Student Number…….

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.

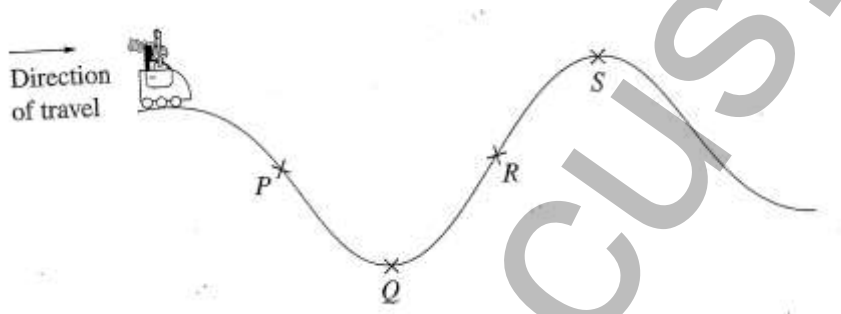
Which of the following pairs of reasons would **not** be responsible for such variations?

(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 200kg and travels with a velocity of 20 000km h^{-1} The gravitational force acting on the satellite is;

(A) 1.8×10^{-3} N
(B) 2.3×10^{-1} N
(C) 1.8×10^{3} N
(D) 2.3×10^{3} 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) 3.10×10^{7}s
(B) 5.51×10^{7}s
(C) 1.39×10^{8}s
(D) 2.47×10^{8}s

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

What is the speed of the particle relative to the laboratory?
(A) 1.68 x 10^8 ms $^{-1}$
(B) 2.10 x 10^8 ms $^{-1}$
(C) 290 000 000 ms $^{-1}$
(D) 2.60 x 10^8 ms $^{-1}$

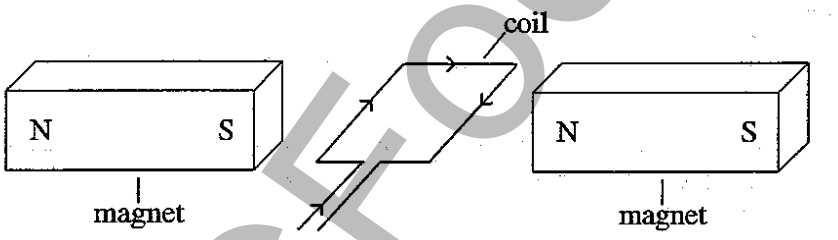
6. Identify which of the following is **not** a component of a DC generator.

(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)

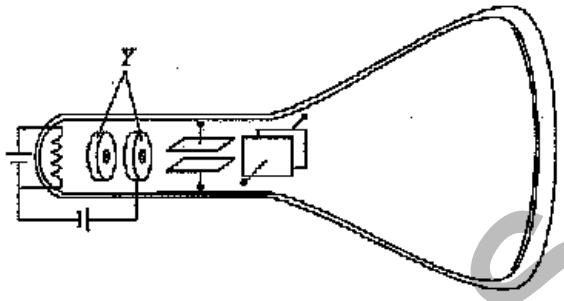
9. A piece of wire 1.0cm long is at right angles to a magnetic field whose magnetic flux density is 1.5T. A current of 2.0 A flows in the wire. What is the magnitude of the force on the wire?

(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

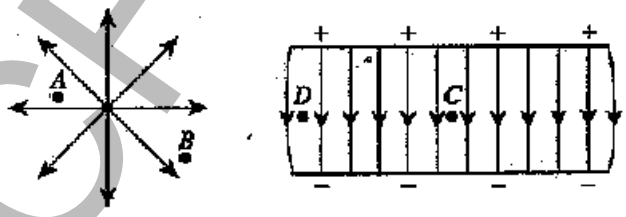
11. The following diagram shows a simple cathode ray tube from an oscilloscope.



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;

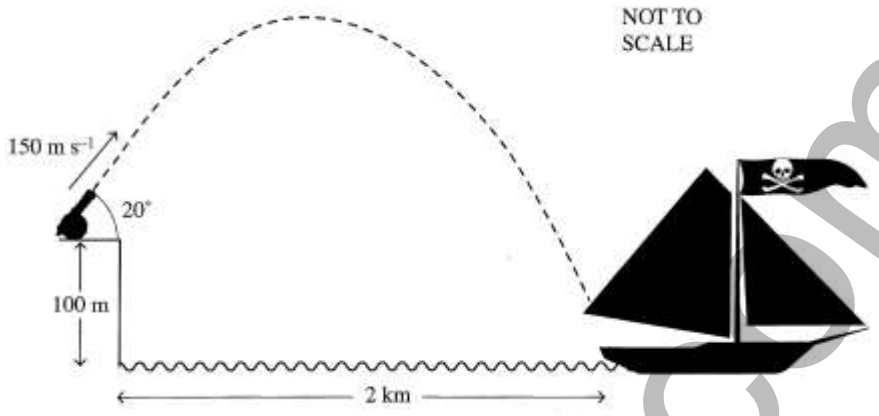
(A) were much smaller and required less current in their circuits.
(B) had a much longer life as they did not become warm at all.
(C) were less reliable and were easily broken.
(D) allowed the cathode coating to evaporate, helping current flow.

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^{O} to the horizontal, at a speed of 150 m/s.

(a) Determine the vertical and horizontal components of the initial velocity. **2**

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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 **2**

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(ii) how far from the ship the cannon ball landed **1**

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(d) Describe an adjustment of the cannon that is necessary for a cannon ball to hit the ship. **1**

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17. Explain why all low earth orbit satellites will eventually fall to the Earth's surface. **2**

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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. **3**

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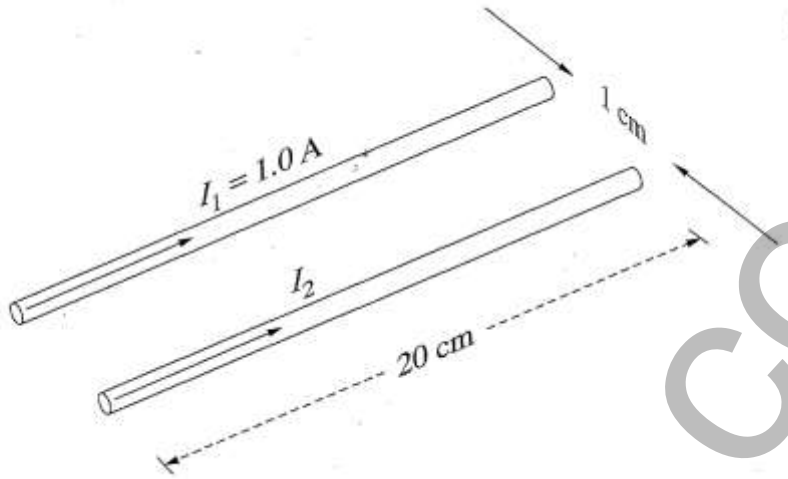
22. The diagram shows part of an experiment designed to measure the force between two parallel current-carrying conductors.

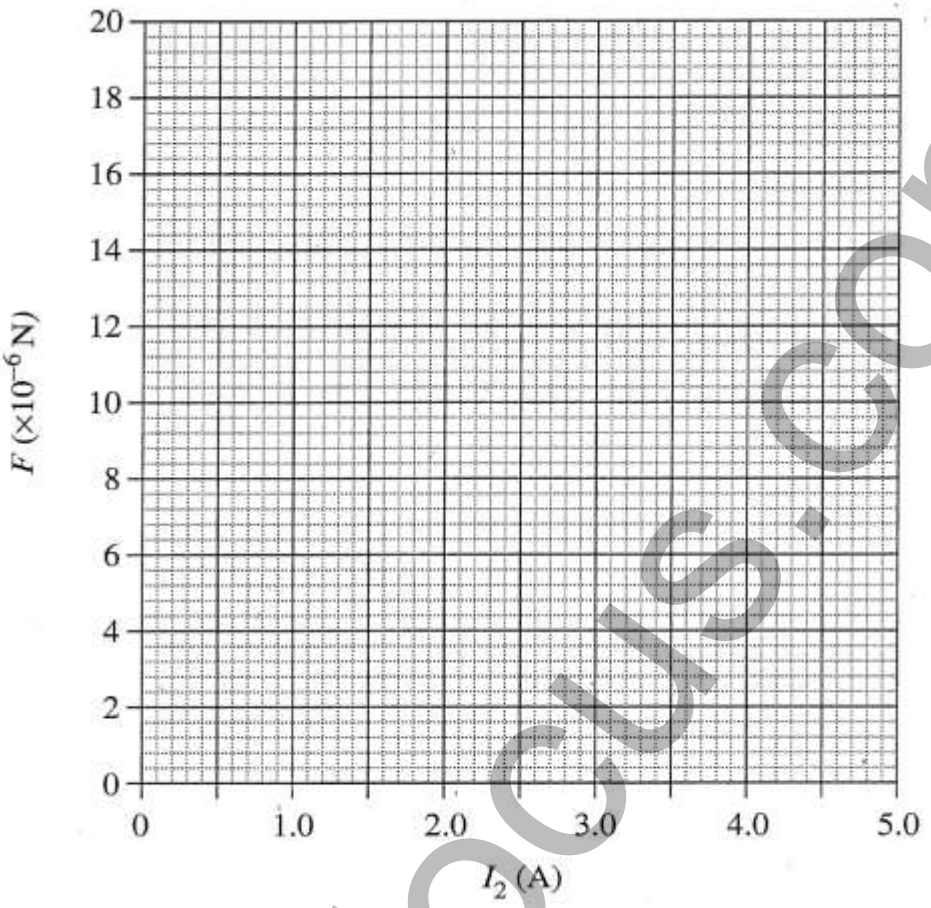


The experimental results are tabulated below.

I_2 (A)	Force ($\times 10^{-6}$ 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. **1**

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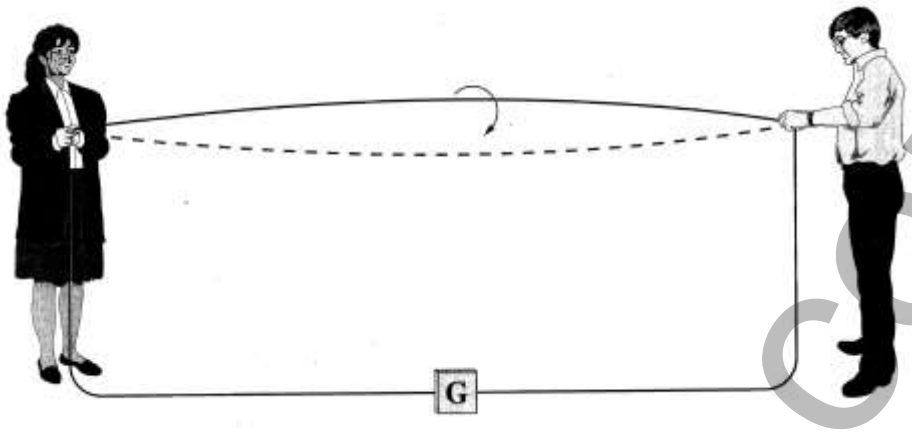
23. In a particular experiment a long length of copper wire of very resistance is rotated by two students. The ends of the wire are connected to a galvanometer G, and a current is detected.



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 1.55×10^{-6}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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Student Number…….

SECTION II- Option

From Quanta to Quarks. (25 Marks) **Marks**

(a) Discuss Rutherford's model of the nuclear atom with orbiting electrons **4**

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

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(c) Identify experimental evidence that supported <u>one</u> of Bohr's postulates and explain how it provided this support. **2**

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(d) Define the term transmutation. **1**

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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 $200 ms^{-1}$. **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	-1.602×10^{-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, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2×10^{-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}

Student Number…….

Formulae sheet

$v = f\lambda$

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

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

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

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

$P = VI$

Energy = VIt

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

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

$\Sigma F = ma$

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

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

$W = Fs$

$p = mv$

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

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

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

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

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

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

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

$$Z = \rho v$$

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

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

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

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Periodic Table of the Elements

KEY

Atomic number	79	Symbol of element
	Au	
Atomic mass	197.0	
	Gold	Name of element

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 Phosphorous	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	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** 144.9 Neodymium	61 **Pm** [146.9] 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.

Student Number…….

SYDNEY BOYS HIGH SCHOOL
HSC PHYSICS TRIAL
MULTIPLE CHOICE ANSWER SHEET

Student number ……

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