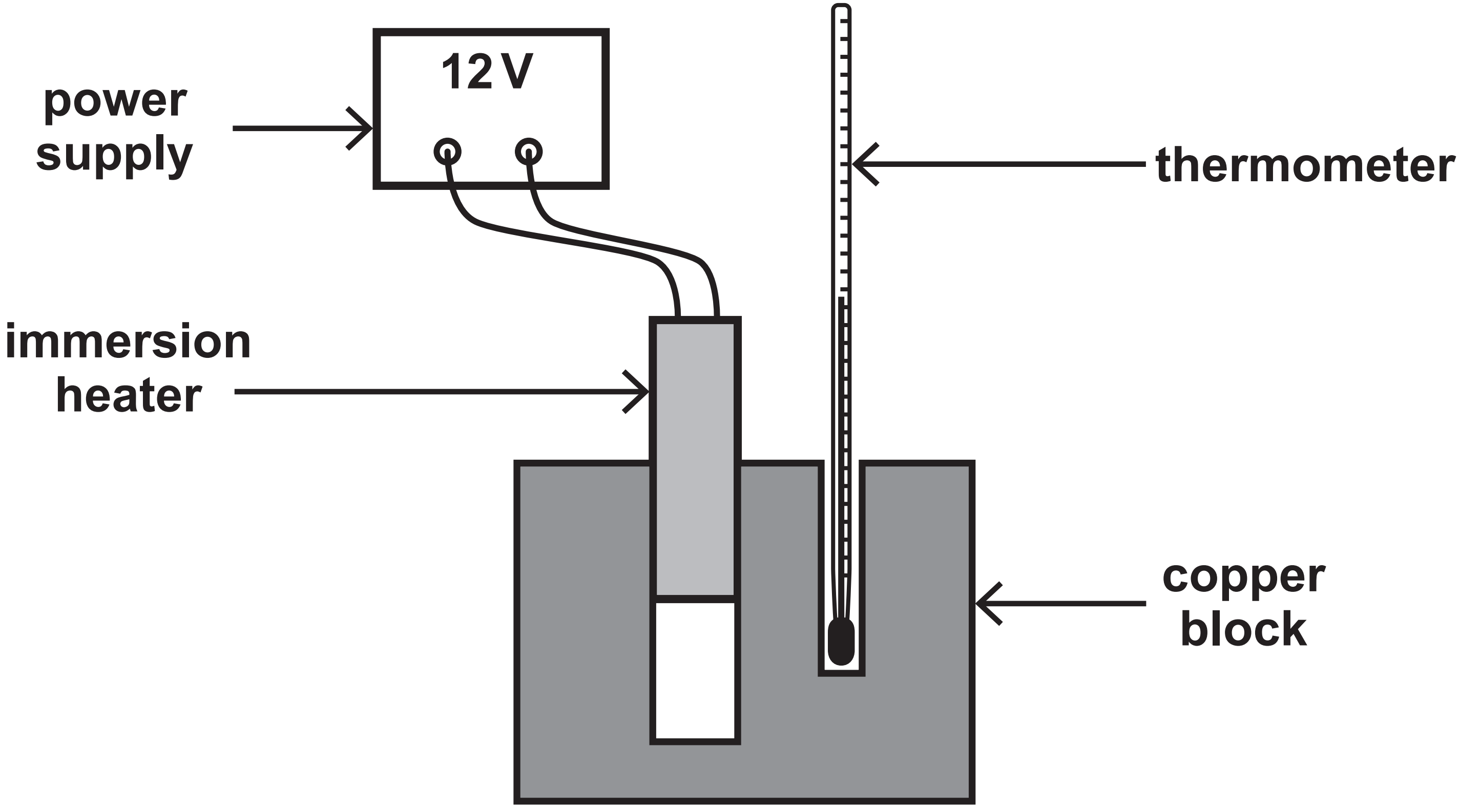

power supply
12 V
thermometer
immersion heater
copper block

DIAGRAM 5.1

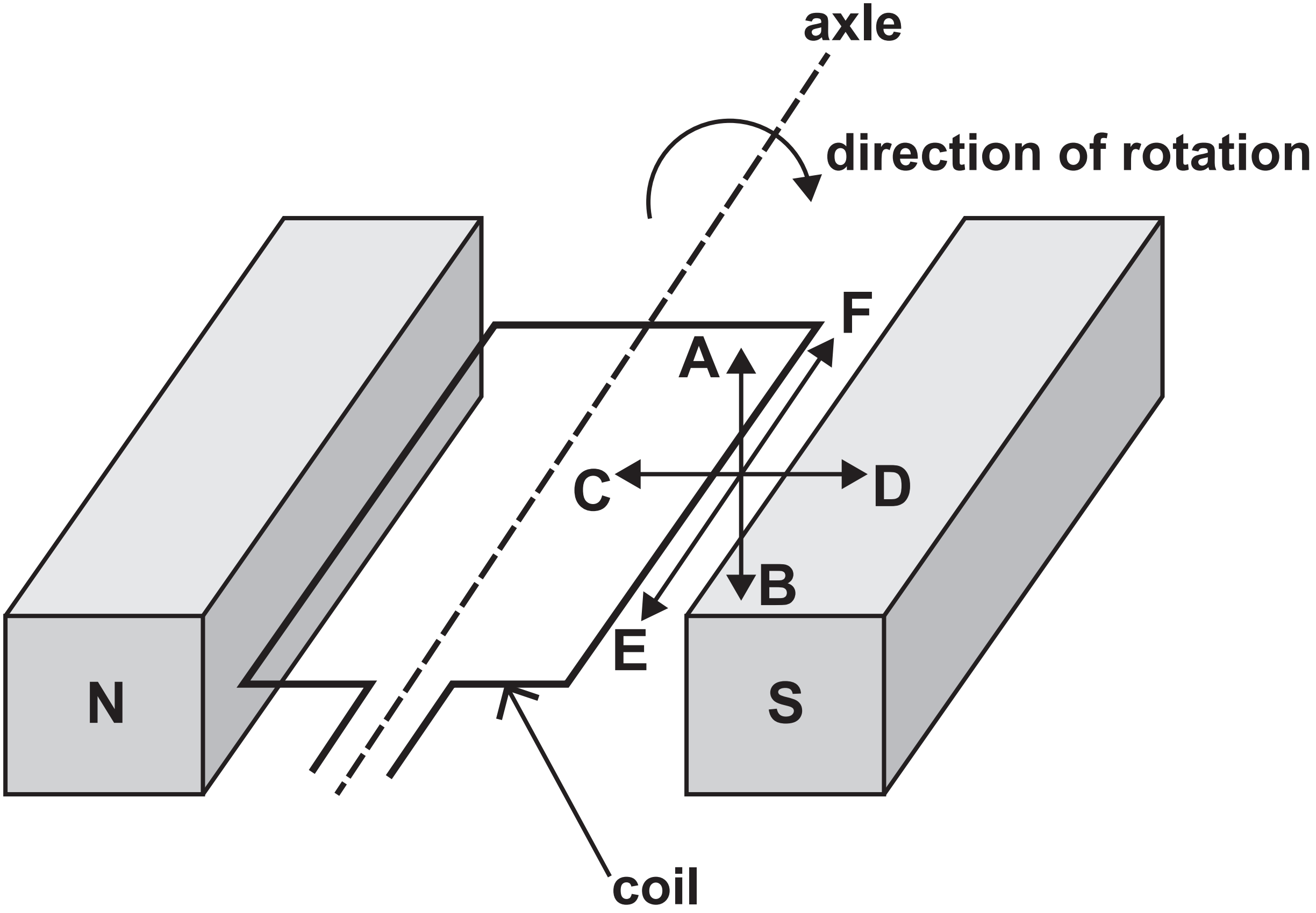
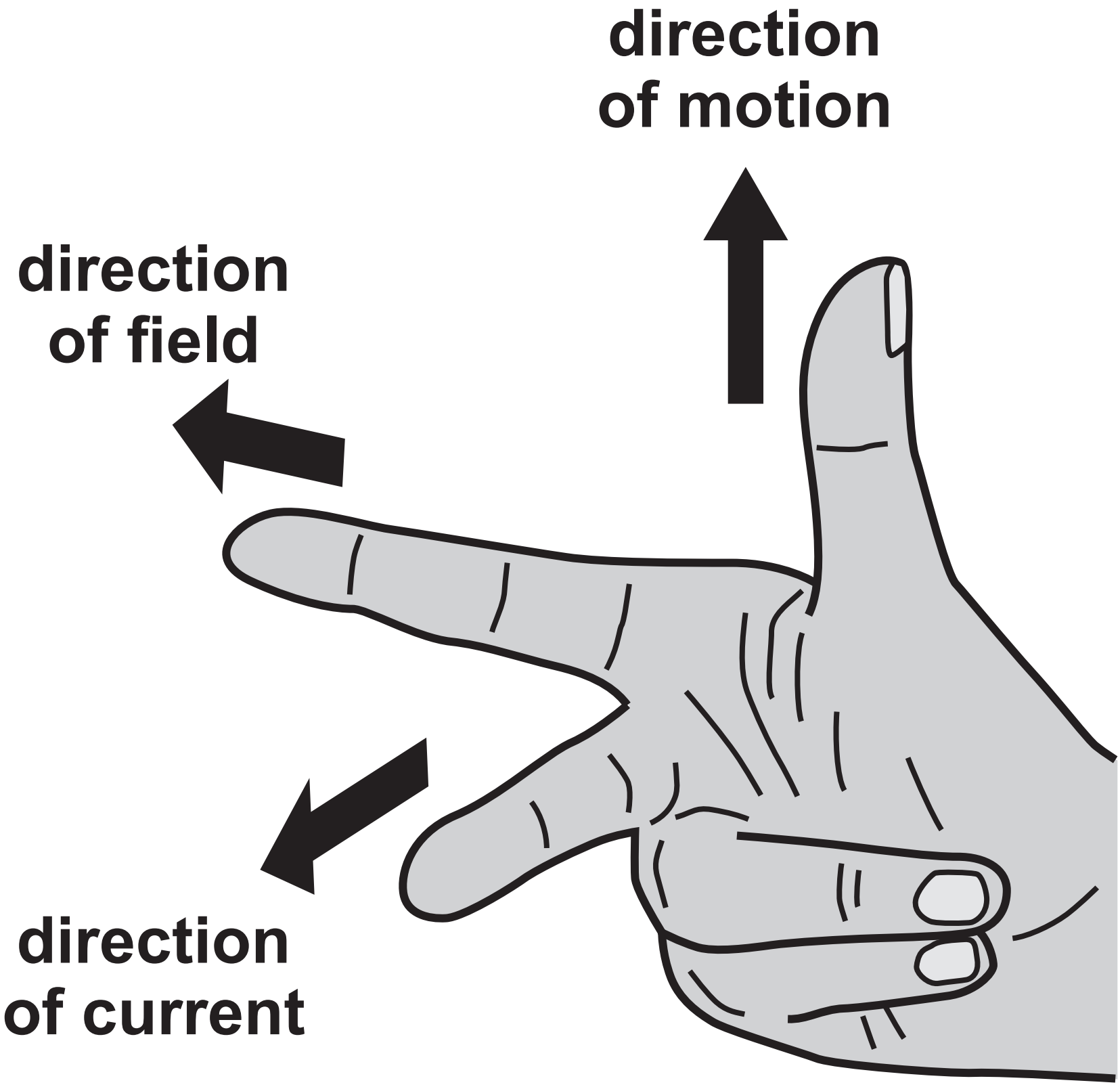


DIAGRAM 5.2


direction
of motion
direction
of field
direction
of current

GRAPH 5.3

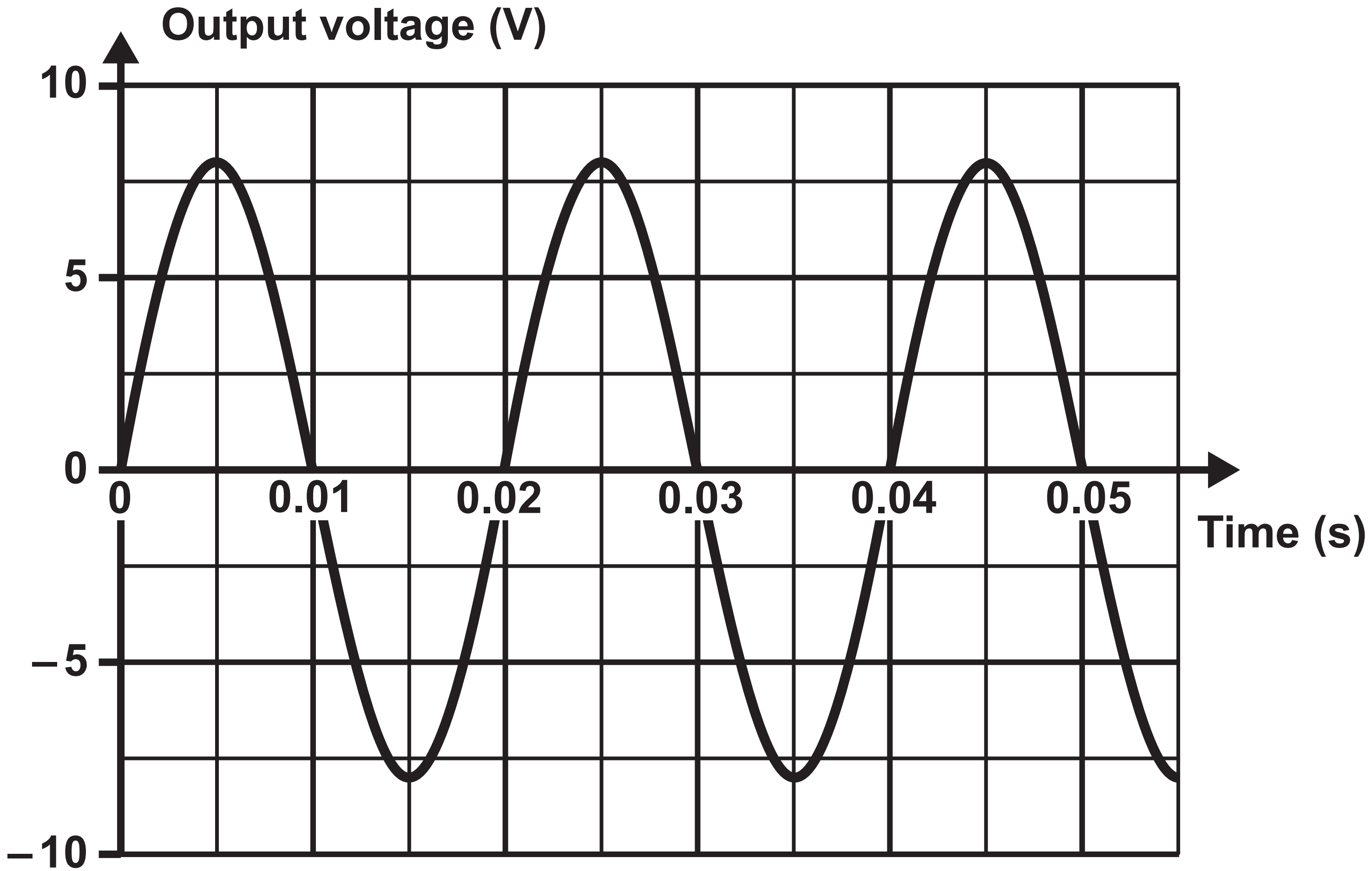


TABLE 5.4

Change made	Effect on maximum voltage	Effect on time for 1 rotation (spin)
Stronger magnets	increases	no effect
More turns on the coil	_____	no effect
Coil spins slower	_____	_____

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TURN OVER

TABLE 7.1

Distance (km)	2000	4000	6000	8000	10 000
Time (s)	0.01	0.02	0.03	0.04	0.05

GRAPH 7.2

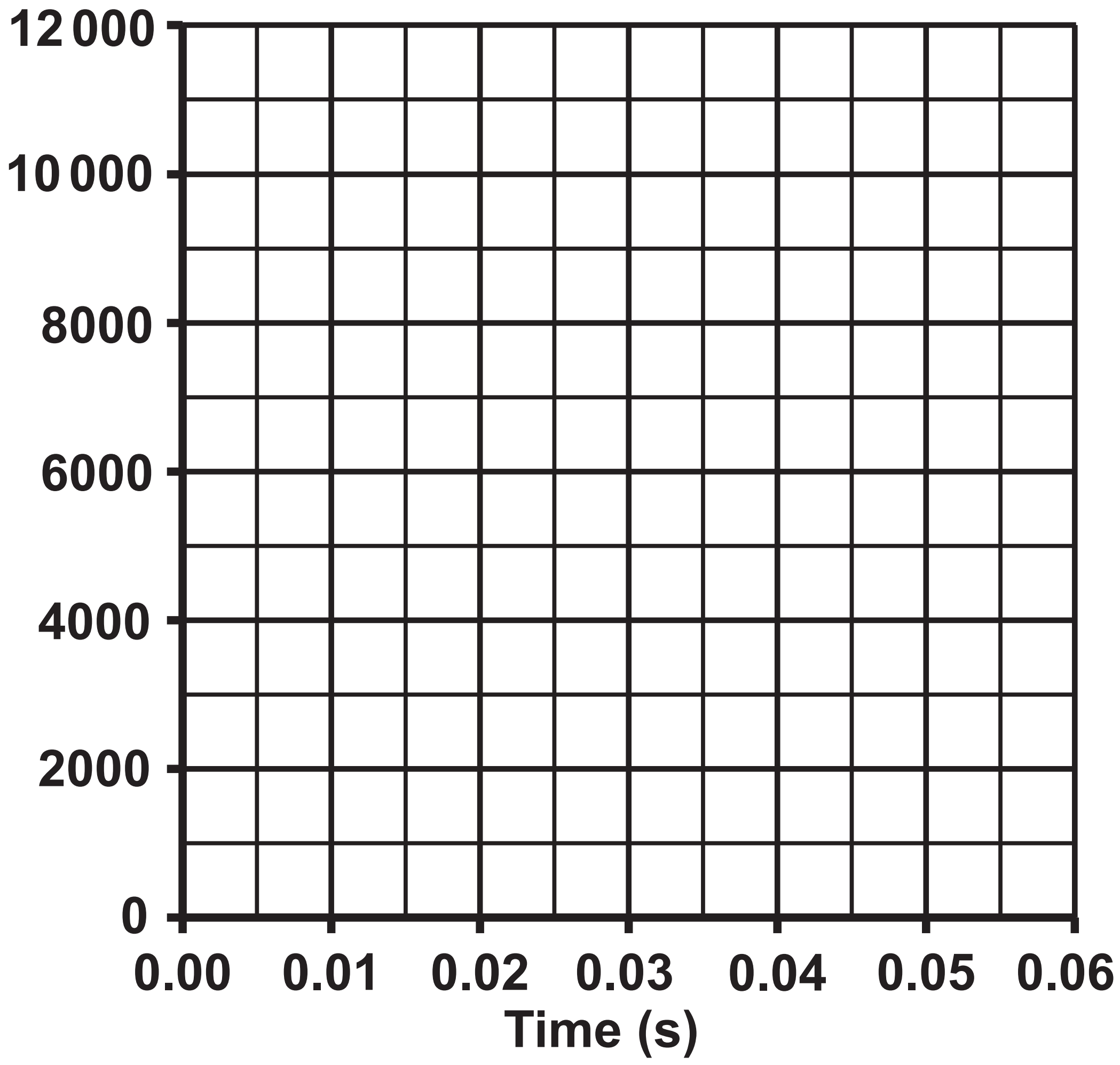

Distance (km)
12 000
10 000
8000
6000
4000
2000
0
0.00
0.01
0.02
0.03
0.04
0.05
0.06
Time (s)

DIAGRAM 8

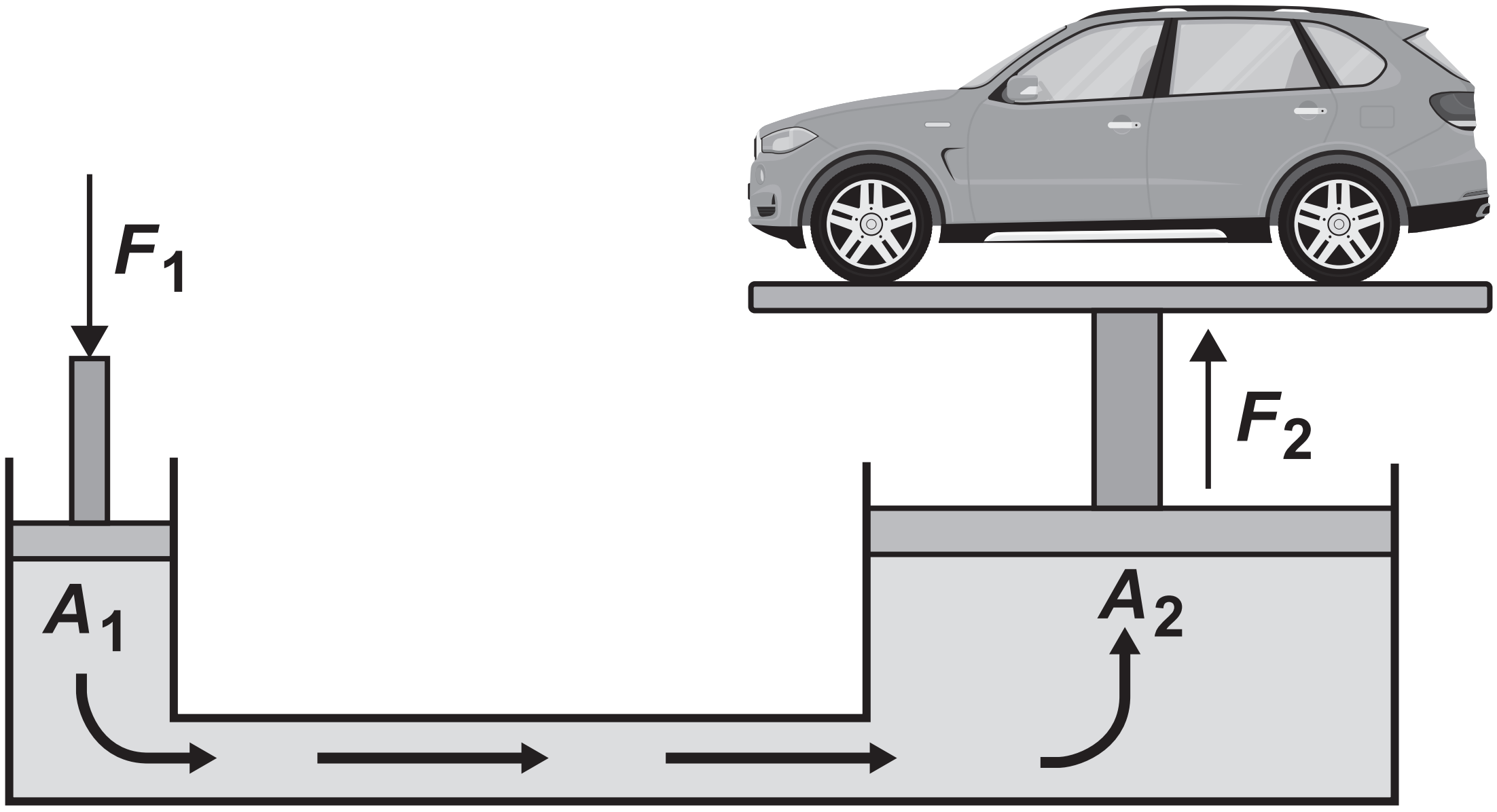


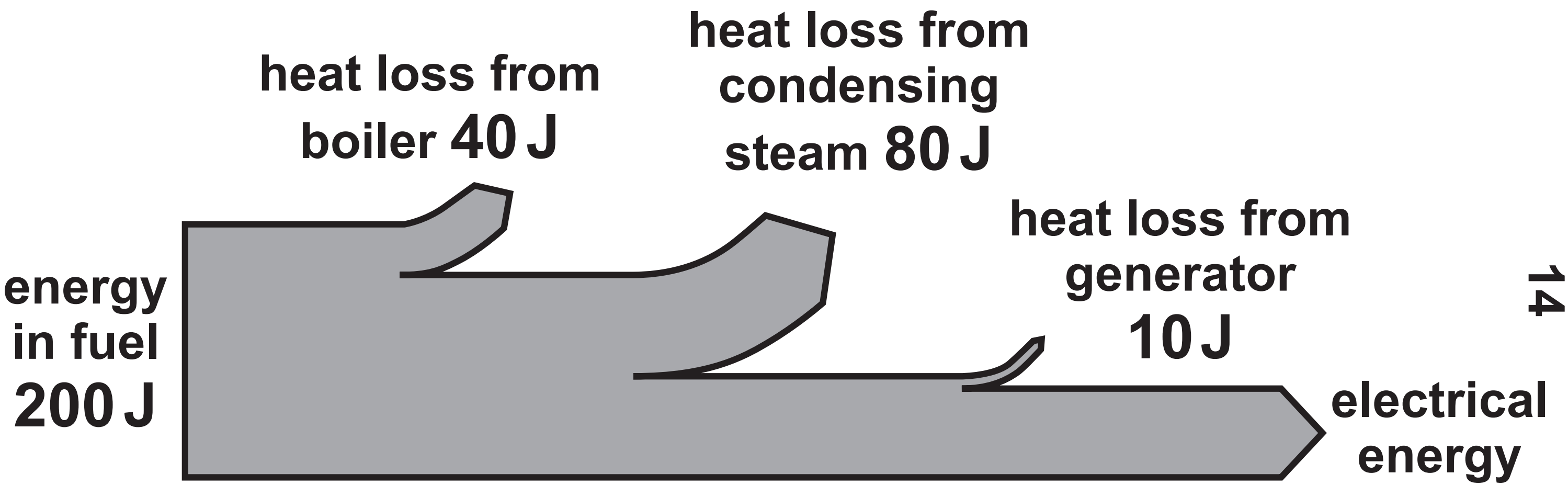
DIAGRAM NOT DRAWN TO SCALE

TABLE 9

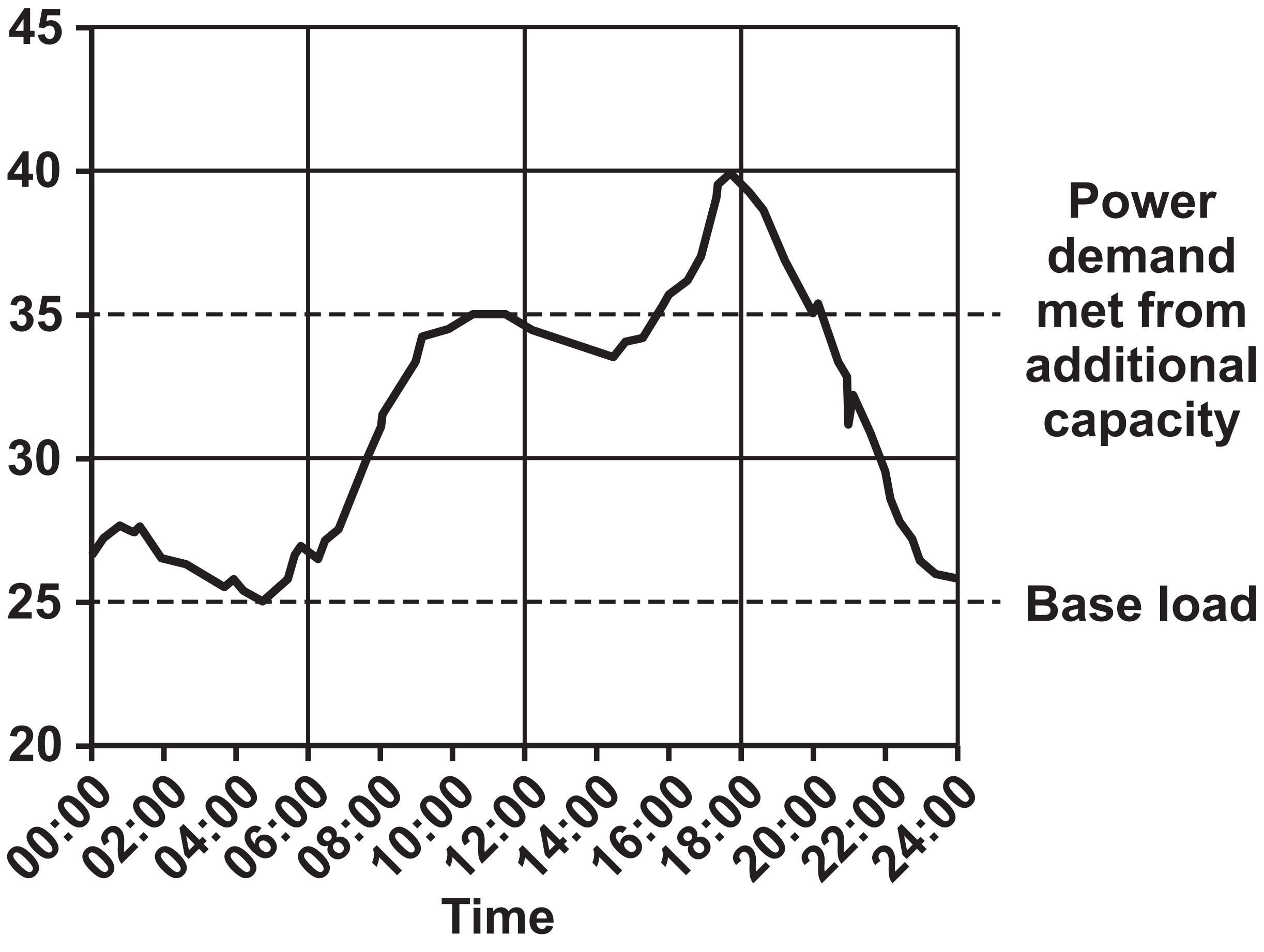
Material	Density (g/cm^3)
cork	0.2
magnesium	1.7
aluminium	2.7
steel	7.8
iron	7.8
copper	8.5
lead	11.3

BLOCK DIAGRAM 10.1

SANKEY DIAGRAM 10.2



GRAPH 10.3


Power demand (GW)
45
40
35
30
25
20
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
24:00
Time
Power demand met from additional capacity
Base load

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MONDAY, 17 JUNE 2024 – MORNING

PHYSICS – Unit 1:
Electricity, Energy and Waves

FOUNDATION TIER

Data Booklet
Equations and SI multipliers

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EQUATIONS

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} \qquad I = \frac{V}{R}$$

$$\text{total resistance in a series circuit} \qquad R = R_1 + R_2$$

$$\text{energy transferred} = \text{power} \times \text{time} \qquad E = Pt$$

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

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

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad \rho = \frac{m}{V}$$

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

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

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

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

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

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

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

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

$$Q = mL$$

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}