BOARD OF STUDIES
NEW SOUTH WALES

2008

HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- Write your Centre Number and Student Number at the top of pages 9, 11, 13, 15, 17 and 19

Total marks – 100

Section I Pages 2–22

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16–27
- Allow about 1 hour and 45 minutes for this part

Section II Pages 23–34

25 marks

- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet for Questions 1–15.

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1 An object on Earth has a weight of 490 N and experiences an acceleration due to gravity of 9.8 m s^{-2}. On Mars, this object would experience an acceleration due to gravity of 3.7 m s^{-2}.

On Mars, what would be the weight of this object?

(A) 490 N

(B) $\frac{490}{9.8}$ N

(C) $\frac{490}{9.8} \times 3.7$ N

(D) $\frac{490}{3.7} \times 9.8$ N

2 Which of these statements best describes the forces acting on a satellite in orbit around Earth?

(A) Although gravity has no effect, there is still an outward force.

(B) The satellite is kept up by an outward force that balances the force due to gravity.

(C) Gravity is the only force acting on the satellite and this results in an inward acceleration.

(D) The effect of gravity is negligible, the satellite is kept in orbit by its momentum and the net force on it is zero.

3 An aeroplane is flying horizontally over level ground. It has an altitude of 490 m and a velocity of 100 m s^{-1}. As the aeroplane passes directly above a cross marked on the ground, an object is released from the aeroplane.

How far away from the cross will this object land?

(A) 490 m

(B) 1000 m

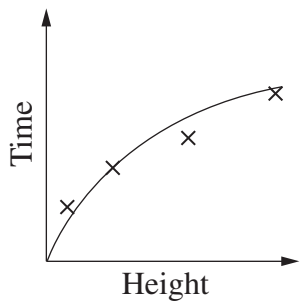
(C) 10 000 m

(D) 49 000 m

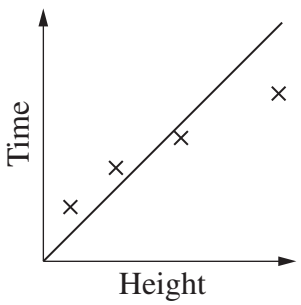
4 An investigation was performed to determine the acceleration due to gravity. A ball was dropped from various heights and the time it took to reach the ground from each height was measured. The results were graphed with the independent variable on the horizontal axis.

Which graph best represents the relationship between the variables?

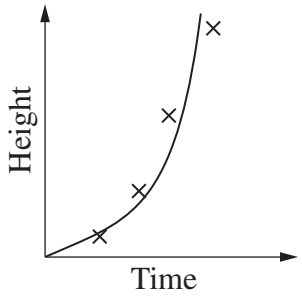
(A)



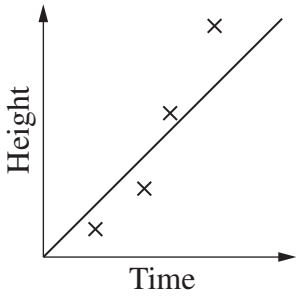
(B)



(C)



(D)



5 A spaceship is travelling away from Earth at 1.8×10^8 m s^{-1}. The time interval between consecutive ticks of a clock on board the spaceship is 0.50 s. Each time the clock ticks, a radio pulse is transmitted back to Earth.

What is the time interval between consecutive radio pulses as measured on Earth?

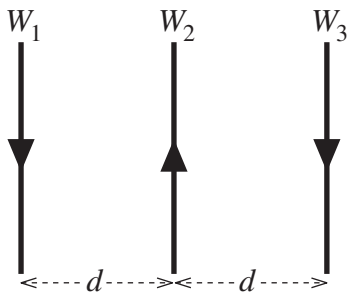
(A) 0.40 s

(B) 0.50 s

(C) 0.63 s

(D) 0.78 s

6 Three identical wires W_1, W_2 and W_3 are positioned as shown. Each carries a current of the same magnitude in the direction indicated.



What is the magnitude and direction of the resultant force on W_2?

	Magnitude	*Direction*
(A)	Zero	None
(B)	Non zero	To the left
(C)	Non zero	To the right
(D)	Non zero	Out of the page

7 Which of the following is necessary for the operation of an AC induction motor?

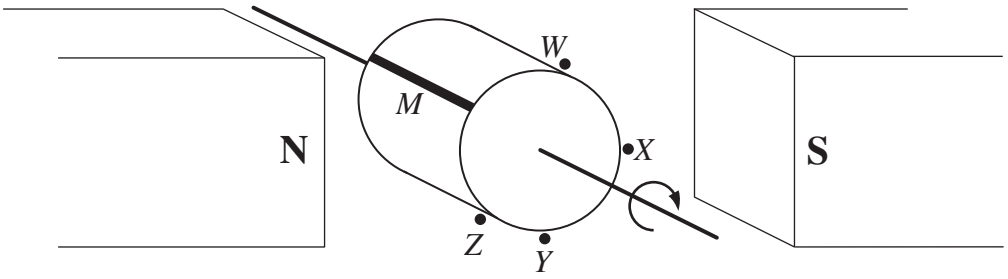
(A) A fixed magnetic field in the rotor

(B) A direct current supply to the rotor

(C) A changing magnetic field in the rotor

(D) Split rings conducting current to the rotor

8 A plastic cylinder with a metal strip, *M*, on its surface is rotated at constant speed about its axis, in a uniform magnetic field. During each rotation the strip, *M*, passes locations *W*, *X*, *Y* and *Z* shown below.



When is the potential difference across *M* greatest?

(A) As *M* passes *W*.

(B) As *M* passes *X*.

(C) As *M* passes *Y*.

(D) As *M* passes *Z*.

9 Which statement best explains how induction cooktops heat food?

(A) Eddy currents generated in the water in the food produce heat.

(B) Eddy currents generated in the base of the saucepan produce heat.

(C) Resistance in the glass of the cooktop produces heat.

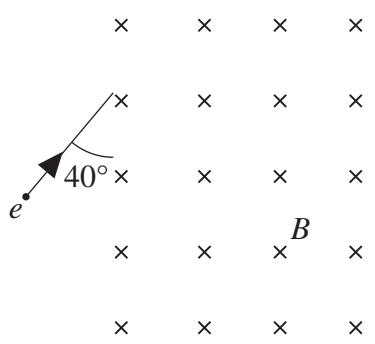
(D) Resistance in the element beneath the glass cooktop produces heat.

10 The cathode ray tube and transistor circuits in a conventional television rely on transformers.

What transformation of the 240 V AC input voltage do these components require?

	Cathode ray tube	*Transistor circuits*
(A)	Step-up	Step-down
(B)	Step-down	Step-up
(C)	Step-up	Step-up
(D)	Step-down	Step-down

11 An electron, e, moving with a velocity of 8.0×10^6 m s^{-1} enters a uniform magnetic field, B, of strength 2.1×10^{-2} T as shown.



The electron experiences a force which causes it to move along a circular path.

What is the radius of the path followed by the electron?

(A) 1.1×10^{-3} m

(B) 1.4×10^{-3} m

(C) 1.7×10^{-3} m

(D) 2.2×10^{-3} m

12 The debate as to whether cathode rays are charged particles or electromagnetic waves continued for many years.

Which observation of cathode rays resolved this debate?

(A) Cathode rays can turn a paddle wheel.

(B) An electric field can deflect cathode rays.

(C) Cathode rays can penetrate thin metal foil.

(D) Fluorescent screens glow when struck by cathode rays.

13 What is the energy of a photon of wavelength 580 nm?

(A) 3.43×10^{-19} J

(B) 3.43×10^{-28} J

(C) 3.85×10^{-31} J

(D) 3.85×10^{-40} J

14 When a magnet is released above a superconductor that has been cooled below its critical temperature, the magnet hovers above the superconductor. This is called the Meissner effect.

What is the best explanation for this?

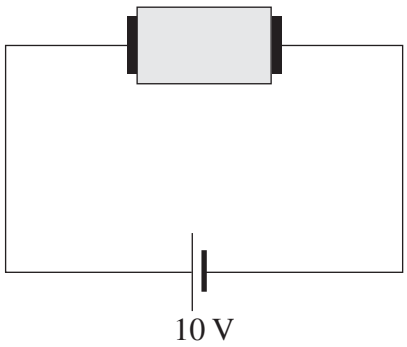
(A) The net force is zero due to electrostatic repulsion.

(B) The magnetic field freezes at very low temperature.

(C) The net force is zero due to repulsion between the Cooper pairs.

(D) The superconductor excludes magnetic fields at very low temperatures.

15 A block of silicon doped with boron is connected as shown in the diagram below.



What is the main way in which conduction occurs in the doped silicon block?

(A) Valence band electrons move to the right.

(B) Valence band electrons move to the left.

(C) Conduction band electrons move to the right.

(D) Conduction band electrons move to the left.

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Physics

Centre Number

Student Number

Section I (continued)

Part B – 60 marks
Attempt Questions 16–27
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (3 marks)

Using a diagram and text, describe how an investigation can be performed to demonstrate the production and reception of radio waves. **3**

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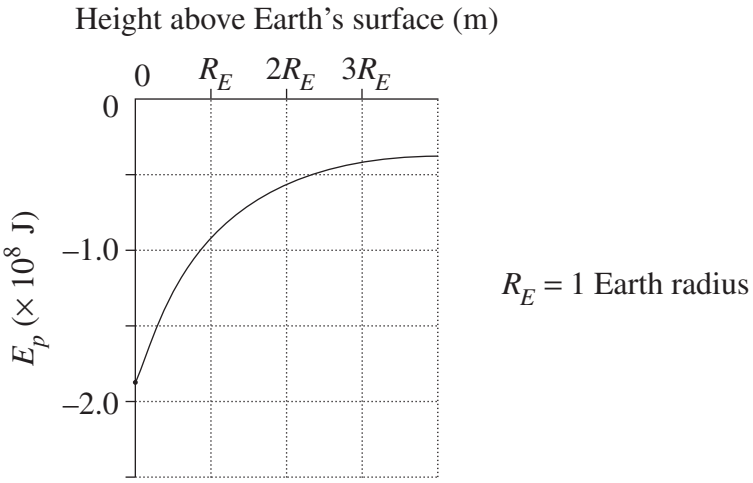
Marks

Question 17 (5 marks)

The graph below represents the gravitational potential energy (E_p) of a mass as it is raised above Earth's surface.



(a) From the graph, what is the gravitational potential energy of the mass when it is one Earth radius above Earth's surface? **1**

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(b) Use an equation to explain why the graph is a curve and not a straight line. **1**

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(c) Explain what happens to a rocket's chemical energy, kinetic energy and gravitational potential energy when it is being launched from the surface of Earth. **3**

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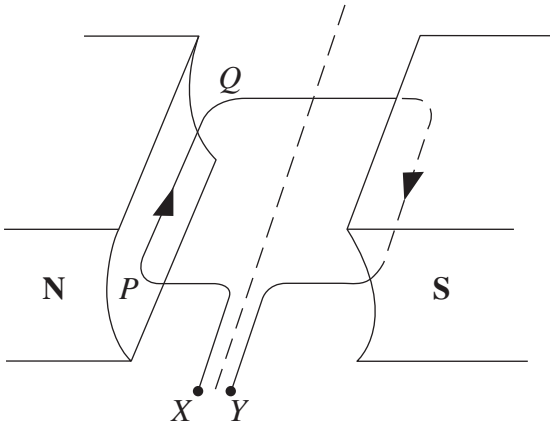
Marks

Question 18 (4 marks)

The diagram shows a coil in a magnetic field. The coil can rotate freely.



The coil is connected to a power supply and, at the instant shown, terminal *X* is positive.

(a) In which direction will side *PQ* initially move? **1**

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(b) When the coil starts rotating, the potential difference experienced by the electrons in the wire is less than that supplied by the power supply. **3**

Describe the origin of this effect.

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Marks

Question 19 (8 marks)

(a) Explain the changes in momentum when a satellite fires its propulsion system. **3**

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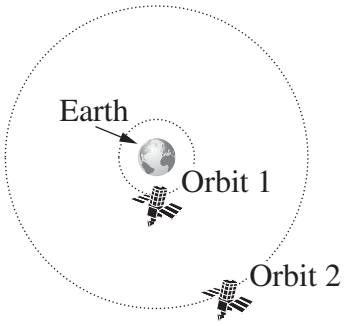
(b) A satellite is propelled from Orbit 1 to Orbit 2 as shown in the diagram.



Orbit 2 has a radius of 27 000 km. What is the satellite's speed in this orbit? **3**

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(c) The radius of Orbit 2 is four times that of Orbit 1. What is the ratio of the new orbital period to the original period? **2**

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Centre Number

Student Number

Section I (continued)

Marks

Question 20 (4 marks)

Compare how electric current is conducted through samples of germanium at room temperature, mercury at room temperature and mercury at 3 K (T_c for mercury is 4.2 K). **4**

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Marks

Question 21 (6 marks)

'The work of scientists is influenced by external factors.' **6**

Do you agree? Justify your answer with reference to the work of a scientist in the development of

- space exploration

OR

- large-scale electricity distribution systems.

Centre Number

Student Number

Section I (continued)

Marks

Question 22 (3 marks)

Explain why the development of transformers was necessary to enable the large-scale distribution of electrical power. **3**

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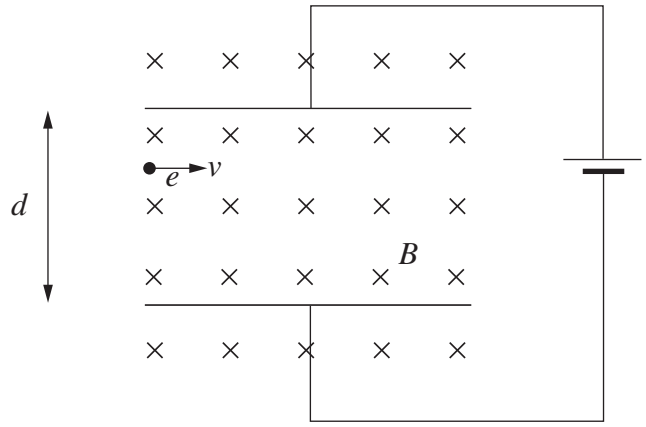
Marks

Question 23 (7 marks)

Two parallel metal plates in a magnetic field are separated by a distance d, as shown. An electron enters the space between the plates.



(a) On the diagram indicate with an arrow the direction of the force on the electron due to the magnetic field. **1**

(b) The strength of the magnetic field is $B = 0.001$ T and the electron's velocity is $v = 2 \times 10^6$ m s^{-1}. Calculate the magnitude of the magnetic force on the electron. **2**

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(c) If $d = 10$ mm, calculate the voltage required for the electron to continue on a straight path parallel to the plates. **2**

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(d) How was this experimental set-up used by Thomson to determine the charge/mass ratio of an electron? **2**

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Centre Number

Student Number

Section I (continued)

Marks

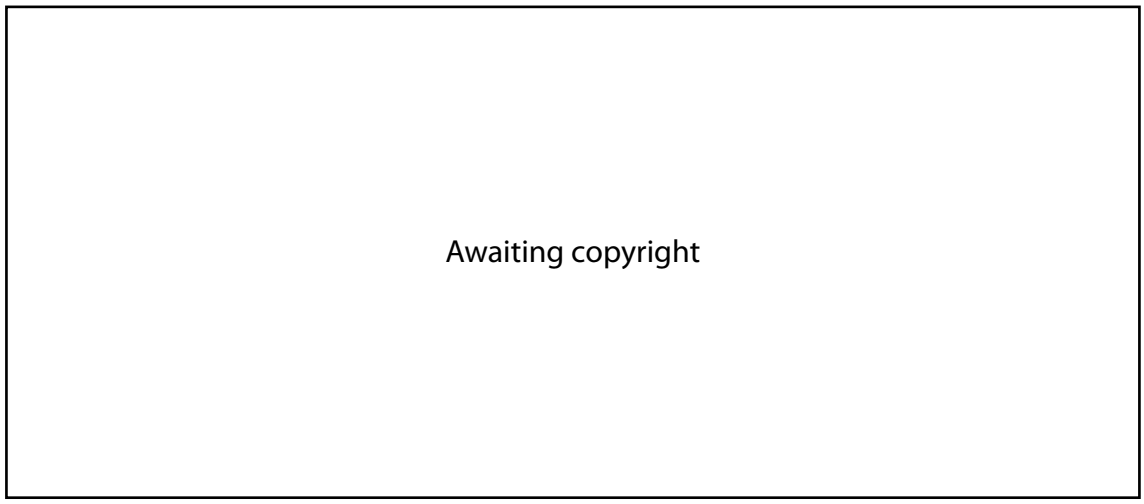
Question 24 (6 marks)

How did Einstein's theory of special relativity and his explanation of the photoelectric effect lead to the reconceptualisation of the model of light? **6**

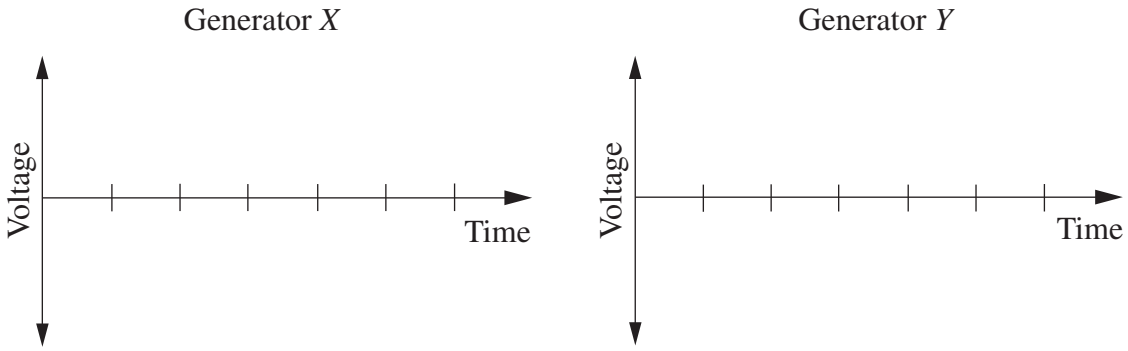
Marks

Question 25 (5 marks)

The diagrams show two different types of generator spinning at the same number of revolutions per minute. The difference between the two generators is in the way they are connected to the external circuits.



(a) On the axes below, sketch a voltage-time graph for each generator. **2**



(b) Explain how the difference in connection to the external circuit accounts for the different output voltages. **3**

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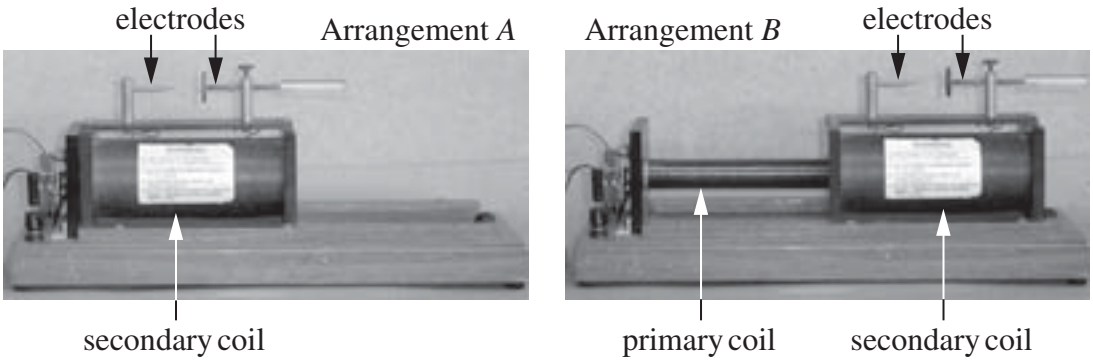
Marks

Question 26 (3 marks)

An induction coil is a type of transformer that allows a small voltage to be stepped up to a higher voltage. An induction coil consists of a primary coil wound around an iron core and a secondary coil. The secondary coil can be moved sideways so that different lengths of the iron core are within the secondary coil.

The photographs show an induction coil with the secondary coil in two different arrangements with the power supply turned off. At sufficiently high voltages a spark can be produced between the secondary coil electrodes.



(a) Which arrangement would produce a spark when the power supply is turned on? Justify your choice. **1**

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(b) Explain how different voltages are induced when the secondary coil is moved to different positions. **2**

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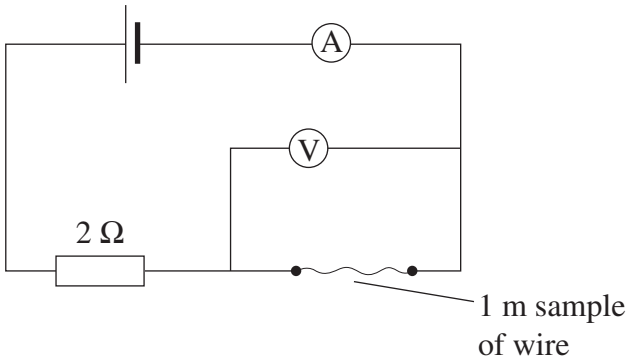
Question 27 (6 marks)

A student was given a sample of wire *X* and a sample of wire *Y*. The wires looked identical. However, one was pure chromium and the other was nichrome, an alloy containing chromium and nickel.

To differentiate between the two wires, the student set up the circuit below and obtained the results shown in the table.



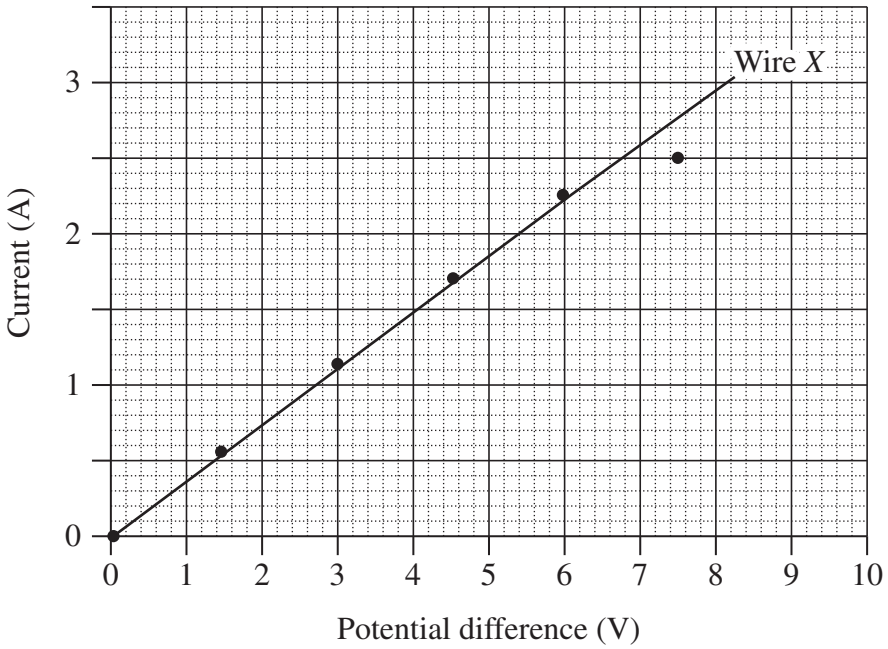
Potential difference (V)	*Current* (A)	
	Wire X	*Wire Y*
0	0	0
1.5	0.57	0.20
3.0	1.14	0.39
4.5	1.71	0.59
6.0	2.28	0.79
7.5	2.50	0.99

Question 27 continues on page 21

Marks

Question 27 (continued)

(a) The data for wire *X* has been plotted on the graph below. Plot the data, including a trend line, for wire *Y* on the same graph. **2**



(b) Calculate the resistance of wire *Y*. **1**

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(c) Which sample of wire was pure chromium? Justify your response with reference to your graph. **2**

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(d) When the data for wire *X* was plotted, one data point was considered inconsistent and was disregarded when drawing the trend line for calculating its resistance. **1**

Suggest a physical reason why this data point is inconsistent with the trend line.

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End of Question 27

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Physics

Section II

25 marks
Attempt ONE question from Questions 28–32
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Marks

Question 28 — Geophysics (25 marks)

(a) The table lists some of the principal methods used in geophysics, a property on which each method is based and an application of each method.

Method used in geophysics	*Property of earth materials*	*Application*
Magnetic	Magnetism	Plate tectonics
Gravitational	Density	*X*
Electrical	*Y*	Water location
Seismic	Elasticity of medium	*Z*

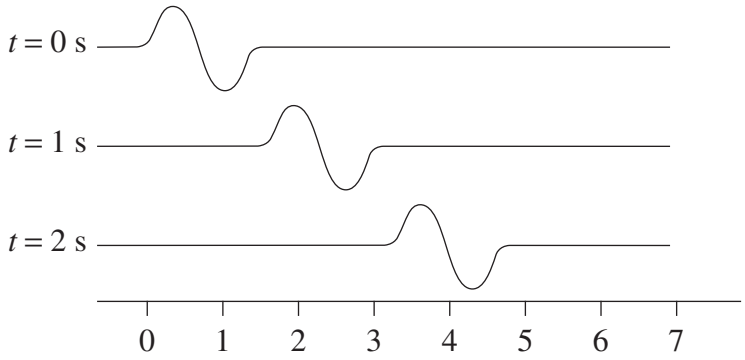
(i) From the table, what do the letters *X*, *Y* and *Z* represent? **3**

(ii) For any one of the principal methods used in geophysics describe how the type of information generated can be used to advance our understanding of Earth. **3**

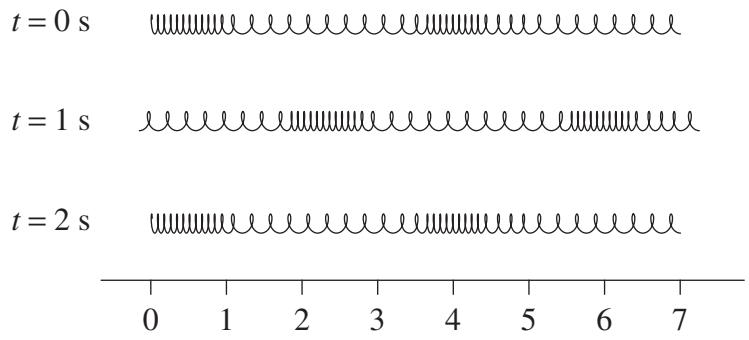
Question 28 continues on page 25

Question 28 (continued)

(b) An *S* wave can be modelled by a transverse pulse sent along a string as indicated below.



A *P* wave can be modelled by a compression wave sent along a slinky spring as indicated below.



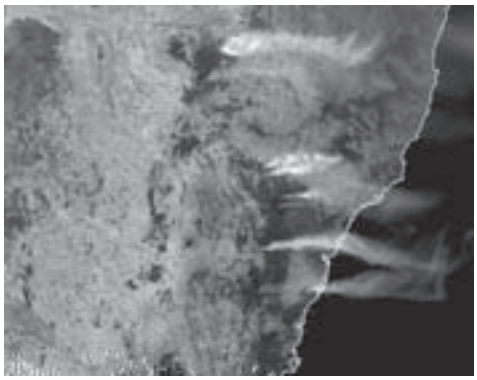
(i) Calculate the speeds of the *S* wave and the *P* wave shown. **3**

(ii) Explain how *S* waves and *P* waves are reflected and refracted at an interface. **4**

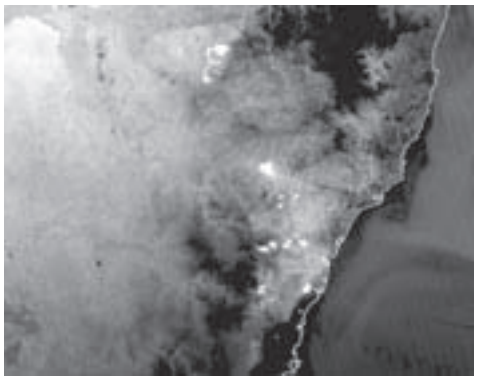
Question 28 continues on page 26

Question 28 (continued)

(c) The CSIRO Remote Sensing Project used images from the NOAA satellites to produce the following scenes of the NSW bushfires in December 1997. The two images were taken simultaneously using different techniques.



visible image



thermal image

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(i) With reference to the two images of the scene, explain the underlying physical principles that result in the different images. **3**

(ii) Describe the role of remote sensing techniques in monitoring climate, pollution and natural hazards. **3**

(d) Both geophones and seismometers detect seismic activity. **6**

Compare the structure and function of these devices and the information they provide about the large-scale structure of the Earth.

End of Question 28

Marks

Question 29 — Medical Physics (25 marks)

(a) (i) Account for the production and detection of ultrasound waves by the transducer of an ultrasound machine. **3**

(ii) Explain what happens to ultrasound waves as they travel through body tissues and return to the transducer. **3**

(b) (i) Outline TWO uses of endoscopy. **2**

(ii) Using diagrams, distinguish between the coherent and incoherent bundles of optical fibres and their roles in endoscopy. **3**

(iii) Outline ONE advantage of endoscopy over alternative surgical procedures. **1**

(c) (i) Contrast the advantages of bone scans with the advantages of X-ray images when examining bones. **3**

(ii) Describe how X-rays are produced. **2**

(iii) Describe the properties of a radiopharmaceutical substance that make it suitable for producing a bone scan. **2**

(d) Explain how different medical imaging techniques use tomography to improve our diagnostic abilities. **6**

End of Question 29

Marks

Question 30 — Astrophysics (25 marks)

(a) The analysis of electromagnetic radiation is widely used by astronomers.

(i) Contrast emission and absorption spectra in terms of how they are produced. **3**

(ii) Describe the physical characteristics of stars and their motion that can be revealed by spectroscopy. **3**

(b) The table shows some photometric measurements of certain stars.

Star	*Apparent magnitude*	*Absolute magnitude*	*Colour index*
Bellatrix	+1.64	−2.72	−0.22
Sirius A	−1.47	+1.42	+0.01
Regulus A	+1.35	−0.52	−0.11
Betelgeuse	+0.58	−5.14	+1.85

(i) How much brighter is Sirius A than Bellatrix when viewed from Earth? **2**

(ii) Calculate the distance from Earth to Regulus A. **2**

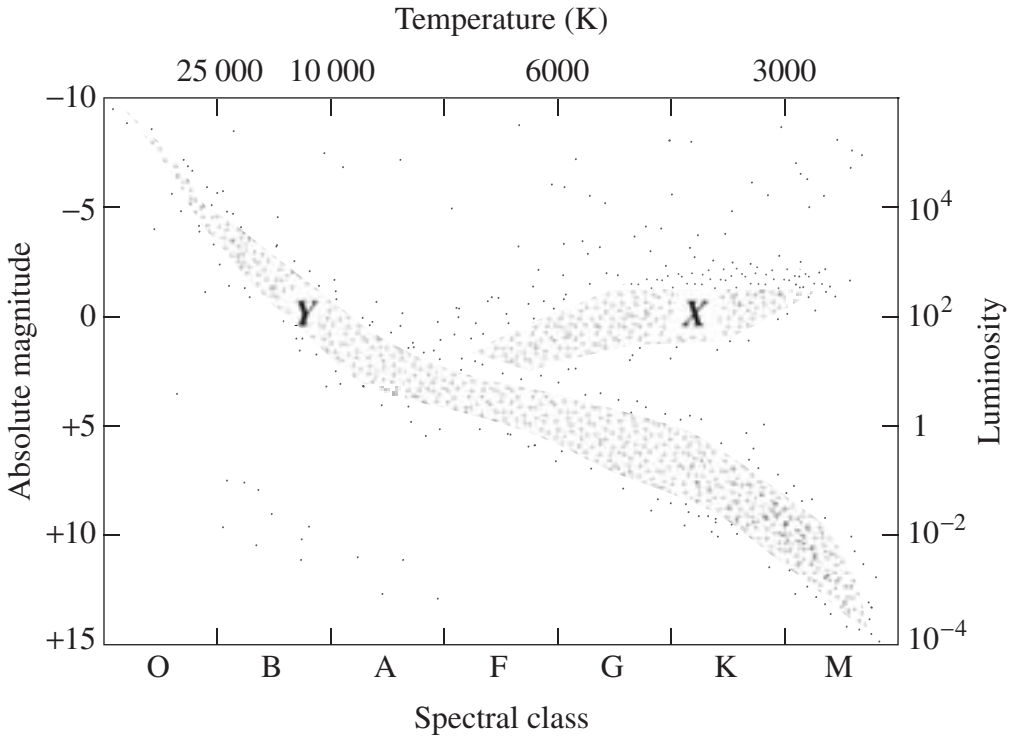
(iii) Explain why cooler stars have a more positive colour index than hotter stars. **3**

Question 30 continues on page 29

Question 30 (continued)

(c) (i) Describe the physical processes that precede nuclear fusion reactions in a newly formed star. **2**

(ii) Compare the nuclear reactions occurring in stars located at positions ***X*** and ***Y*** on the HR diagram below. **2**



(iii) Draw a flowchart summarising the possible pathways a red giant could follow as it evolves. **2**

(d) Explain how observations of binary and variable stars can be used to infer physical properties of these stars. **6**

End of Question 30

Marks

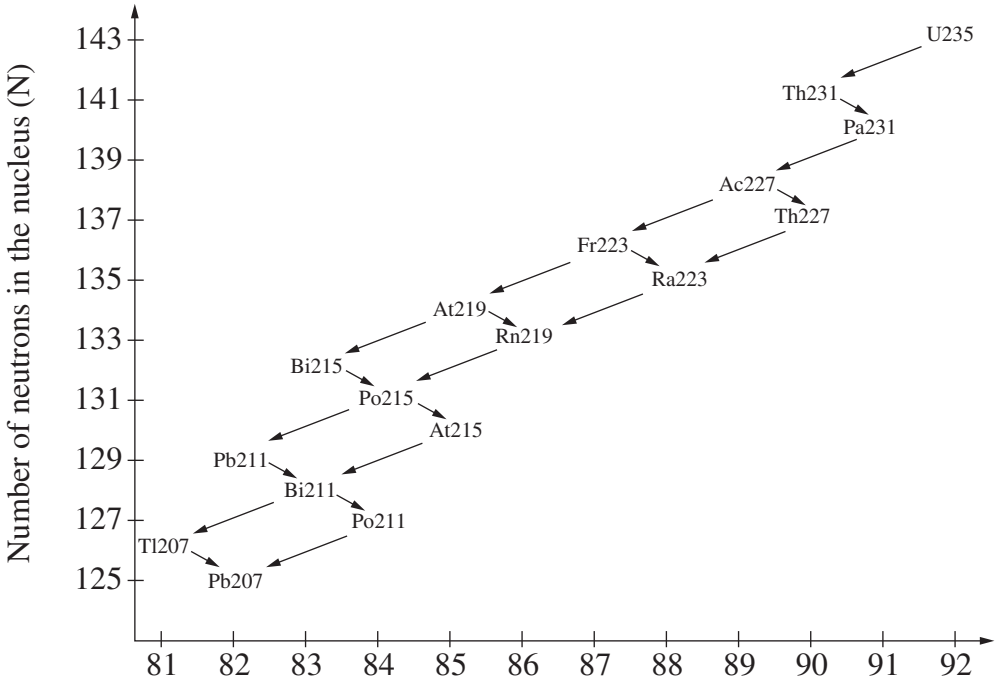
Question 31 — From Quanta to Quarks (25 marks)

(a) (i) Outline how you would conduct a first-hand investigation to observe the visible components of the hydrogen emission spectrum. **2**

(ii) How would the results from this investigation support Bohr's model of the atom? **2**

(iii) Outline ONE feature of atomic emission spectra that cannot be explained by Bohr's model. **2**

(b) Nuclear transmutations caused by natural radioactivity can be represented in diagrams such as the one shown. Each symbol represents a radioactive element and each arrow represents a transmutation.



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(i) How many protons and how many neutrons are there in the nucleus of a Thorium-227 atom? **1**

(ii) Write the equation for the α-decay of Francium-223. **2**

Question 31 continues on page 31

Marks

Question 31 (continued)

(c) (i) An atom of Carbon-12 has 6 protons and 6 neutrons in its nucleus. The mass of a Carbon-12 atom is 12.000 atomic mass unit. Show that the mass defect of one Carbon-12 atom is 0.097 atomic mass unit. **3**

(ii) How much energy is this mass defect equivalent to? **1**

(d) (i) Use a diagram to outline one way in which physicists obtain particles with the appropriate energy to investigate the structure of matter. **2**

(ii) Describe the key features and components of the standard model of matter. **4**

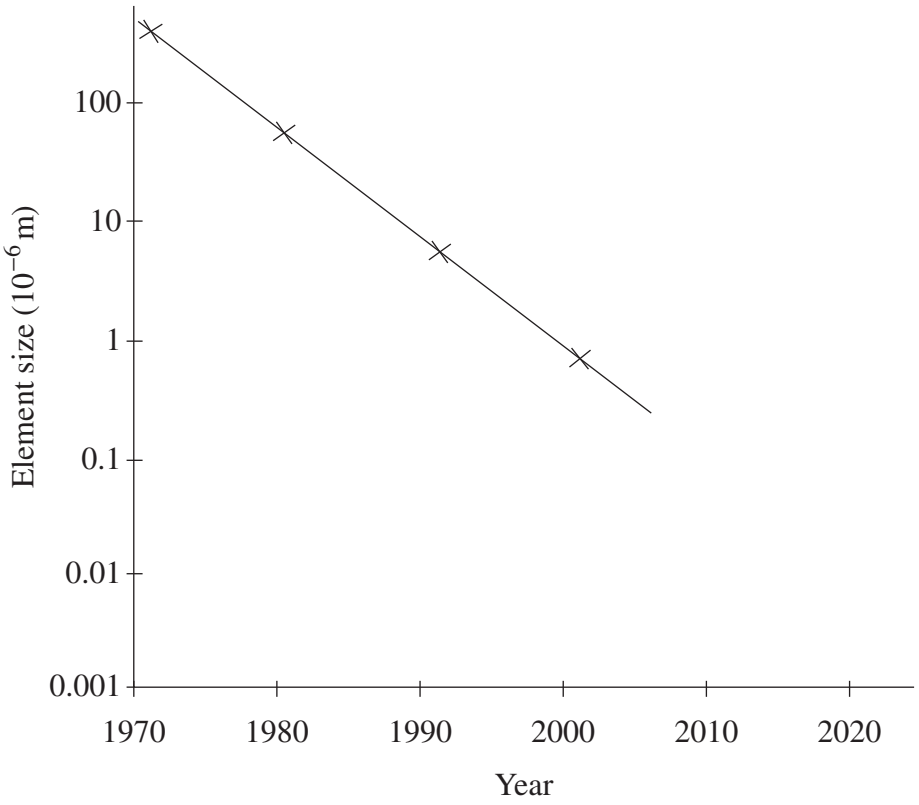
(e) Use the work of TWO physicists to explain how the combination of ideas led to new directions in scientific thinking about atomic structure. **6**

End of Question 31

Marks

Question 32 — The Age of Silicon (25 marks)

(a) The graph below shows how the size of integrated circuit elements has changed over the interval 1970–2000.



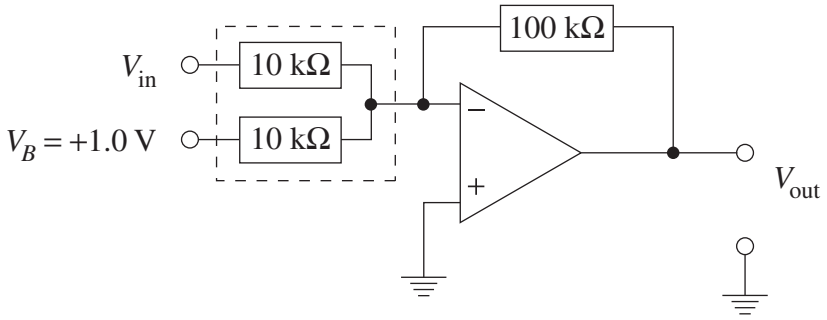
(i) Explain the effect that this trend has had on computer performance. **3**

(ii) Comment on the validity of using this data to predict integrated circuit element size in 2040. **2**

Question 32 continues on page 33

Question 32 (continued)

(b) An ideal differential-input operational amplifier is connected into the following circuit.

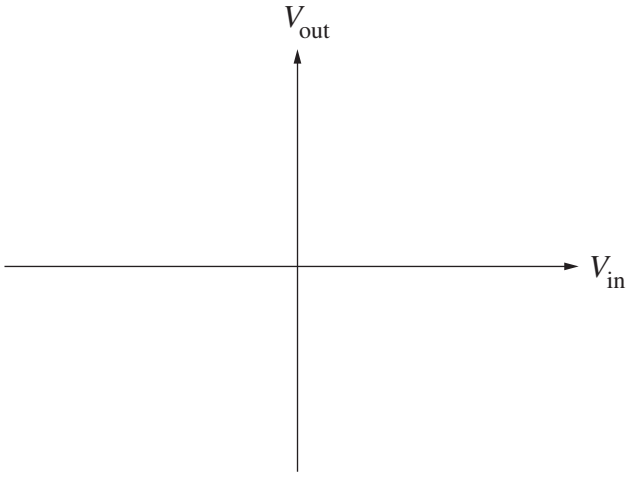


(i) Describe the properties of an ideal operational amplifier. **2**

(ii) Identify the function of the 100 kΩ resistor in this circuit. **1**

(iii) Identify the function of the portion of the circuit enclosed in the dashed box. **1**

(iv) Copy the axes below into your writing booklet and sketch the V_{out} vs V_{in} transfer characteristic of this amplifier. **3**



Question 32 continues on page 34

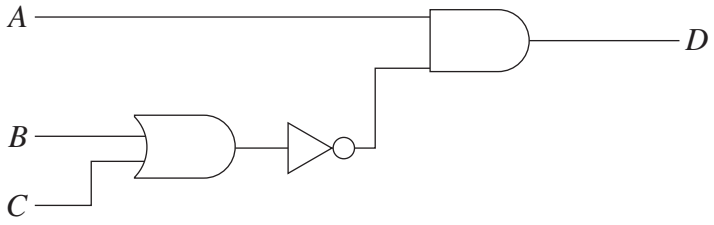
Question 32 (continued)

(c) In recent years, torches using LEDs rather than incandescent bulbs have become commonly available.

(i) Describe the internal structure and operation of a typical LED. **2**

(ii) Explain why LEDs are preferable to incandescent bulbs in this application. **2**

(d) For the logic circuit below, construct a truth table showing the output *D* for all possible combinations of inputs on *A*, *B* and *C*. **3**



(e) Advances in computer technology based on high-speed digital integrated circuits have had a huge impact on the design of electronics. However, analogue transducers still play an important role in many modern circuits. **6**

Explain these statements, providing examples from modern electronics.

End of paper

DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

FORMULAE SHEET

$$v = f\lambda$$

$$I \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$E = \frac{F}{q}$$

$$R = \frac{V}{I}$$

$$P = VI$$

$$\text{Energy} = VIt$$

$$v_{\text{av}} = \frac{\Delta r}{\Delta t}$$

$$a_{\text{av}} = \frac{\Delta v}{\Delta t} \quad \text{therefore} \quad a_{\text{av}} = \frac{v - u}{t}$$

$$\Sigma F = ma$$

$$F = \frac{mv^2}{r}$$

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

$$E_p = -G\frac{m_1 m_2}{r}$$

$$F = mg$$

$$v_x^{\,2} = u_x^{\,2}$$

$$v = u + at$$

$$v_y^{\,2} = u_y^{\,2} + 2a_y\Delta y$$

$$\Delta x = u_x t$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = \frac{Gm_1 m_2}{d^2}$$

$$E = mc^2$$

$$l_v = l_0\sqrt{1 - \frac{v^2}{c^2}}$$

$$t_v = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$m_v = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$d = \frac{1}{p}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{\left(m_B - m_A\right)/5}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$c = f\lambda$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{h}{mv}$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

$$A_0 = \frac{V_{\text{out}}}{V_{\text{in}}}$$

$$\frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_{\text{f}}}{R_{\text{i}}}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Atomic Number: 79 — Symbol of element: Au — Atomic Weight: 197.0 — Name of element: Gold

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.