Collins

AQA

GCSE

PHYSICS

H

SET B – Paper 2 Higher Tier

Author: Lynn Pharaoh

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 06.2, 09.1 and 11.1 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.

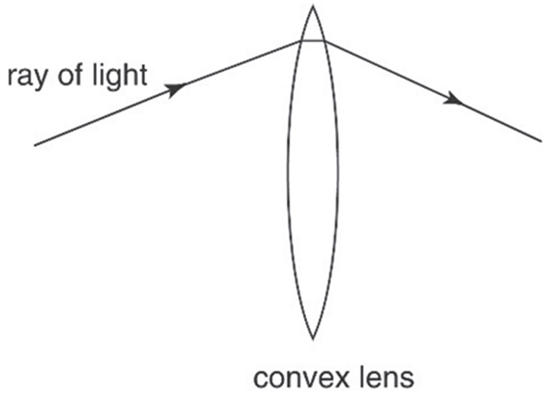
Advice

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

Name: ....

01.1 **Figure 1.1** shows the path of a ray of light through a convex lens.

Figure 1.1



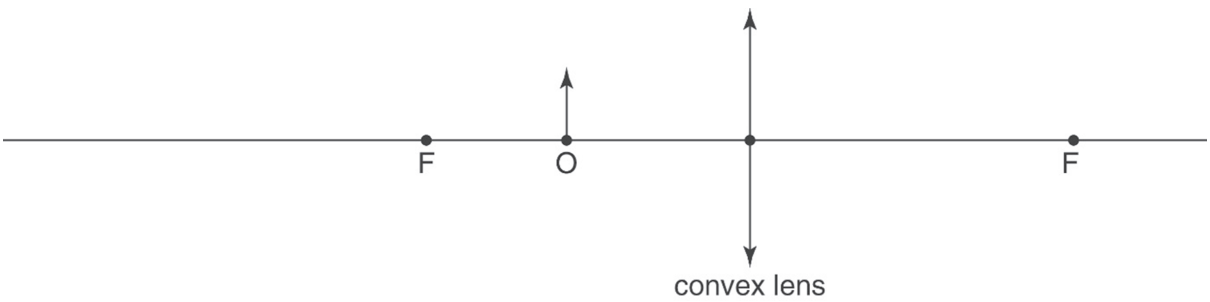
What is the name given to the bending of light at the boundaries between the lens and air?

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

01.2 Complete the ray diagram in **Figure 1.2** to show the formation of an image of the object (O) by the convex lens.

Label the image formed.

Figure 1.2



[4 marks]

01.3 Which **two** descriptions of the images formed by a convex lens are correct?

Tick **two** boxes.

- Always real ☐
- Always virtual ☐
- Can be either real or virtual ☐
- Always upright ☐
- Always upside down ☐
- Can be either upright or upside down ☐

[2 marks]

01.4 Which **two** descriptions of the images formed by a **concave** lens are correct?

Tick **two** boxes.

- Always real ☐
- Always virtual ☐
- Can be either real or virtual ☐
- Always upright ☐
- Always upside down ☐
- Can be either upright or upside down ☐

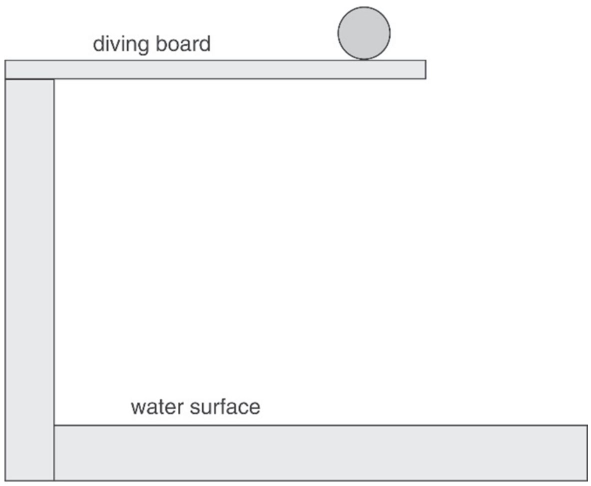
[2 marks]

Turn over >

02 **Figure 2.1** shows a high diving board at a swimming pool.

A ball is stationary on the diving board.

Figure 2.1



02.1 Identify the **two** forces acting on the ball in **Figure 2.1**

1. ....

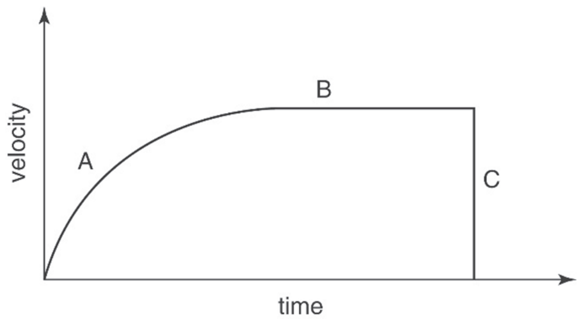
2. .... **[2 marks]**

02.2 The ball is pushed gently so that it falls over the end of the diving board.

When the ball hits the water surface, it floats and is stationary.

Figure 2.2 is a sketch of a velocity–time graph of the ball's motion, showing three stages in the ball's motion: A, B and C.

Figure 2.2



During which stage in **Figure 2.2** is there an **upward** resultant force on the ball?

Tick **one** box.

A ☐

B ☐

C ☐ **[1 mark]**

02.3 During which stage in **Figure 2.2** is there **no** resultant force on the ball?

Tick **one** box.

A ☐

B ☐

C ☐

[1 mark]

02.4 In the space below, draw a free-body force diagram of the ball during stage A of **Figure 2.2**

Label the forces acting.

[3 marks]

02.5 Identify the **two** forces acting on the ball when it is floating on the water surface.

1. ....

2. ....

[2 marks]

Turn over >

03.1 The Earth completes one orbit of the Sun in 3.15×10^7 s

The distance travelled by the Earth in one orbit around the Sun is 9.42×10^{11} m

Calculate the speed of the Earth in its orbit around the Sun.

Give your answer in standard form to three significant figures.

....

....

Speed = ... m/s **[3 marks]**

03.2 The Sun is in orbit around the centre of the Milky Way galaxy.

The mass of the Sun, to the nearest order of magnitude, is 10^{30} kg

The mass of the Milky Way galaxy, to the nearest order of magnitude, is 10^{42} kg

How many times more massive than the Sun is the Milky Way galaxy?

Give your answer as an order of magnitude.

....

Number of times more massive = ... **[2 marks]**

03.3 The Sun is currently about half way through its lifetime as a main sequence star.

In about 5 billion years, the Sun will enter the next stage of its life cycle.

Name this next stage.

Suggest how this change could impact on the Earth.

....

....

.... **[2 marks]**

04.1 Astrophysicists observe **red-shift** in the light from distant galaxies.

Explain what **red-shift** means.

....

.... **[2 marks]**

04.2 Measurements of red-shift have enabled scientists to deduce that distant galaxies are moving away from the Earth.

They were able to calculate the speed at which the galaxies are receding (moving away).

Figure 4.1 is a sketch graph showing how the recession speed of galaxies varies with their distance measured from the Earth.

Figure 4.1

Explain how the observations summarised in **Figure 4.1** changed scientists' model of the universe.

....

....

....

....

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

Turn over >

05 **Figure 5.1** shows the groups of waves in the electromagnetic spectrum.

Figure 5.1

Gamma waves	X-rays	Ultraviolet	Visible light	Infrared	Microwaves	Radio waves

05.1 Which group of waves in the electromagnetic spectrum has the **longest wavelength**?

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

05.2 Which group of waves in the electromagnetic spectrum can be **detected with the human eye**?

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

05.3 Which group of waves in the electromagnetic spectrum **causes skin to age prematurely**?

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

05.4 Which **two** groups of waves in the electromagnetic spectrum can be used to cook food?

.... **[2 marks]**

05.5 An X-ray image showing a broken bone is produced by directing a beam of X-rays at the injured part of the body.

The X-rays that pass through the body are detected electronically to form an image.

Explain why X-rays are suitable for investigating a possible broken bone.

....

.... **[2 marks]**

05.6 X-rays used for medical imaging have a wavelength of 2.0×10^{-10} m

Electromagnetic waves travel at a speed of 3.0×10^{8} m/s in air.

Calculate the frequency of these X-rays.

Give a suitable unit with your answer

....

....

Frequency = ...

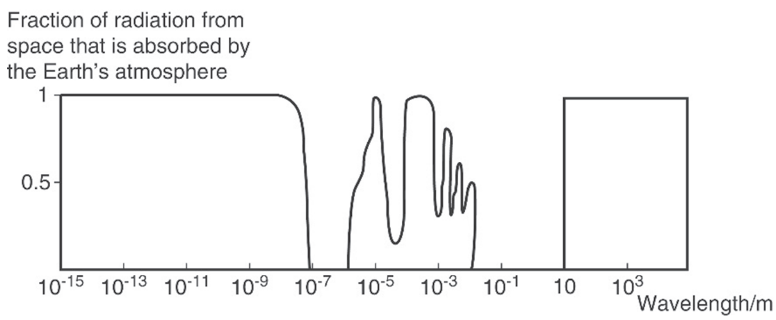
Unit: .... **[3 marks]**

05.7 Satellites used for TV broadcasting orbit the Earth at a height well above the Earth's atmosphere.

Communication between the Earth and the satellite uses microwaves with a wavelength of about 0.1 m

Figure 5.2 provides information about the absorption of electromagnetic radiation by the Earth's atmosphere.

Figure 5.2



Use **Figure 5.2** to explain why microwaves of wavelength 0.1 m, rather than radio waves of typical wavelength 100 m, are used for satellite TV.

....

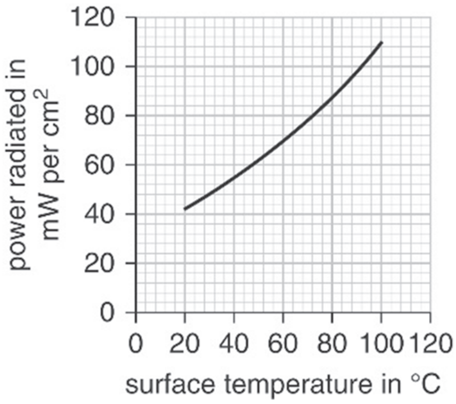
....

.... **[2 marks]**

Turn over >

06.1 **Figure 6.1** shows how the infrared energy radiated per second from a particular surface depends on the surface temperature.

Figure 6.1

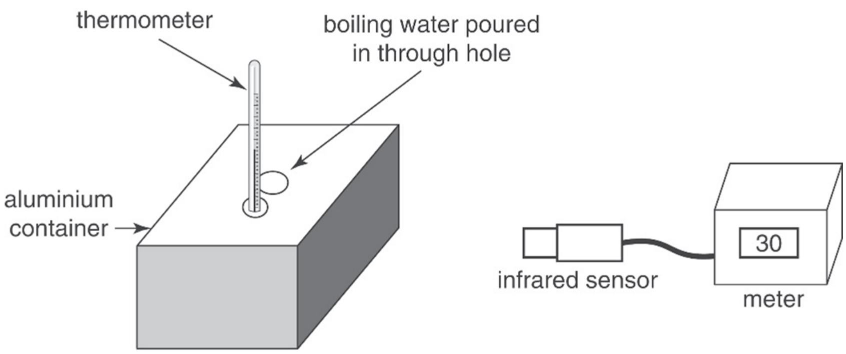


Give **two** conclusions based on the data shown in **Figure 6.1**

[2 marks]

06.2 A student uses the apparatus in **Figure 6.2** to investigate rate of emission of infrared radiation from different surfaces.

Figure 6.2



Boiling water poured into the aluminium container raises its temperature.

The infrared radiation from the container's surface is measured by the infrared sensor and displayed on the meter.

The four vertical faces of the container have a different type of surface:

- polished aluminium
- dull aluminium
- shiny black
- dull black

Write a set of instructions for the student so that the amount of infrared radiated from each of the four surfaces can be compared fairly.

Identify any variables that must be controlled.

....

....

....

....

....

....

....

....

....

.... **[4 marks]**

Question 6 continues on the next page

06.3 **Table 6.1** shows data generated by the experiment in **Figure 6.2**

Table 6.1

Surface	Polished aluminium	Dull aluminium	Shiny black	Dull black
Energy radiated in mW/cm²	3	23	30	33

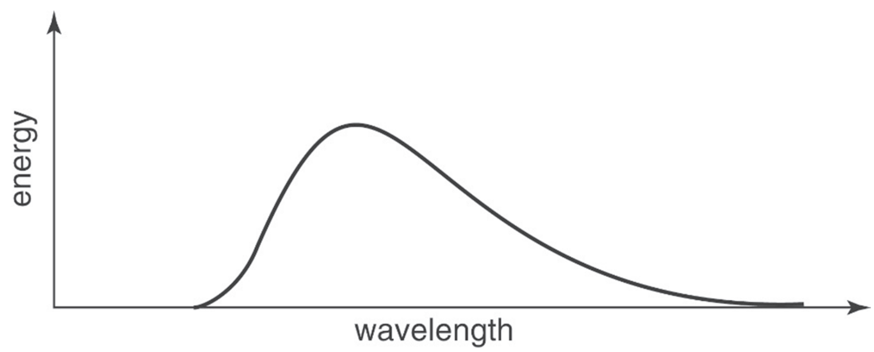
Give **two** conclusions from the data shown in **Table 6.1**

[2 marks]

06.4 The wavelength of the infrared radiation emitted from a different hot object is analysed.

Figure 6.3 is a sketch graph of the results.

Figure 6.3



Give **two** conclusions based on **Figure 6.3**

[2 marks]

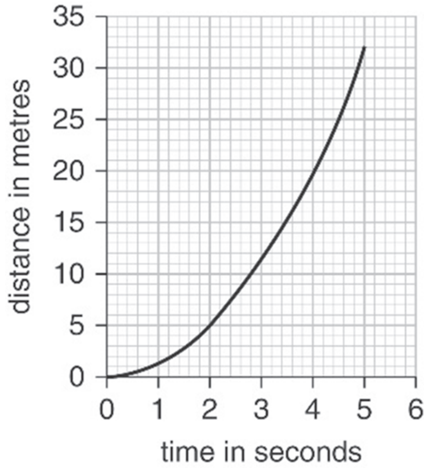
07.1 Give two **scalar** quantities.

[2 marks]

07.2 The distances travelled by a cyclist during the first 5.0 seconds of a road race are monitored electronically.

Figure 7.1 shows the cyclist's distance–time graph for this first 5.0 s

Figure 7.1



What can be concluded from **Figure 7.1** about the cyclist's motion during the first 5.0 s of the race?

Give a reason for your answer.

[2 marks]

Question 7 continues on the next page

07.3 Use **Figure 7.1** to determine the cyclist's speed 3.0 s after the start of the race.

Show your working.

....

Speed = ... m/s **[2 marks]**

07.4 Calculate the cyclist's average speed during the first 5.0 s of the race.

Use data from **Figure 7.1**

....

....

Average speed = ... m/s **[2 marks]**

08.1 A van accidentally collides with a stationary car.

Explain how the idea of the **conservation of momentum** applies to this event.

[2 marks]

08.2 The van has a mass of 1000 kg

Before the collision, it was moving at a velocity of 5.0 m/s

Immediately after the collision, the car moves forwards with a velocity of 4.0 m/s

The mass of the car is 800 kg

Determine the **velocity of the van** immediately after the collision.

Include its direction.

Van's velocity immediately after collision = ... m/s

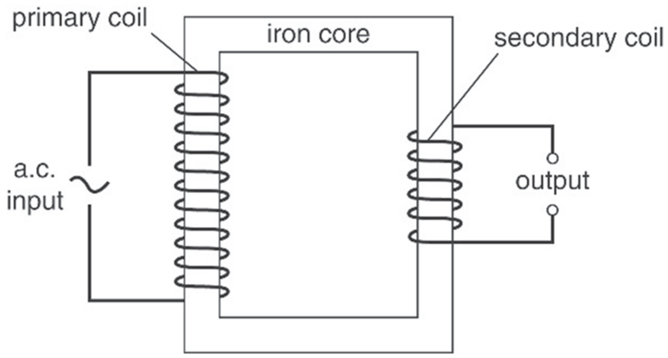
Van's direction immediately after the collision = ... **[3 marks]**

Turn over >

09.1 Step-down transformers are used in laptop battery chargers and have many other uses.

Figure 9.1 shows the basic design of a step-down transformer.

Figure 9.1



Describe the purpose of a step-down transformer.

Explain how the transformer works.

....

....

....

....

....

....

....

....

.... **[4 marks]**

09.2 A laptop battery charger is plugged into the mains electricity supply.

Mains electricity supplies a potential difference of 230 V

The output from the battery charger is 12 V

There are 400 turns in the primary coil of the transformer inside the battery charger.

Calculate the number of turns in the transformer's secondary coil.

Select the correct equation from the Physics Equation Sheet.

Give your answer to the nearest whole number.

....

....

Number of turns in secondary coil = ... **[3 marks]**

09.3 The current in the primary coil of the transformer in the battery charger is 0.20 A

Calculate the current in the transformer's secondary coil.

Select the correct equation from the Physics Equation Sheet.

Give your answer to 2 significant figures.

....

....

....

....

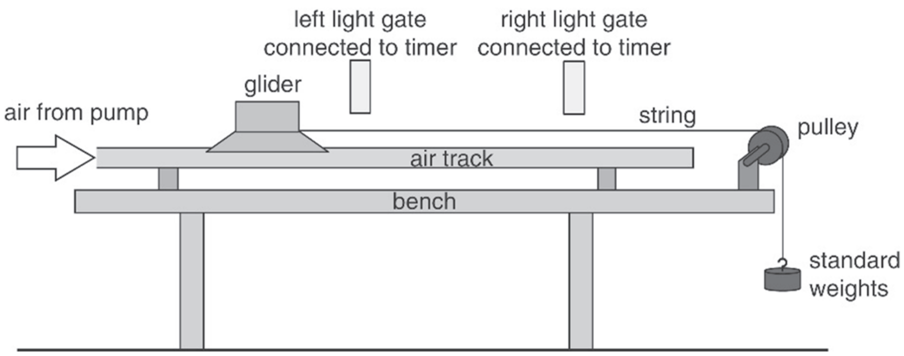
Secondary current = ... A **[3 marks]**

Turn over >

10 Newton's Second Law states that "acceleration is directly proportional to resultant force".

A student uses the air track and glider shown in **Figure 10.1** to demonstrate Newton's Second Law.

Figure 10.1



10.1 Air is pumped into the air track, lifting the glider up from the track slightly.

The glider is pulled along by the weights attached to it by string.

The times registered by the light gates enable the student to determine the acceleration of the glider.

The student plans to determine the acceleration of the glider for different weights attached to the string.

Identify the independent, dependent and control variables.

Independent variable: ....

Dependent variable: ....

Control variable: .... **[3 marks]**

10.2 One set of the student's measurements is shown in **Table 10.1**

Table 10.1

Attached weight in N	Length of glider passing through light gate in m	Distance between light gates in m	Time to pass through first light gate in s	Time to pass through second light gate in s
0.10	0.12	0.50	0.80	0.24

Using data from **Table 10.1**, calculate the glider's initial velocity, as it passes through the first light gate.

Initial velocity = ... m/s **[3 marks]**

10.3 Using data from **Table 10.1**, calculate the glider's final velocity, as it passes through the second light gate.

Final velocity = ... m/s **[2 marks]**

10.4 Show that the glider's acceleration is about 0.2 m/s^2

Select the correct equation from the Physics Equation Sheet.

Show your working.

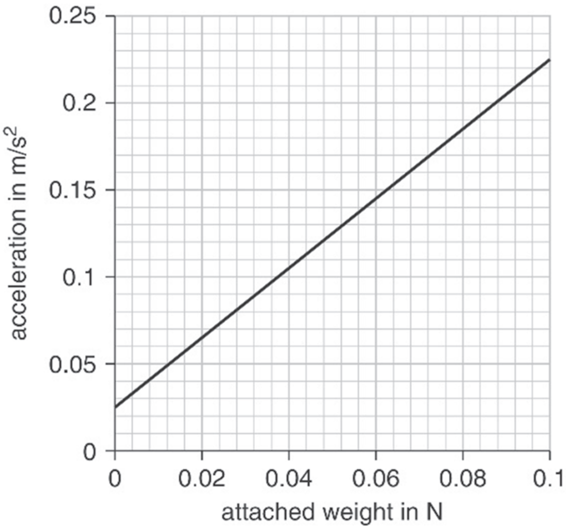
[3 marks]

Question 10 continues on the next page

10.5 The student takes more measurements to calculate the glider's acceleration for other values of attached weight.

Figure 10.2 shows the student's graph of the experimental results.

Figure 10.2



The student expected the results to show that the glider's acceleration is **directly proportional** to the attached weight.

Explain why the graph does **not** confirm what the student was expecting.

[2 marks]

11 When a car driver becomes aware of a hazard ahead, the distance that the car travels before it stops is known as the **stopping distance**. This depends on the car's speed.

11.1 Explain what is meant in this scenario by

- the **thinking distance** and
- the **braking distance**

and how they relate to the stopping distance.

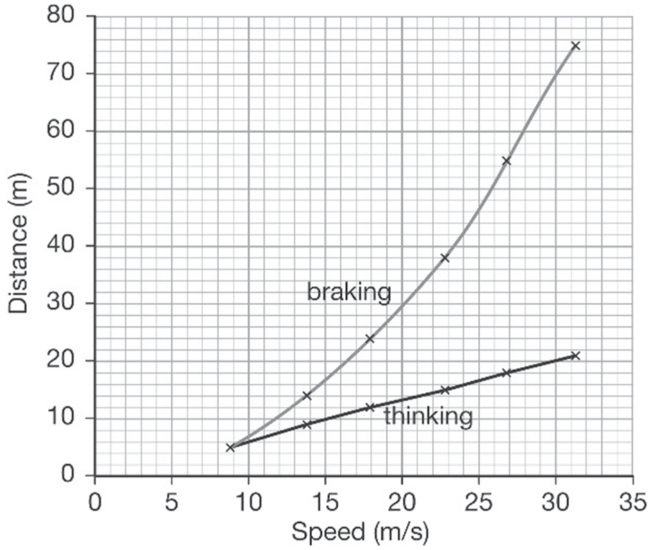
Describe the effect of **three** factors, other than speed, that can affect the size of **each** of these two distances.

[6 marks]

Question 11 continues on the next page

11.2 **Figure 11.1** shows how thinking distance and braking distance each depend on a car's speed.

Figure 11.1



Use **Figure 11.1** to compare the way that thinking distance and braking distance are affected by speed.

Include **at least one similarity** and **at least one difference**.

....

....

....

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

11.3 When a car's brakes are applied, the braking force does work in transferring the car's kinetic energy to thermal energy.

A typical car moving at a speed of 20 m/s has about 200 000 J of kinetic energy.

Estimate the average braking force required to stop the car in an emergency.

Select the required data from **Figure 11.1**

Show your working.

....

....

Average braking force ≈ .... N **[3 marks]**

END OF QUESTIONS

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