Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Friday 18 January 2013 – Morning
Time: 1 hour 30 minutes

Paper Reference
6PH02/01

You do not need any other materials.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **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.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

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

Turn over ▶

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P 4 1 6 2 8 A 0 1 2 8

PEARSON

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 An ampere can be expressed as

☒ **A** $C\ s^{-1}$

☒ **B** $J\ C^{-1}$

☒ **C** $V\ W^{-1}$

☒ **D** $V\ \Omega$

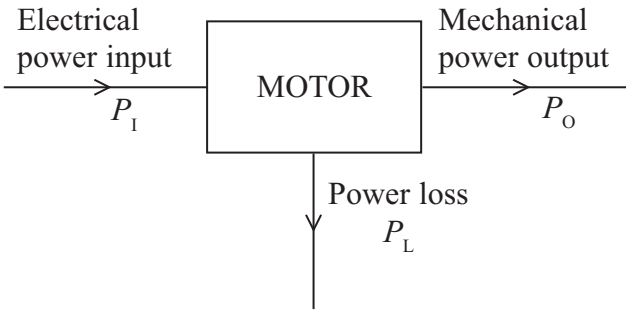
(Total for Question 1 = 1 mark)

2 Which of the following summarises the change in wave characteristics when going from ultraviolet to infrared in the electromagnetic spectrum?

	Frequency	**Speed (in a vacuum)**
☒ **A**	decreases	decreases
☒ **B**	decreases	stays the same
☒ **C**	increases	decreases
☒ **D**	increases	stays the same

(Total for Question 2 = 1 mark)

3 Electrical power is transferred in a motor as shown.



What is the efficiency of the motor?

☒ **A** $\frac{P_O + P_L}{P_I}$

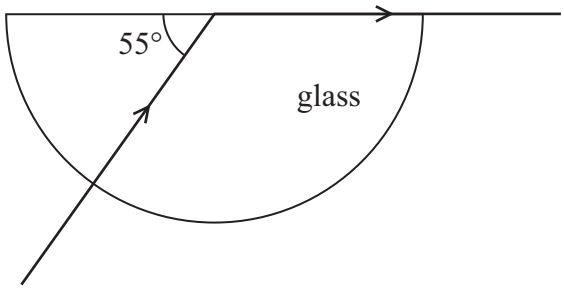
☒ **B** $\frac{P_I}{P_O}$

☒ **C** $\frac{P_L}{P_I}$

☒ **D** $\frac{P_O}{P_I}$

(Total for Question 3 = 1 mark)

4 A ray of monochromatic light passes into a glass block as shown.



The refractive index of the glass for this light is

☒ **A** 0.57

☒ **B** 0.81

☒ **C** 1.22

☒ **D** 1.74

(Total for Question 4 = 1 mark)

5 An electron is accelerated from rest through a potential difference of 5.0 kV.

The kinetic energy gained by the electron is

☒ **A** 8.0×10^{-16} J

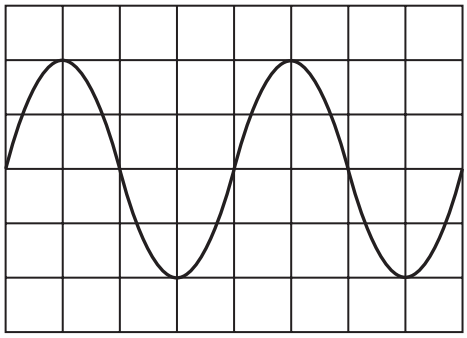
☒ **B** 8.0×10^{-19} J

☒ **C** 3.2×10^{-20} J

☒ **D** 3.2×10^{-23} J

(Total for Question 5 = 1 mark)

6 A particular sound is investigated by connecting a microphone to an oscilloscope. The diagram shows the trace of a sound wave on the oscilloscope. The screen of the oscilloscope has a grid on it. On the x-axis 1 division represents 5 ms.



The frequency of the sound wave is

☒ **A** 0.05 Hz

☒ **B** 0.1 Hz

☒ **C** 50 Hz

☒ **D** 100 Hz

(Total for Question 6 = 1 mark)

7 Two coherent sources emit waves of wavelength λ which are in phase. The two waves meet at a point, having travelled slightly different distances. The waves now have a phase difference of 180° (π radians).

Which of the following could be the path difference at this point?

☒ **A** $\frac{\lambda}{4}$

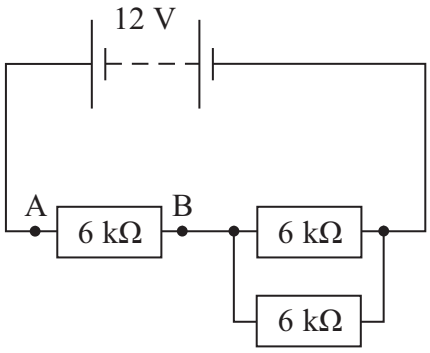
☒ **B** $\frac{\lambda}{2}$

☒ **C** $\frac{3\lambda}{4}$

☒ **D** λ

(Total for Question 7 = 1 mark)

8 A combination of resistors is connected to a 12 V supply of negligible internal resistance.



The potential difference between points A and B is

☒ **A** 4 V

☒ **B** 6 V

☒ **C** 8 V

☒ **D** 12 V

(Total for Question 8 = 1 mark)

9 Ultrasound is used to investigate the blood in an artery in a human body by detecting a Doppler shift. This Doppler shift is used to measure the

☒ **A** diameter of the artery.

☒ **B** size of the particles in the blood.

☒ **C** temperature of the blood.

☒ **D** velocity of the blood.

(Total for Question 9 = 1 mark)

10 The effect of diffraction is more noticeable, in everyday life, with sound than with light. This is because

☒ **A** sound has a much longer wavelength than light.

☒ **B** sound is a longitudinal wave, light is a transverse wave.

☒ **C** sound is a mechanical wave, light is an electromagnetic wave.

☒ **D** sound travels more slowly in air than light does.

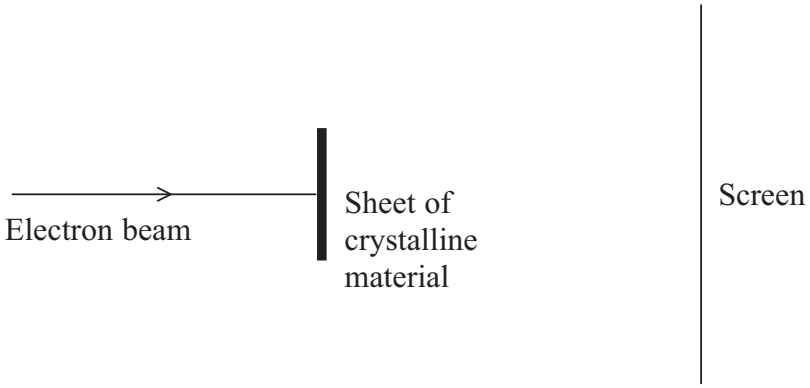
(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

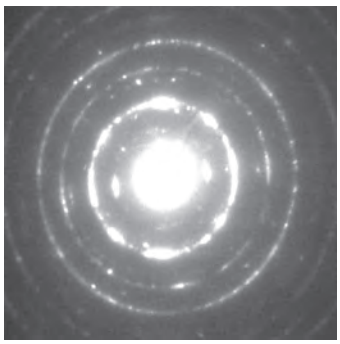
SECTION B

Answer ALL questions in the spaces provided.

11 The diagram shows a beam of electrons being fired towards a thin sheet of crystalline material. The screen detects electrons after they have passed through the sheet.



The photograph shows the positions at which electrons strike the screen.



Explain what can be deduced about the behaviour of electrons from the formation of this pattern.

(3)

(Total for Question 11 = 3 marks)

12 A thermistor has a negative temperature coefficient. With reference to the equation $I = nqvA$, explain what happens to the resistance of the thermistor when its temperature increases.

(3)

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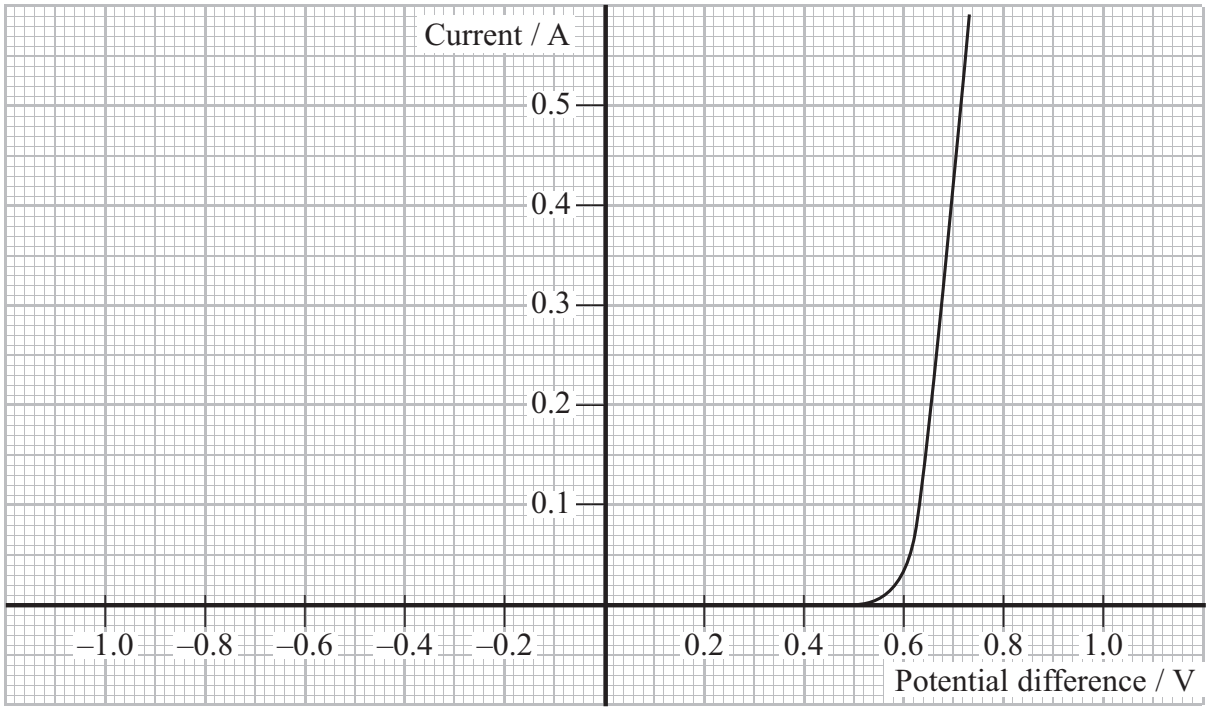
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(Total for Question 12 = 3 marks)

13 The graph shows the current–potential difference characteristic for an electrical component.



(a) State the name of the component.

(1)

.....

(b) State the resistance of the component when the potential difference is – 0.7 V.

(1)

.....

(c) Calculate the resistance of the component when the potential difference is + 0.7 V.

(2)

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.....

.....

Resistance = ...

(d) State a practical use for this component.

(1)

.....

.....

(Total for Question 13 = 5 marks)

14 (a) Explain what is meant by the work function of a metal.

(1)

*(b) Observations of the photoelectric effect support the particle theory of light.

State **one** such observation and explain how it supports the particle theory of light.

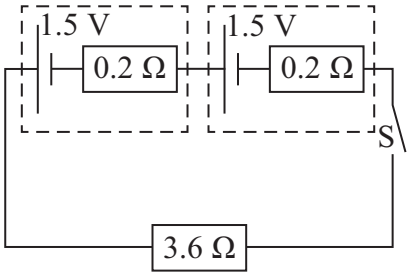
(3)

(Total for Question 14 = 4 marks)

15 Electrically heated gloves are used by skiers and climbers to provide extra warmth for their hands.



Each glove has a heating element of resistance 3.6 Ω. Two cells each of e.m.f. 1.5 V and internal resistance 0.2 Ω are used to operate each heating element.



(a) When the switch is closed:

(i) Calculate the total resistance in the circuit

(1)

.....

Total resistance = ...

(ii) Calculate the current in the heating element

(2)

.....

.....

Current = ...

(iii) Calculate the power output from the heating element.

(2)

.....

.....

Power output = ...

(b) When in use the internal resistance of each cell gradually increases.

State and explain the effect this will have on the power output of the heating element.

(3)

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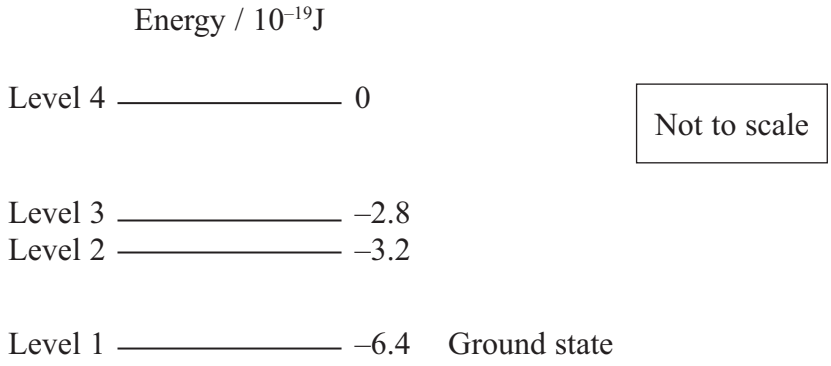
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(Total for Question 15 = 8 marks)

16 The diagram shows four energy levels for an electron in a particular atom.



(a) State what is meant by an energy level.

(1)

(b) Draw on the diagram **two** arrows to indicate two different transitions that would result in emitted radiation of the same frequency.

(2)

(c) A gas consisting of these atoms can emit a line spectrum.

Explain how this happens.

(3)

(d) One of these atoms in its ground state absorbs 3.6×10^{-19} J of energy from a collision with an electron.

Calculate the smallest frequency of radiation that the atom may subsequently emit.

(3)

Smallest frequency = ...

(e) Calculate how much energy in eV would be required to ionise the atom in its ground state.

(2)

Energy = ...

(Total for Question 16 = 11 marks)

17 When tidying a prep room, a teacher discovers a tray of resistance wires that have lost their labels. She decides to ask her students to carry out experiments to determine the material that each wire is made of by measuring the resistivity of the wires.

(a) Explain why the teacher asks the students to measure the resistivity and not the resistance of the wires.

(2)

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*(b) You are to describe a method to determine accurately the resistivity of one of the metal wires.

Your description should include:

- the circuit diagram you would use
- the quantities you would measure
- the graph you would plot
- how you would determine the resistivity.

(9)

(Total for Question 17 = 11 marks)

18 If certain crystals are subjected to a mechanical stress, a potential difference is generated across them. This is called the piezoelectric effect. These crystals can be produced as very thin films.

Below is a photograph of a T-shirt with a built-in phone charger, which is being tested at a music festival. The white rectangle is a piezoelectric film.



(a) By considering how a sound wave travels through the air, explain how sound can cause a piezoelectric film to generate a potential difference.

(4)

(b) Explain why the crystals used in the T-shirt need to be in the form of a large, thin film.

(3)

(c) When the T-shirt is used at a music festival the sound levels are sufficient to generate about 20 kJ over ten hours. This is enough to charge one phone.

Calculate the electrical power output.

(3)

Power output = ...

(d) Give **one** advantage and **one** disadvantage of this charger compared with a conventional charger.

(2)

(Total for Question 18 = 12 marks)

19 The 2010 Football World Cup was held in South Africa and is remembered for the noise of the vuvuzelas.



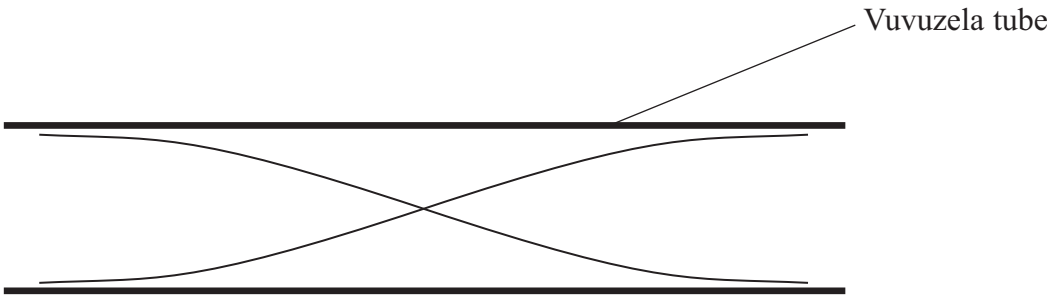
The vuvuzela is a musical instrument which works by making the air inside the vuvuzela vibrate so that a standing wave is produced.

*(a) Explain how a standing wave is produced.

(3)

(b) The vuvuzela makes a noise because it is producing standing waves of different frequencies.

The diagram shows the standing wave with the lowest frequency.



Calculate the frequency of this standing wave.

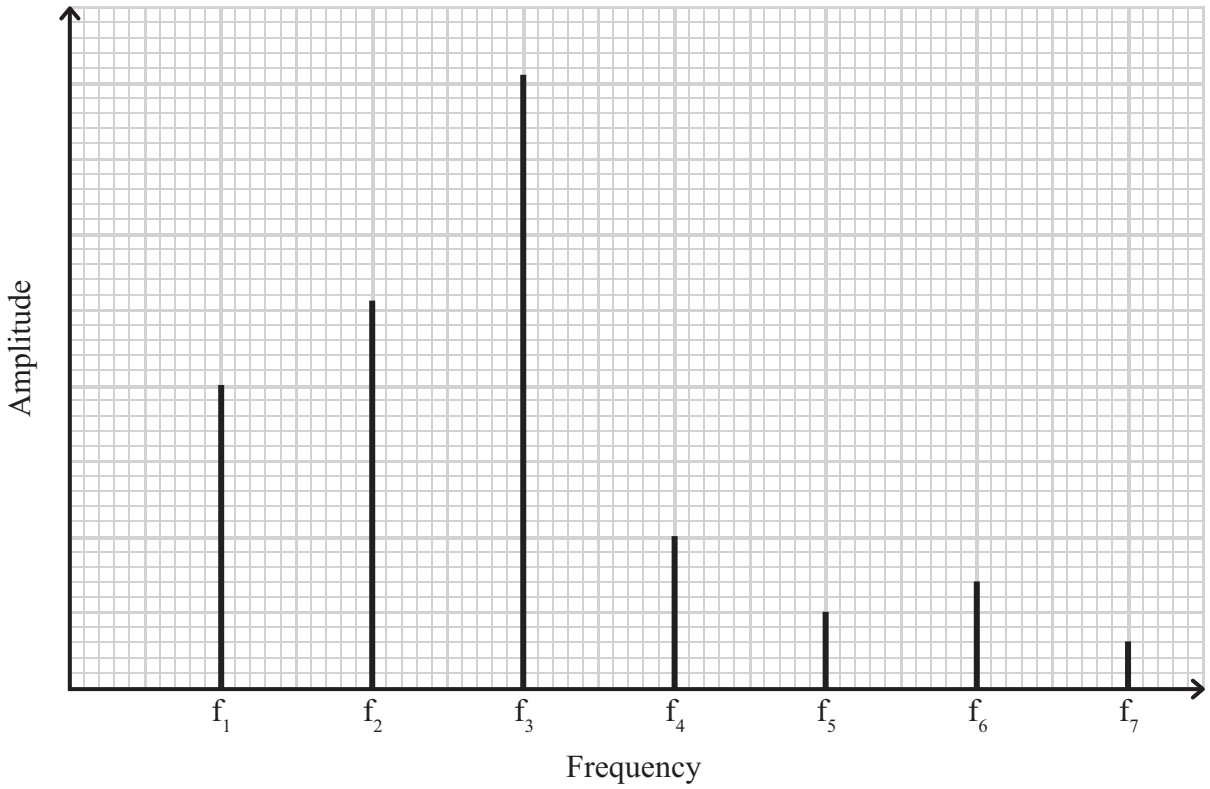
length of the vuvuzela = 60 cm

speed of sound in air = 330 m s^{-1}

(3)

Frequency = ...

(c) Human speech contains a continuous range of frequencies.
When the vuvuzela's sound is analysed it is found to contain only certain fixed frequencies which can be heard by humans.



At the Football World Cup the noise of the vuvuzelas made it difficult for the television commentators to be heard. A solution was to use a filter that removed some of the frequencies produced by the vuvuzelas.

Suggest which **two** frequencies it would be best to remove, the effect this would have and the disadvantage of removing all of the frequencies.

(3)

.....

.....

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.....

.....

(d) Noise cancelling headphones work by detecting a sound and producing another sound that is in antiphase and so causing destructive interference.

(i) Explain what is meant by antiphase and destructive interference.

(3)

(ii) Explain why the headphones could not be used to cancel the noise of the vuvuzelas.

(1)

(Total for Question 19 = 13 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 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

$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$
$$g = F/m$$
$$W = mg$$

Work and energy

$$\Delta W = F\Delta s$$
$$E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_{grav} = mg\Delta h$$

Materials

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

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

Density $\rho = m/V$

Pressure $p = F/A$

Young modulus $E = \sigma/\varepsilon$ where
Stress $\sigma = F/A$
Strain $\varepsilon = \Delta x/x$

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

Unit 2

Waves

Wave speed	$v = f\lambda$
Refractive index	${}_1\mu_2 = \sin i / \sin r = v_1 / v_2$

Electricity

Potential difference	$V = W/Q$
Resistance	$R = V/I$
Electrical power, energy and efficiency	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\%\ \text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\%\ \text{efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
Resistivity	$R = \rho l / A$
Current	$I = \Delta Q / \Delta t$ $I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Quantum physics

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{\max}$