Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Tuesday 16 October 2018

Morning (Time: 1 hour 30 minutes) | Paper Reference **WPH02/01**

Physics

Advanced Subsidiary

Unit 2: Physics at Work

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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 5 5 4 4 3 A 0 1 2 4

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 Which of the following is an equivalent unit to the ampere?

☐ **A** C

☐ **B** C s

☐ **C** C s^{-1}

☐ **D** s C^{-1}

(Total for Question 1 = 1 mark)

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2 The distance between an approaching aircraft and an airport can be determined using the pulse-echo technique with radio waves.

The time between the pulse of radio waves being emitted and the reflected pulse being received is t and the velocity of radio waves in air is c.

Which of the following expressions can be used to determine the distance of the aircraft from the airport?

☐ **A** $2 \times c \times t$

☐ **B** $\frac{c \times t}{2}$

☐ **C** $\frac{c}{2 \times t}$

☐ **D** $c \times t$

(Total for Question 2 = 1 mark)

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3 A person hears the sound from the siren of an approaching police car.

Which of the following properties of the sound wave does **not** change if the car stops moving?

☐ **A** frequency

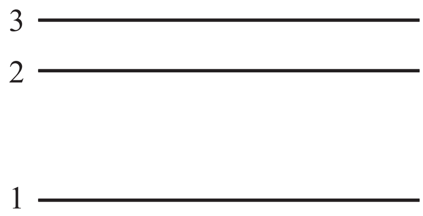
☐ **B** time period

☐ **C** velocity

☐ **D** wavelength

(Total for Question 3 = 1 mark)

4 The diagram shows three energy levels in an atom.



Which of the following electron transitions between energy levels would result in the emission of electromagnetic radiation of the highest frequency?

☒ **A** 1 to 3

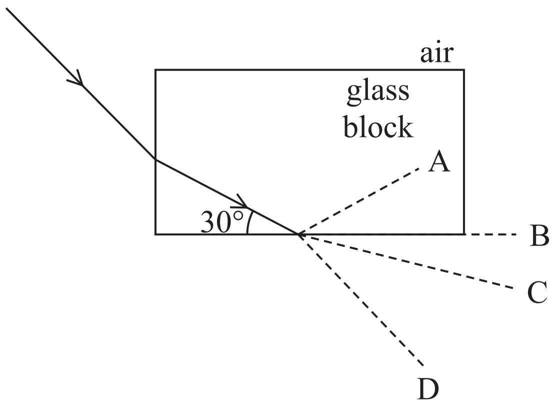
☒ **B** 3 to 2

☒ **C** 2 to 3

☒ **D** 3 to 1

(Total for Question 4 = 1 mark)

5 The diagram shows the path of a ray of light into a glass block.



The critical angle for the glass-air boundary is 40°.

Which dotted line represents the continuing path of the ray of light?

☒ **A**

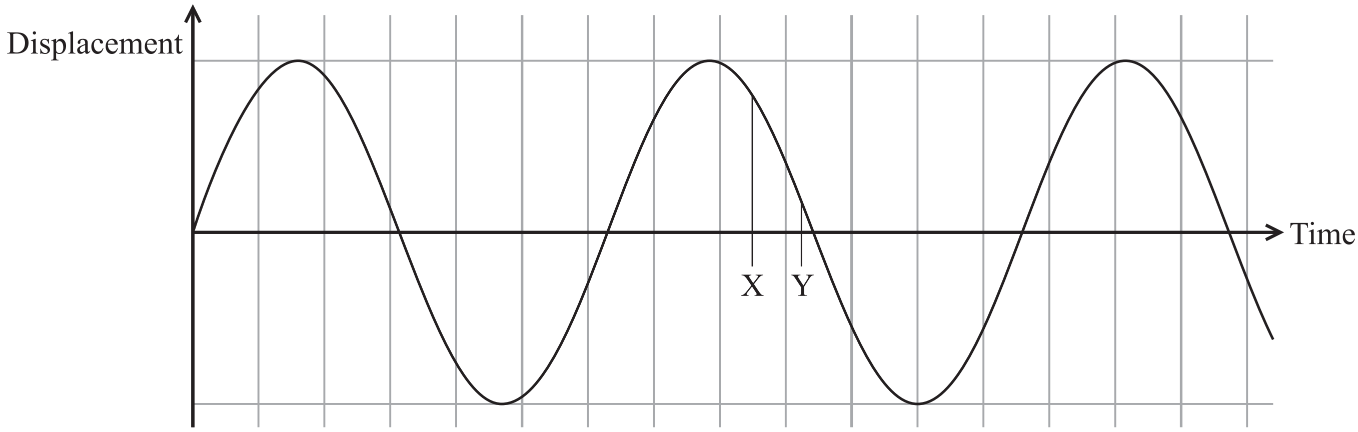
☒ **B**

☒ **C**

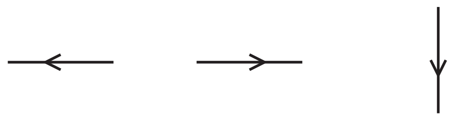
☒ **D**

(Total for Question 5 = 1 mark)

6 A displacement-time graph for a particular point on a transverse wave is shown.
Two times are marked X and Y.



Which of the following represents the change in displacement of this point between times X and Y?



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for Question 6 = 1 mark)

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7 A fluorescent lamp has a power input of 14 W.

The rate of transfer to thermal energy by the lamp is 9.8 W, the remainder of the energy becoming light.

Which of the following is the efficiency of the lamp?

☒ **A** 0.30

☒ **B** 0.43

☒ **C** 0.70

☒ **D** 1.43

(Total for Question 7 = 1 mark)

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8 Which of the following quantities can be defined as the energy transferred per unit charge?

☒ **A** current

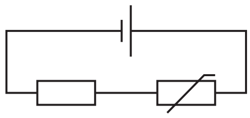
☒ **B** potential difference

☒ **C** power

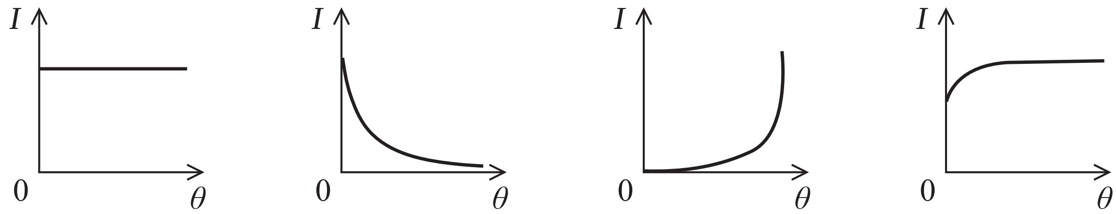
☒ **D** resistance

(Total for Question 8 = 1 mark)

9 A negative temperature coefficient thermistor is connected in series with a resistor. They are then connected to a cell.



Which of the following graphs best shows the variation of current I with temperature θ, in °C, of the thermistor for such a circuit?



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for Question 9 = 1 mark)

10 Sound waves travel through air and pass into a concrete wall. The energy of the sound wave transmitted into the concrete wall is much less than the energy of the sound wave in air.

Which of the following wave properties is the reason for this?

☒ **A** absorption

☒ **B** diffraction

☒ **C** reflection

☒ **D** refraction

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 (a) Describe how a standing wave is formed.

(3)

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(b) An organ pipe is open at both ends. There is an antinode at each end of the pipe.

Determine the shortest length of the pipe required to produce a sound with a wavelength of 2.6 m.

(1)

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Length = ...

(Total for Question 11 = 4 marks)

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12 A torch battery has an e.m.f. of 1.5 V. When connected to the torch bulb, the terminal potential difference is 1.2 V and the current in the circuit is 280 mA.

(a) Calculate the internal resistance of the torch battery.

(3)

Internal resistance = ...

(b) Calculate the power transferred by the torch bulb.

(2)

Power transferred = ...

(Total for Question 12 = 5 marks)

13 (a) Explain the difference between polarised light and unpolarised light.

(3)

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(b) Two photographs of the same car windscreen were taken, under the same conditions. One of these was taken through a polarising filter.

Photograph A

Photograph B

Explain which photograph was taken through a polarising filter.

(3)

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(Total for Question 13 = 6 marks)

14 A slinky spring can be used to demonstrate a number of properties of waves. The diagram shows a wave being produced on a slinky spring when the hand oscillates from left to right.

Describe the waves that are being demonstrated in the diagram.

(4)

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(Total for Question 14 = 4 marks)

15 A radio station uses a frequency of 693 kHz for its broadcasts.

(a) Explain how it is possible to receive these broadcasts in a house on the other side of a hill from the radio station. Your answer should include an appropriate calculation.

(4)

(b) The radiation flux of the radio waves arriving at a particular house is $8.3 \times 10^{-9}\,\mathrm{W\,m^{-2}}$.

Calculate the energy arriving at a person's head from these radio waves in one hour.

area of head = $0.025\,\mathrm{m^2}$

(3)

Energy = ...

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*(c) A student makes the following comment about the answer to part (b).

"Although this electromagnetic wave energy is a very small value and safe, the same amount of electromagnetic energy at an ultraviolet frequency could be dangerous."

Explain this comment.

(4)

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(Total for Question 15 = 11 marks)

16 A variety of colours is often seen when white light is reflected from a thin layer of oil on a puddle of water.

Light reflecting from the top of this layer of oil undergoes a phase change of 180°. This results in a phase difference of 180° between the reflected light and the incident light at the surface.

(a) Explain what is meant by a phase difference of 180°.

(2)

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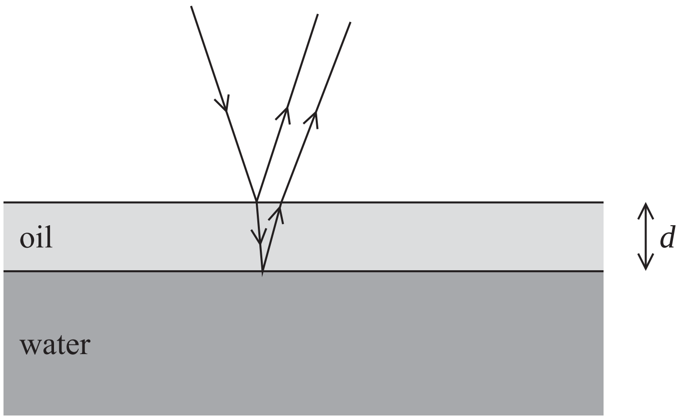
(b) The diagram shows a thin layer of oil, of thickness *d*, on the surface of water. A ray of white light is incident on the layer of oil and reflects from the top and bottom surfaces of the oil. Light reflected from the bottom surface does not undergo a phase change.



(i) Calculate the velocity of light in oil.

refractive index of oil = 1.5

(2)

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Velocity = ...

*(ii) When viewed from directly above the puddle, the oil is seen as yellow.

Explain this observation.

wavelength of yellow light in oil = 4.0×10^{-7} m
$d = 1.0 \times 10^{-7}$ m

(5)

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(Total for Question 16 = 9 marks)

17 Light is shone onto a metal surface. Photoelectrons are emitted from the metal when the frequency of the light is greater than a certain value. This is known as the photoelectric effect.

(a) Explain the photoelectric effect.

(2)

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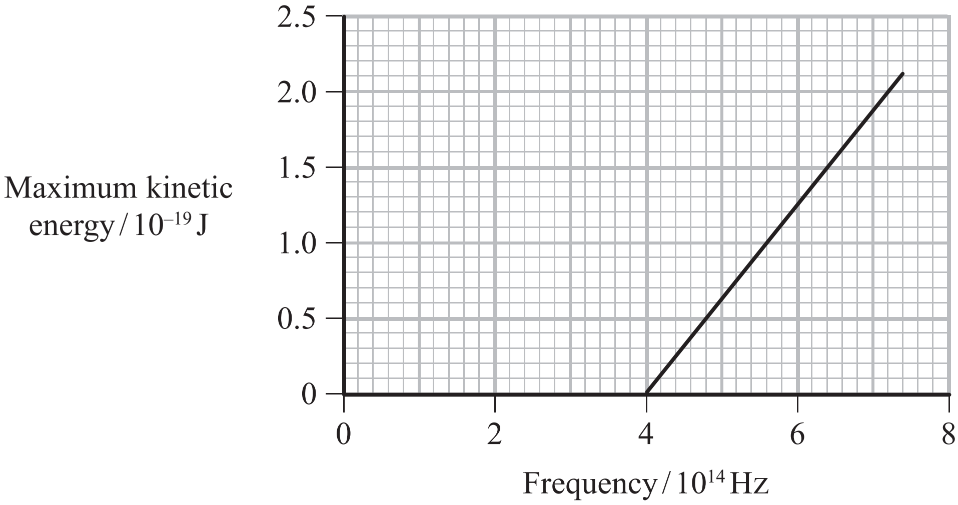
(b) The maximum kinetic energy of the photoelectrons is determined for a range of frequencies of incident light. The results are shown on the graph.



(i) Use the graph to determine the value of the Planck constant.

(2)

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Planck constant = ...

(ii) Describe the significance of the frequency of light having a value of 4×10^{14} Hz in this experiment.

(2)

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(iii) Calculate the work function of the metal in eV.

(3)

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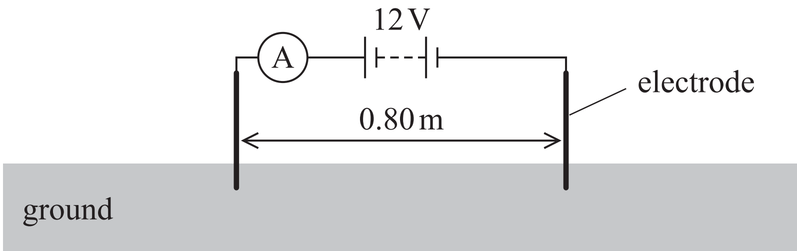
Work function = ... eV

(Total for Question 17 = 9 marks)

18 A geophysicist may use resistivity to determine the different materials within the ground.

Two electrodes and a 12 V battery are connected to two points 0.80 m apart in the ground.



This arrangement is used to measure the current in the ground between the electrodes.

(a) The effective cross-sectional area of conducting material in the ground is 0.25 m^2.
The current between the electrodes is 8.5 mA.

Calculate the resistivity of the ground between the electrodes.

(3)

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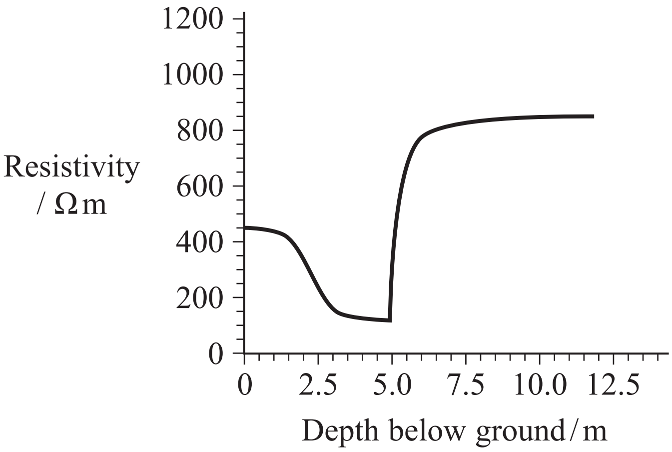
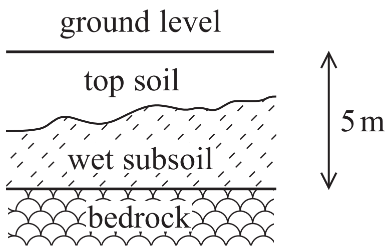
Resistivity = ...

(b) The graph shows how the resistivity varies with depth below ground level at a particular location. A geophysicist has also made a sketch of the different layers of material beneath the ground at this location.





P 5 5 4 4 3 A 0 1 6 2 4

Explain how the sketch corresponds to the graph.

(3)

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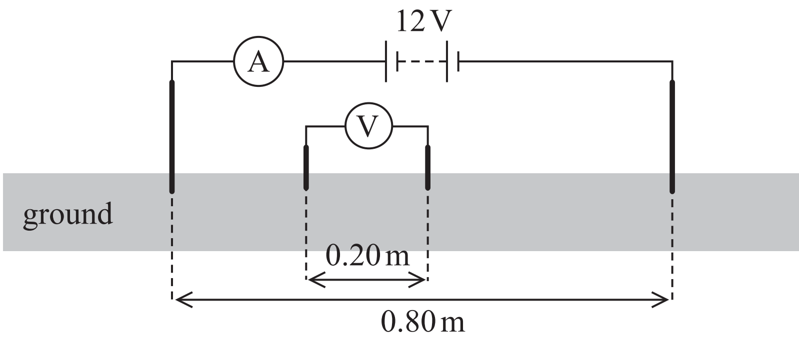
(c) The diagram below illustrates a more accurate method of measuring resistivity.



Two extra electrodes are placed 0.20 m apart and connected to a voltmeter.

(i) Explain the value you would expect to observe on the voltmeter if the cross-sectional area of the ground through which the current is passing were constant.

(3)

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(ii) Give one reason why this method leads to more accurate results than the method described in part (a).

(1)

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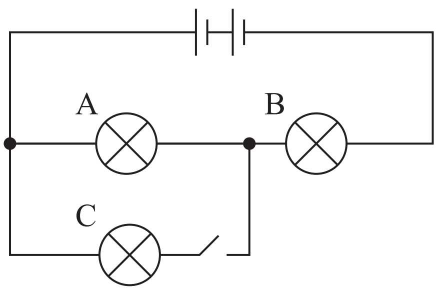
(Total for Question 18 = 10 marks)

19 (a) A student sets up the circuit shown with three identical lamps and a switch.



Each lamp is marked 1.5 V and two 1.5 V cells of negligible internal resistance are used as a power supply.

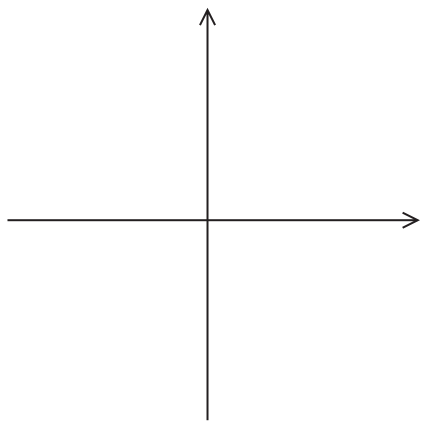
The two lamps labelled A and B light with normal brightness when the switch is open.

Explain what will happen to the brightness of each lamp when the switch is closed.

(6)

(b) (i) Sketch a current-potential difference graph for a filament lamp on the axes below.

(2)



(ii) Explain the shape of this graph in terms of electron movement through the lattice.

(4)

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(Total for Question 19 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

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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	$hf = \phi + \tfrac{1}{2}mv^2_{\text{max}}$