

Candidate Name

Candidate Number

Centre Name

Centre Number

Paper 2: Physics

For Examination December 2023

(2 hours)

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, you must have a soft pencil (preferably of type B or HB), a clean eraser and a dark blue or black pen.

INSTRUCTIONS:

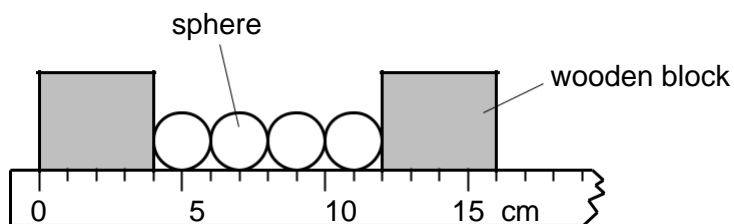
- You must write your name, candidate number, centre name and centre number on the answer sheets in the designated spaces.
- Objective section consists of 25 questions, and it is essential that you attempt all of them.
- Each question has four options labelled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple choice answer sheet using a soft pencil.
- Attempt all the questions from subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.
- You are allowed to use a calculator if needed.
- Take the weight of 1.0 kg to be 10 N (acceleration of free fall = 10 m/s^2).

INFORMATION:

- This paper has a total of 100 marks.
- In objective section there are 25 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 45 marks are for extended theory and 30 marks for practical component.
- The number of marks assigned for every question or its parts is indicated within brackets []

Multiple Choice Section (25 marks)

1 The diagram shows four identical spheres placed between two wooden blocks on a ruler.



What is the diameter of one sphere?

- A 1.0 cm B 2.0 cm C 3.0 cm D 4.0 cm

2 What does the area under a speed-time graph represent?

- A acceleration
B average speed
C deceleration
D distance travelled

3 Two metal blocks X and Y are at room temperature. Each block is heated so that its temperature rises by 10°C .

The blocks are now allowed to cool back to room temperature.

Block Y has a greater thermal capacity than block X.

Which block needs more thermal (heat) energy to heat it up by 10°C and which block loses more thermal (heat) energy as it cools back to room temperature?

	more energy	
	heating	cooling
A	X	X
B	X	Y
C	Y	X
D	Y	Y

- 4 A concrete post is carried up a very high mountain. At the top of the mountain, the gravitational field is slightly weaker than at the bottom.

What is the effect of this weaker field on the mass and on the weight of the post at the top of the mountain?

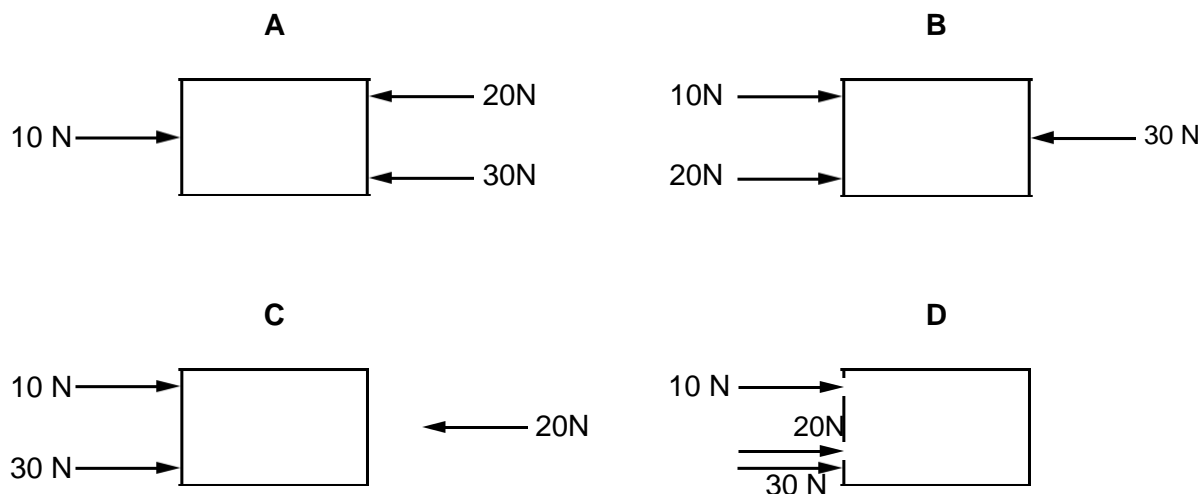
	mass	weight
A	is less	is less
B	is less	is unchanged
C	is unchanged	is less
D	is unchanged	is unchanged

- 5 A radioactive source produces a count rate on a detector of 1600 counts / s. After 32 hours the count rate has fallen to 100 counts / s. Both count rates have been corrected for background radiation.

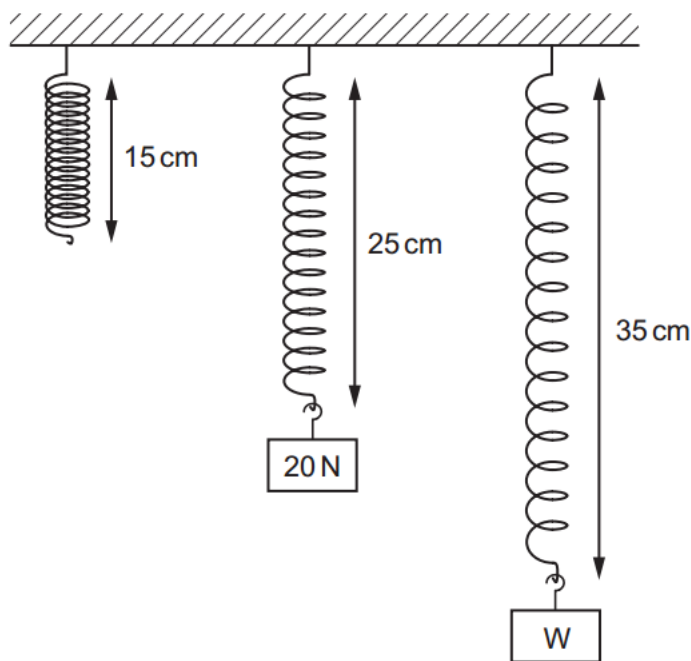
What is the half-life of the source?

- A 2.0 hours B 6.4 hours C 8.0 hours D 16 hours

- 6 The diagrams show four identical objects. Each object is acted on by only the three forces shown. Which object accelerates to the right, with the smallest acceleration?



- 7 Different weights are hung from a spring. The diagram shows the original length of the spring, and the lengths when different weights are added.

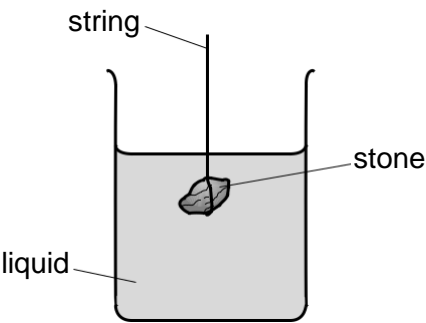


The extension of the spring is directly proportional to the weight hung from it.

What is the weight of W?

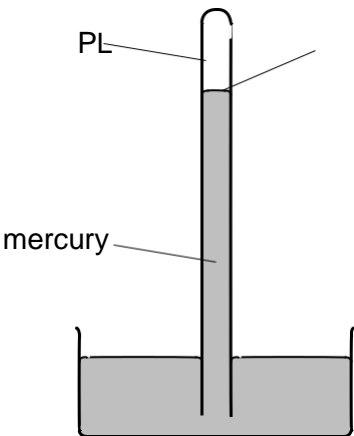
- A 30N B 35N C 40N D 45N
- 8 Which source of energy involves the splitting of heavy atoms?
- A. chemical energy B. geothermal energy C. hydroelectric energy
- D. nuclear energy
- 9 A weight-lifter raises a 2000N weight through a vertical height of 2.0 m in 0.80 s. What useful power does he develop in doing this?
- A. 800 W B. 3200 W C. 4000 W D. 5000 W

10 The diagram shows a stone suspended under the surface of a liquid from a string. The stone experiences a pressure caused by the liquid.



What would increase the pressure on the stone?

- A decreasing the surface area of the stone
 - B increasing the mass of the stone
 - C lowering the stone deeper into the liquid
 - D using a liquid with a lower density
- 11 The diagram shows a simple mercury barometer, used to measure atmospheric pressure.



Atmospheric pressure decreases.

Which row states what happens to the pressure at point P and what happens to the level L?

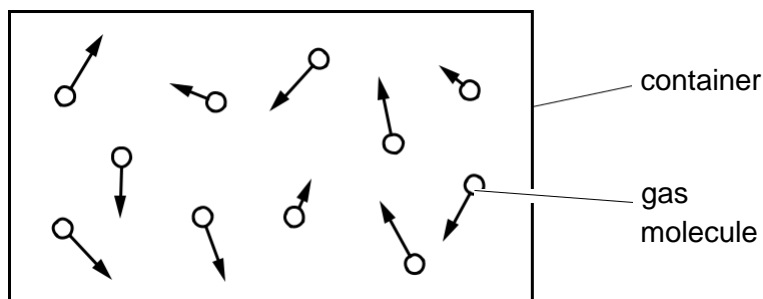
	pressure at P	level L
A	decreases	falls
B	decreases	rises
C	stays the same	falls
D	stays the same	rises

- 12 Puddles of rain water remain after a storm. The water in the puddles gradually evaporates.

How does the evaporation affect the temperature of the water remaining in the puddle, and how does it affect the average speed of the remaining water molecules in the puddle?

	temperature of water in puddle	average speed of water molecules in puddle
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 13 The diagram represents moving gas molecules in a sealed container of fixed volume.

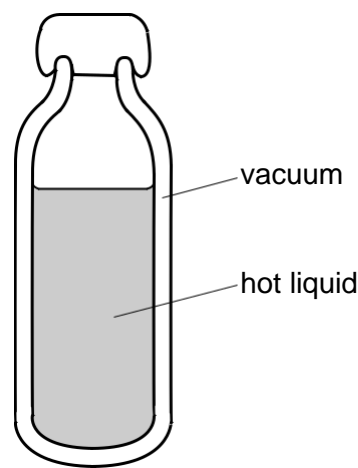


The temperature of the gas is now increased.

What happens to the pressure of the gas, and what happens to the speed of the gas molecules?

	pressure of gas	speed of molecules
A	increases	increases
B	increases	unchanged
C	unchanged	increases
D	unchanged	unchanged

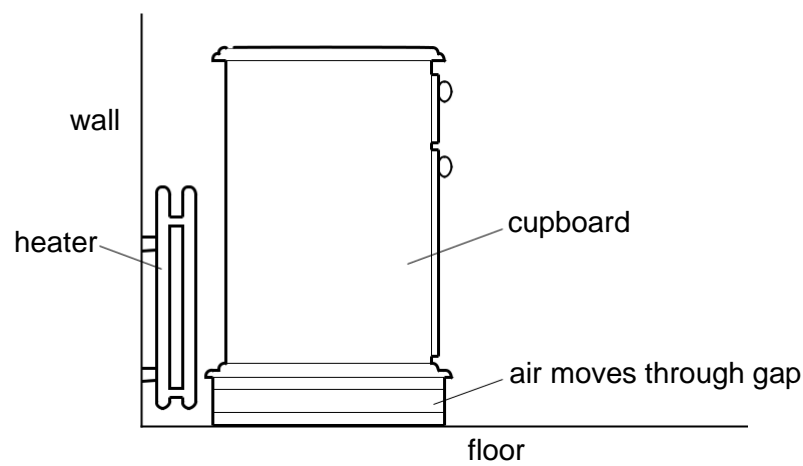
14 The diagram shows a vacuum flask used to keep liquid hot.



How does thermal energy pass through the vacuum?

- A conduction only
- B convection only
- C radiation
- D conduction and convection

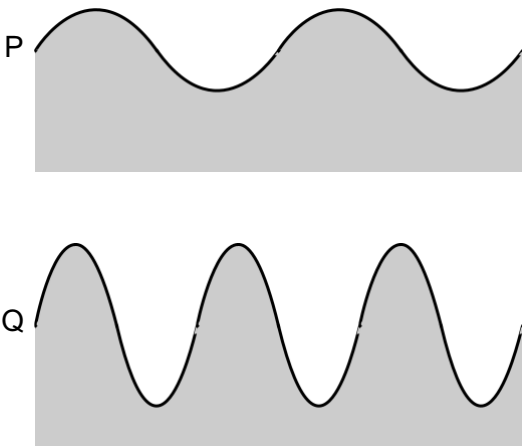
15 A cupboard is placed in front of a heater. Air can move through a gap under the cupboard.



Which row describes the temperature, and the direction of movement, of the air in the gap?

	air temperature	air direction
A	cool	away from the heater
B	cool	towards the heater
C	warm	away from the heater
D	warm	towards the heater

16 The diagrams show two water waves P and Q that are travelling at the same speed on the surface of a pond. The diagrams are to the same scale.

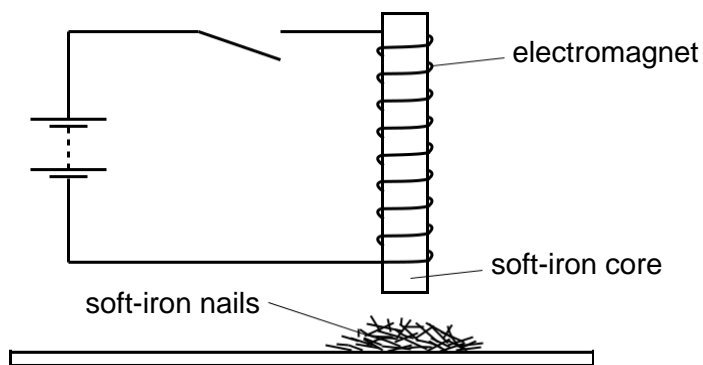


	greater amplitude	greater frequency
A	P	P
B	P	Q
C	Q	P
D	Q	Q

17 A quiet sound is produced by a loudspeaker. The loudness of the sound is increased.
Which property of the sound wave is increased?

- A amplitude B frequency C speed D wavelength

- 18 An electromagnet with a soft-iron core is connected to a battery and an open switch. The soft-iron core is just above some small soft-iron nails.



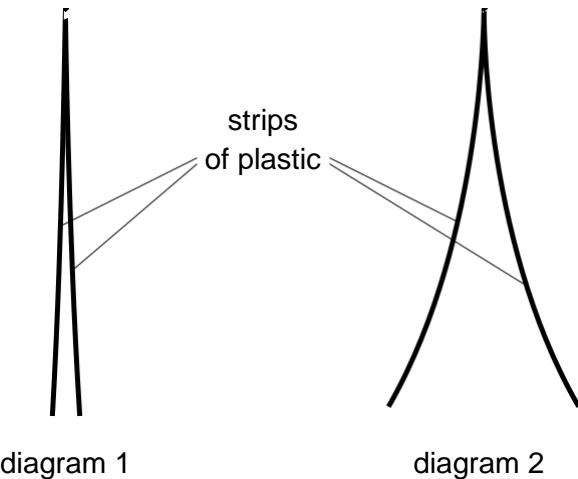
The switch is now closed, left closed for a few seconds, and then opened.

What do the soft-iron nails do as the switch is closed, and what do they do when the switch is then opened?

	as switch is closed	as switch is opened
A	nails jump up	nails fall down
B	nails jump up	nails stay up
C	nails stay down	nails jump up
D	nails stay down	nails stay down

19 Diagram 1 shows two thin, uncharged strips of plastic.

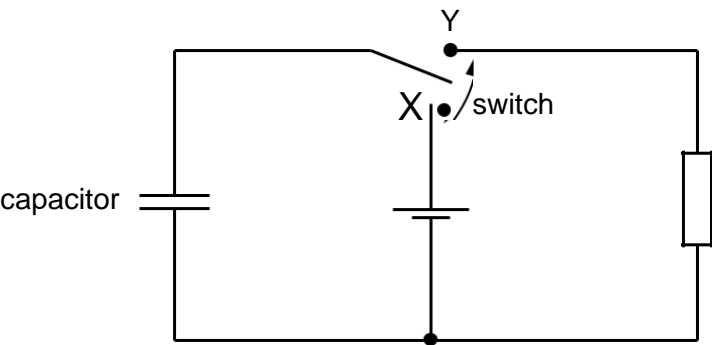
Diagram 2 shows the same strips after they have been rubbed with a dry cloth.



Which row describes the charge on the strips after rubbing, and the force between the strips after rubbing?

	charge on strips	force between strips
A	opposite	attraction
B	opposite	repulsion
C	the same	attraction
D	the same	repulsion

20 The diagram shows a circuit which includes an uncharged capacitor and a switch.



The switch can be moved between position X and position Y.

What happens to the capacitor when the switch is moved to position X, and what happens when the switch is then moved to position Y?

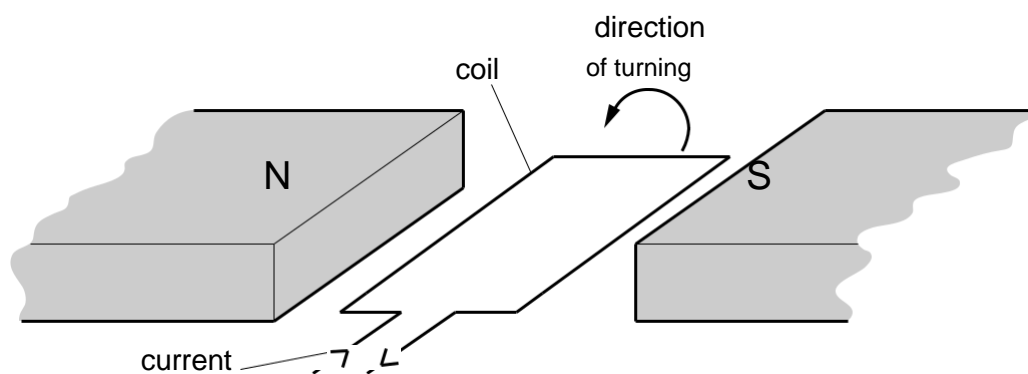
	switch at X	switch at Y
A	capacitor charges	capacitor charges
B	capacitor charges	capacitor discharges
C	capacitor discharges	capacitor charges
D	capacitor discharges	capacitor discharges

- 21 An e.m.f. is induced across a wire when it moves through the magnetic field between the poles of a magnet.

Which electrical device operates because of this effect?

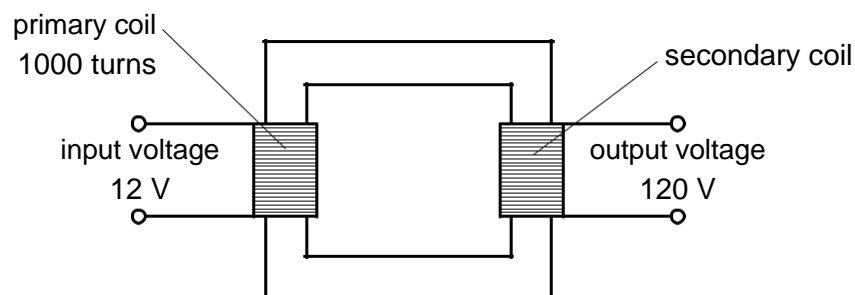
- A a battery
- B a cathode-ray tube
- C a generator
- D a motor

- 22 The diagram shows a flat, rectangular coil placed between the poles of a magnet. There is a current in the coil that makes it turn in the direction shown in the diagram.



Which change would make the coil turn in the opposite direction?

- A decreasing the current in the coil
 - B increasing the number of turns on the coil
 - C reversing both the direction of the current in the coil and the poles of the magnet
 - D reversing only the direction of the current in the coil
- 23 A transformer has 1000 turns on its primary coil. An input voltage of 12 V is applied to the primary coil, and an output voltage of 120 V is induced across the secondary coil.



How many turns are on the secondary coil of the transformer?

- A 100
- B 120
- C 1000
- D 10 000

24 Which statement about α -radiation is correct?

- A It is a stream of fast-moving electrons.
- B It is a form of electromagnetic radiation.
- C It is more highly ionising than γ -radiation.
- D It is more penetrating than β -radiation.

25 A nuclide has the symbol ${}^{22}_{10}\text{Ne}$.

What is the proton number of a nucleus of this nuclide?

- A 10 B 12 C 22 D 32

Question 2

(a) (i) State two ways in which the molecular structure of a liquid is different from the molecular structure of a solid.

1.
-
2.
-
- [2]

(ii) Explain, in terms of energy, the process which takes place as a solid at its melting point changes into a liquid at the same temperature.

-
-
- [1]

(iii) During a severe snowstorm, a layer of snow (ice crystals) forms on the body of an animal in a field. The snow and the surrounding air are at 0 °C. The snow begins to melt.

a. The mass of snow that falls on the animal is 1.65 kg. The specific latent heat of fusion of snow is 330 000 J / kg.

Calculate the thermal energy needed to melt this snow.

thermal energy = [2]

(iv) The animal derives energy from its food to maintain its body temperature. State the energy change that takes place.

- [1]

[Total: 6]

Question 3

- (i) State what is meant by the *specific heat capacity* of a substance.

.....
.....
..... [2]

- (ii) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = [4]

- (iii) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1.
2.
[2]

[Total: 8]

Question 4

(a) Fig. 4.1 shows a bar magnet suspended by a spring over a coil. The coil is connected to a sensitive centre-zero millivoltmeter.

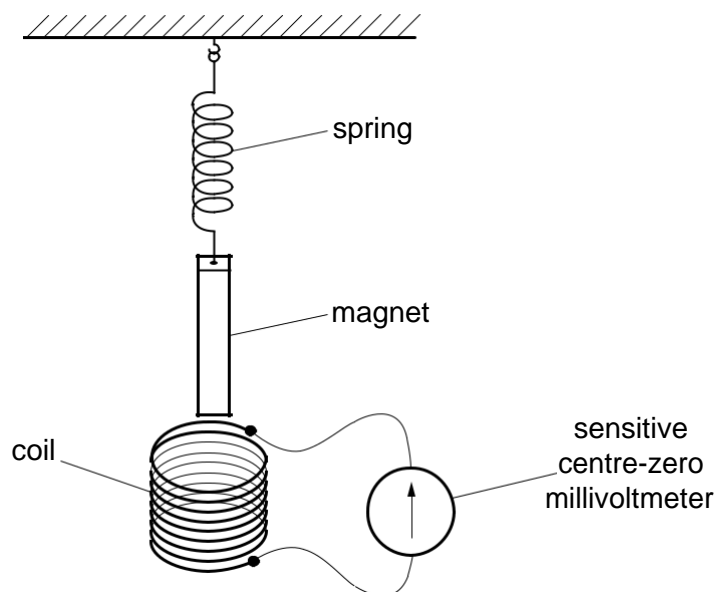


Fig. 4.1

- (a) The lower end of the magnet is pushed down into the upper end of the coil and held at rest.

During the movement, an e.m.f. is induced in the coil. The meter shows a deflection to the right and then returns to zero.

Explain why this e.m.f. is induced.

.....
..... [1]

- (b) State what happens to the needle of the meter when

1. the magnet is released from rest and is pulled up by the spring,

..... [1]

2. the magnet continues to oscillate up and down, moving in and out of the coil with each oscillation.

..... [1]

(c) Fig. 4.2 shows a transformer.

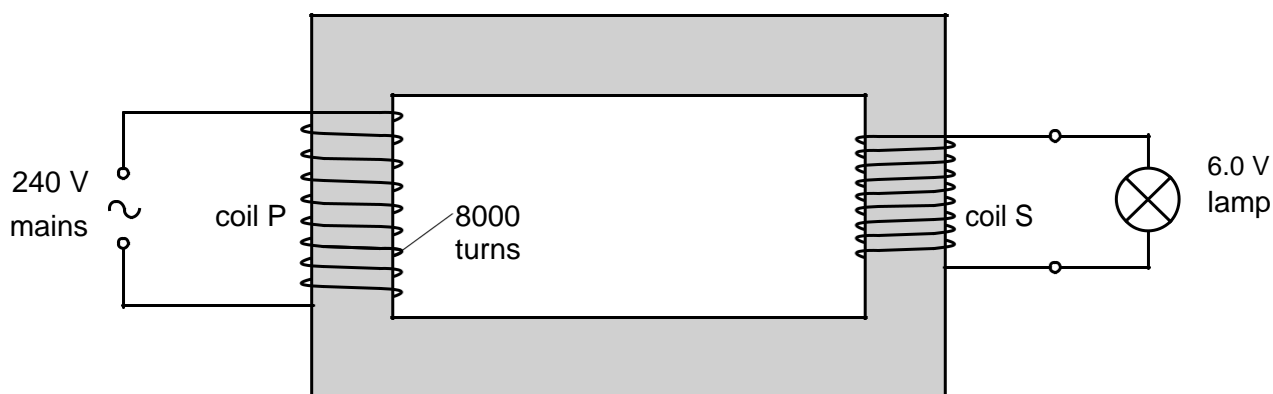


Fig. 4.2

The primary coil P, connected to the 240 V mains supply, has 8000 turns. The secondary coil S supplies 6.0 V to a lamp.

- i) Calculate the number of turns in the secondary coil.

number of turns = [2]

- ii) 1. The current in the primary coil is 0.050 A.

Calculate the power input to the transformer.

power = [1]

- iii) 90% of the power input to the transformer is transferred to the lamp. Calculate the current in the lamp.

current = [2]

[Total: 8]

Question 5

In Fig. 5.1, a 12 V battery supplies a current I to a circuit. The circuit contains a thermistor and a $1000\ \Omega$ resistor in parallel, with a $500\ \Omega$ resistor in series.

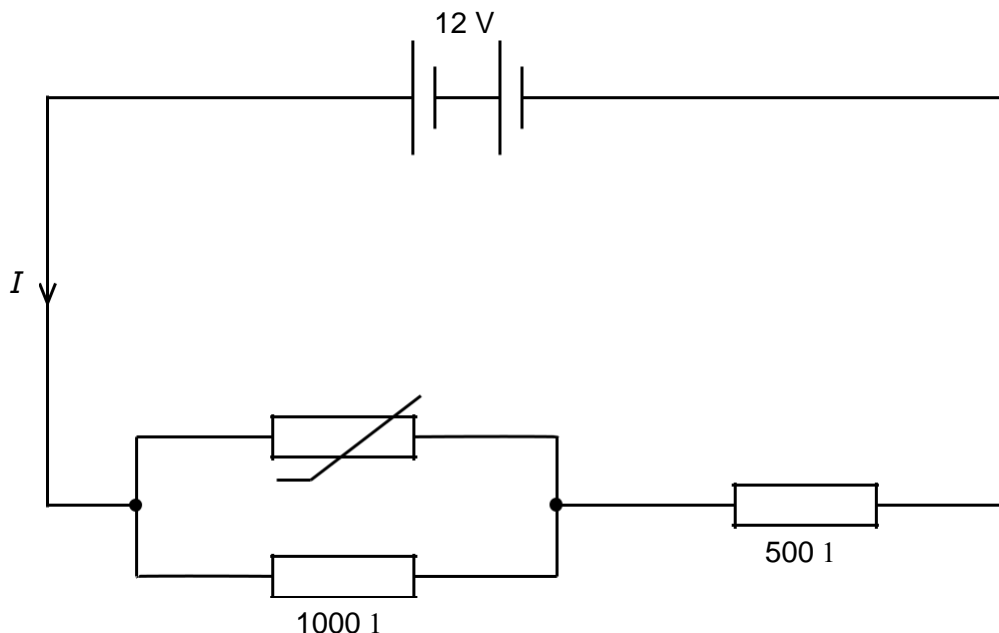


Fig. 5.1

(a) At a certain temperature, the thermistor has a resistance of $1000\ \Omega$. Calculate

(i) the combined resistance of the thermistor and the $1000\ \Omega$ resistor,

resistance = [2]

(ii) the current I ,

current = [1]

(iii) the potential difference across the $500\ \Omega$ resistor.

potential difference = [2]

- (b) The temperature of the thermistor is increased so that its resistance decreases.

State the effect of this change in resistance on the current through the 500 Ω resistor.
Explain your answer.

.....
.....
..... [2]

[Total: 7]

Question 6

- (a) State the nature of γ -rays.

.....
..... [1]

- (b) A beam of α -particles and β -particles passes, in a vacuum, between the poles of a strong magnet.

Compare the deflections of the paths of the two types of particle.

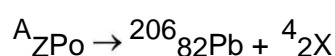
.....
.....
..... [2]

- (c) A beam of β -particles passes, in a vacuum, through the electric field between a pair of oppositely charged metal plates.

Describe the path of the particles.

.....
.....
..... [2]

- (d) The nuclear equation shows the decay of an isotope of polonium.



- (i) State the nature of X.

.....
..... [1]

(ii) Calculate the values of A and Z.

A = Z = [1]

[Total: 7]

Question 7

Researchers have found that the best temperature for drinking coffee is 60 °C.

A designer has developed a new type of cup for keeping coffee at 60 °C. The cup is shown in Fig. 7.1.

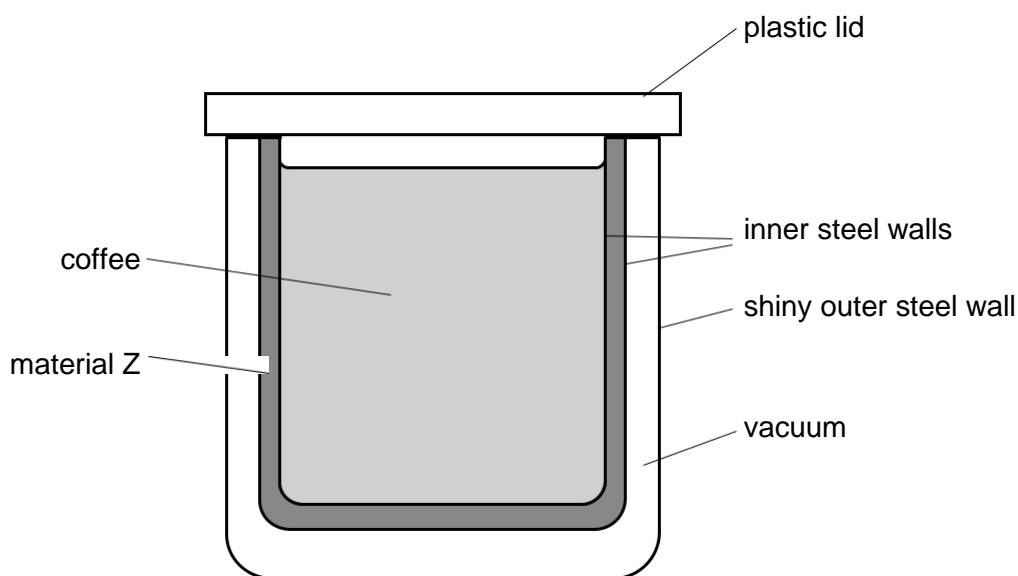


Fig. 7.1

Material Z has a melting point of 60 °C. At room temperature, material Z is solid.

Coffee, at a temperature of 90 °C, is poured into the cup. The coffee cools rapidly to 60 °C.

(a) Explain how the features of the cup enable the coffee to be kept at 60 °C for a long time.

plastic lid
.....
.....
vacuum
.....
.....

[2]

[Total: 2]

Part C: Practical based skills

Question 1

A student investigates water dripping from a tap (faucet).

Fig 8.1 shows the dripping tap and a rule next to a container collecting the drops of water.

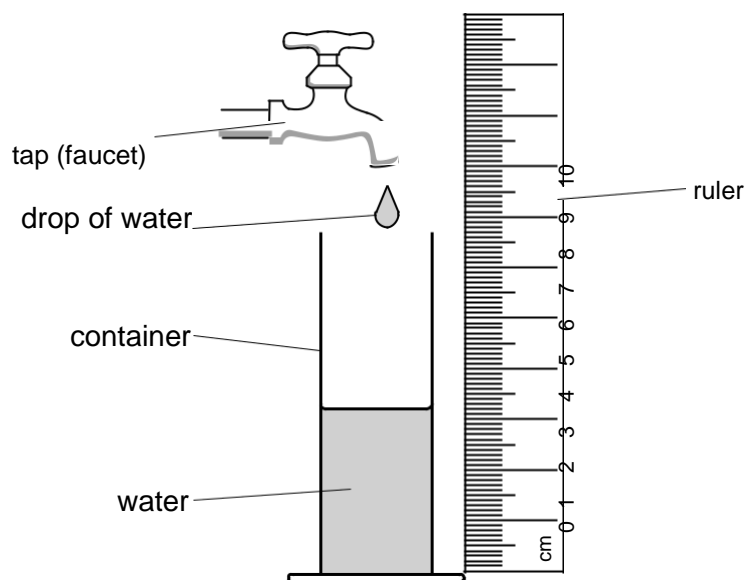
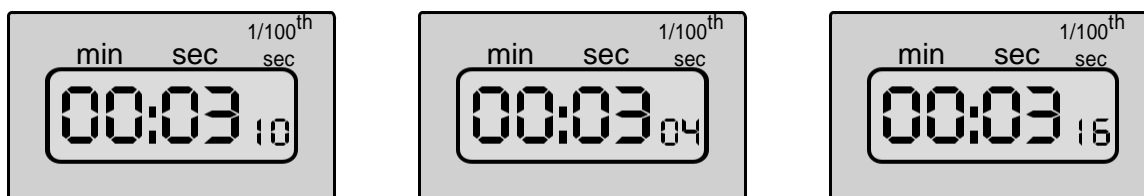


Fig. 8.1

- a) Name the quantity that the student is measuring with the ruler.
 [1]
- b) The student uses a digital stopwatch to measure the time between the drops of water. She repeats her measurement.

Fig. 8.2 shows the reading on the stopwatch for all her measurements.



time = s

time = s

time = s

Fig. 8.2

- c) On the line below each stopwatch, record the time, in seconds, measured by the student. [1]
- d) Calculate the average time between drops of water. Show your working.

average time between drops = s [2]

- e) The student collects drops of water for 15.5 minutes.

Calculate how many drops leave the tap in 15.5 minutes. Use your answer to part **d**).

number of drops = [3]

[Total: 7]

Question 2

Some students are investigating how the surrounding temperature affects the rate at which water cools.

They are using the apparatus shown in Fig. 9.1.

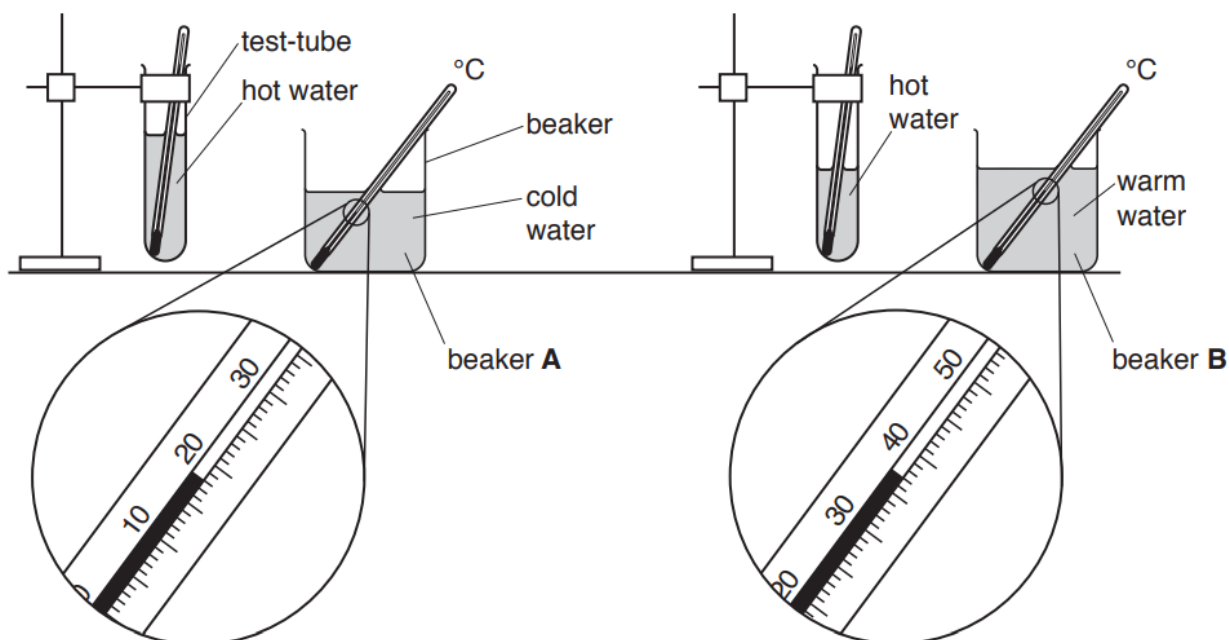


Fig. 9.1.

a. Using Fig. 9.1

- record the temperature θ_A of the cold water in beaker **A**,

$\theta_A = \dots\dots\dots$

- record the temperature θ_B of the warm water in beaker **B**.

$\theta_B = \dots\dots\dots$

[2]

- b. The test-tubes of hot water are placed into beakers **A** and **B**.

The students record the temperatures θ of the water in the test-tubes every 30 s. Their readings are shown in Table 9.2.

Complete the units and the time column in Table 9.2.

Table 9.2

time	tube in beaker A with cold water	tube in beaker B with warm water
$t /$	$\theta /$	$\theta /$
0	80.5	81.0
	52.5	64.5
	42.0	55.0
	36.0	50.5
	32.5	48.0
	30.5	46.5
	29.0	45.5

[2]

- c. Describe **two** precautions that you would take, before reading the thermometer, to ensure that the temperature readings are as accurate as possible in the experiment.

1.

.....

2.

.....

[2]

- d. Write a conclusion stating how increasing the temperature of the surrounding water affects the rate of cooling of the water in the test-tube.

Justify your answer by reference to the results in Table 9.2.

.....

.....

.....

.....[2]

- e) Suggest **one** change to the experiment shown in Fig. 9.1 to ensure that the comparison of the effect of surrounding temperature on cooling is a fair test.

Explain why the change is an improvement.

change

.....

explanation

.....

[3]

- f) The students use a measuring cylinder to measure 200 cm^3 of cold water.

Describe briefly how to read a measuring cylinder to obtain an accurate value for the volume of water. You may draw a diagram.

.....

.....

.....

.....

[4]

[Total: 15]

Question 3

4 A student is investigating how the material of a spring affects its behaviour when its stretched. The following apparatus is available to the student:

- wires of different thickness, length and material
- a set of 10 g masses and a set of 100 g masses (both with hangers), a wooden rod (approximately 1 cm in diameter) and **other standard** laboratory equipment.

Plan an experiment that will enable you to test the extension of springs made from different types of wire.

In your plan, you should include:

- instructions for making a spring from the wire that is provided,
- what you will measure,
- instructions for carrying out the experiment,
- the variables you will keep the same to ensure the comparison is a fair test,
- any precaution which should be taken or difficulty which might occur,
- how you will present your results.

You may draw a diagram if it helps to explain your plan.

.....

.....

.....

.....

.....

[Total: 8]

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