Collins

# AQA

GCSE

# PHYSICS

# H

## SET A – Paper 1 Higher Tier

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Time allowed: 1 hour 45 minutes



**Materials**

**For this paper you must have:**

- a ruler
- a calculator
- the Physics Equation Sheet (found at the end of the paper).

**Instructions**

- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions 02.1, 04.2 and 09.1 you need to make sure that your answer:
  – is clear, logical, sensibly structured
  – fully meets the requirements of the question
  – shows that each separate point or step supports the overall answer.

**Advice**

- In all calculations, show clearly how you work out your answer.

**Name:** ........................................................................................................

**01.1** Which type of radiation has a **range of a few metres in air**?

Tick **one** box.

Alpha ☐

Beta ☐

Gamma ☐

**[1 mark]**

**01.2** Alpha radiation is described as having the highest **ionising power.**

Describe what is meant by **ionising power**.

State how the high ionising power of alpha radiation is linked to its range through the human body.

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.......... **[3 marks]**

**01.3** A radioactive isotope emitting gamma radiation can be used as a tracer in medical diagnosis.

A gamma camera outside the human body then produces an image of the internal organ.

Explain why gamma radiation is suitable for this use.

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....................................................................................................................... **[1 mark]**

**01.4** Which is the most suitable half-life for an isotope used as a tracer in medical diagnosis?

Tick **one** box.

10 seconds ☐

6 hours ☐

3 months ☐ **[1 mark]**

Explain your answer.

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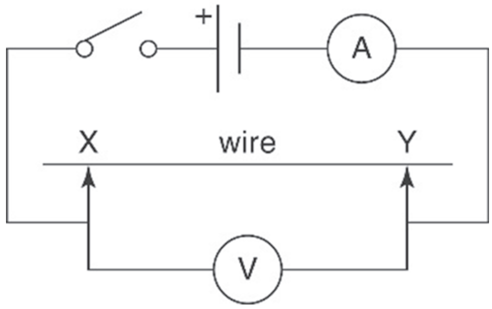
**Turn over >**

**02.1** A student is provided with the apparatus shown in **Figure 2.1**

**Figure 2.1**




Describe how the student could use the apparatus in **Figure 2.1** to obtain accurate values of resistance for a range of different lengths of wire.

The wire is connected between crocodile clips X and Y.

**[4 marks]**

**02.2** After the experiment, the student realised that the metre rule had been damaged at one end.

Instead of starting at 0 mm, the end of the rule corresponded to the 1 mm mark.

State what type of error this creates in the measurement of the wire's length.

**[1 mark]**

**02.3** Explain how the student should correct the length measurements made in the experiment.

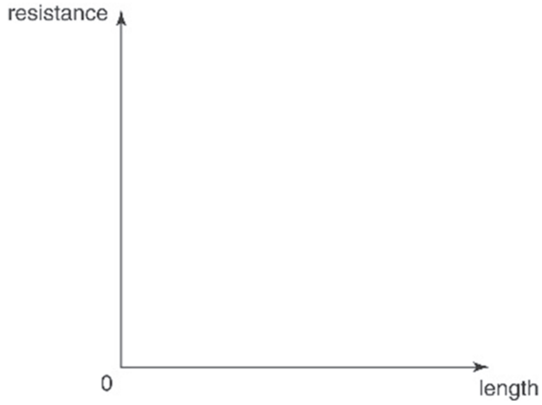
**[1 mark]**



**02.4** The resistance of the student's wire doubles each time the length connected between X and Y is doubled.

**Sketch** a graph on the axes in **Figure 2.2** to show how the resistance of the wire depends on its length.

**Figure 2.2**

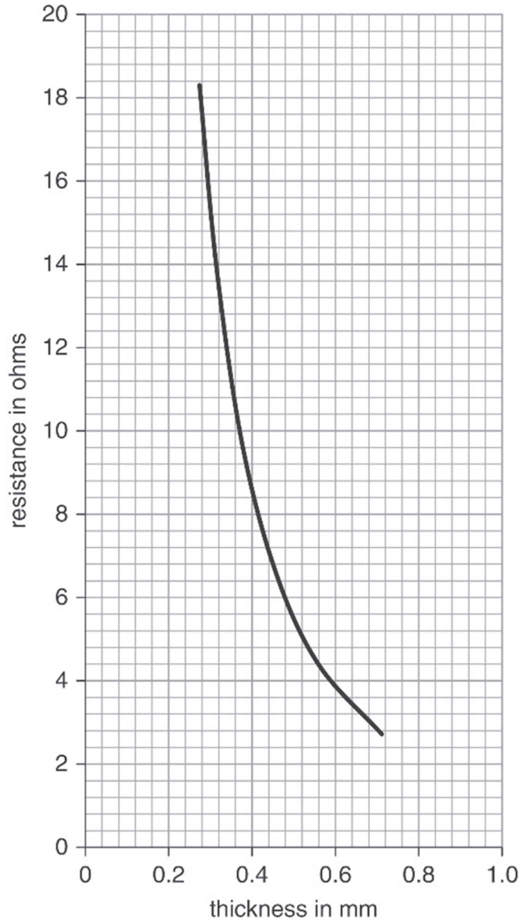



**[1 mark]**

**Question 2 continues on the next page**

**02.5** **Figure 2.3** shows how the resistance of a 1 m length of nickel-chromium wire depends on the wire's **thickness**.

**Figure 2.3**




Give **one** conclusion based on the graph.

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.............................................................................................................................. **[1 mark]**



**02.6** Use **Figure 2.3** to estimate the resistance of a nickel-chromium wire of thickness 0.8 mm

Resistance = .................................................. Ω **[1 mark]**

**03.1** An electric kettle is used to heat 1.0 kg of water.

Calculate the thermal energy that must be transferred to the water to raise its temperature from 20°C to 100°C

Specific heat capacity of water = 4200 J/ kg °C

Select the correct equation from the Physics Equation Sheet.

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Thermal energy transferred = .................................... J **[2 marks]**

**03.2** Write down the equation that links energy transferred, power and time.

.................................................................................................................. **[1 mark]**

**03.3** The electrical heater inside the kettle has a power of 3000 W

The kettle takes 120 s to bring the water to its boiling point.

Calculate the thermal energy transferred by the heater in the time taken to boil the water.

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Thermal energy transferred = .................................... J **[2 marks]**

**03.4** Write down the equation for efficiency.

.................................................................................................................. **[1 mark]**

**Question 3 continues on the next page**

**03.5** Calculate the efficiency of the kettle.

Give your answer as a percentage to 2 significant figures.

Efficiency = .................... % **[3 marks]**

**03.6** The kettle is not 100% efficient, partly because thermal energy is dissipated to the surrounding room.

Suggest **one** other reason that the kettle is not 100% efficient.

**[1 mark]**

**04.1** Electricity is generated in the UK using both renewable and non-renewable energy sources.

Explain what is meant by a **renewable** energy source.

**[1 mark]**

**04.2** Compare the use of wind turbines and nuclear power stations for generating electricity in the UK.

Include a comparison of their **reliability** and their **environmental effects**.

**[6 marks]**



**Turn over >**

**5** In Rutherford's alpha particle scattering experiment, a beam of alpha particles was fired at gold foil.

**05.1** Give an order of magnitude estimate for the diameter of a gold atom.

Diameter ~ .................................................... m **[1 mark]**

**05.2** Any change in direction of the alpha particles on hitting the gold foil was monitored.

**Table 5.1** shows some typical results.

**Table 5.1**

| Path followed by the alpha particles | Percentage of alpha particles |
|---|---|
| Continued undeflected in a straight line | >99% |
| Deflected by angles up to 90° | 0.05% |
| Deflected by angles greater than 90° | 0.013% |

This alpha particle scattering experiment led to the nuclear model of the atom replacing the plum pudding model.

Use the results in **Table 5.1** to explain why the model had to be replaced.

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**05.3** The symbol for the nucleus of a stable isotope of gold is $^{197}_{79}Au$

Describe the arrangement and numbers of the different subatomic particles in a gold atom.

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**06.1** Radon is a radioactive gas that is emitted from some types of rock.

Radon gas is one of the main natural sources of background radiation.

Give **one** other **natural source** of background radiation.

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**06.2** Radon gas can accumulate in buildings.

Radon nuclei decay by emitting alpha particles.

Explain the particular hazard created by a radon gas being present in a building.

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**06.3** **Table 6.1** contains dose data due to radon gas.

**Table 6.1**

| **Location** | **Annual average dose due to radon, in mSv** |
| --- | --- |
| Whole of UK | 1.3 |
| Cornwall, UK | 6.9 |

[Data from Public Health England]

Calculate **how many times greater** the radiation dose due to radon gas is in Cornwall compared with the average across the UK.

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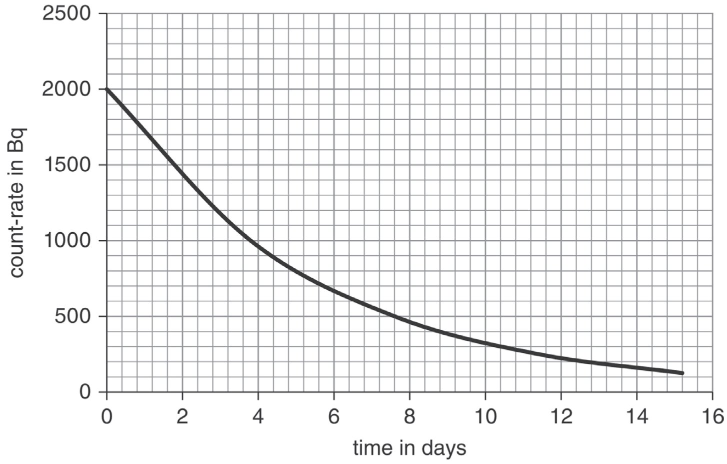
Number of times greater = .............................. **[1 mark]**

**Question 6 continues on the next page**

**06.4** **Figure 6.1** shows the changes in activity of a sample of radon-222 as time passes.

**Figure 6.1**




Use the graph to determine an accurate value for the half-life of radon-222

Show your working.

Half-life = .................... days **[3 marks]**

**06.5** The activity of a sample of radon gas is measured at 400 kBq

Calculate how many days would have to pass for the activity of the sample to be less than 40 kBq

Number of days = .................... **[2 marks]**

**06.6** The naturally occurring isotope of radon is $^{222}_{86}Rn$ which decays by emitting an alpha particle to form polonium.

Complete the decay equation below:

$$^{222}_{86}Rn \rightarrow \ ^{218}_{\dots}Po + \ ^{4}_{\dots}He$$

**[2 marks]**

**07.1** Name the system of cables and transformers that links power stations to consumers in the UK.

.......................................................................................................... **[1 mark]**

**07.2** Mains electricity supplies an alternating potential difference.

Explain what is meant by an **alternating** potential difference.

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.......................................................................................................... **[1 mark]**

**07.3** In a faulty electric toaster, the live wire may make contact with the toaster's metal casing.

Explain why this could be very dangerous.

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**07.4** There are three wires in the cable connecting a plug to a toaster.

Identify the wire that provides protection from the fault detailed in question 07.3

.......................................................................................................... **[1 mark]**

**07.5** An electric toaster has a power rating of 0.92 kW

The UK mains supplies a potential difference of 230 V

Calculate the electric current drawn by the toaster when it is plugged into the mains.

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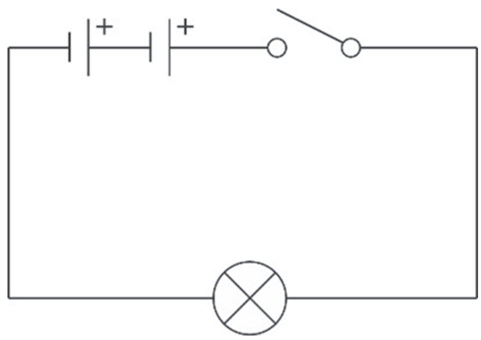
Current = .................................... A **[3 marks]**



**Turn over >**

**08** **Figure 8.1** shows the circuit diagram for a torch.

**Figure 8.1**




**08.1** The battery supplies 3.0 V of potential difference across the bulb.

The resistance of the bulb is 100 Ω

Calculate the current flowing through the bulb.

Current = ................ A **[3 marks]**

**08.2** Calculate the charge that flows through the bulb if the torch is switched on for 5 minutes.

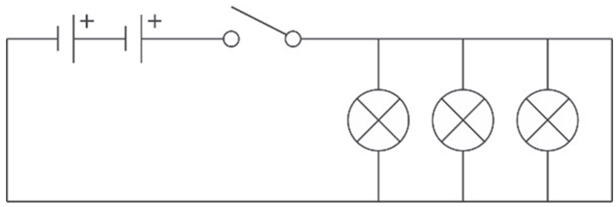
Charge = ................ C **[3 marks]**

08.3 Calculate the energy transferred by the bulb over this 5 minutes.

Energy transferred = ................ J **[2 marks]**

**08.4** **Figure 8.2** shows three **identical** bulbs connected to a battery.

**Figure 8.2**




Which **two** statements about the circuit in **Figure 8.2** are correct?

Tick **two** boxes.

The potential difference across each bulb has the same value. ☐

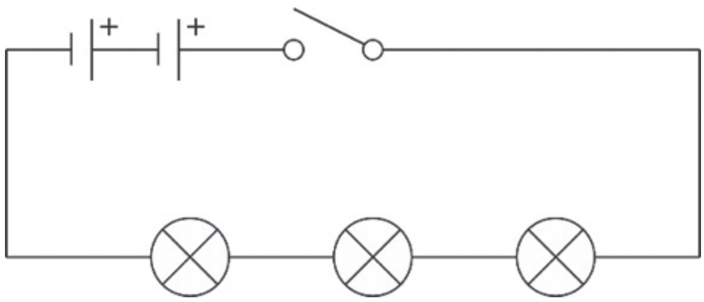
The bulbs are connected in series. ☐

The current through each bulb has a different value. ☐

The bulbs are connected in parallel. ☐ **[2 marks]**

**08.5** **Figure 8.3** shows three **different** bulbs connected to a battery.

**Figure 8.3**




Bulbs A, B and C each have a **different** resistance value and **different** brightness.

Which **two** statements about the circuit are correct?

Tick **two** boxes.

The potential difference across each bulb has the same value. ☐

The bulbs are connected in series. ☐

The current through each bulb has a different value. ☐

The current through each bulb has the same value. ☐ **[2 marks]**



**Turn over >**

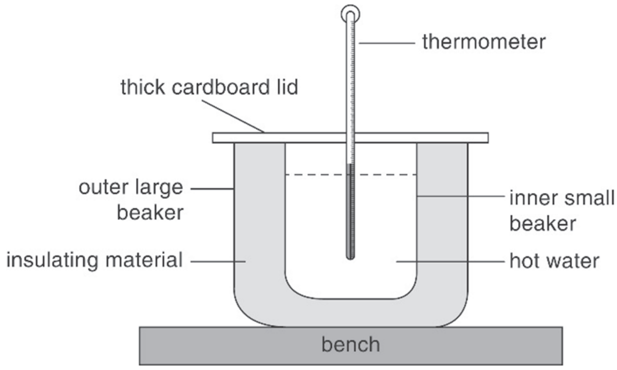
**09** A student plans to use the apparatus in **Figure 9.1** to compare the insulation properties of different materials.

The insulating material is sandwiched between the inner beaker and the outer beaker.

Hot water is poured into the inner beaker.

The rate at which the hot water cools is a measure of the thermal insulation property of the material.

**Figure 9.1**




**09.1** Write a set of instructions for the student, to give valid data that can be used to compare the insulation properties of different materials.

Include instructions for keeping all control variables constant.

Specify any additional apparatus that is required.

Explain how the data generated can be used to compare the insulation property of the materials tested.

**[6 marks]**

**09.2** The insulating materials used by the student in the experiment are listed in **Table 9.1** with their thermal conductivity values.

**Table 9.1**

| Material | Thermal conductivity in W/(m K) |
|---|---|
| Sheep's wool | 0.039 |
| Feathers | 0.034 |
| Cotton wool | 0.029 |

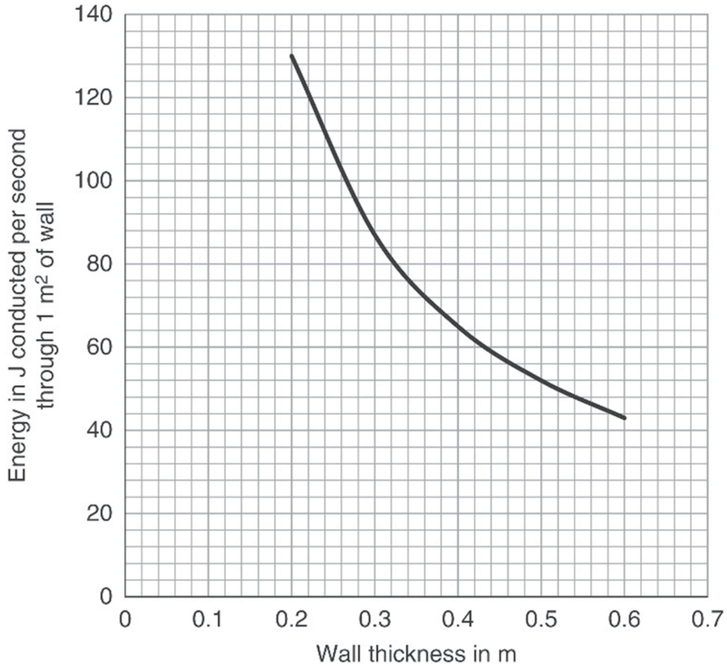
Which of the materials in the table is the best thermal insulator?

**[1 mark]**

**Question 9 continues on the next page**

**09.3** **Figure 9.2** gives information about the conduction of thermal energy through stone walls.

**Figure 9.2**




Write a conclusion about the effect of wall thickness on the energy conducted per second through 1 $m^2$ of stone wall.

Select appropriate data from **Figure 9.2** to support your conclusion.

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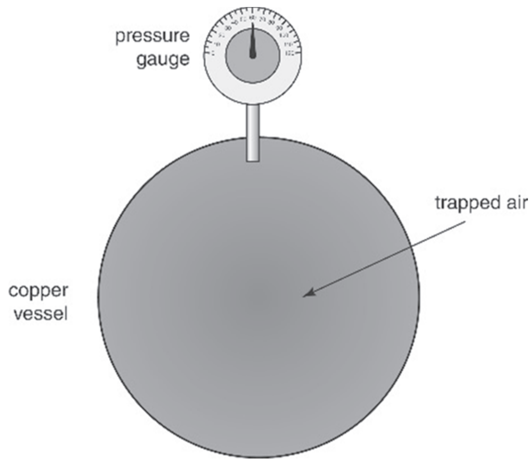
**10.1** **Figure 10.1** shows a sealed copper vessel containing air.

A gauge attached to the copper vessel shows the pressure of the air inside.

**Figure 10.1**




Describe the motion of the air molecules inside the copper vessel.

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**10.2** Describe how the air inside the copper vessel in **Figure 10.1** exerts pressure on the inside wall of the vessel.

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........................................................................................................ **[1 mark]**

**Question 10 continues on the next page**

**10.3** The copper vessel in **Figure 10.1** is lowered into a hot water bath.

This raises the temperature and the pressure of the air inside.

The volume of the copper vessel does not change.

Explain why the increase in temperature affects the pressure of the air inside the vessel.

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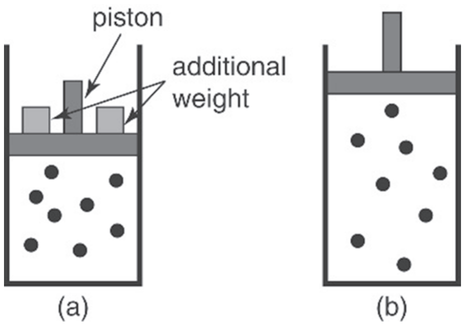
**10.4** **Figure 10.2(a)** shows a gas-filled cylinder.

It is sealed by a moveable piston.

**Figure 10.2**




The volume of the gas is $2.4 \times 10^{-3}$ m$^3$

The gas pressure is $1.0 \times 10^5$ Pa

When the additional weights are slowly removed, the gas expands to a new volume of $3.2 \times 10^{-3}$ m$^3$ with no change in temperature **(Figure 10.2(b))**.

Calculate the new gas pressure.

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New pressure = .............................................. Pa **[3 marks]**

**10.5** A large downward force is now applied quickly to the piston in **Figure 10.2(b)**.

This rapidly compresses the gas inside, causing an increase in temperature.

What is the effect of the work done by the downward force?

Write **one** tick in **each** row.

| **Quantity** | **Increases** | **Decreases** | **Doesn't change** |
|---|---|---|---|
| Internal energy of the molecules | | | |
| Average molecule speed | | | |
| Average separation of the molecules | | | |

**[3 marks]**



**Turn over >**

**11.1** A cyclist cycles to the top of a small hill of height 10 m

When he reaches the top of the hill, he freewheels down the other side.

As he freewheels down the hill, 50% of his gravitational potential energy is dissipated to the surroundings as thermal energy.

Calculate the speed of the cyclist as he reaches the bottom of the hill.

The mass of the cyclist and his bicycle is 100 kg

Take gravitational field strength = 10 N/kg

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Speed = ........................................ m/s **[5 marks]**



**END OF QUESTIONS**

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**Physics Equation Sheet**

| Equation Number | Word Equation | Symbol Equation |
|---|---|---|
| 1 | pressure due to a column of liquid = height of column × density of liquid × gravitational field strength | $p = h \rho g$ |
| 2 | (final velocity)$^2$ – (initial velocity)$^2$ = 2 × acceleration × distance | $v^2 - u^2 = 2as$ |
| 3 | force = $\frac{\text{change in momentum}}{\text{time taken}}$ | $F = \frac{m\Delta v}{\Delta t}$ |
| 4 | elastic potential energy = 0.5 × spring constant × (extension)$^2$ | $E_e = \frac{1}{2} ke^2$ |
| 5 | change in thermal energy = mass × specific heat capacity × temperature change | $\Delta E = m c \Delta\theta$ |
| 6 | period = $\frac{1}{\text{frequency}}$ | |
| 7 | magnification = $\frac{\text{image height}}{\text{object height}}$ | |
| 8 | force on a conductor (at right-angles to a magnetic field) carrying a current = magnetic flux density × current × length | $F = B I l$ |
| 9 | thermal energy for a change of state = mass × specific latent heat | $E = m L$ |
| 10 | $\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}}$ = $\frac{\text{number of turns in primary coil}}{\text{number of turns in seconday coil}}$ | $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ |
| 11 | potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil | $V_p I_p = V_s I_s$ |
| 12 | For gases: pressure × volume = constant | $pV$ = constant |