Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
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Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

**Time** 1 hour 20 minutes

**Paper reference** **WPH13/01**

# Physics

## International Advanced Subsidiary/Advanced Level
## UNIT 3: Practical Skills in Physics I

**You must have:**
Scientific calculator, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

## Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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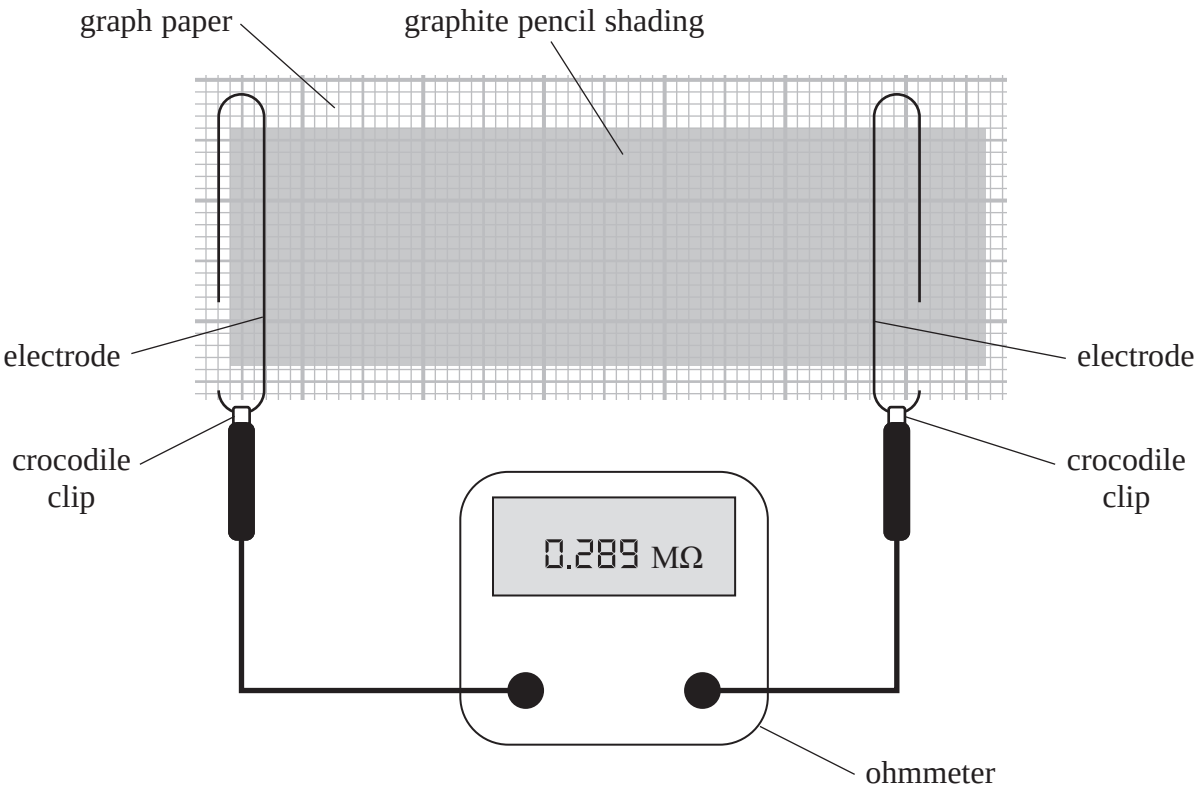
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**Answer ALL questions.**

**1** A student used a graphite pencil to shade in an area of graph paper. The thickness of the shading was uniform.

She placed electrodes in contact with the graphite pencil shading. She measured the resistance $R$ of the shading between the electrodes using an ohmmeter, as shown.




(a) (i) State the resolution of the ohmmeter.

**(1)**

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(ii) Determine the percentage uncertainty in the measurement of $R$.

**(2)**

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Percentage uncertainty = .....

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(b) The thickness of the graphite pencil shading can be determined from a known value for the resistivity of graphite.

(i) Describe how the student could determine an accurate value for the thickness of the graphite pencil shading. The method should use a suitable graph.

**(4)**

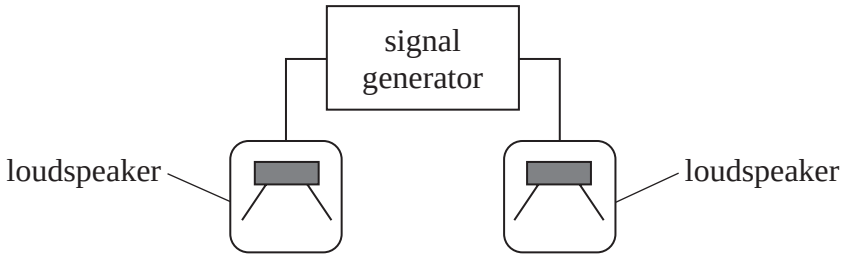
(ii) Identify a possible source of systematic error in your method.

**(1)**

**(Total for Question 1 = 8 marks)**

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**2** A student investigated the interference of sound waves. The student used a signal generator with two loudspeakers, as shown.




Plan view not to scale

(a) The student adjusted the signal generator output until he heard a loud, continuous sound from the loudspeakers.

(i) State a reason for connecting both loudspeakers to the same signal generator.

**(1)**

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(ii) Identify a health and safety issue for the student and how it may be dealt with.

**(2)**

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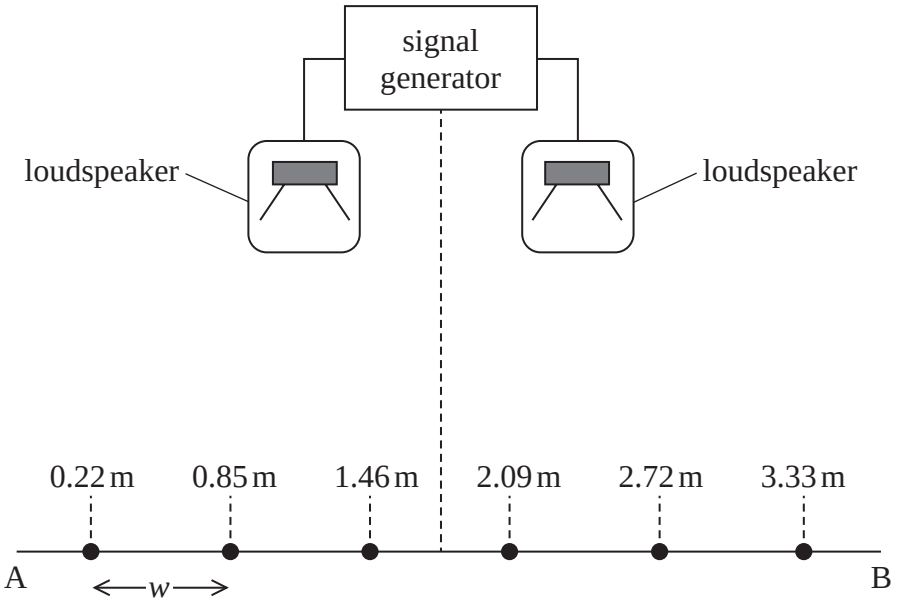
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(b) The student walked along a line between points A and B carrying a sound meter. The sound meter indicated the positions of maximum sound intensity, as shown.

Drawing not to scale




Key

● position of maximum sound intensity

The student measured the distance of each maximum from point A using a tape measure.

(i) Determine an accurate value for the separation $w$ of the maxima.

**(3)**

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$w$ = .....

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(ii) The relationship between $w$ and the wavelength $\lambda$ of the sound waves is given by

$$w = \frac{\lambda D}{s}$$

where $D$ is the perpendicular distance between the loudspeakers and the line AB, and $s$ is the separation of the loudspeakers.

Determine the value of $\lambda$.

$D = 4.0\,\text{m}$
$s = 110\,\text{cm}$

**(2)**

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$\lambda =$ .....

(iii) The student expected a maximum intensity at the point equidistant from the loudspeakers.

Suggest why there was actually a minimum intensity at this point.

**(2)**

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(c) The student used this investigation to determine the speed of sound in air.

(i) To determine an accurate value for the speed of sound, the student would need to use other apparatus.

Explain what other apparatus the student would need.

**(2)**

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(ii) On a humid day, the speed of sound in air increases.

Explain how an increase in the speed of sound would affect the value of *w* for this investigation.

**(2)**

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**(Total for Question 2 = 14 marks)**

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**3** A student investigated the stretching of a spring.

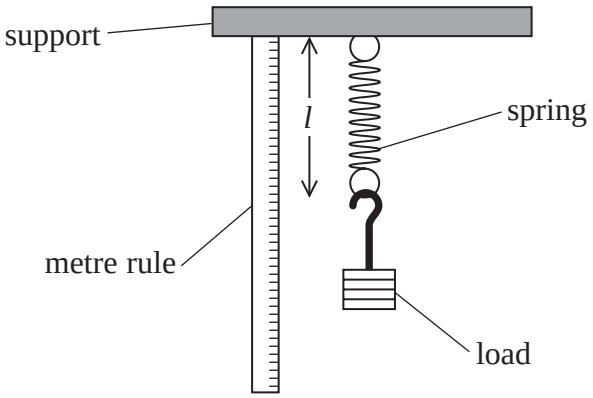
(a) The student used a metre rule to measure the unstretched length $l_0$ of the spring.

(i) The value of $l_0$ was 5.2 cm.

Explain why a metre rule is an appropriate instrument for this measurement.

**(2)**

(ii) The student added a load to the spring and measured the stretched length $l$ of the spring, as shown.




Describe **two** techniques the student should use to make this measurement as accurate as possible.

**(2)**

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(b) The student determined the weight $W$ of different loads, and the corresponding values of $l$. He recorded the results in the following table.

| $W$ / N | $l$ / cm |
|---|---|
| 0 | 5.20 |
| 0.2 | 7.9 |
| 0.39 | 12 |
| 0.59 | 13.4 |
| 0.78 | 16.0 |

(i) Criticise the recording of these results.

**(1)**

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(ii) The student plotted the graph shown opposite.

Explain which value he should check.

**(2)**

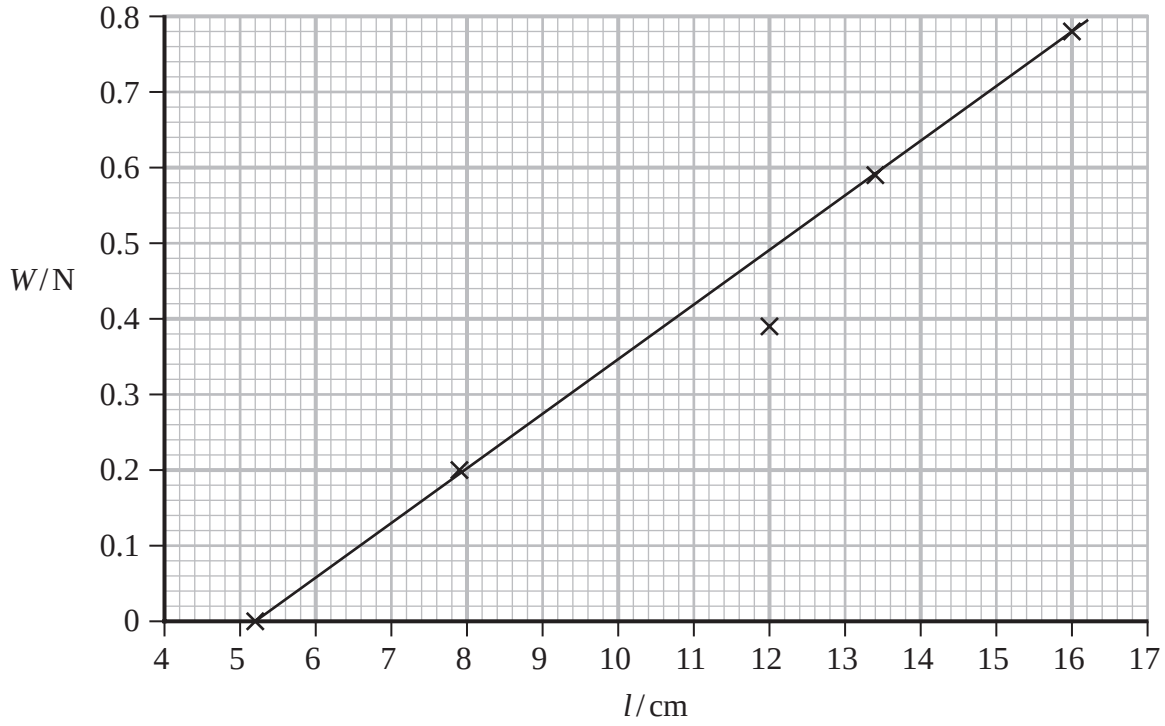
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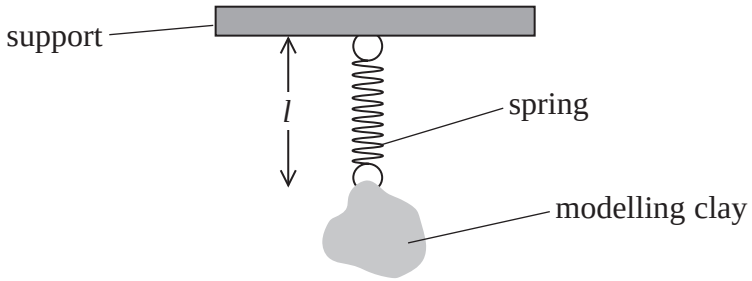
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(iii) The student replaced the load with a small piece of modelling clay, as shown.




He measured $l$ to be 8.4 cm.

Determine the weight $W$ of the piece of modelling clay.

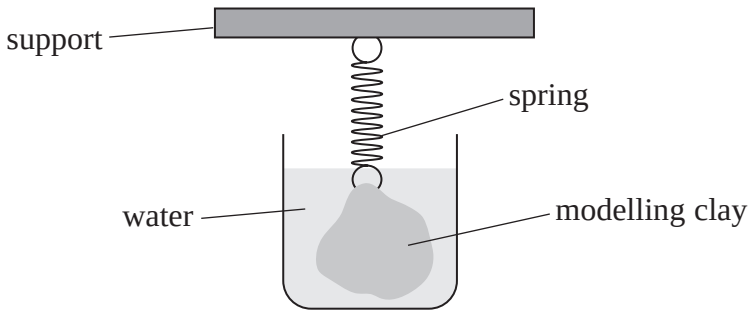
**(1)**

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$W$ = .....

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(c) The student added more modelling clay to the spring and determined the weight $W_1$. Then he submerged the clay in a beaker of water and determined the new force $F$ on the spring.




The density of the modelling clay can be determined from the ratio

$$\frac{\text{density of modelling clay}}{\text{density of water}} = \frac{W_1}{W_1 - F}$$

(i) Determine the density of the modelling clay.

$W_1 = 0.65\,\text{N}$
$F = 0.27\,\text{N}$
density of water = $1000\,\text{kg}\,\text{m}^{-3}$

**(2)**

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Density of modelling clay = .....

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(ii) The student estimated the percentage uncertainty in his calculated value of the density of modelling clay to be 4%.

The density of polymer clay is 1760 kg m$^{-3}$.

Deduce whether the modelling clay could be made from polymer clay.

**(2)**

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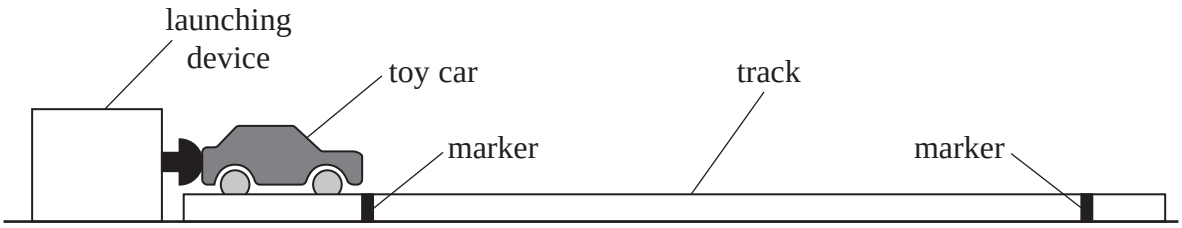
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**(Total for Question 3 = 12 marks)**

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**4** A student investigated the motion of a toy car along a horizontal track using the apparatus shown.




The launching device applies a force on the car. The force causes the car to accelerate. The mean value of the applied force during each launch is *F*.

(a) The student used a stopwatch to measure the time the toy car took to travel between the two markers.

She recorded the following measurements.

| **Time / s** | 3.57 | 3.61 | 3.54 | 3.51 |
|---|---|---|---|---|

(i) Determine the mean value of time in s.

**(2)**

Mean value of time = ..... s

(ii) Determine the percentage uncertainty in the mean value of time.

**(2)**

Percentage uncertainty = .....

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(b) The student adjusted the launching device to vary the mean force $F$ applied to the car.

For larger values of $F$ there was a greater percentage uncertainty in the measurement of time.

Describe how different apparatus could be used to measure the time, so that the percentage uncertainty is reduced.

**(2)**

(c) For each launch, the launching device applied the force to the car for a constant time $t$. For each value of $F$ the student determined the mean velocity $v$ of the toy car.

The relationship between $F$ and $v$ is given by

$$Ft = Mv$$

where $M$ is the mass of the toy car.

(i) Explain why a graph of $F$ against $v$ can be used to determine a value for $t$.

**(2)**

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(ii) The student recorded the following results.

| $F$/N | $v$/ms$^{-1}$ |
|---|---|
| 0.5 | 0.28 |
| 1.5 | 0.84 |
| 2.5 | 1.40 |
| 3.5 | 1.97 |
| 4.5 | 2.52 |

Plot a graph of $F$ on the $y$ axis against $v$ on the $x$ axis on the grid opposite.

**(5)**

(iii) Determine a value for $t$ using the gradient of your graph.

$M = 0.125\,\text{kg}$

**(3)**

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$t =$ .....

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**(Total for Question 4 = 16 marks)**

**TOTAL FOR PAPER = 50 MARKS**

## List of data, formulae and relationships

| | | |
|---|---|---|
| Acceleration of free fall | $g = 9.81 \text{ m s}^{-2}$ | (close to Earth's surface) |
| Electron charge | $e = -1.60 \times 10^{-19} \text{ C}$ | |
| Electron mass | $m_e = 9.11 \times 10^{-31} \text{ kg}$ | |
| Electronvolt | $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ | |
| Gravitational field strength | $g = 9.81 \text{ N kg}^{-1}$ | (close to Earth's surface) |
| Planck constant | $h = 6.63 \times 10^{-34} \text{ J s}$ | |
| Speed of light in a vacuum | $c = 3.00 \times 10^{8} \text{ m s}^{-1}$ | |

***Unit 1***

*Mechanics*

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

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Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

*Materials*

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

Stokes' law $F = 6\pi\eta rv$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \frac{1}{2}F\Delta x$

Young modulus $E = \frac{\sigma}{\varepsilon}$ where

Stress $\sigma = \frac{F}{A}$

Strain $\varepsilon = \frac{\Delta x}{x}$

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***Unit 2***

*Waves*

| | |
|---|---|
| Wave speed | $v = f\lambda$ |
| Speed of a transverse wave on a string | $v = \sqrt{\frac{T}{\mu}}$ |
| Intensity of radiation | $I = \frac{P}{A}$ |
| Refractive index | $n_1 \sin\theta_1 = n_2 \sin\theta_2$ |
| | $n = \frac{c}{v}$ |
| Critical angle | $\sin C = \frac{1}{n}$ |
| Diffraction grating | $n\lambda = d \sin\theta$ |

*Electricity*

| | |
|---|---|
| Potential difference | $V = \frac{W}{Q}$ |
| Resistance | $R = \frac{V}{I}$ |
| Electrical power, energy | $P = VI$ |
| | $P = I^2R$ |
| | $P = \frac{V^2}{R}$ |
| | $W = VIt$ |
| Resistivity | $R = \frac{\rho l}{A}$ |
| Current | $I = \frac{\Delta Q}{\Delta t}$ |
| | $I = nqvA$ |
| Resistors in series | $R = R_1 + R_2 + R_3$ |
| Resistors in parallel | $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ |

*Particle nature of light*

| | |
|---|---|
| Photon model | $E = hf$ |
| Einstein's photoelectric equation | $hf = \phi + \frac{1}{2}mv^2_{\max}$ |
| de Broglie wavelength | $\lambda = \frac{h}{p}$ |

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