Engineering Science Data Booklet

National 4/5

For use in National Qualification Courses
leading to the 2014 examinations and beyond.

Published date: 2013
Publication code:
ISBN:

Published by the Scottish Qualifications Authority
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www.sqa.org.uk

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Preface

This data booklet is intended for use by candidates in examinations in Engineering Science at National 5. It may also be used as a reference for assignments at National 4 and National 5. 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 the concepts which may be assessed through written question 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 question paper.

Teachers/lecturers should note that all of the material contained in this booklet is likely to be examined at some time. 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 appropriate information or formulae.

Quantities, Symbols and Units

Quantity	Symbol	Unit	Abbreviation
distance	d,x	metre	m
height	h	metre	m
length	l	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	ms^{-1}
mass	m	kilogram	kg
force	F	newton	N
gravitational acceleration	g	metre per second per second	ms^{-2}
work done	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	Nm^{-2}
temperature	T	kelvin, celsius	K, °C
specific heat capacity	c	joule per kilogram per degree kelvin	$Jkg^{-1}K^{-1}$
voltage, potential difference	V	volt	V
current	I	ampere (amp)	A
resistance	R	ohm	Ω
frequency	f	hertz	Hz
rotational speed	n	revolutions per minute	revs min^{-1}
		revolutions per second	revs sec^{-1}
stress	σ	pascal	Pa
strain	ε		

Decimal Prefixes

Prefix	Symbol	Multiplying factor
peta	P	10^{15}
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

Energy and power

Potential energy	$E_p = mgh$	$g = 9{\cdot}8\ ms^{-2}$ (to 2 significant figures)
Kinetic energy	$E_k = \frac{1}{2}mv^2$	
Heat energy	$E_h = cm\Delta T$	$c_{water} = 4180 Jkg^{-1}K^{-1}$
Electrical energy	$E_e = VIt$	
Work done	$E_w = Fd$	
Power	$P = \frac{E}{t}$	
Electrical power	$P = VI = \frac{V^2}{R} = I^2R$	
Mechanical power	$P = Fv$	$P = 2\pi nT$ (n= no of revs per second)
Efficiency	$\eta = \frac{Energy_{out}}{Energy_{in}} = \frac{Power_{out}}{Power_{in}}$	

Mechanisms

Velocity ratio $VR = \frac{\text{speed of input}}{\text{speed of output}}$

Input speed x input size = output speed x output size

Torque $T = Fr$

Circumference of circle $C = \pi d$

Moment of force $M = Fx$ (x is perpendicular distance)

Principle of moments $\Sigma M = 0$

Σ clockwise moments = Σ anti-clockwise moments

Conditions of equilibrium $\Sigma F_h = 0$ $\Sigma F_V = 0$ $\Sigma M = 0$

Pneumatic Systems

Pressure, force and area $P = \frac{F}{A}$

Area of circle $A = \pi r^2$ $A = \frac{\pi d^2}{4}$ $\pi = 3{\cdot}14$

Structures

Stress $\sigma = \frac{F}{A}$

Strain $\epsilon = \frac{\Delta l}{l}$

Electrical and electronic

Ohm's Law $V = IR$

Resistors in series $R_t = R_1 + R_2 + R_3 + \ldots..$

Resistors in parallel $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots..$

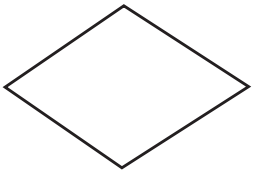
2 resistors in parallel $R_t = \frac{R_1 R_2}{(R_1+R_2)}$

Kirchhoff's 1st law (parallel branch) $I_t = I_1 + I_2 + I_3 + \ldots..$

Kirchhoff's 2nd law (series circuit) $V_t = V_1 + V_2 + V_3 + \ldots..$

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

Symbols for Flowcharts

Terminator symbol		Used for the start and end of a main program or sub-procedure.
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		Used to call a sub-procedure.

[END OF DATA BOOKLET]