




NQ
NATIONAL
QUALIFICATIONS

Physics

Data Booklet

Standard Grade and
Access 3 to
Advanced Higher

 **SQA**

Physics Data Booklet

Standard Grade and Access 3 to Advanced Higher

For use in National Qualification Courses
leading to the 2008 examinations and beyond

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Introduction

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 2008 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 that 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, such information will be included in the examination paper.

Additional relationships, which candidates may find useful, are contained 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 for Access 3 and/or Intermediate 1

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

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

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

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

$$\text{weight} = 10 \times \text{mass}$$

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

Relationships for Standard Grade and/or Intermediate 2

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

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

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

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

$$W = mg$$

$$F = ma$$

$$p = mv$$

$$E_w = Fd$$

$$E_p = mgh$$

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

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

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

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

$$E_h = cm\Delta T$$

$$E_h = ml$$

$$Q = It$$

$$V = IR$$

$$R_T = R_1 + R_2 + \dots$$

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

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

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

$$P = IV$$

$$P = I^2 R$$

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

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

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

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

$$v = f\lambda$$

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

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

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

$$H = DW_R$$

Relationships for Higher

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

$$v = u + at$$

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

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

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

$$F = ma$$

$$E_w = Fd$$

$$E_p = mgh$$

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

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

$$p = mv$$

$$Ft = mv - mu$$

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

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

$$P = \rho gh$$

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

$$W = QV$$

$$E = V + Ir$$

$$\Sigma E = \Sigma IR$$

$$R_T = R_1 + R_2 + \dots$$

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

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

$$V = IR$$

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

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

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

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

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

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

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

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

$$v = f\lambda$$

$$\text{path difference} = n\lambda$$

$$\text{path difference} = (n + \frac{1}{2})\lambda$$

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

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

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

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

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

Relationships for Higher

$$E = hf$$

$$I = Nhf$$

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

$$E_k = hf - hf_0$$

$$W_2 - W_1 = hf$$

$$E = mc^2$$

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

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

$$H = Dw_R$$

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

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

Relationships for Advanced Higher

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

$$v = u + at$$

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

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

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

$$E = mc^2$$

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

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

$$\omega = \omega_0 + \alpha t$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

$$a_r = \frac{v^2}{r} = r\omega^2$$

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

$$T = Fr$$

$$T = I\alpha$$

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

$$L = I\omega$$

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

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

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

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

$$\omega = 2\pi f$$

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

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

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

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

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

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

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

$$F = \frac{Q_1Q_2}{4\pi\epsilon_0 r^2}$$

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

$$F = QE$$

Relationships for Advanced Higher

$$V = Ed$$

$$F = IlB \sin \theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

$$F = qvB$$

$$\mathcal{E} = -L \frac{dI}{dt}$$

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

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

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

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

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

$$\text{optical path difference} = m\lambda$$

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

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

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

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

$$n = \tan i_p$$

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

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

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

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

Additional Relationships

Circle

$$\text{circumference} = 2\pi r$$

$$\text{area} = \pi r^2$$

Sphere

$$\text{area} = 4\pi r^2$$

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

Trigonometry

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

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

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

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

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

Group 1 Group 2

Group 3 Group 4 Group 5 Group 6 Group 7 Group 0

(1)	
1 H 1 Hydrogen	
3 Li 2, 1 Lithium	4 Be 2, 2 Beryllium
11 Na 2, 8, 1 Sodium	12 Mg 2, 8, 2 Magnesium
19 K 2, 8, 8, 1 Potassium	20 Ca 2, 8, 8, 2 Calcium
37 Rb 2, 8, 18, 8, 1 Rubidium	38 Sr 2, 8, 18, 8, 2 Strontium
55 Cs 2, 8, 18, 18, 8, 1 Caesium	56 Ba 2, 8, 18, 18, 8, 2 Barium
87 Fr 2, 8, 18, 32, 18, 8, 1 Francium	88 Ra 2, 8, 18, 32, 18, 8, 2 Radium

Key

Atomic number
Symbol
Electron arrangement
Name

Transition Elements

(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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
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
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
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			

(13)	(14)	(15)	(16)	(17)	(18)
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
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
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
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
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

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
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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
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