Class

Student Number

Marks

Question 15 (4 marks)

A satellite of mass 4000 kg is launched into a circular orbit at an altitude of 250 km above the surface of the Earth.

(a) Determine the gravitational potential energy of the satellite at the surface of the Earth. 1

(b) Determine the gravitational potential energy of the satellite when it is in orbit 250 km above the surface. 1

(c) Determine the kinetic energy of the satellite when it is in orbit 250 km above the surface. 2

Class

Student Number

Marks

Question 16 (6 marks)

Jupiter has a mass of 1.900×10^{27} kg and is orbited by Callisto, one of the four moons of Jupiter that were discovered by Galileo. The table below gives some statistics relating to Callisto:

Callisto Statistics	
Discovered by	Simon Marius & Galileo Galilei
Date of discovery	1610
Mass (kg)	1.08×10^{23}
Equatorial radius (km)	2,400
Orbital radius (km)	1,883,000
Orbital period	?
Escape velocity (km/sec)	2.45

(a) Calculate the gravitational force exerted on Callisto by Jupiter. 2

(b) Calculate the centripetal acceleration of Callisto 2

(c) Calculate the orbital period of Callisto. 2

7 A subatomic particle moving at relativistic speed was observed to have a measured mass that was twice its rest mass. What was the velocity of this subatomic particle?

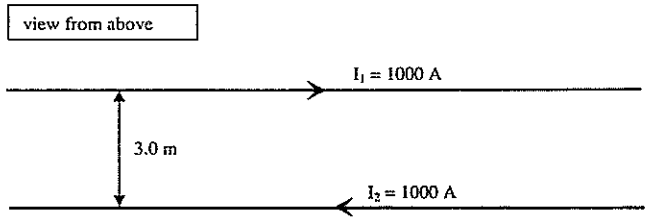
(A) $v = c$

(B) $v = \sqrt{3}(c)$

(C) $v = \left(\frac{\sqrt{3}}{2}\right)(c)$

(D) $v = \frac{3}{4}(c)$

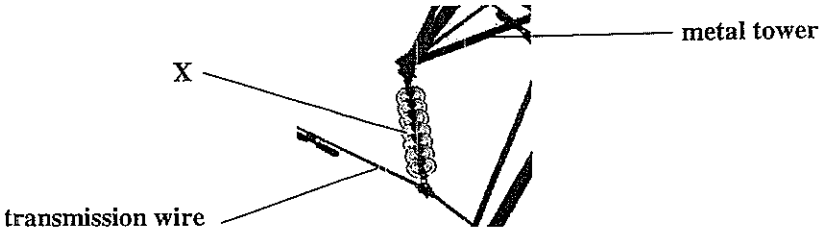
8 The electrical power to a small town is supplied by a pair of very long parallel wires, 3.0 metres apart. Each wire carries a current of 1000A.



What is the magnitude of the electromagnetic force per unit length between the wires?

(A) 0.022 Nm^{-1}
(B) 0.033 Nm^{-1}
(C) 0.067 Nm^{-1}
(D) 0.200 Nm^{-1}

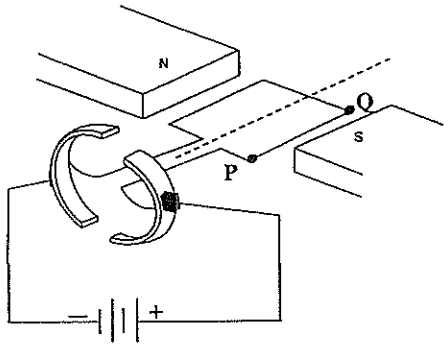
9 The structure labelled X in the diagram below is found supporting wires that transport electricity from a power station to a city.



Which of the following statements applies to structure X?

(A) It is made of ceramic and is superconducting.
(B) It is made of ceramic and is insulating.
(C) It is made with a metal core and is conducting.
(D) It is earthed to protect the transmission wire from lightning strikes.

10 The diagram below shows a rectangular coil (single loop) free to rotate in a magnetic field.
The length of side PQ of the coil is 5.0 cm and the magnetic field is 0.20 T.



What is the magnitude and direction of electromagnetic force on side PQ of this coil at the position shown if the current is 2.5 A?

(A) 0.025 N upwards
(B) 0.025 N downwards
(C) 2.50 N toward magnetic south.
(D) 2.50 N downwards

Class

Student Number

Marks

Question 17 (3 marks)

Sir Isaac Newton used a thought experiment to show that it was theoretically possible to put an object into orbit around the Earth. Describe Newton's thought experiment and include a diagram to illustrate his idea. 3

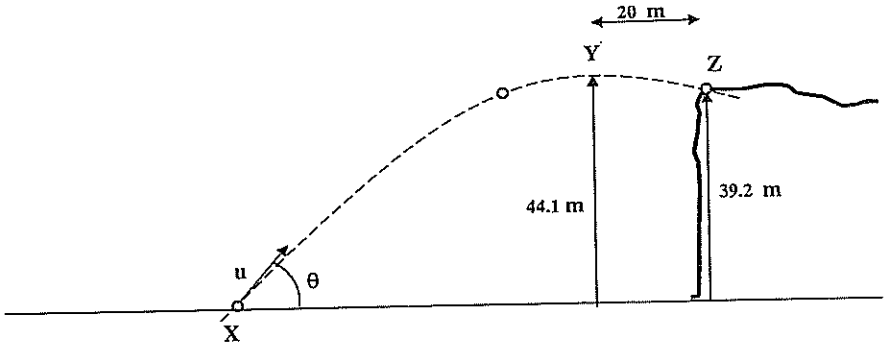
Class

Student Number

Marks

Question 18 (5 marks)

An experimental golf club was used to hit a ball from point X, as illustrated in the following diagram. The ball reaches a maximum height Y, 44.1 metres vertically above the launch point and lands on top of a cliff Z, at a height of 39.2 metres. The horizontal distance from point Y to point Z is 20.0 metres.



(a) Calculate the time taken for the ball to travel from Y to Z 2

(b) Determine the magnitude and direction of the initial velocity of projection, u, at point X. 3

Class

Student Number

Marks

Question 19 (3 marks)

An astronaut travelling at 0.89c relative to the Earth sets off on a trip to a star. According to the astronaut, the trip takes 2.4 years.

(a) Determine the distance to the star, according to the astronaut. 1

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(b) Determine the time taken for the trip, according to an observer on the Earth. 1

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(c) Determine the distance to the star, according to an observer on the Earth. 1

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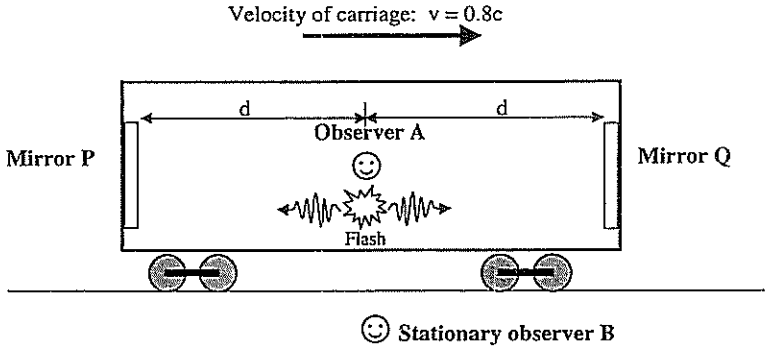
Class

Student Number

Marks

Question 20 (4 marks)

In a thought experiment, an observer A, travelling in a train carriage and located at the mid-point of the carriage, sends simultaneous flashes of light to mirrors P and Q located at each end of the carriage as shown in the diagram. The train is moving to the right at a velocity of 0.8c and is passing a stationary observer B, on a platform directly opposite A at the moment the flashes are sent.



Analyse this thought experiment to show how it demonstrates the relativity of simultaneity. 4

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Class

Student Number

Marks

Question 23 (4 marks)

Compare the structure and function of a galvanometer with that of a D.C. electric motor. 4

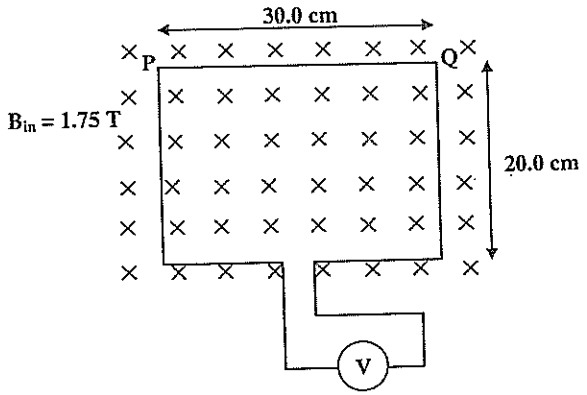
Class

Student Number

Marks

Question 24 (4 marks)

The diagram below shows a single rectangular loop of wire of dimensions 20.0 cm x 30.0 cm sitting in a uniform magnetic field of 1.75 T, directed into the page perpendicular to the loop.



(a) Calculate the magnetic flux through the loop: 2

(b) (i) The magnetic field strength is reduced to zero at a regular rate over 30 seconds. Calculate the reading on the voltmeter: 1

(ii) What is direction of the initial induced current between P and Q in the loop as the magnetic field begins to decrease. 1

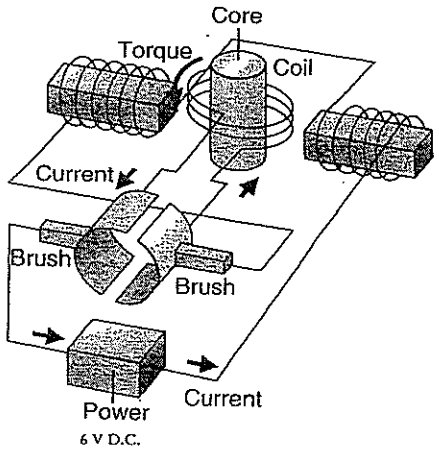
Class

Student Number

Marks

Question 21 (2 marks)

The diagram below shows the structure of a D.C. motor:



(a) In the motor show n, identify the method used to produce the magnetic field. 1

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(b) What causes the motor effect in a D.C. motor? 1

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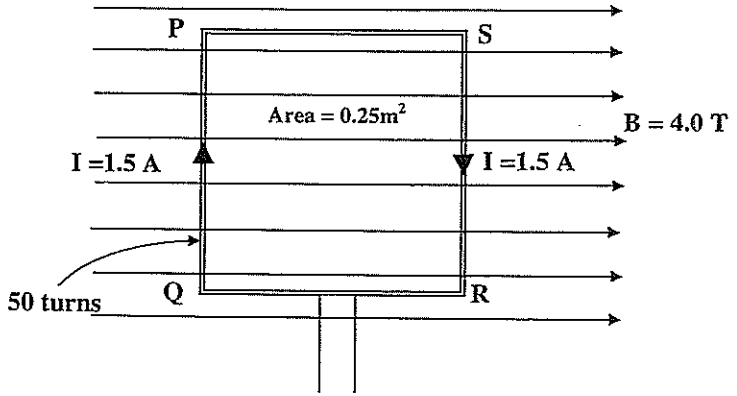
Class

Student Number

Marks

Question 22 (3 marks)

The diagram bellow shows, a square coil of area 0.25 m^2 and consisting of 50 turns of wire, placed in a uniform magnetic field of 4.0 T.
A current of 1.5 A flows through the coil in the direction shown:



(a) Calculate the magnitude and direction of the electromagnetic force on side PQ of the coil. 2

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(b) Calculate magnitude of the torque on the coil. 1

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Class

Student Number

Marks

Question 25 (4 marks)

In the 1830's Michael Faraday observed that relative motion between a conductor and a bar magnet generates an electric current. Describe an investigation you have performed to investigate the effect on the electric current generated when the relative velocity between the bar magnetic and the conductor is varied. 4

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Class

Student Number

Marks

Question 26 (3 marks)

Explain why it is relatively easy to turn the shaft of an electrical generator when it is not connected to an external circuit, but much harder when such a connection is made. 3

Question 27 (4 marks)

Explain how an electromagnetic braking system works. 4

Class

Student Number

Marks

Question 28 (3 marks)

Outline the competition between Westinghouse and Edison to supply electricity to cities. 3

Class

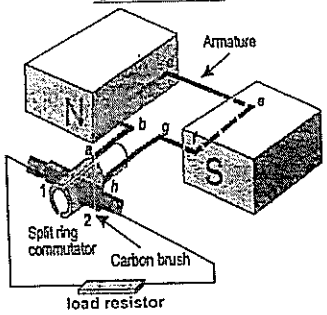
Student Number

Marks

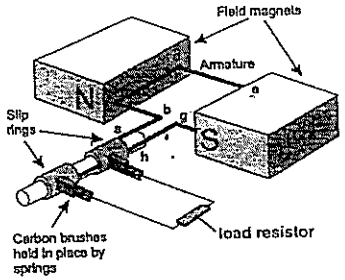
Question 29 (6 marks)

The following diagram illustrates the structure of two different types of generator.

Generator A



Generator B



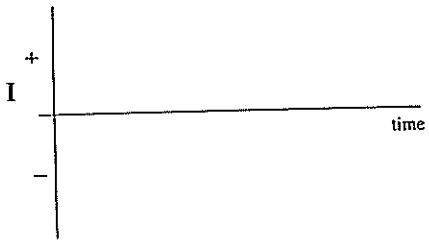
(a) Identify each type of generator 2

Generator A: .....

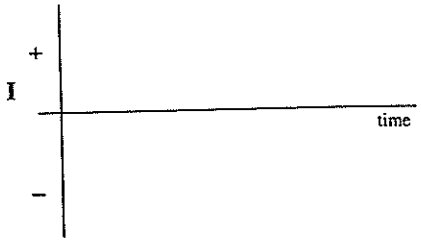
Generator B: .....

(b) For each generator in the diagram above, sketch a graph of the output current in the load resistor, for one complete rotation of the coil beginning with the coil in the position shown. 4
(Your choice of positive direction for current in the load resistor is arbitrary)

Generator A



Generator B



Class

Student Number

Marks

Question 30 (6 marks)

An electric welder for domestic use on 240 V A.C. includes a transformer that has an input current of 10 A from the mains supply. The primary coil has 500 turns and the secondary coil has 25 turns.

(a) Calculate the output current for this domestic welder. 2

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(b) During the operation of this welder, the output current is much higher than the current input by the mains supply. Explain this difference in terms of conservation of energy. 3

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(c) Explain why a step-up transformer is used for this welder rather than a step-down transformer. 1

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Class

Student Number

Marks

Question 31 (6 marks)

Discuss the need for transformers in the transfer of electrical energy from a power station to its point of use. 6

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FORMULAE SHEET

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$Energy = VIt$$

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

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

$$\sum F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$Impulse = Ft$$

$$E_p = -\frac{Gm_1m_2}{r}$$

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

$$F = \frac{Gm_1m_2}{d^2}$$

$$E = mc^2$$

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

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

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

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

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

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

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

Physics

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}
Radius of Earth, R_E	6.4×10^6 m
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	6.7×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's 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}

PERIODIC TABLE OF THE ELEMENTS

KEY: Atomic Number; Symbol of element; Atomic Weight; Name of element — e.g. 79 Au 197.0 Gold

1 H 1.008 Hydrogen																	2 He -4.1003 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 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 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 [210.0] 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 [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun — Ununnilium	111 Uuu — Unununium	112 Uub — Ununbium	113	114 Uuq — Ununquadium	115	116 Uuh — Ununhexium	117	118 Uuo — Ununoctium

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 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 [239.1] Plutonium	95 Am [241.1] Americium	96 Cm [244.1] Curium	97 Bk [249.1] Berkelium	98 Cf [252.1] 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 ^{98}Tc.

SYDNEY GRAMMAR SCHOOL

2005
FORM VI
MAY EXAMINATION

Physics CRIB

General Instructions

- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet, Formula Sheet and Periodic Table are provided at the back of this paper
- Write your student number and class at the top of the Multiple Choice Answer Sheet and each page of Part B
- Hand in your Multiple Choice Sheet and all of Section B in one bundle. (Do not staple together)

Total marks (88)

This paper has two parts, Part A and Part B

Part A
Total marks (12)
- Attempt ALL Questions
- Allow about 20 minutes for this Part

Part B
Total marks (76)
- Attempt ALL Questions
- Allow about 1 hour and 40 minutes for this Part

EXAMINERS: AWW/ MRW /AAH/ SRW

CHECKLIST	
Each boy should have the following:	
1 Question Paper	
1 Multiple Choice Answer Sheet	

Part A
Total marks (12)
Attempt ALL Questions
Allow about 20 minutes for this Part

1. C
2. C
3. D
4. C
5. C
6. D
7. C
8. C
9. B
10. B
11. B
12. B

Class

Student Number

Part B
Total marks (76)
Attempt ALL Questions
Allow about 1 hour and 40 minutes for this Part

Answer the questions in the spaces provided
Show all relevant working in questions involving calculations

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Marks

Question 13 (2 marks)

Describe two reasons that can account for variations in the acceleration due to gravity at the Earth's surface **2**

Any 2 sensible reasons – 2 x (1)

(But must be CLEAR and DISTINCT)

NOT : Effect of other Planets, Moon etc.

Class

Student Number

Marks

Question 14 (4 marks)

The table below contains information related to two satellites, P and Q, orbiting the fictitious planet Rammarg:

Satellite	Orbital Radius (m)	Orbital Period (Earth Days)
P	3.77×10^8	16.7
Q	1.22×10^9	T_Q

(a) Calculate the orbital period, T_Q, for the satellite Q. **2**

$T_1^2 / r_1^3 = T_2^2 / r_2^3$ $T_1 = 97$ days or 8.4×10^6 s - (2)

↑ *Correct Substitution in here only - (1)*

(b) Calculate the mass of the planet Rammarg. **2**

$r^3/T^2 = G.M/4\pi^2 \longrightarrow M = 1.52 \times 10^{25}$ kg - (2)

NB : if T = 16.7 days is not converted to seconds then $M = 1.14 \times 10^{35}$ kg

Class

Student Number

Marks

Question 15 (4 marks)

A satellite of mass 4000 kg is launched into a circular orbit at an altitude of 250 km above the surface of the Earth.

(a) Determine the gravitational potential energy of the satellite at the surface of the Earth. 1

$GM_EM / R_E = -2.5 \times 10^{11}$ J - (1)

(b) Determine the gravitational potential energy of the satellite when it is in orbit 250 km above the surface. 1

$GM_EM / (R_E + h) = -2.4 \times 10^{11}$ J - (1)

↑ must convert to m!

(c) Determine the kinetic energy of the satellite when it is in orbit 250 km above the surface. 2

Use $KE = -1/2 GPE$ ⟶ $KE = 1.2 \times 10^{11}$ J - (2)

OR $GMm/r^2 = MV^2/r$ ⟶ $V = 7.76 \times 10^3$ m/s - (1)

Class

Student Number

Marks

Question 16 (6 marks)

Jupiter has a mass of 1.900×10^{27} kg and is orbited by Callisto, one of the four moons of Jupiter that were discovered by Galileo. The table below gives some statistics relating to Callisto:

Callisto Statistics	
Discovered by	Simon Marius & Galileo Galilei
Date of discovery	1610
Mass (kg)	1.08×10^{23}
Equatorial radius (km)	2,400
Orbital radius (km)	r_o=1,883,000
Orbital period	?
Escape velocity (km/sec)	2.45

(a) Calculate the gravitational force exerted on Callisto by Jupiter. 2

$F = G(M_1/r_o^2).M_2$ ⟶ $F = 3.87 \times 10^{21}$ N - (2)

correct substitution only - (1)

NB : r_o in km - (1)

(b) Calculate the centripetal acceleration of Callisto 2

$a = F/m = 0.0359$ m/s^2 - (2) ; correct substitution - (1)

NB : $a = v^2/r$ with $V = 2.45$ km/s - (0) !!

(c) Calculate the orbital period of Callisto. 2

$r^3/T^2 = GM/4\pi^2$ ⟶ $T = 1.4 \times 10^6$ s - (2)

Correct substitution only - (1)

NB : if $M = 1.08 \times 10^{23}$ kg here ⟶ - (0) !!

Class

Student Number

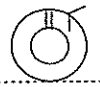
Marks

Question 17 (3 marks)

Sir Isaac Newton used a thought experiment to show that it was theoretically possible to put an object into orbit around the Earth. Describe Newton's thought experiment and include a diagram to illustrate his idea. 3

For full marks , answer must include :

1. Diagram showing Orbital Motion



2. Concept of Launch from High Point

3. Appreciation that Range increases as Velocity of Launch increases

4. Description of Orbital Motion at sufficient velocity

(-1) for any omission.

NB : not necessary to discuss "Escape Velocity"

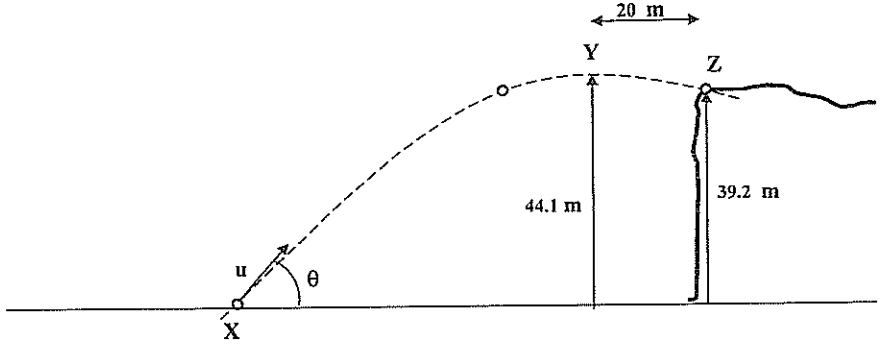
Class

Student Number

Marks

Question 18 (5 marks)

An experimental golf club was used to hit a ball from point X, as illustrated in the following diagram. The ball reaches a maximum height Y, 44.1 metres vertically above the launch point and lands on top of a cliff Z, at a height of 39.2 metres. The horizontal distance from point Y to point Z is 20.0 metres.



(a) Calculate the time taken for the ball to travel from Y to Z 2

$r_y = 4.9m$
$a = 9.8m/s^2$
$u = 0$

$t = (2r/a)^{1/2}$ – *correct substitution - (1)*

$t = 1s$ *- (2)*

(b) Determine the magnitude and direction of the initial velocity of projection, **u**, at point X. 3

$u_x = 20m/s$ *from (a)*
$u_y = 29.4m/s$ *- (1)*

(from $r = 44.1$, $u_y = ?$, $v_y = 0$, $a_y = -9.8$)

$\therefore u = (u_x^2 + u_y^2)^{1/2}$ $\therefore u = 35.6m/s$ *- (1)*

$\tan\theta = u_y/u_x$ $\therefore \theta = 55.8^o$

Class

Student Number

Marks

Question 19 (3 marks)

An astronaut travelling at 0.89c relative to the Earth sets off on a trip to a star. According to the astronaut, the trip takes 2.4 years.

(a) Determine the distance to the star, according to the astronaut. 1

$D = 0.89c \times 2.4 = 2.136$ light years or 2.02×10^{16}m

(b) Determine the time taken for the trip, according to an observer on the Earth. 1

$T = T_o / \sqrt{1-v^2/c^2} = 2.4 \times 2.19 = 5.26$ years or 1.66×10^8sec

(c) Determine the distance to the star, according to an observer on the Earth. 1

$D = 5.26 \times 0.89c = 4.68$ light years or 4.43×10^6m

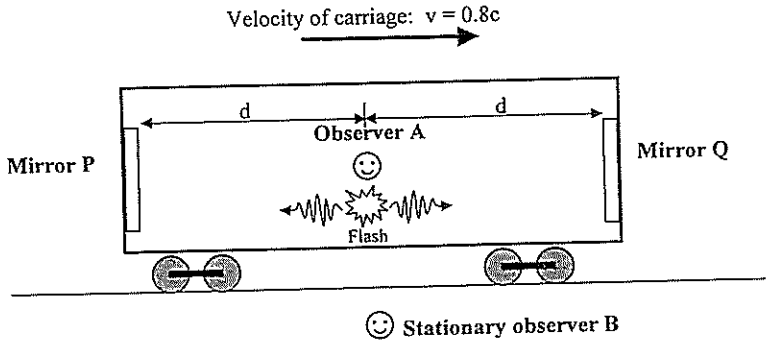
Class

Student Number

Marks

Question 20 (4 marks)

In a thought experiment, an observer A, travelling in a train carriage and located at the mid-point of the carriage, sends simultaneous flashes of light to mirrors P and Q located at each end of the carriage as shown in the diagram. The train is moving to the right at a velocity of 0.8c and is passing a stationary observer B, on a platform directly opposite A at the moment the flashes are sent.



Analyse this thought experiment to show how it demonstrates the relativity of simultaneity. 4

Observer A sees both doors open simultaneously as in his reference frame the doors are equally distant and at rest. – (2)

Observer B sees door P open first as P is moving toward the light while Q is moving away from the light. Since the speed of light is the same for both observers they can't agree on the simultaneity of the two events. – (2)

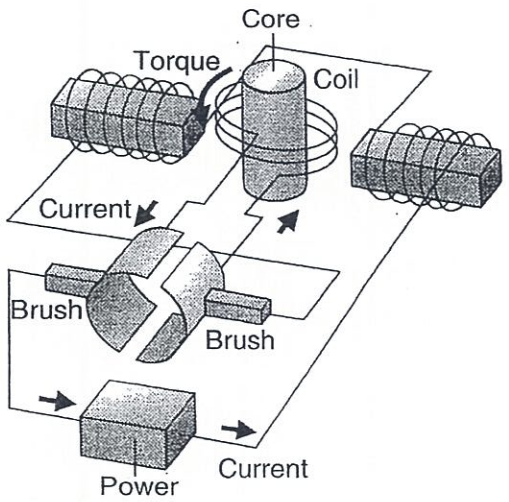
Class

Student Number

Marks

Question 21 (2 marks)

The diagram below shows the structure of a D.C. motor:



(a) In the motor shown in the diagram, identify the method used to produce the magnetic field. **1**

Electromagnet (current carrying coils produce a magnetic field)

(b) What causes the motor effect in a D.C. motor? **1**

Force on a current carrying wire in the magnetic field of the coils.

Form VI Physics

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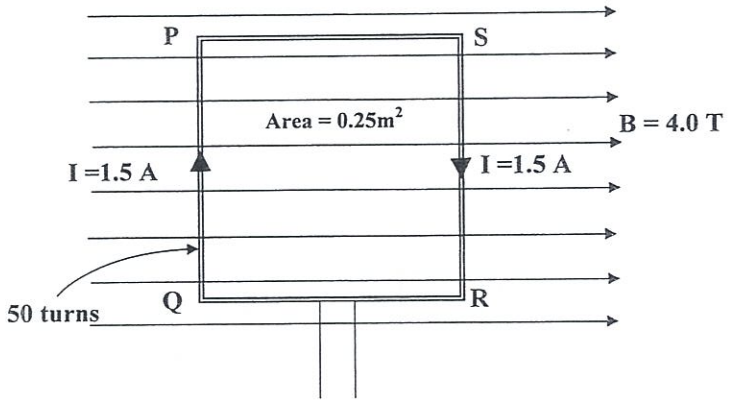
Question 22 (3 marks)

The diagram bellow shows, a square coil of area 0.25 m^2 and consisting of 50 turns of wire, placed in a uniform magnetic field of 4.0 T.
A current of 1.5 A flows through the coil in the direction shown:



(a) Calculate the magnitude and direction of the electromagnetic force on side PQ of the coil. **2**

F = nBIL = 150N (1 mark) into page (1 mark)

NB : downwards is a dangerous expression

(b) Calculate magnitude of the torque on the coil. **1**

T = nBIL = 75N.m

Class

Student Number

Marks

Question 23 (4 marks)

Compare the structure and function of a galvanometer with that of a D.C. electric motor. 4

Marking Scheme.

** Shows an excellent understanding of both motor and galvo with appropriate comparisons of similarities and differences in structure and function. Includes function of both well expressed, motor effect, all parts of spring/commutator, refers to to rotatio limits/direction and differences. –(4 marks)*

** Shows a good understanding of both structure and function with comparison; with some omissions. –(3 marks)*

** Describes two aspects of structure and/or function with an attempt to compare but makes critical omissions such as spring or commutator, OR omits motor effect, OR describes one device to the exclusion of the other. –(2 marks)*

** Gives at least one correct fact about structure or function. –(1 mark)*

Possible Answer: Both have an iron cored rotor coil in a static magnetic field so that when I flows in the coil, the motor effect produces a torque on the coil. In the motor the torque causes a continuous rotation because there is a commutator to reverse the current every half turn however the galvo does not have a commutator but has a restoring spring to stop the rotation when spring torque = motor effect torque on coil; rotation is limited to a max of 90°. The function of the motor is to convert E.E. to kineti energy whereas the function of the galvo is to measure current.

NB : words that imply comparisons are underlined.

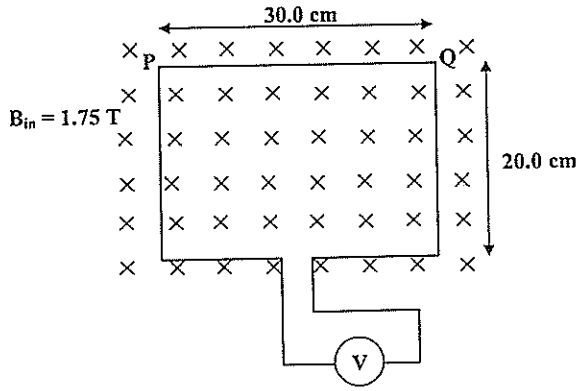
Class

Student Number

Marks

Question 24 (4 marks)

The diagram below shows a single rectangular loop of wire of dimensions 20.0 cm x 30.0 cm sitting in a uniform magnetic field of 1.75 T, directed into the page perpendicular to the loop.



(a) Calculate the magnetic flux through the loop: 2

$\phi = BA = 1.75 \times 0.3 \times 0.2 = 0.105 W_b$

correct answer -(1)

unit W_b -(1)

(b) (i) The magnetic field strength is reduced to zero at a regular rate over 30 seconds. Calculate the reading on the voltmeter: 1

$V = \Delta\phi / \Delta t = 0.105/30 = 0.0035V$

(ii) What is direction of the initial induced current between P and Q in the loop as the magnetic field begins to decrease. 1

From P to Q, OR right.

Class

Student Number

Marks

Question 25 (4 marks)

In the 1830's Michael Faraday observed that relative motion between a conductor and a bar magnet generates an electric current. Describe an investigation you have performed to investigate the effect on the electric current generated when the relative velocity between the bar magnetic and the conductor is varied. 4

Marking Scheme.

** Hypothesis listed or implied AND/OR lists variables to the tested (velocity and current) - (1 mark)*

** lists at least two variables that are kept constant OR describes repetition.*

(B field strength, "one magnet"; starting/finishing position of magnet; distance away from magnet/coil) - (1 mark)

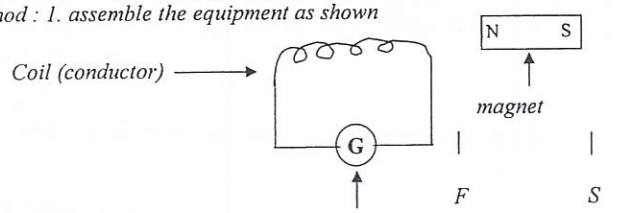
** describes or draws equipment (diagram must be labelled). Need magnet, coil, galvo or ammeter. Voltmeter not accepted. - (1 mark)*

** describes result or tabulates expected measurements - (1 mark)*

Possible answer:

Aim : To investigate the effect of changing magnet velocity on the induced current in a coil.

Method : 1. assemble the equipment as shown



Galvanometer to measure current

2. keeping the strength of the magnet and starting and finishing points for movement (S and F) constant move the magnet at high speed toward the coil.

3. Record the maximum current induced.

4. Repeat step 3 and average the current.

5. Repeat steps 2-4 using a low speed.

Expected result : as the speed of the magnet increases the induced current increases.

Class

Student Number

Marks

Question 26 (3 marks)

Explain why it is relatively easy to turn the shaft of an electrical generator when it is not connected to an external circuit, but much harder when such a connection is made. 3

⇒ *no connection ∴ no induced current (emf still induced) ∴ no opposing force.*

⇒ *connection ∴ induced current flows ∴ force produced on induced current which opposes motion ∴ harder to turn.*

OR when external circuit connected, current flows ∴ more work needed to produce this energy ∴ more force necessary as W = Fs

Note : 1. emf's don't flow

2. extra effort is not due to overcoming "back emf"

3. many boys have only a vague understanding of Lenz's Law – they talked vaguely about an emf or a current induced to oppose the motion (force opposes the motion)

4. do not use the word "resistance" when you mean "force"

5. non connected circuit is ∞ resistance not 0 Ω

Question 27 (4 marks)

Explain how an electromagnetic braking system works. 4

Demonstrates a clear, unambiguous understanding of :

1. S = description of physical set-up. i.e. metal disc spinning in a B field.

2. ϕ I = motion of conductor in B field ∴ $\Delta\phi$ ∴ emf induced ∴ eddy currents induced.

3. L = force of B on eddy currents opposes motion (Lenz's Law)

4. M = results in a slowing down of the metal disc

Any 3 of the above points - (3 marks)

Any 2 of the above points - (2 marks)

Any 1 of the above points - (1 mark)

Class

Student Number

Marks

Question 28 (3 marks)

Outline the competition between Westinghouse and Edison to supply electricity to cities. 3

Must have :Westinghouse produced AC, Edison produced DC

AND two other relevant, correct features

Any two relevant points - (2 marks)

Any one relevant point - (1 mark)

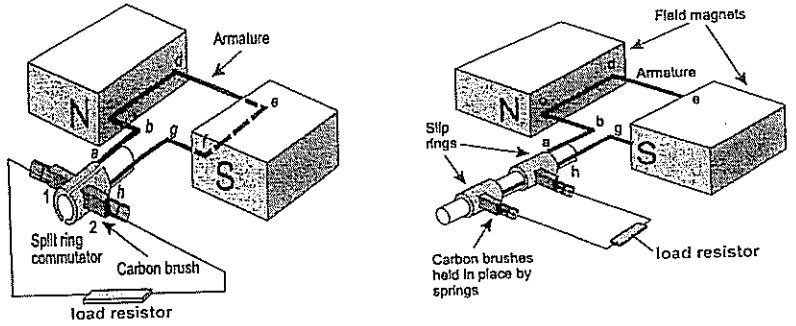
Class

Student Number

Marks

Question 29 (6 marks)

The following diagram illustrates the structure of two different types of generator.



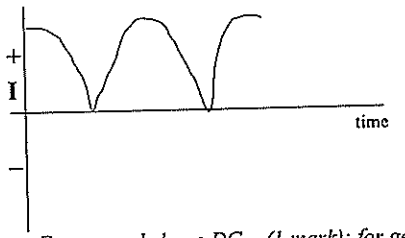
(a) Identify each type of generator 2

Generator A: *DC generator*

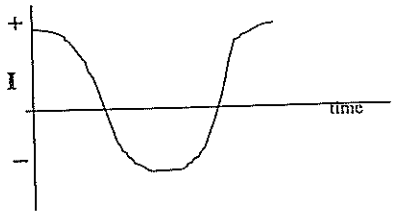
Generator B: *AC generator*

(b) For each generator in the diagram above, sketch a graph of the output current in the load resistor, for one complete rotation of the coil beginning with the coil in the position shown. 4
(Your choice of positive direction for current in the load resistor is arbitrary)

Generator A



Generator B



For general shape DC – (1 mark); for general shape AC – (1 mark); start at maximum I on both graphs - (1 mark)

Class

Student Number

Marks

Question 30 (6 marks)

An electric welder for domestic use on 240 V A.C. includes a transformer that has an input current of 10 A from the mains supply. The primary coil has 500 turns and the secondary coil has 25 turns.

(a) Calculate the output current for this domestic welder. 2

$n_p/n_s = I_s/I_p$

$500/25 = I_s/10 \quad \therefore I_s = 200A$

Incorrect substitution -1 mark

If ratio incorrect. i.e. $n_p/n_s = V_p/V_s = I_p/I_s$ giving 0.5A (1 mark)

(b) During the operation of this welder, the output current is much higher than the current input by the mains supply. Explain this difference in terms of conservation of energy. 3

E = statement of conservation of energy of inferred.

P = conservation of energy requires $E = V_pI_pt = V_sI_st$ hence $V_pI_p = V_sI_s$

I = If stepdown $I_p < I_s$ which means $V_p > V_s$ [when voltages are transformed, the current is inversely affected]

** Any two of the above - (2 marks)*

** Any one of the above - (1 mark)*

(c) Explain why a step-up transformer is used for this welder rather than a step-down transformer. 1

A step down transformer reduces the voltage and increases the current which i used to create a large quantity of heat.

Class

Student Number

Marks

Question 31 (6 marks)

Discuss the need for transformers in the transfer of electrical energy from a power station to its point of use. 6

Class

Student Number

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Physics

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}
Radius of Earth, R_E	6.4×10^{6} m
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	6.7×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's 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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$Energy = VIt$$

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

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

$$\sum F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$Impulse = Ft$$

$$E_p = -\frac{Gm_1m_2}{r}$$

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

$$F = \frac{Gm_1m_2}{d^2}$$

$$E = mc^2$$

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

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

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

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

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

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

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

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 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 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 [210.0] 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 [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun — Ununnilium	111 Uuu — Unununium	112 Uub — Ununbium	113	114 Uuq — Ununquadium	115	116 Uuh — Ununhexium	117	118 Uuo — Ununoctium

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 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 [239.1] Plutonium	95 Am [241.1] Americium	96 Cm [244.1] Curium	97 Bk [249.1] Berkelium	98 Cf [252.1] 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.