Physics

Data Booklet

For use in National Qualification Courses
leading to the 2006 examinations and beyond

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Preface

This data booklet is intended for use by candidates in examinations in Physics at Standard Grade, Intermediate 1, Intermediate 2, Higher and Advanced Higher levels from the 2006 examination diet. It is recommended that candidates become familiar with the contents of the data booklet through use in undertaking Units of these Courses, including Physics Units at Access 3.

The range of data contained in the booklet has been limited to syllabus content which may be assessed through written examination papers. This data should be supplemented by other resource material as necessary during the course, eg by using data sheets. However, should any additional information (or data not included in this booklet) be required in an examination, it will be included in the examination paper.

Additional relationships, which candidates may find useful, are given on page 8.
A periodic table of elements is included on page 9.

From the variety of data offered in this booklet, candidates will be expected to demonstrate the ability to select an appropriate:

- formula
- relationship
- element or data pertaining to an element

Relationships required for Access 3 and/or Intermediate 1 Physics

$$resistance = \frac{voltage}{current}$$

$$current = \frac{power}{voltage}$$

$$speed = \frac{distance}{time}$$

$$voltage\ gain = \frac{output\ voltage}{input\ voltage}$$

$$weight = 10 \times mass$$

$$average\ speed = \frac{distance}{time}$$

Relationships required for Standard Grade and/or Intermediate 2 Physics

$$d = \bar{v}\,t$$

$$s = \bar{v}\,t$$

$$a = \frac{\Delta v}{t}$$

$$a = \frac{v - u}{t}$$

$$W = mg$$

$$F = ma$$

$$p = mv$$

$$E_w = Fd$$

$$E_p = mgh$$

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

$$P = \frac{E}{t}$$

$$percentage\ efficiency = \frac{useful\ E_o}{E_i} \times 100$$

$$percentage\ efficiency = \frac{useful\ P_o}{P_i} \times 100$$

$$E_h = cm\Delta T$$

$$E_h = ml$$

$$Q = It$$

$$V = IR$$

$$R_T = R_1 + R_2 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

$$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_s$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$P = IV$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

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

$$V_{gain} = \frac{V_o}{V_i}$$

$$P_{gain} = \frac{P_o}{P_i}$$

$$v = f\lambda$$

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

$$A = \frac{N}{t}$$

$$D = \frac{E}{m}$$

$$H = Dw_R$$

Relationships required for Higher Physics

$$a = \frac{\Delta v}{t}$$

$$v = u + at$$

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \tfrac{1}{2}(u + v)t$$

$$F = ma$$

$$E_w = Fd$$

$$E_p = mgh$$

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

$$P = \frac{E}{t}$$

$$p = mv$$

$$Ft = mv - mu$$

$$\rho = \frac{m}{V}$$

$$P = \frac{F}{A}$$

$$P = \rho gh$$

$$\frac{PV}{T} = constant$$

$$W = QV$$

$$E = V + Ir$$

$$\Sigma E = \Sigma IR$$

$$R_T = R_1 + R_2 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

$$V = IR$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$V_{peak} = \sqrt{2}V_{rms}$$

$$I_{peak} = \sqrt{2}I_{rms}$$

$$C = \frac{Q}{V}$$

$$E = \tfrac{1}{2}QV = \tfrac{1}{2}CV^2 = \tfrac{1}{2}\frac{Q^2}{C}$$

$$\frac{V_o}{V_1} = -\frac{R_f}{R_1}$$

$$V_o = (V_2 - V_1)\frac{R_f}{R_1}$$

$$T = \frac{1}{f}$$

$$path\ difference = n\lambda$$

$$path\ difference = \left(n + \tfrac{1}{2}\right)\lambda$$

$$d\sin\theta = n\lambda$$

$$n = \frac{\sin\theta_1}{\sin\theta_2}$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$

$$\sin\theta_c = \frac{1}{n}$$

$$I = \frac{k}{d^2}$$

Relationships required for Higher Physics

$$E = hf$$

$$I = Nhf$$

$$E_k = hf - hf_0$$

$$W_2 - W_1 = hf$$

$$E = mc^2$$

$$A = \frac{N}{t}$$

$$D = \frac{E}{m}$$

$$H = Dw_R$$

$$\dot{H} = \frac{H}{t}$$

$$random\ uncertainty = \frac{max.\ value - min.\ value}{number\ of\ values}$$

Relationships required for Advanced Higher Physics

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

$$v = u + at$$

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$E = mc^2$$

$$\omega = \frac{d\theta}{dt}$$

$$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$$

$$\omega = \omega_o + \alpha t$$

$$\theta = \omega_o t + \tfrac{1}{2}\alpha t^2$$

$$\omega^2 = {\omega_o}^2 + 2\alpha\theta$$

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

$$a_{\mathrm{r}} = \frac{v^2}{r} = r\omega^2$$

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

$$T = Fr$$

$$T = I\alpha$$

$$L = mvr = mr^2\omega$$

$$L = I\omega$$

$$E_{rot} = \tfrac{1}{2}I\omega^2$$

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

$$V = -\frac{Gm}{r}$$

$$v = \sqrt{\frac{2Gm}{r}}$$

$$\omega = 2\pi f$$

$$\frac{d^2y}{dt^2} = -\omega^2 y$$

$$y = A\cos\omega t \text{ or } y = A\sin\omega t$$

$$v = \pm\omega\sqrt{\left(A^2 - y^2\right)}$$

$$E_k = \tfrac{1}{2}m\omega^2\left(A^2 - y^2\right)$$

$$E_p = \tfrac{1}{2}m\omega^2 y^2$$

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

$$mvr = \frac{nh}{2\pi}$$

$$F = \frac{Q_1Q_2}{4\pi\varepsilon_o r^2}$$

$$E = \frac{Q}{4\pi\varepsilon_o r^2}$$

$$V = \frac{Q}{4\pi\varepsilon_o r}$$

$$F = QE$$

Relationships required for Advanced Higher Physics

$V = Ed$

$F = IlB\sin\theta$

$B = \dfrac{\mu_o I}{2\pi r}$

$\dfrac{F}{l} = \dfrac{\mu_o I_1 I_2}{2\pi r}$

$F = qvB$

$\varepsilon = -L\dfrac{dI}{dt}$

$E = \frac{1}{2}LI^2$

$y = A\sin 2\pi\left(ft - \dfrac{x}{\lambda}\right)$

$f = f_s\left(\dfrac{v}{v \pm v_s}\right)$

$f = f_s\left(\dfrac{v \pm v_o}{v}\right)$

$\Phi = \dfrac{2\pi x}{\lambda}$

$optical\ path\ difference = m\lambda$

$optical\ path\ difference\ = \left(m + \frac{1}{2}\right)\lambda$

$\Delta x = \dfrac{\lambda l}{2d}$

$d = \dfrac{\lambda}{4n}$

$\Delta x = \dfrac{\lambda D}{d}$

$n = \tan i_p$

$\dfrac{\Delta X}{X} = \sqrt{\left(\dfrac{\Delta Y}{Y}\right)^2 + \left(\dfrac{\Delta Z}{Z}\right)^2}$

$\Delta X = \sqrt{\Delta Y^2 + \Delta Z^2}$

$\Delta m = \dfrac{m_1 - m_2}{2\sqrt{(n-2)}}$

$\Delta c = \dfrac{c_1 - c_2}{2\sqrt{(n-2)}}$

Additional relationships

Circle

$circumference = 2\pi r$

$area = \pi r^2$

Sphere

$area = 4\pi r^2$

$volume = \frac{4}{3}\pi r^3$

Trigonometry

$$\sin\theta = \frac{opposite}{hypotenuse}$$

$$\cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

$$\sin^2\theta + \cos^2\theta = 1$$

Moment of inertia

point mass
$I = mr^2$

rod about centre
$I = \frac{1}{12}ml^2$

rod about end
$I = \frac{1}{3}ml^2$

disc about centre
$I = \frac{1}{2}mr^2$

sphere about centre
$I = \frac{2}{5}mr^2$

Table of standard derivatives

$f(x)$	$f'(x)$
$\sin ax$	$a\cos ax$
$\cos ax$	$-a\sin ax$

Table of standard integrals

$f(x)$	$\int f(x)dx$
$\sin ax$	$-\frac{1}{a}\cos ax + C$
$\cos ax$	$\frac{1}{a}\sin ax + C$

ELECTRON ARRANGEMENTS OF ELEMENTS

Key

Atomic number Symbol Electron arrangement Name

TRANSITION ELEMENTS

Group 1	Group 2	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	Group 0 (18)
1 **H** 1 Hydrogen																	2 **He** 2 Helium
3 **Li** 2, 1 Lithium	4 **Be** 2, 2 Beryllium											5 **B** 2, 3 Boron	6 **C** 2, 4 Carbon	7 **N** 2, 5 Nitrogen	8 **O** 2, 6 Oxygen	9 **F** 2, 7 Fluorine	10 **Ne** 2, 8 Neon
11 **Na** 2, 8, 1 Sodium	12 **Mg** 2, 8, 2 Magnesium											13 **Al** 2, 8, 3 Aluminium	14 **Si** 2, 8, 4 Silicon	15 **P** 2, 8, 5 Phosphorus	16 **S** 2, 8, 6 Sulphur	17 **Cl** 2, 8, 7 Chlorine	18 **Ar** 2, 8, 8 Argon
19 **K** 2, 8, 8, 1 Potassium	20 **Ca** 2, 8, 8, 2 Calcium	21 **Sc** 2, 8, 9, 2 Scandium	22 **Ti** 2, 8, 10, 2 Titanium	23 **V** 2, 8, 11, 2 Vanadium	24 **Cr** 2, 8, 13, 1 Chromium	25 **Mn** 2, 8, 13, 2 Manganese	26 **Fe** 2, 8, 14, 2 Iron	27 **Co** 2, 8, 15, 2 Cobalt	28 **Ni** 2, 8, 16, 2 Nickel	29 **Cu** 2, 8, 18, 1 Copper	30 **Zn** 2, 8, 18, 2 Zinc	31 **Ga** 2, 8, 18, 3 Gallium	32 **Ge** 2, 8, 18, 4 Germanium	33 **As** 2, 8, 18, 5 Arsenic	34 **Se** 2, 8, 18, 6 Selenium	35 **Br** 2, 8, 18, 7 Bromine	36 **Kr** 2, 8, 18, 8 Krypton
37 **Rb** 2, 8, 18, 8, 1 Rubidium	38 **Sr** 2, 8, 18, 8, 2 Strontium	39 **Y** 2, 8, 18, 9, 2 Yttrium	40 **Zr** 2, 8, 18, 10, 2 Zirconium	41 **Nb** 2, 8, 18, 12, 1 Niobium	42 **Mo** 2, 8, 18, 13, 1 Molybdenum	43 **Tc** 2, 8, 18, 13, 2 Technetium	44 **Ru** 2, 8, 18, 15, 1 Ruthenium	45 **Rh** 2, 8, 18, 16, 1 Rhodium	46 **Pd** 2, 8, 18, 18, 0 Palladium	47 **Ag** 2, 8, 18, 18 1 Silver	48 **Cd** 2, 8, 18, 18, 2 Cadmium	49 **In** 2, 8, 18, 18, 3 Indium	50 **Sn** 2, 8, 18, 18, 4 Tin	51 **Sb** 2, 8, 18, 18, 5 Antimony	52 **Te** 2, 8, 18, 18, 6 Tellurium	53 **I** 2, 8, 18, 18, 7 Iodine	54 **Xe** 2, 8, 18, 18, 8 Xenon
55 **Cs** 2, 8, 18, 18, 8, 1 Caesium	56 **Ba** 2, 8, 18, 18, 8, 2 Barium	57 **La** 2, 8, 18, 18, 9, 2 Lanthanum	72 **Hf** 2, 8, 18, 32, 10, 2 Hafnium	73 **Ta** 2, 8, 18, 32, 11, 2 Tantalum	74 **W** 2, 8, 18, 32, 12, 2 Tungsten	75 **Re** 2, 8, 18, 32, 13, 2 Rhenium	76 **Os** 2, 8, 18, 32, 14, 2 Osmium	77 **Ir** 2, 8, 18, 32, 15, 2 Iridium	78 **Pt** 2, 8, 18, 32, 17, 1 Platinum	79 **Au** 2, 8, 18, 32, 18, 1 Gold	80 **Hg** 2, 8, 18, 32, 18, 2 Mercury	81 **Tl** 2, 8, 18, 32, 18, 3 Thallium	82 **Pb** 2, 8, 18, 32, 18, 4 Lead	83 **Bi** 2, 8, 18, 32, 18, 5 Bismuth	84 **Po** 2, 8, 18, 32, 18, 6 Polonium	85 **At** 2, 8, 18, 32, 18, 7 Astatine	86 **Rn** 2, 8, 18, 32, 18, 8 Radon
87 **Fr** 2, 8, 18, 32, 18, 8, 1 Francium	88 **Ra** 2, 8, 18, 32, 18, 8, 2 Radium	89 **Ac** 2, 8, 18, 32, 18, 9, 2 Actinium	104 **Rf** 2, 8, 18, 32, 32, 10, 2 Rutherfordium	105 **Db** 2, 8, 18, 32, 32, 11, 2 Dubnium	106 **Sg** 2, 8, 18, 32, 32, 12, 2 Seaborgium	107 **Bh** 2, 8, 18, 32, 32, 13, 2 Bohrium	108 **Hs** 2, 8, 18, 32, 32, 14, 2 Hassium	109 **Mt** 2, 8, 18, 32, 32, 15, 2 Meitnerium									

LANTHANIDES	57 **La** 2, 8, 18, 18, 9, 2 Lanthanum	58 **Ce** 2, 8, 18, 20, 8, 2 Cerium	59 **Pr** 2, 8, 18, 21, 8, 2 Praseodymium	60 **Nd** 2, 8, 18, 22, 8, 2 Neodymium	61 **Pm** 2, 8, 18, 23, 8, 2 Promethium	62 **Sm** 2, 8, 18, 24, 8, 2 Samarium	63 **Eu** 2, 8, 18, 25, 8, 2 Europium	64 **Gd** 2, 8, 18, 25, 9, 2 Gadolinium	65 **Tb** 2, 8, 18, 27, 8, 2 Terbium	66 **Dy** 2, 8, 18, 28, 8, 2 Dysprosium	67 **Ho** 2, 8, 18, 29, 8, 2 Holmium	68 **Er** 2, 8, 18, 30, 8, 2 Erbium	69 **Tm** 2, 8, 18, 31, 8, 2 Thulium	70 **Yb** 2, 8, 18, 32, 8, 2 Ytterbium	71 **Lu** 2, 8, 18, 32, 9, 2 Lutetium
ACTINIDES	89 **Ac** 2, 8, 18, 32, 18, 9, 2 Actinium	90 **Th** 2, 8, 18, 32, 18, 10, 2 Thorium	91 **Pa** 2, 8, 18, 32, 20, 9, 2 Protactinium	92 **U** 2, 8, 18, 32, 21, 9, 2 Uranium	93 **Np** 2, 8, 18, 32, 22, 9, 2 Neptunium	94 **Pu** 2, 8, 18, 32, 24, 8, 2 Plutonium	95 **Am** 2, 8, 18, 32, 25, 8, 2 Americium	96 **Cm** 2, 8, 18, 32, 25, 9, 2 Curium	97 **Bk** 2, 8, 18, 32, 27, 8, 2 Berkelium	98 **Cf** 2, 8, 18, 32, 28, 8, 2 Californium	99 **Es** 2, 8, 18, 32, 29, 8, 2 Einsteinium	100 **Fm** 2, 8, 18, 32, 30, 8, 2 Fermium	101 **Md** 2, 8, 18, 32, 31, 8, 2 Mendelevium	102 **No** 2, 8, 18, 32, 32, 8, 2 Nobelium	103 **Lr** 2, 8, 18, 32, 32, 9, 2 Lawrencium