Technological Studies Data Booklet Standard Grade and Intermediate 2

For use in National Qualification Courses
leading to the 2007 examinations and beyond.

Published date: December 2006
Publication code: BB3377
ISBN: 978 1 85969 676 7

Published by the Scottish Qualifications Authority
The Optima Building, 58 Robertson Street, Glasgow G2 8DQ
Ironmills Road, Dalkeith, Midlothian EH22 1LE

www.sqa.org.uk

For an up-to-date list of prices visit the **Publication Sales and Downloads** section of SQA's website.

This document can be produced, on request, in alternative formats, including large type, braille and numerous community languages.

For further details telephone SQA's Customer Contact Centre on 0845 279 1000.

Contents

Preface

This data booklet is intended for use by candidates in examinations in Technological Studies at Standard Grade and Intermediate 2. It is recommended that candidates should become familiar with the contents of the data booklet through use in undertaking units of these courses.

It should be noted that the range of data contained in the booklet has been limited to that syllabus content which may be assessed through written examination papers. This range 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.

Teachers/lecturers should note that all of the material contained in this booklet is likely to be examined at some time. This excludes the additional PBASIC commands listed on page 15. With regard to tables of information, not every entry in a table will necessarily be involved in examination questions.

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

- item of information
- formulae
- material property
- operational amplifier circuit
- PBASIC instruction

Quantities, Symbols and Units

Quantity	Symbol	Unit	Abbreviation
distance	s, x	metre	m
height	h	metre	m
diameter	d	metre	m
radius	r	metre	m
area	a	square metre	m^2
circumference	c	metre	m
time	t	second	s
speed, velocity	v	metre per second	m/s
mass	m	kilogram	kg
weight	W	newton	N
force	F	newton	N
gravitational acceleration	g	metres per second squared	m/s^2
work done	W or E_w	joule	J
energy	E	joule	J
power	P	watt	W
torque	T	newton metre	Nm
efficiency	η	–	–
pressure	P	newton per square metre	N/m^2
temperature	T	degree celsius kelvin	°C K
specific heat capacity	c	joule per kilogram degree kelvin	J/kgK
voltage, potential difference	V	volt	V
current	I	Ampere (amp)	A
resistance	R	ohm	Ω
transistor current gain	h_{FE}	–	–
frequency	f	hertz	Hz
capacitance	C	farad	F

Decimal Prefixes

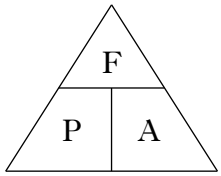
Prefix	Symbol	Multiplying factor
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Relationships

Pneumatic Systems

Pressure, force & area

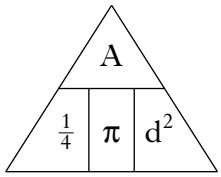
$$P = \frac{F}{A}$$



Area of circle

$$A = \frac{\pi d^2}{4}$$

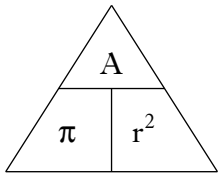
$$d = \sqrt{\frac{4A}{\pi}}$$



$$\pi = 3 \cdot 14$$

$$A = \pi r^2$$

$$r = \sqrt{\frac{A}{\pi}}$$

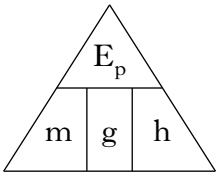


Energy and Power

Potential energy

$E_p = mgh$

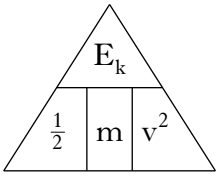
$g = 9{\cdot}81\ m/s^2$



Kinetic energy

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

$v = \sqrt{\frac{2E_k}{m}}$

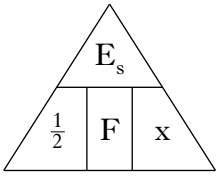


Strain energy

$E_s = \frac{1}{2}Fx$

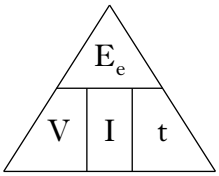
$F = \frac{2E_s}{x}$

$x = \frac{2E_s}{F}$



Electrical energy

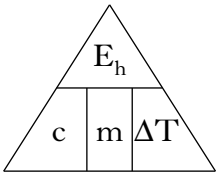
$E_e = VIt$



Heat energy

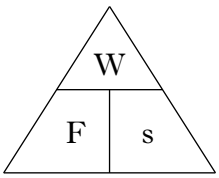
$E_h = cm\Delta T$

$c_{water} = 4190\ J/kgK$



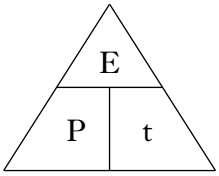
Work done

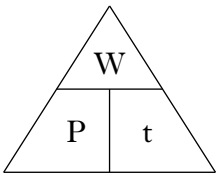
$W = Fs$



Power

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



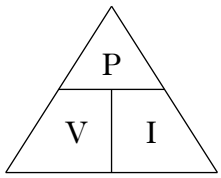


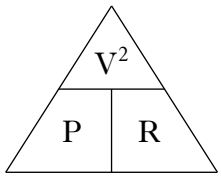
Electrical power

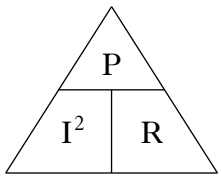
$P = VI$ or $\frac{V^2}{R}$ or I^2R

$V = \sqrt{PR}$

$I = \sqrt{\frac{P}{R}}$

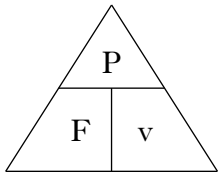






Mechanical power

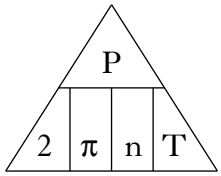
$P = Fv$



$P = 2\pi nT$

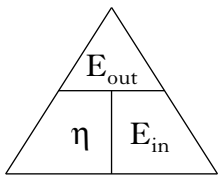
$\pi = 3{\cdot}14$

n is number of rev/s

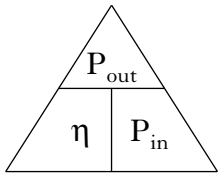


Efficiency

$\eta = \frac{\text{Output Energy}}{\text{Input Energy}}$



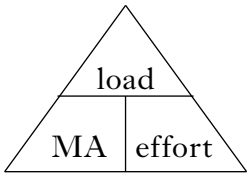
$\eta = \frac{\text{Output Power}}{\text{Input Power}}$



Mechanical Systems

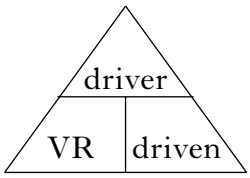
Mechanical Advantage

$$MA = \frac{\text{Load}}{\text{Effort}}$$



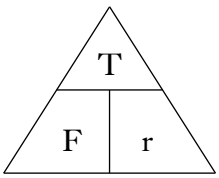
Velocity Ratio

$$VR = \frac{\text{driver}}{\text{driven}}$$



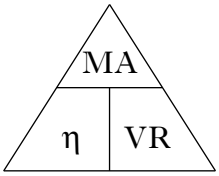
Torque

$T = Fr$



Efficiency

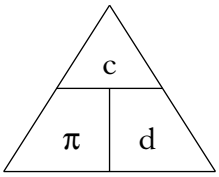
$$\eta = \frac{MA}{VR}$$



Circumference of circle

$c = \pi d$

π is 3·14



Moment of force

$M = Fx$

x is the perpendicular distance

Principle of moments

$\Sigma M = 0$ or

Σ CWM = Σ ACWM

Conditions of equilibrium

$\Sigma F_h = 0$

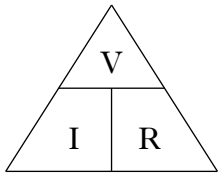
$\Sigma F_v = 0$

$\Sigma M = 0$

Electrical/Electronic

Ohm's law

$V = IR$



Resistors in series

$R_t = R_1 + R_2 + R_3 \ldots$

Resistors in parallel

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

for 2 resistors in parallel

$$R_t = \frac{R_1 R_2}{(R_1 + R_2)}$$

Kirchoff's 1st Law
(parallel branch)

$I_t = I_1 + I_2 + I_3 \ldots$

Kirchoff's 2nd Law
(series circuit)

$V_t = V_1 + V_2 + V_3 \ldots$

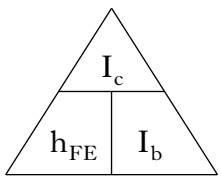
Voltage Divider

$$\frac{V_1}{V_s} = \frac{R_1}{R_t} \quad \text{or} \quad V_1 = \frac{R_1}{R_t} \times V_s$$

Bi-polar transistor gain

$$h_{FE} = \frac{I_{collector}\,(I_c)}{I_{base}\,(I_b)}$$

$I_e \approx I_c$

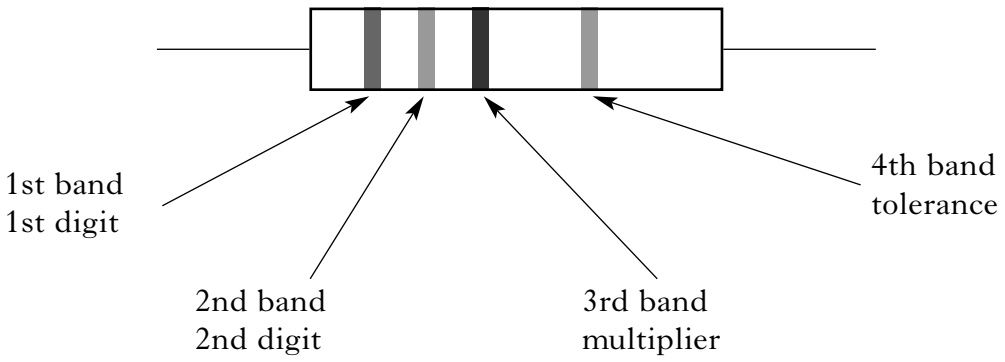


Saturated Transistor

$V_{be} = 0{\cdot}7\,V$

Resistor Colour Coding

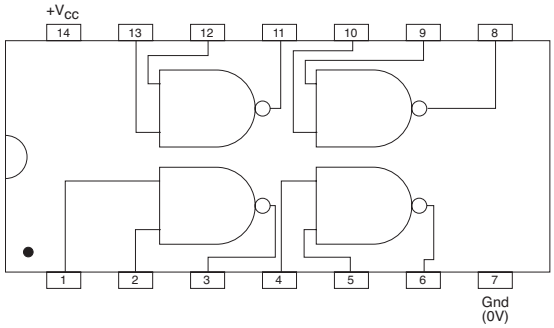
4 Band Resistor Colour Code Layout



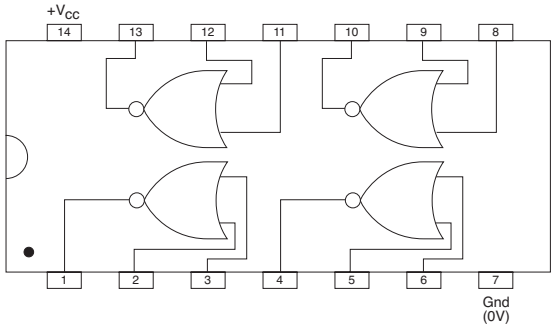
1st and 2nd Colour Band	Digit	Multiplier
Black	0	× 1
Brown	1	× 10
Red	2	× 100
Orange	3	× 1000 or 1 k
Yellow	4	× 10 000 or 10 k
Green	5	× 100 000 or 100 k
Blue	6	× 1 000 000 or 1 M
Violet	7	Silver is divide by 100
Grey	8	Gold is divide by 10
White	9	Tolerances: • Brown 1% • Red 2% • Gold 5% • Silver 10% • None 20%

7400 series IC Pinout Diagrams

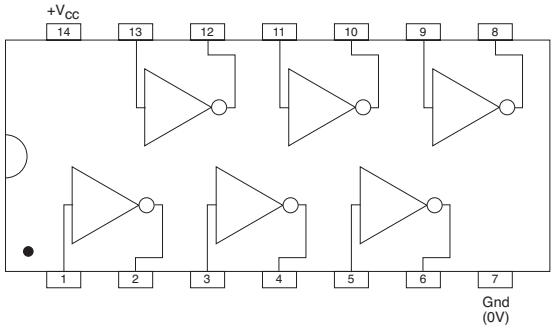
7400



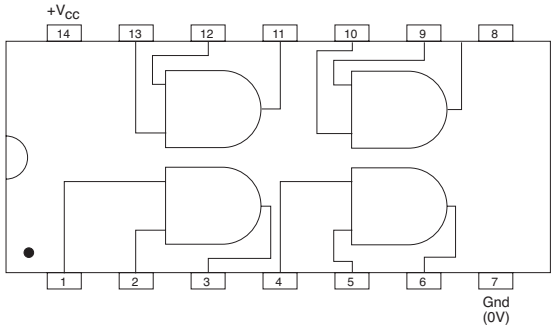
7402



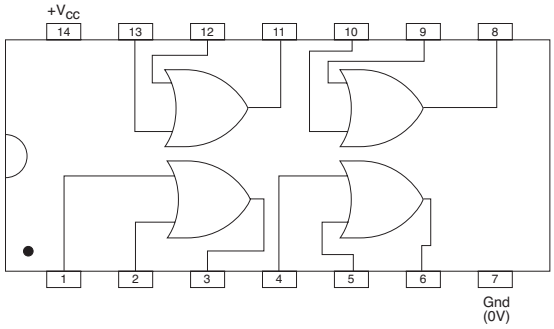
7404



7408

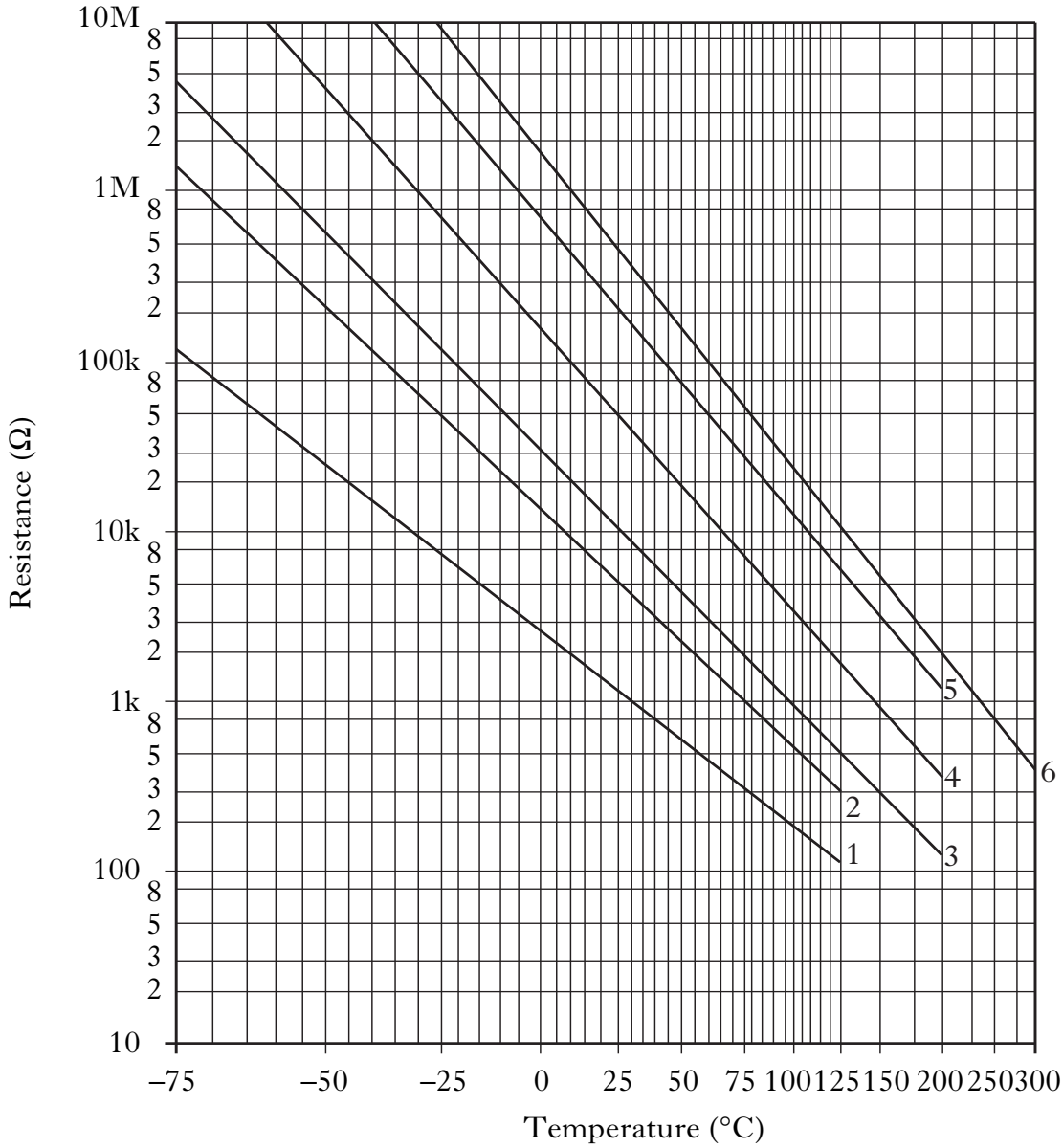


7432

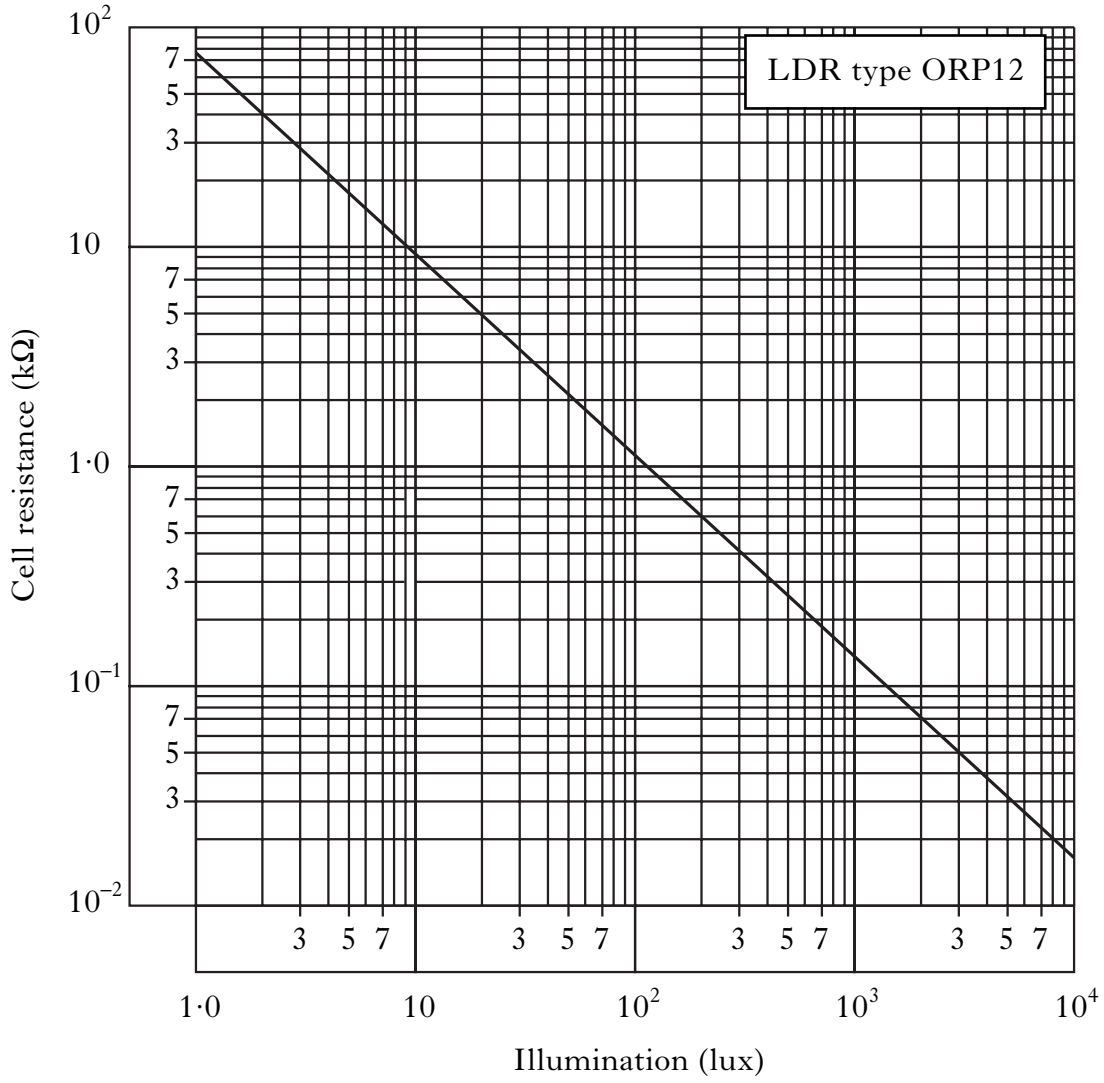


Graphs for Thermistors and LDR

Thermistors



Light Dependent Resistor (LDR)



Binary Weighting of Data Lines

bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
weighting	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

Decimal to Binary conversion

Decimal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Symbols for Flowcharts

Terminator symbol

Used for the start and end of a main program.

Line symbol

Shows the direction of program flow.

For flow down or to the right an arrow is not needed.

For flow upwards or to the left arrows are added.

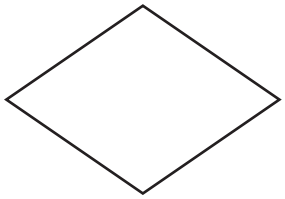
Input/Output

Used to control outputs or to show that data is being received.

Process symbol

Used for operations which take place within the microcontroller, for example a delay.

Decision symbol



Program flow is determined by a “yes” or “no” answer to the question in the box.

Sub procedure symbol

Entry to or exit from a sub-procedure.

PBASIC Instruction Set

PBASIC Instruction	Explanation
symbol	Allocate a name to a pin or variable
let	Allocate variables using mathematic equations
INPUT/OUTPUT	
high *x*	Set pin "*x*" high
low *x*	Set pin "*x*" low
dirs	Set pins on PORTB to input or output
pins	Set level of all pins at once
sensor	Converts analogue input (A or B) into a scaled value 1–240
TIME	
pause *n*	Create a time delay of *n* in milliseconds (0–65535)
PROGRAM FLOW	
goto *label*	Jump to *label*
gosub *label*	Jump to sub-procedure at *label*
return	Return from sub-procedure
if . . . . . then *label*	If a condition is met, jump to a *label* (but not a sub-procedure)
for . . . . . next	Set a loop which repeats a specific number of times
end	End program

The default number system is decimal.
For binary numbers, the prefix "%" is used.

Variables

The *byte* variables (b0–b13) can store values between 0 and 255.

The *word* variables (w0–w5) can store values between 0 and 65535; w0 contains b0 and b1 within it; w1 contains b2 and b3 within it etc.