PETRUS KY COLLEGE
NEW SOUTH WALES

in partnership with

VIETNAMESE COMMUNITY IN AUSTRALIA
NSW CHAPTER

JULY 2007

PHYSICS

PRE-TRIAL TEST

HIGHER SCHOOL CERTIFICATE (HSC)

Student Number: | | | | |

Student Name: _____

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours and 15 minutes
- 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 1 and 8

TOTAL MARKS: 75

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

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

Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

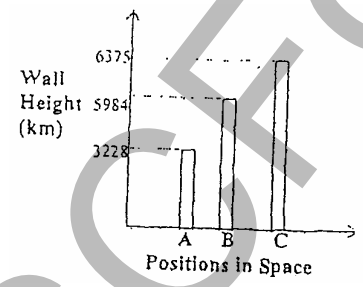
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word correct and drawing an arrow as follows.

Question

1 The science fiction author Arthur C. Clarke once stated the energy gain necessary to get into space in terms of the height of the wall you would have to climb under constant sea-level gravity.



A = low Earth orbit

B = geo-stationary orbit

C = beyond Earths gravity

How much energy would need to be expended to lift a satellite, of a total average mass of 1000 kg, from a low earth orbit to a position where it remained in the same relative position above the Earth's equator?

(A) 2.7×10^{10} J
(B) 2.7×10^{7} J
(C) 3.09×10^{10} J
(D) 2.76×10^{6} J

2 A pendulum can be used to measure the acceleration due to gravity. The equation $T = 2\pi\sqrt{(1/g)}$ is used. At a distance R from the centre of a planet the period of such a pendulum is found to be 10.0 seconds. What will be the period of the pendulum at a distance 2R from the centre of the planet?

(A) 14 seconds
(B) 7 seconds
(C) 20 seconds
(D) 5 seconds

3 Which of the following is a correct statement about escape velocity?

(A) The initial velocity which rockets must have to escape the earth's gravitational field.
(B) The initial velocity which rockets must have to achieve a stable earth orbit.
(C) The initial velocity which projectiles must have to achieve a stable earth orbit.
(D) The initial velocity which projectiles must have to escape the earth's gravitational field.

4 In the slingshot effect a space probe swings around behind a planet and emerges with increased momentum and kinetic energy. Which of the following is the ultimate source of that energy?

(A) The potential energy of the space probe
(B) The potential energy of the planet.
(C) The kinetic energy of the planet.
(D) The gravitational field of the planet

5 Which of the following was not a postulated property of the aether which was investigated in the Michelson-Morley experiment?

(A) It was highly elastic.
(B) It was the medium carrying light waves which made the aether visible.
(C) It had negligible mass.
(D) It passed through all objects in the universe including solids.

6 Which of the following is the best description of the outcome of the Michelson-Morley experiment?

(A) It failed to detect any motion of the earth relative to the aether

(B) It produced an interference shift when the apparatus was rotated

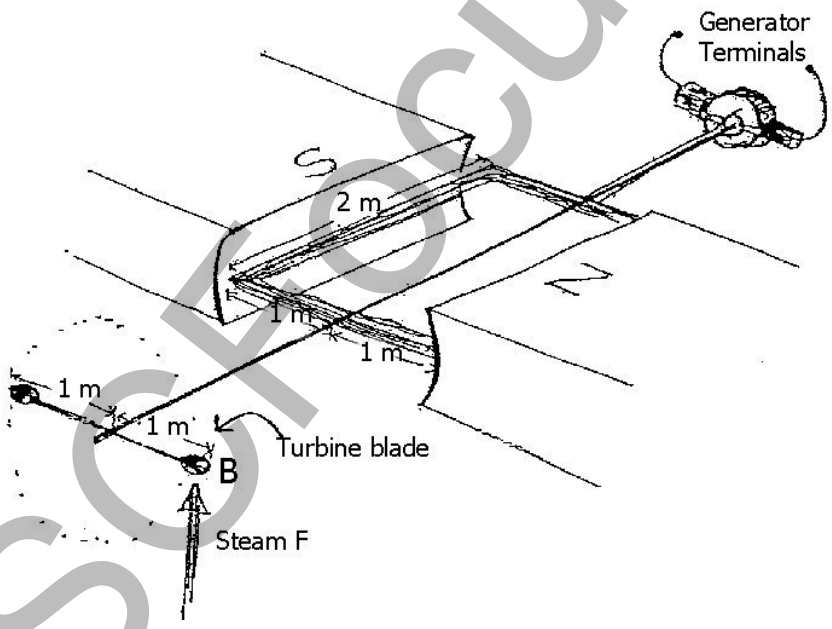
(C) It showed that the speed of light was a constant.

(D) It showed that all velocities are relative to the speed of light.

7 Refer to the diagram below, and assume frictionless bearings.

F is the only force being applied to the blade of a steam driven turbine in an early power station.

What magnitude of force F must the steam apply at B to produce the torque necessary to generate a current of 15A in a 500 turn coil which is in a magnetic field of 5T?



(A) Zero N

(B) 1.5×10^2 N

(C) 3.0×10^2 N

(D) 1.5×10^5 N

8 A field of magnetic flux density (magnetic field intensity) 4 T could be formed by a magnetic flux of 2 Wb passing through a circular coil. What is the radius of the coil?

(A) 0.2 m
(B) 0.4 m
(C) 0.8 m
(D) 1.0 m

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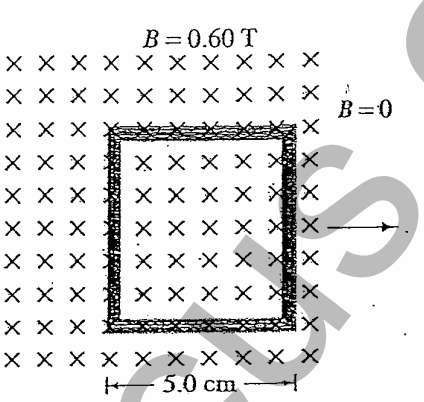


Faraday's Law can be expressed as $\varepsilon = -\Delta \Phi_B / \Delta t$. Where ε = induced emf, $\Delta \Phi_B$ = change in magnetic flux, Δt = change in time. The square metallic coil (see diagram above) has 100 loops and is in a magnetic fie1d where B = 0.60 T. Over a period of 0.50 s it is pulled smoothly to the right into a region where B = 0. What will be the change in the magnetic flux through the square coil, the emf induced and the direction of the induced (conventional) current?

(A)	1.5×10^{-1} Wb,	3.0×10^{-4} V,	anticlockwise
(B)	1.5×10^{-3} Wb,	0.3 V.	clockwise
(C)	-1.5×10^{-1} Wb,	3.0×10^{-4} V,	anticlockwise
(D)	-1.5×10^{-3} Wb,	0.3 V,	clockwise

10 Which of the following alternatives best describes what a simple, 240V, 50Hz, AC motor will do when switched on and allowed to run at the rate of the current supplied?

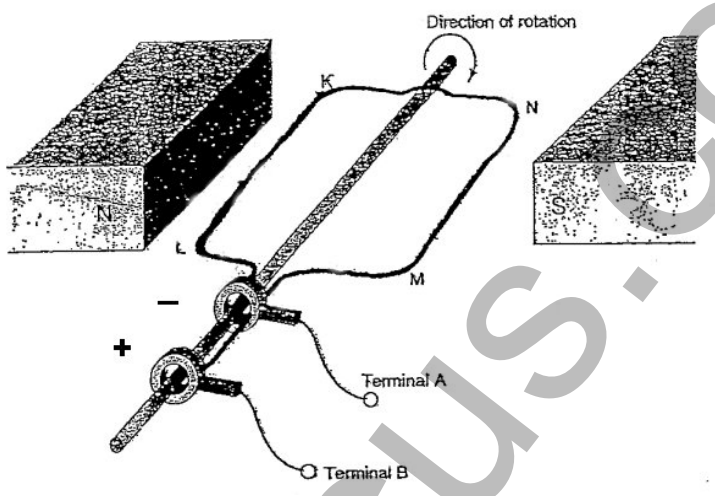
(A) Spin near 3000 revolutions per minute

(B) Spin at a rate that is dependent on the amount of electricity that is supplied to the motor

(C) Spin its stator at 50Hz to induce the rotor to spin in step with it.

(D) Very quickly overheat the bearings supporting the rotor, seize-up, and stop.

11 Which of the following statements best describes the generator in the diagram below?



(A) This is a DC generator and at the instant shown in the diagram Terminal A is negative.

(B) This is a DC generator and at the instant shown in the diagram Terminal A is positive.

(C) This is an AC generator and at the instant shown in the diagram Terminal A is negative.

(D) This is an AC generator and at the instant shown in the diagram Terminal A is positive.

12 In an ideal situation there should be no power loss when changing from one voltage to another. That is, the primary power will be equal to the secondary power, or $P_P = P_S$.

In these circumstances it is also possible to calculate the secondary current, I_S. Which equation below allows I_S to be calculated correctly?

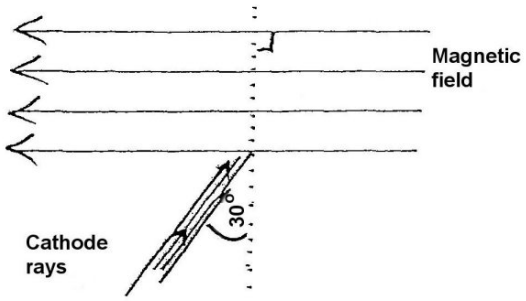
(A) $I_s = I_p n_p / n_s$

(B) $I_s = n_p / n_s I_p$

(C) $I_s = I_p Vs / V_p$

(D) $I_s = V_p / V_s I_p$

13 Cathode rays enter a 0.1 T magnetic field at an angle of 30° and at 5.0 x 10^6 ms^{-1} as shown in the diagram below. What is the force on each electron in the beam as it enters The magnetic field?



(A) 4.0 x 10^{-14} N into the page

(B) 6.9 x 10^{-14} N into the page

(C) 4.0 x $l0^{-14}$ N out of the page

(D) 6.9 x 10^{-14} N out of the page

14 An FM radio station transmits at a frequency of 102.8 MHz.

What is the energy, in joules, of each photon emitted by the transmitter?

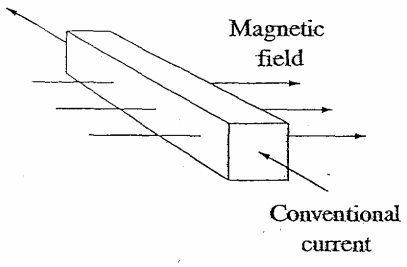
(A) 6.446 x 10^{-42}

(B) 6.812 x 10^{-26}

(C) 2.918

(D) 3.084 x 10^{16}

15 A current is passed along a square semiconductor rod as shown. Half of the current is carried by electrons and half by holes. A magnetic field is then applied to the rod at right angles to its axis.



Which of the following correctly describes the movement of the electrons and holes in the rod when the magnetic field is applied?

(A) They speed up.

(B) They slow down.

(C) They move to the same side of the rod.

(D) They move to opposite sides of the rod.

Physics

Student Number: | | | | |

Part B — 60 marks

Attempt Questions 16—27

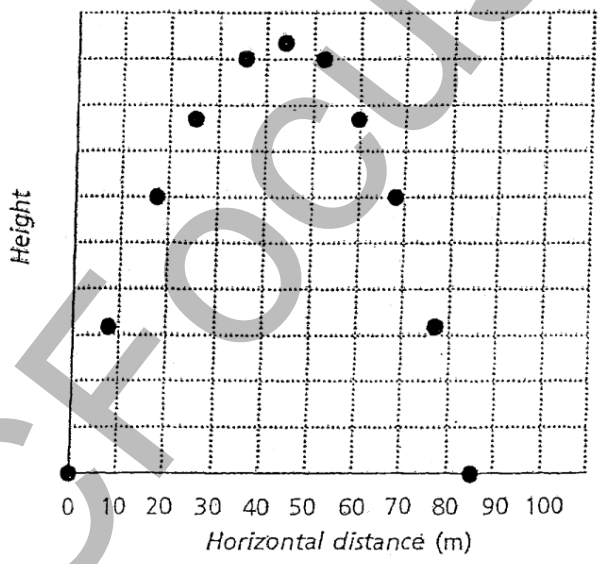
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question **Marks**

16 Figure 3.21 represents a stroboscope photograph of an object projected from a level surface. The stroboscope was flashing at 1.0 flash per second (a frequency of 1.0 Hz). The vertical scale is deliberately not shown, since to do so would allow a simple method to be used. **4**



(a) What was the time of flight? 1

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(b) What is the horizontal component of the object's velocity during flight? 1

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(c) What was the vertical component of its initial velocity ? 1

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(d) What was the maximum height reached by the object ? 2

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17 **5**

(a) Explain how the mass and radius of a planet affects the escape velocity of a rocket that is to be launched from its surface. 2

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(b) Isaac Newton hypothesised about the motion of a projectile launched horizontally from a mountain top. Outline Newton's ideas that led to the concept of escape velocity. 3

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18 **5**

(a) For a satellite undergoing circular motion around a planet, the centripetal force is provided by the gravitational force. Equate centripetal force and Newton's law of universal gravitation to verify that orbital velocity, 3

$$V = \sqrt{\frac{Gm_{planet}}{r_{orbit}}}$$

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(b) Use the expression from part (a) of this question to calculate the orbital velocity for a satellite moving around the Earth in a circular orbit at an altitude of 300 km. 2

(Use radius of Earth = 6378 km)

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19 **6**

(a) Explain what is meant by the 'equivalence between mass and energy . 2

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(b) Most celestial objects outside our Solar System are too distant to reach at current maximum speeds. Discuss the prospect of near light-speed space travel to such destinations with reference to relativistic changes in mass, time and length. 4

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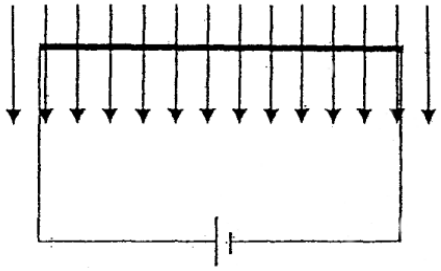
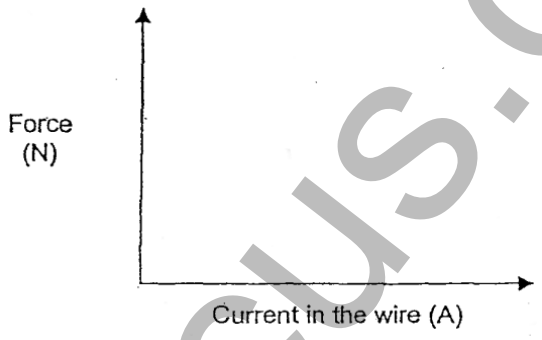
20 A current-carrying conductor is placed in, and perpendicular to, a uniform magnetic field which is represented by the arrows, in the following diagram: **4**



(a) On the axes below sketch a graph that shows how the magnitude of force on the wire would vary if the current in the wire was increased. 1



(b) Describe how a varying current is used to produce sound in a loudspeaker. 3

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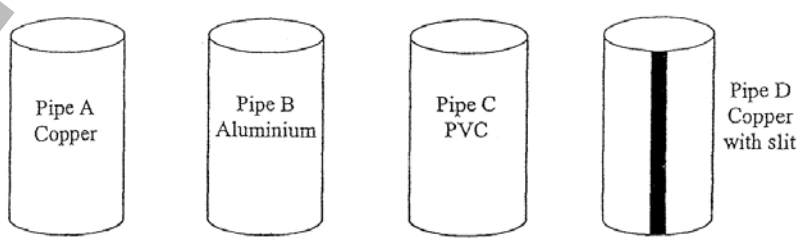
21 Students carried out an experiment where they took four pipes and dropped a magnet through them, timing how long it took the magnet to fall. Pipe A was solid copper, Pipe B was solid aluminium, Pipe C was solid PVC and Pipe D was copper with a vertical slit the length of the pipe. **5**



The students' results showed that the time taken for the magnet to fall through the PVC was equivalent to the time taken to freefall the same distance. Pipe D was the next shortest time followed by Pipe B and finally Pipe A. The time taken to pass through Pipe A was almost three times the time of freefall.

Explain the students' results in this experiment with reference to Lenz's Law.

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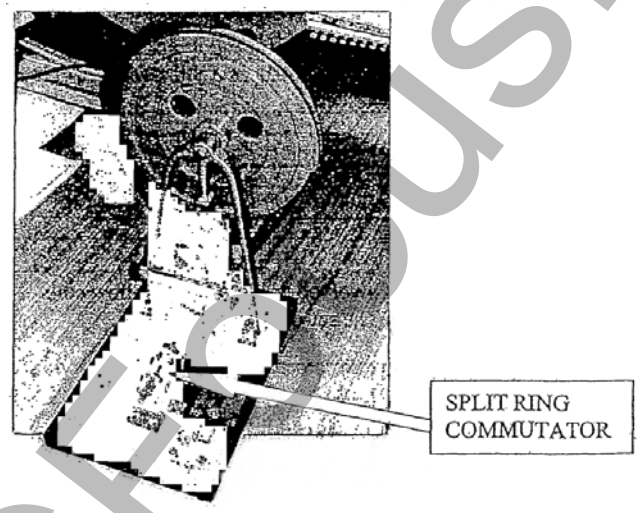
22 Below is a photograph of a hand-operated AC/DC generator. **5**



(a) Identify the function of the split-ring commutator in this generator. 1

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(b) Compare a DC generator to a DC motor 4

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23 Explain how an understanding of black body radiation changed the direction of scientific thinking in the early twentieth century. **3**

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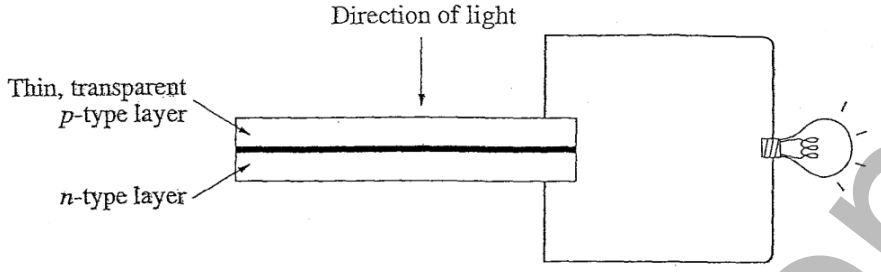
24 Draw a table to classify and qualitatively compare copper, silicon and glass in terms of the relative number of free electrons that can drift between atoms. **4**

25 An example of a solar cell is shown below. **6**



The solar cell is able to produce a current due to the photoelectric effect and the electrical properties of the n-type and p-type layers.

Use this information to outline the process by which light shining on the solar cell produces an electric current that can light up a light globe.

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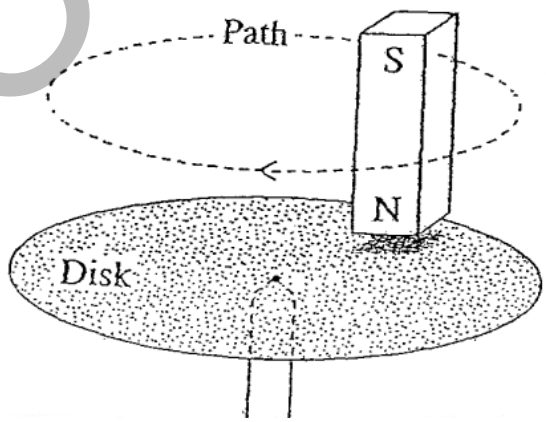
26 A non-magnetic metal disk is balanced on a support as shown in the diagram below. The disk is initially stationary. A magnet is moved in a circular path just above the surface of the disk, without touching it. The disk begins to spin. **5**



(a) Explain how this demonstration works, and predict which direction the disk will spin 3

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(b) The principle involved in the demonstration above has been incorporated into the workings of domestic electrical appliances such as hair-dryers and power-tools. Describe one energy transfer and one energy transformation that occurs when a domestic hair-dryer is operating. 2

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27 **7**

(a) Describe the radiation produced when the walls of a black body cavity are heated. 2

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(b) Identify Planck's hypothesis which was used to explain black body radiation. 1

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(c) Describe how Einstein used Planck's hypothesis to develop a new model of light. 1

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(d) Einstein used this new model to explain the way photoelectrons are produced from a metal surface by incident light. Explain how he used this model to account for the effect of light frequency and light intensity on the photoelectrons. 3

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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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

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

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

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

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

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

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

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

$$Z = \rho v$$

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

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

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

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

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 Lanthanides	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 [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] 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

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.