National
Qualifications
2018

2018 Engineering Science

National 5

Finalised Marking Instructions

SQA
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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 specific marking instructions for each question. The marking schemes are written to assist in determining the 'minimal acceptable answer' rather than listing every possible correct and incorrect answer.

(a) Marks for each candidate response must **always** be assigned in line with these general marking principles and the specific marking instructions for the relevant question.

(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.

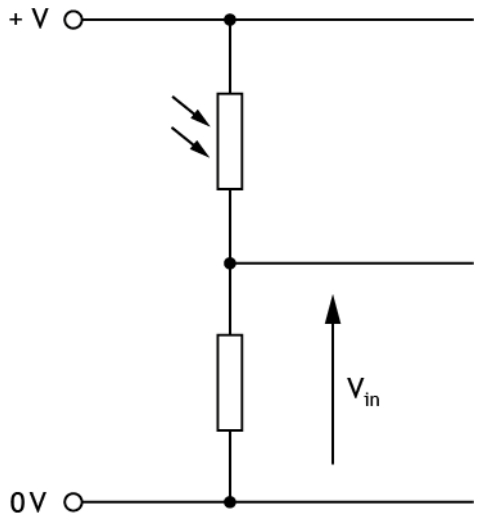
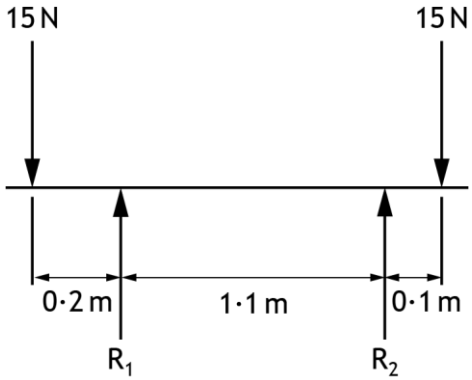
(c) Where a candidate makes an error at an early stage in a multi-stage calculation, credit should normally be given for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which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

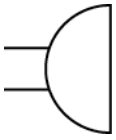
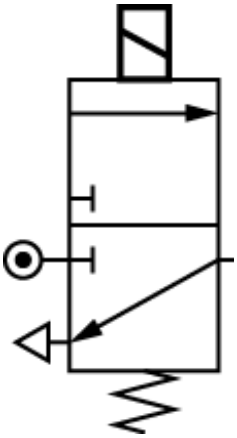
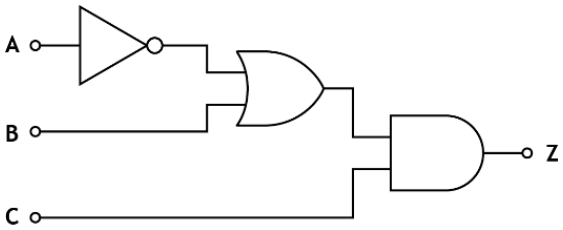
(d) All units of measurement will be presented in a consistent way, using negative indices where required (eg ms^{-1}). Candidates may respond using this format, or solidus format (m/s) or words (metres per second), or any combination of these (eg metres/second).

(e) Answers to numerical questions must be rounded to an appropriate number of significant figures. However, the mark can be awarded for answers which have up to two figures more or one figure less than the expected answer.

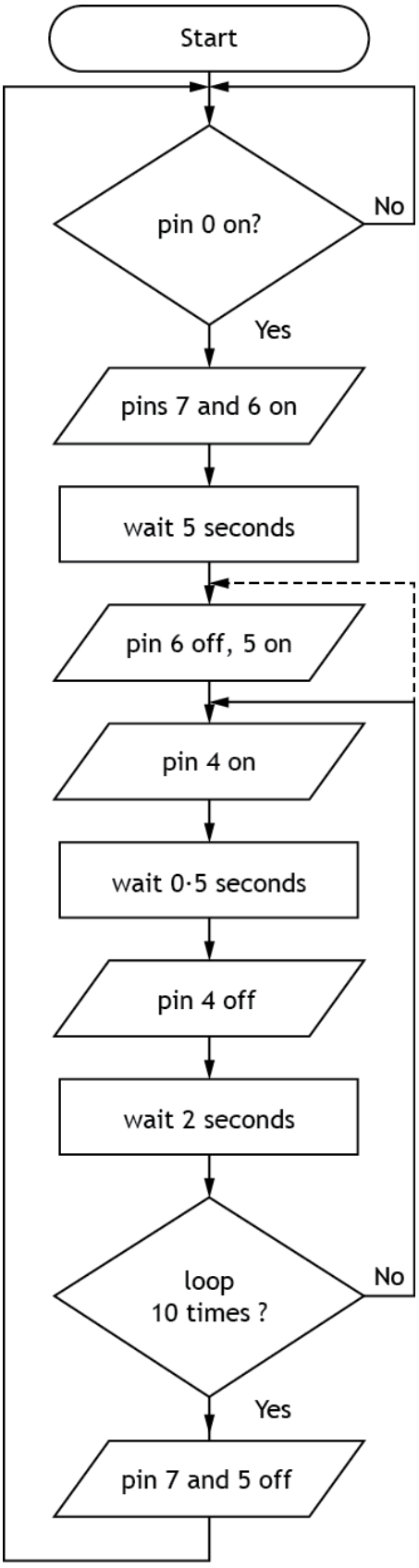
Marking instructions for each question

Section 1

Question			Expected response	Max mark	Additional guidance
1.	(a)		Mechanical (engineer)	**1**	
	(b)		Electronic (engineer)	**1**	Not electrical engineer
2.				**3**	1 mark for LDR symbol 1 mark for fixed resistor symbol 1 mark for correct wiring of components with given sensor at top of voltage divider
3.				**2**	1 mark for all forces with arrows and units in the correct position 1 mark for all dimensions with units (dimension and leader lines are not required)
4.	(a)		Open loop	**1**	Do not accept open on its own
	(b)		*The speed limit is set.* The sensor measures the speed of the car The control unit compares the set speed limit with the speed of the car If the speed is too fast then camera is activated taking the photograph	**3**	Descriptive response covering: 1 mark sensor measuring car speed (inferred) Do not accept speed sensor detects a car without reference to speed 1 mark control unit decision 1 mark camera being activated when speed is too fast / no photo taken when within speed limit

Question			Expected response	Max mark	Additional guidance
5.				**1**	1 mark for correct symbol
6.			**A** - Compressive/compression **B** - Tensile/tension	**2**	Accept strut/tie/squashed/ stretched No FTE
7.				**1**	Correct actuator symbol drawn on the top surface of the valve symbol Should include both the rectangle and an inclined line (any direction)
8.			Incorrect line type used / not solid lines Should be crosses in the centres / not dots Double outlines missing	**2**	Must be descriptive response Do not accept overlapping Do not accept lines incorrect
9.				**3**	1 mark for NOT gate on A 1 mark for OR gate with correct connections 1 mark for AND gate with correct connections

Section 2

Question			Expected response	Max mark	Additional guidance
10.	(a)			**10**	Pin numbers must be correct where applicable Pin 0 on ? (inc Y or N, loop and arrow head) – 1 mark Pin 7 on and off positions – 1 mark Pin 6 on and off positions – 1 mark Pin 5 on and off positions – 1 mark Pin 4 on and off positions – 1 mark All three delays with unit – 1 mark Loop x10 ? decision (inc Y or N) – 1 mark Feedback loop and arrow to before pin 4 on – 1 mark Continuous loop (with arrow to start) – 1 mark All marked symbols correct – 1 mark Ignore any additional steps.

Question			Expected response	Max mark	Additional guidance
10.	(b)		$0 \cdot 0016 = \frac{\Delta l}{1200}$ $\Delta l = 0 \cdot 0016 \times 1200$ $\Delta l = 1.92$ mm **1·9 mm (2 sf)**	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit

Question			Expected response	Max mark	Additional guidance
11.	(a)		Oscillating	**1**	
	(b)	(i)	E_p = mgh E_p = 69 × 9·8 × 6·8 E_p = 4598 J E_p = **4600 J (2 sf)**	**2**	1 mark for substitution 1 mark for answer from given working with unit
		(ii)	$Ek = \frac{1}{2} mv^2$ $970J = \frac{1}{2} 69kg\ v^2$ $v = \sqrt{\frac{2 \times 970}{69}}$ 5·302 ms^{-1} v = **5·3 ms^{-1} (2 sf)**	**3**	1 mark for substitution 1 mark for transposition 1 mark for answer from given working with unit
	(c)	(i)	$\sum M = 0$	**1**	Accept ∑CWM = ∑ACM or written response
		(ii)	450 (N)	**1**	Accept 445N-455N
	(d)		Material C It is durable **and** will support the (1300N) load It is strong (enough) to support the acrobats and it is durable	**2**	1 mark for correct material 1 mark for justification in terms of durability and tensile load/ strength

Question			Expected response	Max mark	Additional guidance
12.	(a)	(i)	$L = (A \cdot \overline{B}) \cdot C$	**2**	1 mark for NOT B 1 mark for ANDing A and B and C (ignore brackets if given)
		(ii)	<table><tr><th>D</th><th>E</th><th>L</th></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</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>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></table>	**3**	1 mark for each correct column Allow FTE: column E – A AND D column L – E AND C
	(b)	(i)	A variety of unlock codes can be programmed User can set own unlock code Time delays can be incorporated Automatic lockout after a set number of incorrect attempts	**1**	1 mark for any description of an advantage relating to function Response must relate to the context (lock control/coding)
		(ii)	Less components needed to be manufactured so less fumes produced. Less materials needed so fewer natural resources used up Can be reprogrammed/reusable therefore less waste (to landfill).	**2**	Response must relate to environment 1 mark for cause (advantage) 1 mark for effect (reason for advantage) Do not accept less materials used as an effect on its own. Do not accept less waste material

Question			Expected response	Max mark	Additional guidance
13.	(a)	(i)	$(1{\cdot}8 \times 1{\cdot}5) + (R_A \times 5{\cdot}0) = (3{\cdot}2 \times 2{\cdot}5)$ $R_A = \frac{5{\cdot}3}{5{\cdot}0}$ 1·06 kN R_A = **1·1 kN (2 sf)**	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit If R_B is calculated correctly (3·9 kN) 2 marks
		(ii)	$3{\cdot}2 + 1{\cdot}8 = 1{\cdot}1 + R_B$ $R_B = 5{\cdot}0 - 1{\cdot}1$ R_B = **3·9 kN (2 sf)**	**2**	1 mark for substitution (allow FTE from 13(a)(i) 1 mark for correct answer from given working with unit
	(b)		Calculate the forces on the hull Select material for the mast Test the mast cables / ensure the cables are strong enough Design the deck (to ensure the loads are supported)	**2**	1 mark for each appropriate descriptive response of an engineer's activity **and** specific structural aspect Must be linked to development - design/calculate/select/simulate/ model/test (ensure) and management related activities Two different activities must be used Do not accept design the sail on its own Do not accept developing as an activity on its own

Question			Expected response	Max mark	Additional guidance
14.	(a)		The resistance of the thermistor decreases… ...this results in V_{in} increasing… …the transistor switches on... …and the motor will switch on	**4**	Descriptive responses covering: 1 mark thermistor resistance decreasing 1 mark V_{in} increasing 1 mark transistor switching on/saturating / V_{BE} = 0·7 V (do not accept V_{in} = 0·7 V) (do not accept transistor acts as a switch on its own) 1 mark motor switching on Apply FTE from each statement
	(b)		$V_1 = 6{\cdot}0 - 4{\cdot}5 = 1{\cdot}5$ V $\frac{R}{16k} = \frac{1{\cdot}5V}{4{\cdot}5V}$ $R = 0{\cdot}333 \times 16k$ $R = 5328\ \Omega$ R = **5·3 kΩ (2 sf)** **OR** $V_2 = IR_2$ $I = V_2/R_2$ $I = 4{\cdot}5/16000$ $I = 0{\cdot}000281$A $V_1 = 6{\cdot}0 - 4{\cdot}5 = 1{\cdot}5$ V $V_1 = IR_1$ $R_1 = V_1/I$ $R = 1{\cdot}5/0{\cdot}000281$ $R = 5{\cdot}33\ k\Omega$ R= **5·3 kΩ (2 sf)**	**4**	1 mark for calculating voltage V_1. (ignore unit) 1 mark for substitution (apply FTE and accept 6·0 V if V_1 not calculated) 1 mark for transposition 1 mark for correct answer from given working with unit 1 mark for calculating current (ignore unit) 1 mark for calculating voltage V_1 (ignore unit). 1 mark for substitution (allow FTE) 1 mark for correct answer from given working with unit

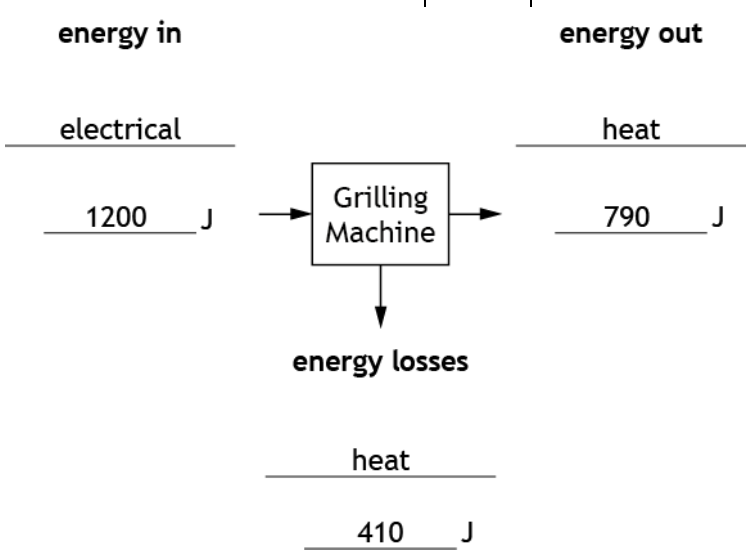
Question			Expected response	Max mark	Additional guidance
Question			**Expected response**	**Max mark**	**Additional guidance**
14.	(c)		Replace the fixed resistor with a variable resistor Add a variable resistor	**1**	Descriptive response Do not accept just use a variable resistor
	(d)		50 kΩ	**1**	Unit required
	(e)		$0 \cdot 029 = \frac{25}{A}$ $A = \frac{25}{0 \cdot 029}$ A = 862.1 mm^2 A = **860 mm^2 (2 sf)**	**3**	1 mark for substitution 1 mark for transposition 1 mark for correct answer from given working with unit

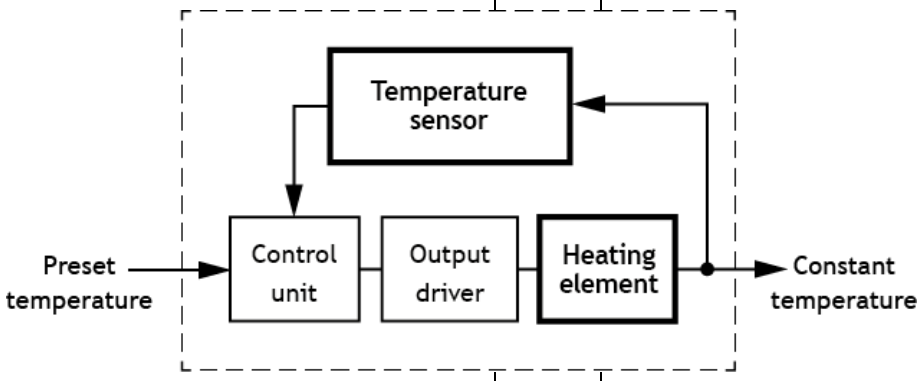
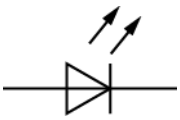
Question			Expected response	Max mark	Additional guidance
15.	(a)	(i)	Teeth A x Speed A = Teeth B x Speed B 8 × 880 = 32x B $\frac{8 x 880}{32} = Speed\ B$ B = 220 revs min^{-1} Teeth C x Speed C = Teeth D x Speed D 16 × 220 = 32 × D $\frac{16 x 220}{32} = Speed\ D$ D = **110 revs min^{-1}** OR $\frac{\text{input speed}}{\text{output speed}} = \frac{A}{B} x \frac{C}{D}$ $output\ speed = \frac{8}{32} x \frac{16}{32} x\ 880$ output speed = **110 revs min^{-1}**	**4**	1 mark for substitution 1 mark for answer from working (units not required) 1 mark for substitution (allow FTE) 1 mark for answer from working with unit Do not accept RPM 1 mark for first ratio 1 mark for second ratio 1 mark for substitution. (880/8 if ratios inverted) 1 mark for answer from working with unit
		(ii)	VR : $\frac{\text{input speed}}{\text{output speed}}$ $VR = \frac{880}{110}$ VR = 8:1 or 8	**2**	1 mark for substitution (allow FTE from 15(a)(i)) 1 mark for answer from working (ignore units)
	(b)		Reduce/remove a number of teeth Make the gear smaller	**1**	1 mark for descriptive response

Question			Expected response	Max mark	Additional guidance
15.	(c)		*When the air bleed is covered valve 1 is actuated...* ...pilot air is sent to Valve 2 causing the piston in Cylinder A to outstroke… …air is also sent to (Components 3 and 4) creating a time delay... ...pilot air is sent to Valve 2 again causing the piston in Cylinder A to instroke.	**3**	Must be descriptive responses using appropriate terminology 1 mark for Valve 2 causing piston to outstroke 1 mark for time delay before instroking (second piston movement) 1 mark for Valve 2 causing piston to instroke
	(d)		It is clean therefore will not contaminate pastry/hygienic Does not apply pressure therefore will not damage pastry	**2**	Response must be in the context/ referencing pastry 1 mark for cause 1 mark for effect
	(e)		$P = \frac{F}{A}$ $P = \frac{73}{810}$ P = 0·09012 Nmm^{-2} P = **0·090 Nmm^{-2} (2 sf)**	**2**	1 mark for substitution 1 mark for answer from working with unit Accept 0.090 x 10^{-6} Nm^{-2} (Pa)

Question			Expected response	Max mark	Additional guidance
16.	(a)	(i)	Less pollution/clean source of energy Lower/no emissions of greenhouse gases Reduction in global warming.	**1**	1 mark for any appropriate descriptive response of a positive environmental impact Do not accept does not use fossil fuel on its own
		(ii)	Cost of having to build additional power stations to cope with demand. Reduction in fossil fuel cars being sold so less profit. Installation costs (charging points) Specialist vehicle technicians may be more expensive	**1**	1 mark for any appropriate descriptive response of a negative economic impact of the increasing use Do not accept it costs money to charge the batteries Do not accept loss of jobs / unemployment on its own without link to economy Do not accept expensive to manufacture
	(b)		$R_p = \frac{5 \cdot 6 \times 12}{5 \cdot 6 + 12}$ $R_p = \frac{67 \cdot 2}{17 \cdot 6}$ $R_p = 3 \cdot 82$ $R_t = 3 \cdot 82 + 15$ $R_t = 18 \cdot 82\ k\Omega$ $R_t =$ **19 kΩ (2 sf)**	**3**	1 mark for R_p substitution 1 mark for R_p answer (ignore units) 1 mark for correct answer with unit (apply FTE for R_p)

Question			Expected response	Max mark	Additional guidance
16.	(c)	(i)	V = 0·6 ×15 V = **9·0 V (2 sf)**	**2**	1 mark for substitution 1 mark for correct answer from given working with unit
		(ii)	12 – 9·0 = 3·0V 3·0V = I × 5·6k $I = \frac{3 \cdot 0}{5 \cdot 6k}$ I = 0·5357 mA I = **0·54 mA (2 sf)**	**4**	1 mark for calculating voltage across 5·6 kΩ resistor (FTE from (c)(i)) 1 mark for substitution (allow FTE for calculated voltage) 1 mark for transposition 1 mark for correct answer from given working with unit
	(d)		Graphene Conducts and stores electricity more efficiently than other materials. This will result in batteries being charged quicker/holding their charge for longer Self driving car Impact of emerging system is it may not be fully tested and so may have faults and be unreliable/unsafe	**2**	Accept impact for any emerging technology 1 mark for cause 1 mark for effect If no technology named or the given example is clearly an established / developing type, 1 mark maximum for cause and effect

Question			Expected response	Max mark	Additional guidance
17.	(a)			**3**	1 mark for electrical and 1200 (J) input Do not accept electricity 1 mark for heat and 790 (J) output 1 mark for heat/sound/light and 410 (J) lost
	(b)		$\eta = \frac{Energy\ out}{Energy\ in}$ $\eta = \frac{790}{1200}$ η = 0·6583 η = **0·66 (2 sf) or 66%**	**2**	1 mark for substitution 1 mark for answer from working (ignore any units)
	(c)	(i)	Closed loop (control)	**1**	

Question			Expected response	Max mark	Additional guidance
		(ii)		**3**	1 mark for heating element/ heater 1 mark for temperature sensor accept thermistor/thermostat/heat sensor 1 mark for feedback lines from node into control unit, with an arrow head showing direction. Do not accept feedback joining preset temperature input
17.	(d)	(i)		**2**	1 mark for correct symbol 1 mark for correct orientation (apply FTE mark if diode is drawn)
	(ii)		Add a resistor (in series). Lower the voltage	**1**	1 mark for descriptive answer

[END OF MARKING INSTRUCTIONS]