

SYDNEY BOYS HIGH SCHOOL



HSC TRIAL EXAMINATION 2006

PHYSICS

General Instructions

Reading Time 5 minutes
 Working Time 3 hours
 Write using blue or black pen
 Draw diagrams using pencil.
 Board- approved calculators may be used.
 A data sheet, formulae sheets and
 Periodic Table are provided with this
 paper.

Marks may be allocated to working
 Show all working

Total marks – 100**Section I** Pages 2 – 16**Total marks 75**

This section has two parts, Part A and
 Part B.

Part A – 15 marks

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

Part B – 60 marks

- Attempt Questions 16 – 30
- Allow about hour and 45 minutes for this part.

Section II Page 15**Total marks 25**

1. There are a number of reasons which contribute to variations in the value of the acceleration due to gravity at specific locations on the surface of the Earth.

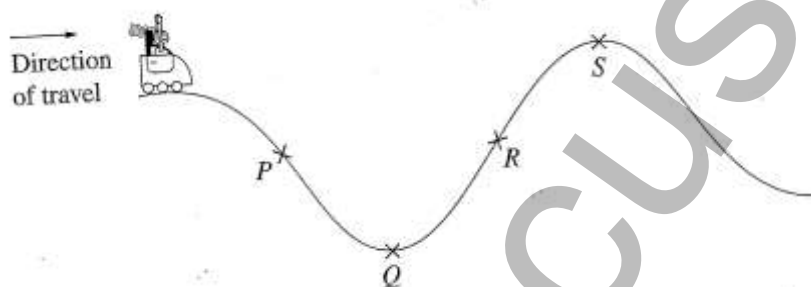
Which of the following pairs of reasons would **not** be responsible for such variations?

- (A) Crustal variations and the shape of the Earth.
- (B) The shape of the Earth and the height above sea level.
- (C) Height above sea level and the Earth's spin.
- (D) Crustal variations and the Earth's orbit around the Sun.

2. The Earth, of radius and mass, 6.38×10^6 m and 5.98×10^{24} kg respectively, has an artificial satellite. The satellite orbits at an altitude of 300 km, has a mass of 200 kg and travels with a velocity of $20\,000 \text{ km h}^{-1}$. The gravitational force acting on the satellite is;

- (A) $1.8 \times 10^{-3} \text{ N}$
- (B) $2.3 \times 10^{-1} \text{ N}$
- (C) $1.8 \times 10^3 \text{ N}$
- (D) $2.3 \times 10^3 \text{ N}$

3. The diagram shows four positions of a car on a roller coaster ride.



At which point during this ride would the occupant experience maximum 'g force'?

- (A) P
- (B) Q
- (C) R
- (D) S

4. The table contains information related to two planets orbiting a distant star.

Planets	Mass (kg)	Orbital radius (m)	Radius of planets (m)	Length of day (s)	Orbital period (s)
Alif	1.21×10^{25}	4.00×10^{11}	8.0×10^6	9.5×10^4	8.75×10^7
Ba	1.50×10^{24}	8.00×10^{11}	4.0×10^6	4.7×10^4	—

The orbital period of the planet Ba can be determined by using data selected from this table.

What is the orbital period of the planet Ba?

- (A) $3.10 \times 10^7 \text{ s}$
- (B) $5.51 \times 10^7 \text{ s}$
- (C) $1.39 \times 10^8 \text{ s}$
- (D) $2.47 \times 10^8 \text{ s}$

5. A radioactive particle used in a linear accelerator. Measured at rest relative to the laboratory it has a half life of $2.5\mu\text{s}$. When measured at constant speed by an observer in the laboratory, its half life has increased to $10\mu\text{s}$.

What is the speed of the particle relative to the laboratory?

- (A) $1.68 \times 10^8 \text{ ms}^{-1}$
- (B) $2.10 \times 10^8 \text{ ms}^{-1}$
- (C) $290\,000\,000 \text{ ms}^{-1}$
- (D) $2.60 \times 10^8 \text{ ms}^{-1}$

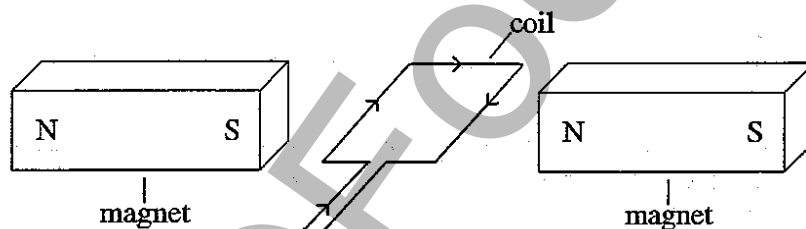
6. Identify which of the following is **not** a component of a DC generator.

- (A) brushes
- (B) coil
- (C) magnetic field
- (D) slip-rings

7. Two long parallel wires are carrying electrical currents. The direction of the current in one of the wires is reversed. How does this affect the force between the wires?

- (A) The force does not change.
- (B) The force changes direction.
- (C) The force increases.
- (D) The force decreases.

8. The following diagram shows a coil of wire between two magnets.



When a current passes through the coil in the direction shown, which is now free to move, the coil will:

- (A) start rotating clockwise (viewed from the front)
- (B) not move
- (C) move vertically
- (D) start rotating anticlockwise (viewed from front)

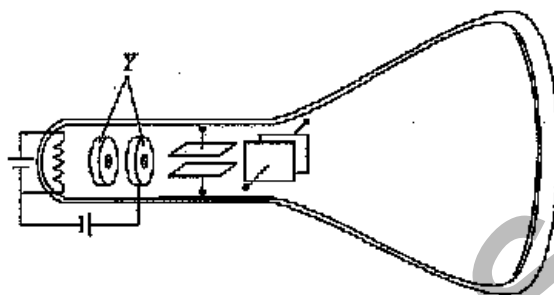
9. A piece of wire 1.0cm long is at right angles to a magnetic field whose magnetic flux density is 1.5T . A current of 2.0 A flows in the wire. What is the magnitude of the force on the wire?

- (A) 3.0 N
- (B) 0.3 N
- (C) 0.03 N
- (D) zero

10. A transformer is needed to convert an input voltage of 6000V to an output voltage of 240V. The **type of transformer** and the **ratio** of the number of turns in its secondary coil to the number of turns in its primary coil are

- (A) step up, 25:1
- (B) step up, 1:25
- (C) step down, 25:1
- (D) step down, 1:25

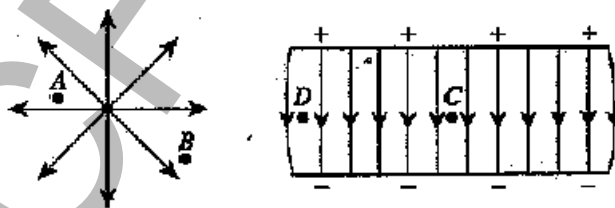
11. The following diagram shows a simple cathode ray tube from an oscilloscope.



The parts labelled Y have the function of

- (A) producing electrons.
- (B) showing the position of the beam.
- (C) deflecting the beam horizontally.
- (D) accelerating the electrons.

12. The following diagram shows the electric fields near a point charge and between parallel plates.



At which point is the magnitude of the electric field greatest?

- (A) A
- (B) B
- (C) C
- (D) D

13. Which of the following statements is correct?

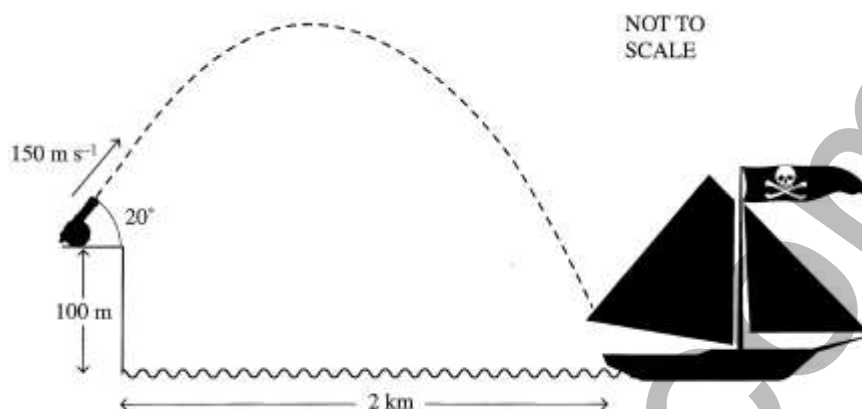
- (A) Einstein was the first person to observe the photoelectric effect.
- (B) Planck hypothesised that energy was exchanged, in quanta amounts, by the atomic oscillators of a black body.
- (C) Hertz performed experiments to measure the speed of light, using radio waves.
- (D) Einstein predicted that for a black body, as the wavelength shortens, the radiation intensity will increase.

14. Solid state devices replaced thermionic devices because thermionic devices;

- (A) were much smaller and required less current in their circuits.
- (B) had a much longer life as they did not become warm at all.
- (C) were less reliable and were easily broken.
- (D) allowed the cathode coating to evaporate, helping current flow.

15. In metal conductors, the resistance

- (A) increases as the amount of impurities increase.
- (B) increases as the lattice vibrations decrease.
- (C) decreases as more electrons are scattered by lattice vibrations.
- (D) decreases as the temperature of the metal increases.

Section B (60 marks) Show all working**Marks****16.**

An enemy ship was sailing 2km from the coast. A cannon on a 100 metre-high cliff fired a projectile at an angle of 20° to the horizontal, at a speed of 150 m/s.

(a) Determine the vertical and horizontal components of the initial velocity.

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(b) Calculate the time taken for the cannon ball to reach the maximum height **and** the maximum height of the cannon ball above the water.

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(c) Calculate

(i) the range of the cannon ball

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(ii) how far from the ship the cannon ball landed

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(d) Describe an adjustment of the cannon that is necessary for a cannon ball to hit the ship.

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17. Explain why all low earth orbit satellites will eventually fall to the Earth's surface.

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18. A boy standing on train station platform observes a NLST (near light-speed transport) train pass through the station. He observes the clocks on the train to be running slower than normal. However, a girl on the train observes the boy's watch, and notices that his watch is running slower than the clocks on the train.

Account for the above situation with reference to the principle of relativity.

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19. Michelson and Morley set up an experiment to measure the velocity of Earth relative to the aether. **Mark**

(a) Outline TWO features of the aether model for the transmission of light. **2**

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(b) Recount the Michelson and Morley experiment, which attempted to measure the relative velocity of Earth through the aether, and describe the results they anticipated. **4**

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20. In your course you performed an investigation to demonstrate the production of an alternating current. **Mark**

(a) Describe an experiment you did to produce alternating current, with particular reference to how you verified that alternating current was actually produced. **3**

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(b) Describe two advantages of using AC generators for large-scale electrical power production. **2**

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21. The photograph shows a small electrical motor from an electric drill. **3**

(a) Name the labelled parts
A, B, and C and

(b) Describe the function
Of each

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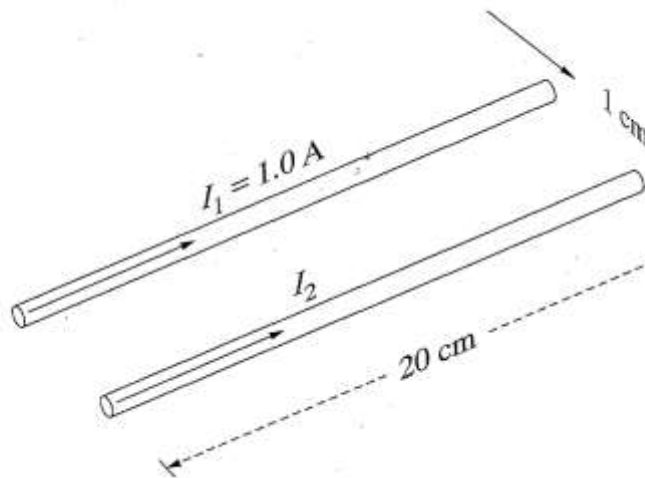
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22. The diagram shows part of an experiment designed to measure the force between two parallel current-carrying conductors.

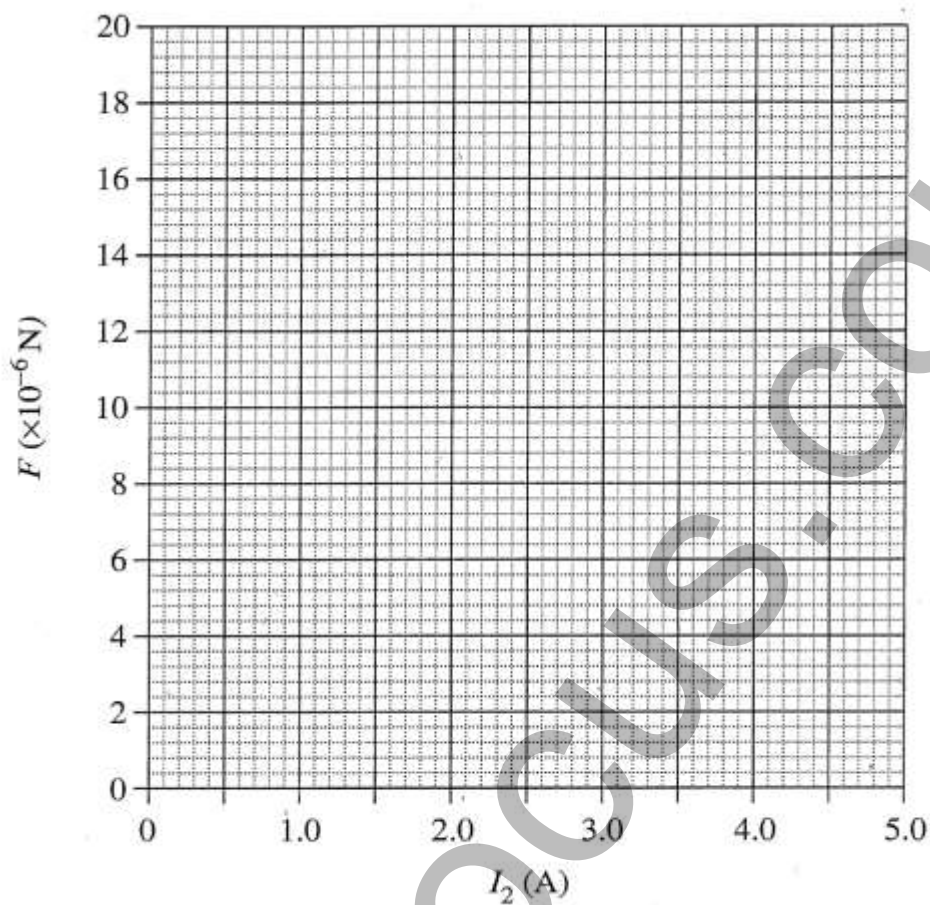


The experimental results are tabulated below.

$I_2 \text{ (A)}$	Force ($\times 10^{-6} \text{ N}$)
0	0
2.0	7
3.0	11
4.0	14
5.0	18

Question 22 (continued)**Mark**
3

(a) Plot the data and draw the line of best fit.



(b) Calculate the gradient of the line of best fit for the graph.

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(c) Write an expression for the magnetic force constant k in the terms of the gradient and other variables.**2**

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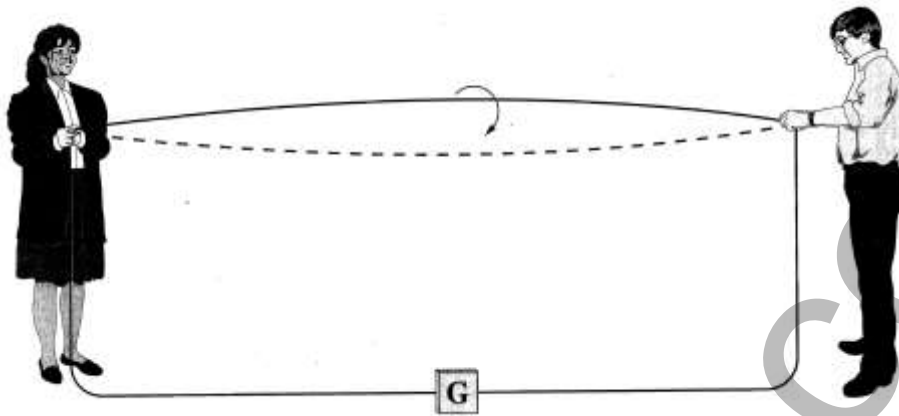
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(d) Use this expression and the gradient calculated in part (b) to determine the value of the magnetic force constant k .**1**

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23. In a particular experiment a long length of copper wire of very resistance is rotated by two students. The ends of the wire are connected to a galvanometer G, and a current is detected.



Explain the effect of increasing the speed of rotation on the current measured by the galvanometer 4

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24. Using silicon as an example of a semiconductor, describe how it carries a current and how doping effects the process. 2

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25. During your course you carried out an investigation to model behaviour of semiconductors, including the concept of holes. **Marks 3**

Outline what you did in your investigation. Explain how the model showed conduction in semiconductors.

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26. In early studies, the observed characteristics of cathode rays led to the belief that they were electromagnetic waves. **3**

Describe the wave-like properties of cathode rays and explain how other evidence shows them to be particles.

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27. A physics student was conducting an investigation on the photoelectric effect. The student used an infrared laser with a wavelength of $1.55 \times 10^{-6} \text{ m}$ for this investigation.

(a) Calculate the energy of a photon from this laser. **2**

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(b) When the laser light was shone onto a photo-cell, no current was detected. The student **3**

increased the intensity of the light but still detected no current.
Explain this observation.

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28. (a) Calculate the frequency of a photon of blue light of wavelength 460nm. **1**

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(b) Identify Planck's hypothesis that allowed him to successfully account for the black body radiation curve. **1**

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29. Outline how Hertz measured the speed of radio waves. **3**

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30. Describe how superconductors and magnetic levitation have played a part in the development of the maglev train. **2**

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SECTION II- Option

From Quanta to Quarks. (25 Marks)

Marks

(a) Discuss Rutherford's model of the nuclear atom with orbiting electrons

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(b) In refining the model of the atom, Bohr began with three postulates. State 2 of Bohr's postulates.

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(c) Identify experimental evidence that supported one of Bohr's postulates and explain how it provided this support.

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(d) Define the term transmutation.

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Marks

- (e) As a result of the studying the electrons emitted during beta decay, Pauli suggested the existence of a then unknown particle. **Discuss** Pauli's suggestion, and relate this to the energy of the emitted electrons. 4

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- (f) Calculate the mass of a particle that has a De Broglie wavelength of 2.5×10^{-12} m when moving with speed of 200ms^{-1} . 1

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- (g) Calculate the energy of the lowest frequency photon emitted in the Balmer series? 2

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- (h) Write the transmutation equation for the beta decay of Bi^{210}_{83} . 2

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Marks

(i) Explain the significance of the conservation laws, in Chadwick's discovery of the neutron. **4**

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(j) Justify the existence of the strong nuclear force. **3**

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END OF EXAMINATION

Data sheet

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

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

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

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

$$F = BIl \sin \theta$$

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

$$\tau = Fd$$

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

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

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

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

$$F = qvB \sin \theta$$

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

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

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

$$E = hf$$

$$c = f\lambda$$

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

$$Z = \rho v$$

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

$$\frac{I_r}{I_o} = \frac{[Z_2 - Z_1]^2}{[Z_2 + Z_1]^2}$$

Periodic Table of the Elements

1 H 1.008 Hydrogen		4 Be 9.012 Beryllium		KEY										79 Au 197.0 Gold		Symbol of element Name of element		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		2 He 4.003 Helium																																																																																																																																			
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3	Li 6.941 Lithium	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 [98.91] 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 [La-Lu]	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 [Ac-Lu]	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	112	Cn [285] Copernicium	113	Nh [284] Nihonium	114	Fl [289] Flerovium	115	Mc [288] Moscovium	116	Lv [293] Livermorium	117	Ts [294] Tennessine	118	Og [294] Oganesson

Lanthanides														
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
138.9	140.9	140.9	144.9	[146.9]	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
Lanthanum	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium
Actinides														
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
[227.0]	232.0	231.0	238.0	[237.0]	[244.1]	[243.1]	[247.1]	[247.1]	[251.1]	[252.1]	[257.1]	[258.1]	[259.1]	[262.1]
Actinium	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Livermorium

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 .

SYDNEY BOYS HIGH SCHOOL **HSC PHYSICS TRIAL** **MULTIPLE CHOICE ANSWER SHEET**

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