National Qualifications 2017

2017 Engineering Science

National 5

Finalised Marking Instructions

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General marking principles for National 5 Engineering Science

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the detailed marking instructions for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

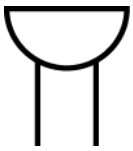
(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader.

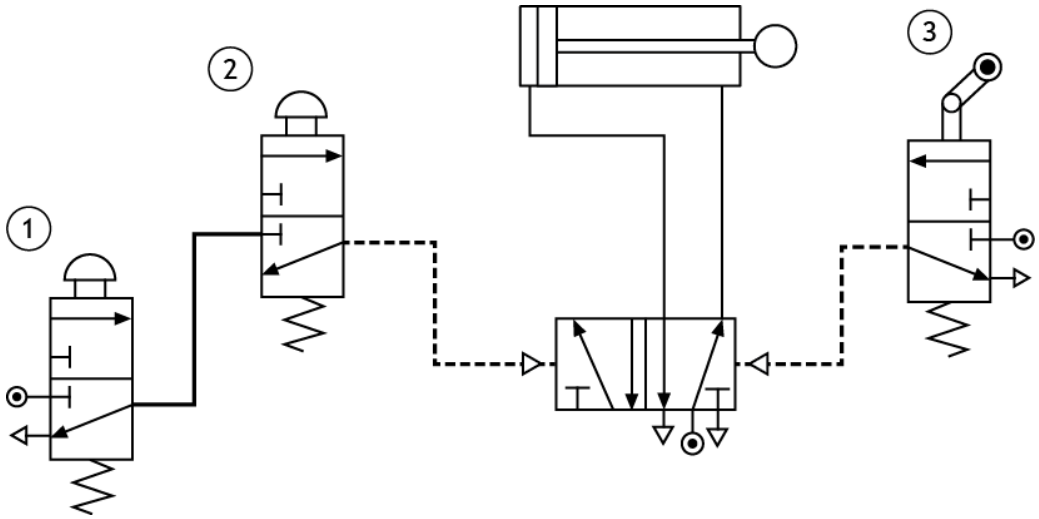
(d) Where a candidate makes an error at an early stage in a multi-stage calculation, credit should normally be given for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning.

(e) All units of measurement will be presented in a consistent way, using negative indices where required (eg ms^{-1}). Candidates may respond using this format, or solidus format (m/s) or words (metres per second), or any combination of these (eg metres/second).

Marking instructions for each question

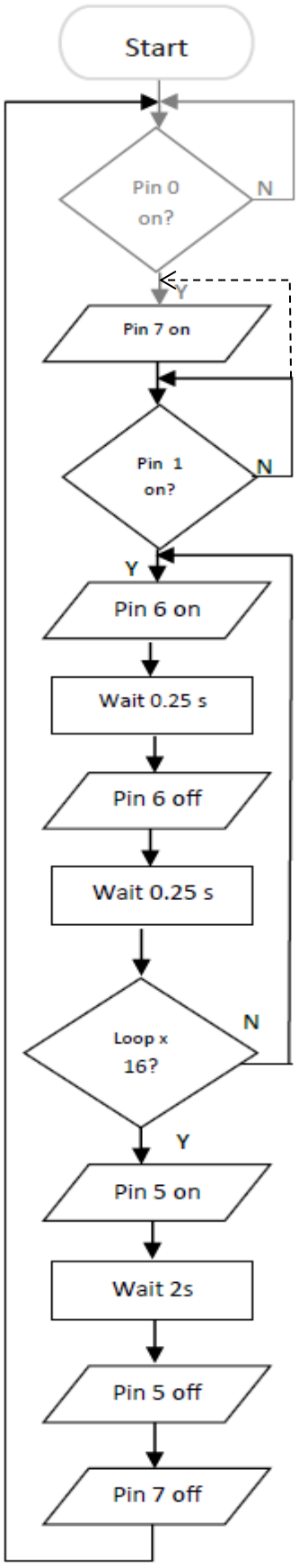
Section 1

Question			Expected answer(s)	Max mark	Additional guidance
1.	(a)		Open loop	**1**	Not Open on its own
	(b)		System boundary	**1**	Not Boundary on its own Accept sub-system boundary
2.			$Z = (A \cdot B) + \overline{C}$	**3**	1 mark for AND with () 1 mark for OR 1 mark for NOT C If a response only has the Boolean for ANDing then brackets are not required for that mark
3.	(a)			**1**	1 mark for correct symbol of buzzer in the correct position
	(b)		Ammeter	**1**	Also accept Multimeter but not Ampmeter
4.			$E_k = ½ mv^2$ $E_k = 0{\cdot}5 \times 5{\cdot}4 \times 8{\cdot}2^2$ $E_k =$ **180 J** (2 s.f.) 181·5 J	**2**	1 mark substitution 1 mark final answer with unit
5.	(a)		**A** – Tension/tensile/tie **B** - Compression/compressive/ strut	**2**	Stated or inferred
	(b)		F = mg = 2·2 x 9·8 = **22 N** (2 s.f.) 21·56 N	**2**	1 mark for substitution (9·8) 1 mark for correct answer from given working with unit

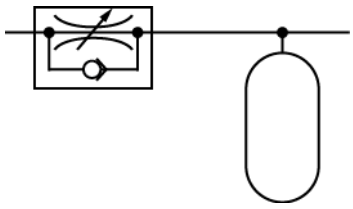
Question			Expected answer(s)	Max mark	Additional guidance
6.				**3**	1 mark for **both** lines creating AND control. 1 mark for line from valve (3) to 5/2 valve. 1 mark for a pilot air line type to 5/2. Piping must be port to port Ignore any additional pipes
					
7.	(a)	(i)	Idler	**1**	
		(ii)	No effect	**1**	
	(b)		Velocity Ratio = $\frac{\text{speed of input}}{\text{speed of output}}$ Velocity Ratio = $\frac{990}{66}$ Velocity Ratio = **15 : 1**	**2**	1 mark for substitution 1 mark for correct answer from given working Allow follow through error Ignore any units Accept just 15

Section 2

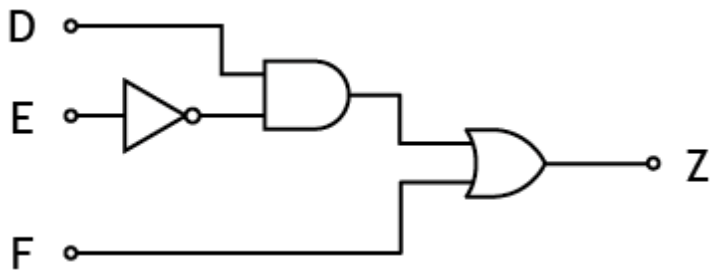
Question			Expected answer(s)	Max mark	Additional guidance
8.	(a)		*As the light level increases…* The resistance (of the LDR) decreases Voltage (V_{in}) decreases	**2**	Descriptive response 1 mark resistance 1 mark voltage must be correct to resistance response Accept V_{in} decreases on own
	(b)		Switch on the relay Acts as a switch	**1**	Descriptive response Accept amplification Not switch/turn on (the lamps/ other circuit)
	(c)		The diode is the wrong way round	**1**	Not LED Not diode wired/connected incorrectly
	(d)		$\varepsilon = \frac{\Delta l}{l}$ $0 \cdot 00056 = \frac{0 \cdot 34}{l}$ $l = \frac{0 \cdot 34}{0.00056}$ $l = \mathbf{610\ mm}\ (2s.f.) \quad 607.1\ mm$	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit

Question			Expected answer(s)	Max mark	Additional guidance
9.				9	**Pin numbers must** be correct where applicable. Pin 7 on and off – 1 Pin 6 on and off - 1 Pin 5 on and off - 1 Pin 1 on? (inc. Y/N, loop **and** arrow head) – 1 All 3 delays (with wait 2s) – 1 Assume all delays in seconds unless units are given or a high level command is used: pause 250 (PBASIC) delay 250 (C) LED on/off time total = 0.5 s – 1 Loop x 16? (inc. Y/N, loop **and** arrow to before pin 6 on) – 1 Continuous loop (with arrow to start) – 1 All marked symbols correct – 1 Ignore any additional steps.

Question			Expected answer(s)	Max mark	Additional guidance
10.	(a)	(i)	Efficiency $= \frac{\text{E out}}{\text{E in}}$ $0{\cdot}82 = \frac{\text{E out}}{1{\cdot}4}$ E out = 0·82 x 1·4 E out = **1·1 MJ** (2 s.f.) 1·148 MJ	**3**	1 mark for substitution 1 mark for transposition 1 mark for final answer from working with unit
		(ii)	$E_h = cm\Delta t$ $1{\cdot}1 \times 10^6 = 4180 \times m \times 91$ $m = \frac{1{\cdot}1 \times 10^6}{4180 \times 91}$ m = **2·9 kg** (2 s.f.) 2.892 kg (3.018 kg using 1.148 MJ)	**3**	1 mark for substitution (allow FTE from (a) (i) 1 mark for transposition 1 mark for final answer from working with unit
	(b)		Designing the sensor Testing the sensor Testing the circuit to see how it works Selecting appropriate components Calculating values/ratings of components Assemble the prototype Simulate the control sequence Writing the control program/ flowchart	**2**	1 mark for any appropriate descriptive response of an engineer's **task**. Must be linked to electronic temperature monitoring circuit design. Design/test/build/simulate the circuit is insufficient on own.

Question			Expected answer(s)	Max mark	Additional guidance
	(c)		<u>Positive:</u> Jobs created manufacturing the tap and heating tank creating wealth. Jobs created installing the tap and heating tank creating wealth. Reduced running cost due to efficiency <u>Negative:</u> Reduction in kettles being sold so less profit. Initial costs are more expensive. It is on 24/7 so cost to keep water at correct temperature when office is not in use Higher repair cost because system is more complex	**2**	1 mark for each economic description. Jobs/employment needs to describe economic impact Not no need to buy a kettle/urn as an economic advantage Not on all the time without reference usage and running costs as an economic disadvantage
11.	(a)		Valve 1 OR 3 is actuated. Air is sent to valve 4 causing both pistons to outstroke. The piston from cylinder A will actuate valve 5 causing both pistons to instroke.	**3**	1 mark for OR statement 1 mark for both pistons outstroking 1 mark for valve 5 **and** both pistons instroking
	(b)			**3**	1 mark for reservoir symbol 1 mark for uni-directional restrictor symbol 1 mark for correct position **and** orientation of uni-directional restrictor

Question			Expected answer(s)	Max mark	Additional guidance
	(c)		$A = \frac{\pi d^2}{4}$ $A = \frac{3{\cdot}14 \times 16^2}{4}$ $A = 200{\cdot}96\ mm^2$ (201.1 mm^2 when using π) $\sigma = \frac{F}{A}$ $3{\cdot}4 = \frac{F}{200{\cdot}96}$ $F = 3{\cdot}4 \times 200{\cdot}96$ F = **680 N** (2 s.f.) 683·3 N (683.9 N when using π)	**4**	1 mark for area (unit not required) 1 mark for substitution (accept 16 mm) 1 mark for transposition 1 mark for final answer from working with unit

Question			Expected answer(s)	Max mark	Additional guidance
12.	(a)		<table><tr><th>M</th><th>N</th><th>Z</th></tr><tr><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr></table>	3	1 mark per correct column Allow for follow through error
	(b)			3	1 mark for each gate with connections

Question			Expected answer(s)	Max mark	Additional guidance
	(c)		4800 x 10 = output speed x 30 Output speed = $\frac{48000}{30}$ Output speed = 1600 revs min^{-1} 1600 x 12 = 200 x size of D Size of D = $\frac{19200}{200}$ Size of D = 96 teeth OR VR = 4800 revs min^{-1} / 200 revs min^{-1} VR = 24 : 1 24 = 30 / 10 x D / 12 D = (24 x 12) / 3 Size of D = 96 teeth	**4**	1 mark for substitution 1 mark for answer from working (unit not required) 1 mark for substitution (allow follow through error) 1 mark for final answer from working (ignore any units) 1 mark for calculating VR 1 mark for substitution 1 mark for transposition 1 mark for answer from given working
	(d)		Lubricate/bearings/'slippier' material used to reduce friction/energy loss(to heat/sound); or location for change gears/shafts/moving parts etc	**2**	1 mark lubrication (cause) 1 mark for location / reason (effect)

Question			Expected answer(s)	Max mark	Additional guidance
13.	(a)	(i)	Design/calculate/select/simulate/ model /test [any appropriate structural aspect] Calculate the forces on the structure Select appropriate material for the structure. Design the structure	**1**	1 mark for any appropriate descriptive response of an engineer's **activity** and the structural **aspect**. Must be linked to development.
		(ii)	Design/calculate/select/model/ test… [any appropriate electrical aspect] Design the solar panels to connect to the mains supply Calculate the electrical power requirements of the extension	**1**	1 mark for any appropriate descriptive response of an engineer's **activity** and the electrical **aspect**. Must be linked to development. Not design the circuit on its own. Not electronic or electrician related.
	(b)		Less pollution/clean source Lower/no emissions of greenhouse gases Reduction in global warming	**2**	1 mark for each appropriate descriptive response specific to **environmental** advantages during use or installation. Not 'renewable' Not 'reduction in fossil fuels'
	(c)		Temperature sensor feeds information (to control unit) Control unit compares set and actual temperatures (Control unit).. switches on heater if it's too cold (Control unit).. switches on fan if it's too hot	**4**	Descriptive responses covering: 1 mark temperature feedback 1 mark control unit action 1 mark heater switching 1 mark fan switching

Question			Expected answer(s)	Max mark	Additional guidance
	(d)		800 Ω (0·8 kΩ)	**1**	Unit required
	(e)		$\frac{R1}{R2} = \frac{V1}{V2}$ $\frac{R1}{1.9} = \frac{2.3}{3.7}$ $R1 = \frac{2.3}{3.7} x\ 1.9$ $R2 = \mathbf{1.2\ k}\Omega\ (2\ s.f.)$ 1181Ω **Alternative Method** $I = \frac{V}{R} = \frac{3.7V}{1.9} = 1.95mA$ (1) (1) $R = \frac{V}{I} = \frac{2.3V}{1.95mA} = 1.2k\Omega$ (1)	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit Ignore current unit

Question			Expected Answer(s)	Max Mark	Additional Guidance
14	(a)		$\Sigma ACWM = \Sigma CWM$ $(RBx6) = (5.2\ x\ 1.5) +\ (22\ x\ 3)$ $RB = \frac{73.8}{6}$ $RB = \mathbf{12kN}\ (2s.f.)\quad 12300N$	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit
	(b)		Metal **B** The maximum tensile load (5·6 kN) exceeds the (5·2 kN) weight of the sign **and** it is corrosion resistant as the sign will be outdoors.	**2**	1 mark metal choice 1 mark for reason including reference maximum tensile load **and** corrosion resistance. Accept highest tensile load but not high tensile load with corrosion resistance.
	(c)		Journey time reduced by early warning of congestion Improved safety because of early warning Feedback may make travel less stressful Job created maintaining the sign	**1**	Any descriptive response relating to situation Not faster/safer on own
	(d)		V_R = 5V – 1.4V V_R = 3.6 V $V = IR$ $3.6 = 0.015\ x\ R$ $R = \frac{3.6}{0.015}$ $R = 240\Omega$	**4**	1 mark for V_R No units necessary 1 mark for substitution (accept 5V but not 1.4V) 1 mark for transposition 1 mark for correct answer from given working with unit

[END OF MARKING INSTRUCTIONS]