Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Wednesday 9 June 2010 – 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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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 A formula for the speed v of ocean waves, in terms of the acceleration of free fall g and the wavelength λ, is $v = \sqrt{g\lambda}$.

Which of the following is the correct expression for the SI base units on the right hand side of this formula?

☒ **A** $\sqrt{\text{m}^2\text{s}^{-2}}$

☒ **B** m s^{-2}

☒ **C** m^2s^{-2}

☒ **D** $\sqrt{\text{m s}^{-2}}$

(Total for Question 1 = 1 mark)

2 Which line of the table correctly summarises the changes in wave characteristics when moving from ultraviolet to infrared in the visible spectrum?

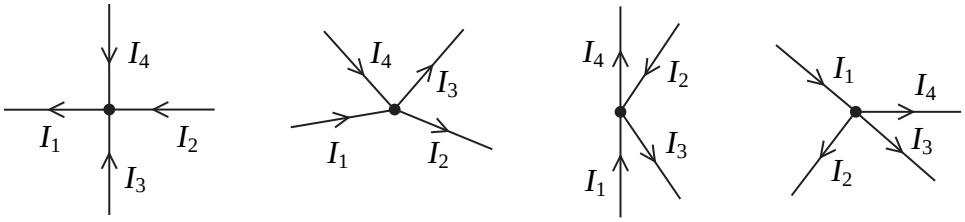
		Wavelength	Speed in a vacuum
☒	**A**	Decreases	Increases
☒	**B**	Increases	Decreases
☒	**C**	Decreases	Remains the same
☒	**D**	Increases	Remains the same

(Total for Question 2 = 1 mark)

3 The diagrams show connected wires that carry currents I_1, I_2, I_3 and I_4.

The currents are related by the equation $I_1 + I_2 = I_3 + I_4$

Identify the diagram that this equation applies to.



A **B** **C** **D**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

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4 A 100 W lamp connected to the 230 V mains is replaced by a lamp which has twice the resistance. The power of the new lamp is

☒ **A** 25 W

☒ **B** 50 W

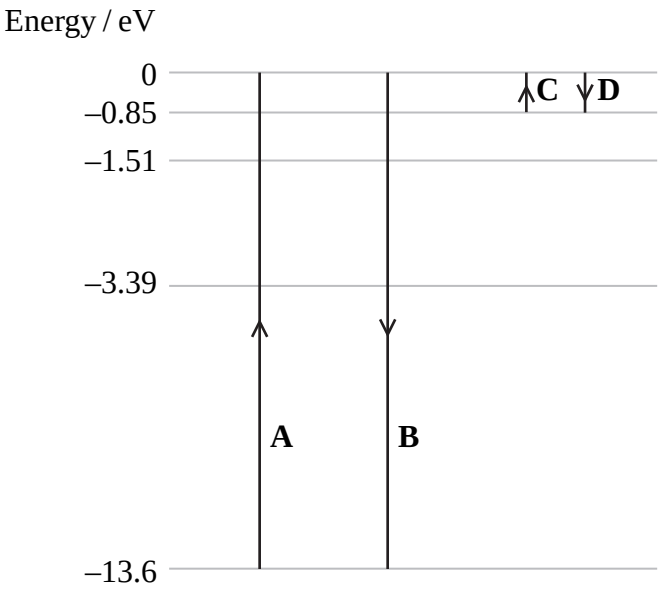
☒ **C** 200 W

☒ **D** 400 W

(Total for Question 4 = 1 mark)

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5 The diagram shows some of the electron energy levels for the hydrogen atom with four possible transitions.



The transition that would result in the emission of the longest wavelength is

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 5 = 1 mark)

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6 Ultrasound pulses are used to detect shoals of fish in the sea. A shoal of fish is at a depth of 300 m and the speed of ultrasound in water is 1500 m s^{-1}. The time interval between transmitting and receiving the pulse will be

☒ **A** 0.20 s

☒ **B** 0.40 s

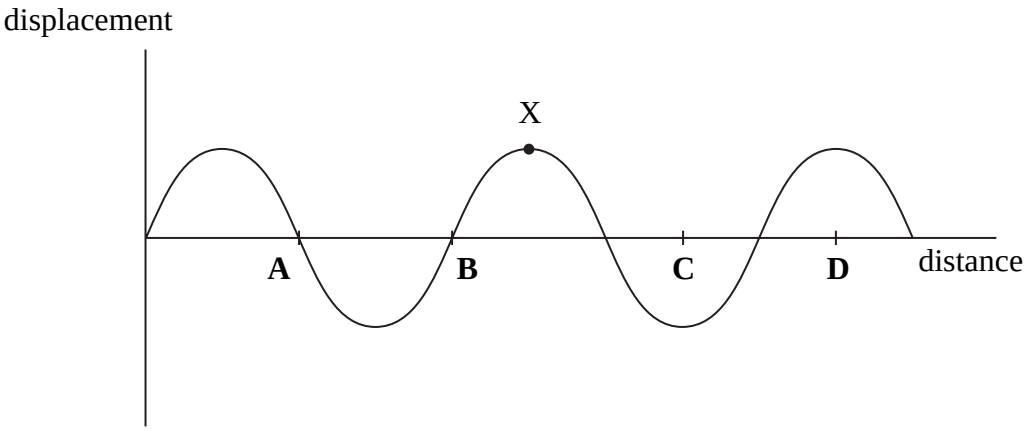
☒ **C** 2.5 s

☒ **D** 5.0 s

(Total for Question 6 = 1 mark)

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7 The graph shows the displacement of molecules against their distance from a wave source. Which of the points A to D, marked on the graph, has a phase difference of 270° with point X?



- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 7 = 1 mark)

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8 The behaviour of light can be described in terms of waves or particles. The particle nature of light can be demonstrated by

- ☒ **A** light being diffracted as it passes through a narrow slit.
- ☒ **B** the speed of light reducing when it is refracted by glass.
- ☒ **C** light causing electrons to be emitted from a metal surface.
- ☒ **D** light being polarised.

(Total for Question 8 = 1 mark)

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9 The current in a wire

☒ **A** depends only on the potential difference applied.

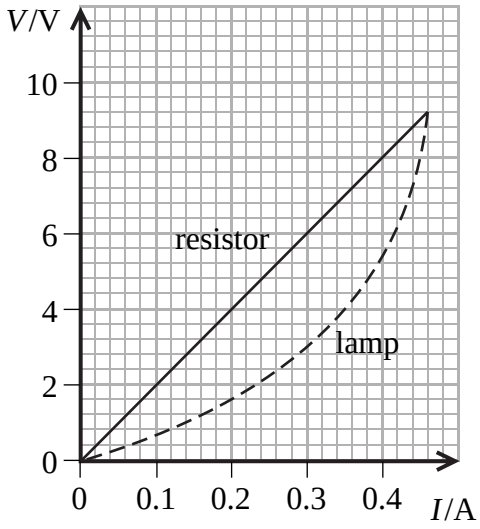
☒ **B** depends only on the resistance of the wire.

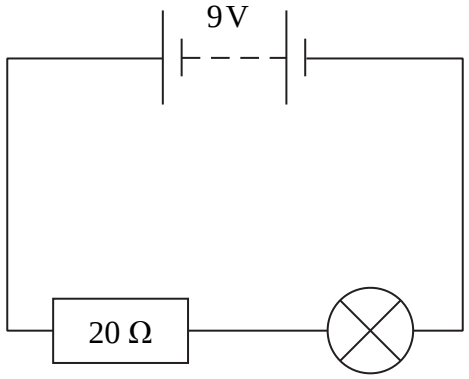
☒ **C** depends on both the potential difference and the resistance of the wire.

☒ **D** does not depend on the potential difference or the resistance of the wire.

(Total for Question 9 = 1 mark)

10 The graph shows the relationship between potential difference V and current I for a fixed 20 Ω resistor and a filament lamp.





The resistor and lamp are placed in series with a 9 V battery of negligible internal resistance. The current in the circuit is

☒ **A** 0.1 A

☒ **B** 0.2 A

☒ **C** 0.3 A

☒ **D** 0.4 A

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 A London radio station broadcasts at a frequency of 95.8 MHz. Calculate the wavelength in air of these radio waves.

Wavelength = ...

(Total for Question 11 = 3 marks)

12 (a) Explain the difference between resistance and resistivity.

(2)

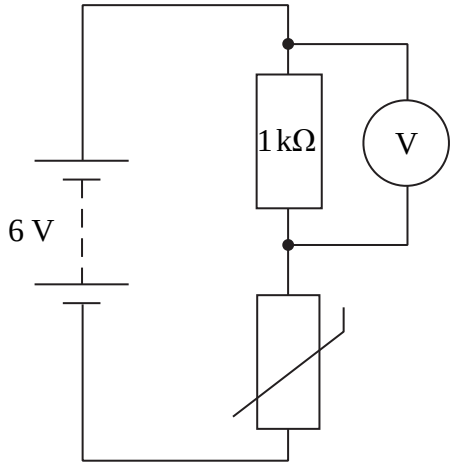
(b) The resistivity of copper is 1.7×10^{-8} Ω m. A copper wire is 0.50 m long and has a cross sectional area of 1.0×10^{-6} m^2. Calculate its resistance.

(2)

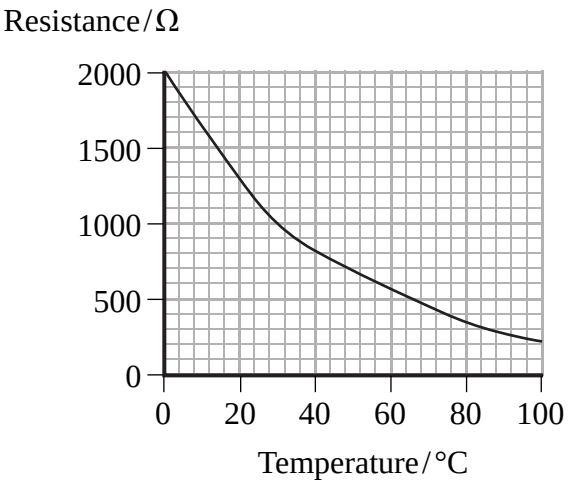
Resistance = ...

(Total for Question 12 = 4 marks)

13 The following circuit is used to monitor the temperature in a greenhouse. The battery has no internal resistance.



(a) The graph shows how the resistance of the thermistor varies with temperature.



(i) Use the graph to find the resistance of the thermistor at 20 °C.

(1)

Resistance = ...

N 3 5 8 7 6 A 0 8 2 4

(ii) Calculate the reading on the voltmeter when the thermistor is at 20 °C.

(3)

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Reading on the voltmeter = ...

(b) Explain what will happen to the reading on the voltmeter as the temperature of the greenhouse decreases.

(2)

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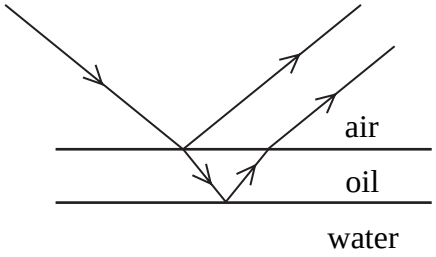
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(Total for Question 13 = 6 marks)

***14** When oil floats on water, coloured interference patterns are often seen. The interference patterns are formed because of the thin film of oil. A thin film of oil can also produce interference patterns with monochromatic light.
The diagram shows light from a monochromatic source, incident on a film of oil.

Explain why interference patterns may be seen.

(5)



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(Total for Question 14 = 5 marks)

***15** Many computers operate through an uninterrupted power supply (UPS) to protect them and the information stored on them from power surges or power cuts. A UPS will run the computer from the mains supply until it detects a problem and then the computer will run off the UPS's rechargeable battery.
A UPS is rated by the maximum power that it can provide to the computer. The unit that is used is the volt-amp (VA).

(a) Use expressions for potential difference and current to show that the volt-amp is equivalent to the watt.

(3)

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(b) Each cell of the rechargeable battery has an internal resistance. An advertisement for a UPS states that, at an output power to the computer of 700 W, it can provide a continuous supply for 7 minutes.

(i) Calculate how much energy is provided in this time.

(2)

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Energy = ...

(ii) The advertisement also states that if the output power is halved, the supply will last for 23 minutes. Without doing any calculations, explain why halving the power output more than doubles the time.

(3)

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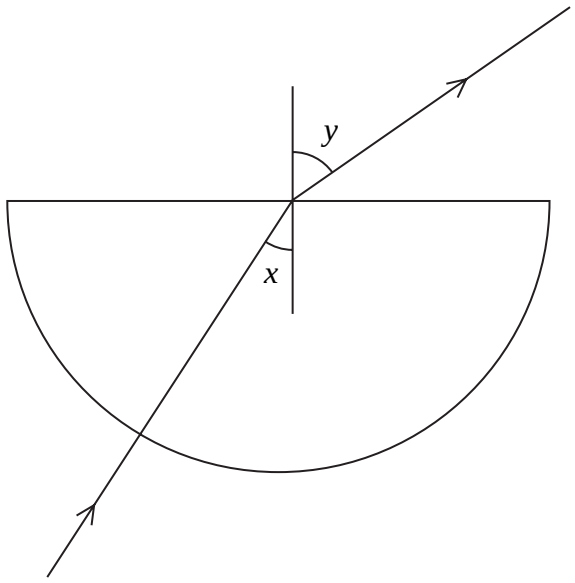
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(Total for Question 15 = 8 marks)

***16** A student carries out an experiment to measure the refractive index of glass. She does this by shining a ray of light through a semicircular glass block and into the air as shown.



$x = 30°$
$y = 48°$

(a) Calculate the refractive index from air to glass ${}_{a}\mu_{g}$.

(2)

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Refractive index = ...

(b) (i) The student steadily increases the angle x in glass and finds that eventually the light does not pass into the air. Explain this observation.

(3)

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(ii) Calculate the largest value of angle x that allows the light to pass out of the block into the air.

(2)

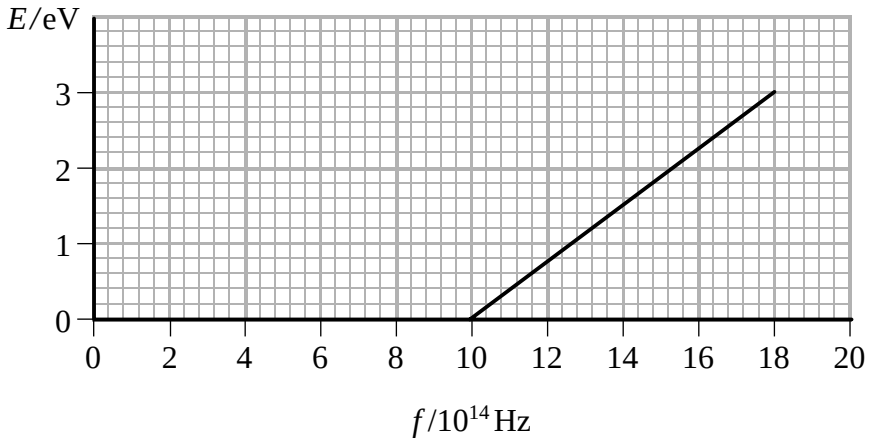
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Angle = ...

(Total for Question 16 = 7 marks)

17 The graph shows how the maximum kinetic energy E of photoelectrons emitted from the surface of aluminium varies with the frequency f of the incident radiation.



(a) Explain why no photoelectrons are emitted below a frequency of 10×10^{14} Hz.

(1)

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(b) Calculate the work function of aluminium in electron volts.

(3)

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Work function = ...

(c) State the quantity represented by the gradient of the graph.

(1)

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(d) Add a second line to the graph to show how E varies with f for a metal which has a work function less than aluminium.

(2)

(Total for Question 17 = 7 marks)

18 A length of wire has a cross-sectional area of 3.1×10^{-6} m^2. A current of 1.5 A flows through the wire when there is a p.d. of 3.0 V across it.

(a) Draw a diagram of the circuit you would use to check these current and p.d. values.

(2)

(b) Calculate the rate at which energy is transferred to the wire.

(2)

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Rate of energy transfer = ...

(c) (i) The wire has 1.0×10^{29} electrons per metre cubed.

Calculate the drift velocity of the electrons.

(2)

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Drift velocity = ...

(ii) The temperature of the wire increases. Explain what happens to the drift velocity of the electrons if the potential difference remains constant.

(3)

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(Total for Question 18 = 9 marks)

19 A student is investigating the physics of an electric guitar. When a string on a guitar is plucked, a standing wave is produced with one antinode.

The student finds that the speed of a wave, v, in a stretched string is given by

$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the string and μ is the mass per unit length of the string.

The student decides to measure the diameters of the strings and the frequency of the fundamental note produced when each string is plucked. She then constructs a spreadsheet to record these results and to calculate v, μ and T for each string.

The strings are made of a material of density (mass per unit volume) 7800 kg m^{-3}.

	A	B	C	D	E	F	G
1	Length / m	Frequency / Hz	Speed / m s^{-1}	Diameter / mm	Volume of a 1 metre length / 10^{-6} m^3	Mass per unit length / 10^{-3} kg m^{-1}	Tension / N
2	0.655	82	107	1.240	1.210	9.42	108
3	0.655	110	144	0.914	0.656		106
4	0.655	147	193	0.711	0.397	3.10	115
5	0.655	196	257	0.457	0.164	1.28	84
6	0.655	247	324	0.356	0.100	0.78	
7	0.655	330	432	0.279	0.061	0.48	90

(a) (i) The formula to calculate the value of cell C3 is

= 2*A3*B3

Explain why this is the correct formula.

(2)

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(ii) Write the formula to calculate the value of cell E3.

(1)

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(iii) Write the formula to calculate the value of cell F4.

(1)

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(iv) Hence calculate the value of cell F3.

(1)

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(v) Calculate the value of cell G6.

(2)

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(b) The student decides to verify the equation $v = \sqrt{\frac{T}{\mu}}$ by using one string.

She removes a string from the guitar and clamps one end in a support. She varies the tension by hanging known weights on the other end of the string. The speed of the wave is calculated from the length of the string and the measured frequency of the fundamental note when the string is plucked.

Describe how the student could use a graph to verify the equation.

(3)

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(Total for Question 19 = 10 marks)

20 Warning traffic signs that tell motorists they are speeding are often solar powered.



The speed of an approaching car is measured by transmitting microwaves towards it. These waves are reflected off the car and picked up by a receiver, which uses the Doppler effect to calculate the speed of the car.

(a) A narrow beam of waves is necessary to pick out a single car. Suggest a reason why microwaves are used rather than radio waves.

(2)

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(b) (i) State how the frequency of the reflected signal would differ from the frequency of the transmitted signal.

(1)

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(ii) Explain how the system detects that a car is speeding.

(2)

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(c) If a car is speeding, the warning sign flashes to alert the driver. The warning sign is powered by solar cells covering a rectangular area 0.5 m × 0.3 m. The average intensity of the solar energy radiation hitting the solar cells is 500 W m^{-2}. The solar cells are 8% efficient at transforming light energy into electrical energy, which is stored in a battery.

(i) Calculate how much electrical energy is produced each second by the solar panel.

(3)

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Electrical energy each second = ...

(ii) The panel receives solar energy for 8 hours per day. The warning sign requires 100 J of electrical energy each time it flashes.

Calculate how many times the warning sign can flash in a day.

(3)

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Number of flashes = ...

(Total for Question 20 = 11 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	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young's modulus	$E = \sigma/\varepsilon$ where Stress $\sigma = F/A$ Strain $\varepsilon = \Delta x/x$
Elastic strain energy	$E_{el} = \frac{1}{2}F\Delta x$

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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{power input}} \times 100$$

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	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Quantum physics

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