



National
Qualifications
2026

2026 Engineering Science

N5

Question Paper Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by Qualifications Scotland appointed markers when marking external course assessments.

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General marking principles for National 5 Engineering Science

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) 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.
- (c) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages. Do not award marks if the error significantly reduces the complexity of the remaining stages. Apply the same principle in questions which require several stages of non-mathematical reasoning.
- (d) Qualifications Scotland presents all units of measurement in a consistent way, using negative indices where required (for example ms^{-1}). Candidates can respond using this format, or solidus format (m/s), or words (metres per second), or any combination of these (for example metres/second).
- (e) For numerical questions, candidates should round their answers to an appropriate number of significant figures. However, award marks if their answer has up to two figures more or one figure less than the expected answer. (Note: the use of a recurrence dot, e.g. $3\cdot$, would imply an infinite number of significant figures and would therefore not be acceptable.)
- (f) Unless a numerical question specifically requires candidates to show evidence of their working, award full marks for a correct final answer (including unit) on its own.
- (g) Award marks where a labelled diagram or sketch conveys clearly and correctly the response required by the question.
- (h) Award marks regardless of spelling if the meaning is unambiguous.
- (i) Where a question asks for or requires a specific number of reasons, examples, points, etc and the candidate provides more than the required number then each incorrect response negates a correct response.
- (j) Where a question asks a candidate to **state**, they must provide a name or brief statement giving a short factual response, in the context of and appropriate to the question.
- (k) Where a question asks candidates to **describe**, they must provide an account or structure of characteristics and/or features, in the context of and appropriate to the question.
- (l) Where a question asks candidates to **explain**, they must relate cause and effect, or provide a relationship between two aspects, in the context of and appropriate to the question.

Marking instructions for each question

Section 1

Question			Expected response	Max mark	Additional guidance								
1.			<table><tr><td>Air type symbol</td><td>Name of air type</td></tr><tr><td></td><td>main</td></tr><tr><td></td><td>exhaust</td></tr><tr><td></td><td>pilot</td></tr></table>	Air type symbol	Name of air type		main		exhaust		pilot	3	1 mark for main air. 1 mark for exhaust. 1 mark for pilot air. Accept air types clearly labelled on the valve.
Air type symbol	Name of air type												
	main												
	exhaust												
	pilot												
2.			$E_k = \frac{1}{2} mv^2$ $E_k = \frac{1}{2} \times 1.2 \times 15^2$ $E_k = 135$ $E_k = 140 \text{ J (2 sf)}$	2	1 mark for substitution. 1 mark for correct answer from given working with unit.								
3.	(a)		Series (circuit).	1									
	(b)			2	1 mark for voltmeter symbol. 1 mark for shown symbol connected in parallel to the battery.								
	(c)		LED is connected in the wrong direction/incorrect orientation.	1	Descriptive response. 1 mark for LED polarity, stated or inferred. Award 1 mark for resistor value is too high.								

Question			Expected response	Max mark	Additional guidance
4.	(a)		$\Sigma F_{\text{vertical}} = 0$ $R_A = 260 + 120 - 270$ $R_A = 110 \text{ N (2 sf)}$	2	1 mark for substitution. 1 mark for correct answer from given working with unit.
	(b)		Dimensions between forces. Length of the beam.	1	Do not accept dimension/distance on its own.
5.			$Z = (A + \overline{B}) \bullet C$	3	1 mark for A OR B. 1 mark for NOT B. 1 mark for AND C.
6.	(a)		The length increases.	1	Stated or inferred.
	(b)		The length decreases.	1	Stated or inferred. Do not apply FTE.
7.	(a)		The user input is shown coming out of the system. The motor is part of the system/not an external output.	2	Descriptive response of an error made on the system diagram. 1 mark for user input should be going into the system. 1 mark for the motor is part of the system. Accept corrections such as the input arrow should point into the system/output should be movement.
	(b)		Open loop (control)	1	Do not accept open on its own.

Section 2

Question			Expected response	Max mark	Additional guidance
8.	(a)	(i)	Design the sensor circuit (to detect objects in its way). Write the control program (to steer the motorised wheels). Test the camera circuit (to ensure it operates correctly). Calculate the values of components in the sensor circuit.	1	Descriptive response linked to a specific electronic aspect of the development of the robot. Accept build/make reference only if linked to the testing of a prototype. Do not accept development as an appropriate task.
		(ii)	Calculate the power requirements for the motor. Select a battery with an appropriate power output for the motor/sensor/camera. Test the battery circuit to measure the time taken to recharge.	1	Descriptive response linked to a specific electrical aspect of the development of the robot. Accept build/make reference only if linked to the testing of a prototype. Do not accept development as an appropriate task.
	(b)		Shopping is automatically delivered ... giving everyone easier access to goods. Robots deliver the shopping ... so delivery drivers will lose their jobs. Robots could take up space on the pavement ...which will obstruct pedestrians.	2	Descriptive response relating to a positive or negative social impact of using a robot to deliver shopping. 1 mark for cause. 1 mark for effect. For full marks the effect must relate to the given cause.
	(c)		Compound gear (train).	1	

Question			Expected response	Max mark	Additional guidance
8.	(d)		$1920 \times 8 = \text{output speed} \times 32$ $\text{output speed} = \frac{1920 \times 8}{32}$ $\text{output speed} = 480 \text{ (revs min}^{-1}\text{)}$ $480 \times \text{size of C} = 120 \times 64$ $\text{size of C} = \frac{120 \times 64}{480}$ C = 16 (teeth) (2 sf) Alternative method $\text{VR} = \frac{1920}{120}$ $\text{VR} = 16:1$ $\frac{16}{1} = \frac{32}{8} \times \frac{64}{C}$ $16 = 4 \times \frac{64}{C}$ $C = \frac{64}{4}$ C = 16 (teeth) (2 sf)	4	1 mark for substitution. 1 mark for correct answer from given working (unit not required). 1 mark for substitution. Apply FTE. 1 mark for correct answer from given working (ignore any units). 1 mark for velocity ratio (does not need to be simplified). 1 mark for 32:8 ratio (ratios could be inverted). 1 mark for transposition. 1 mark for correct answer from given working (ignore any units).

Question			Expected response	Max mark	Additional guidance
8.	(e)	(i)	It would mean the gears will last longer/be more durable. The gear will be less likely to break in use. Will allow the robot gear drive to move heavier loads (without damage).	1	Descriptive positive response relating to the use of a gear made from a high strength material. 1 mark for advantage of high strength. Do not accept stronger/will not break on its own.
		(ii)	It will reduce the need for maintenance on the gear drive. It will not need oil applied to the gears when in use. Less energy lost in the gear drive. The gear drive will be more efficient.	1	Descriptive positive response relating to the use of a gear made from a self-lubricating material. 1 mark for advantage of self-lubricating. If maintenance advantage is used in part (i), no mark can be awarded for this response in (ii).

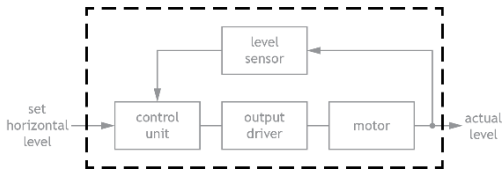
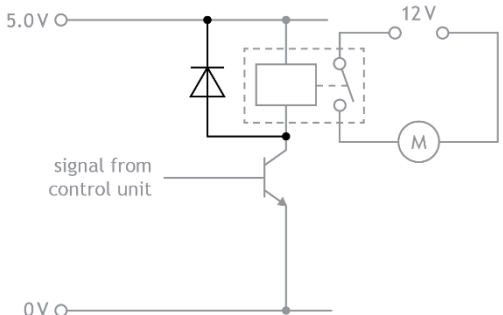
Question			Expected response	Max mark	Additional guidance
9.	(a)		Calculate the forces/stress/strain acting on the support frame. Select an appropriate material to be used in the cage. Simulate the forces that would be applied to the support structure. Design the structural shape of the support frame.	2	Descriptive response relating to a development task for a structural element of the slingshot. 1 mark for each task. Tasks described must be different activities/aspects. Accept build/make reference only if linked to the testing of a prototype. Do not accept development as an appropriate task. If tasks are similar, 1 mark max. Calculate the force... Calculate the stress...
	(b)		$\epsilon = \frac{\Delta l}{l}$ $0.17 = \frac{6.2}{l}$ $l = \frac{6.2}{0.17}$ $l = 36.47058824$ $l = 36 \text{ m (2 sf)}$	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
	(c)		$F_2 = 2100 \text{ (N) (2 sf)}$ $F_3 = 2700 \text{ (N) (2 sf)}$	2	1 mark for force F_2. 1 mark for force F_3. Apply a tolerance of $\pm 30 \text{ N}$. Unit only required if answer is not written in space provided.

Question			Expected response	Max mark	Additional guidance
9.	(d)		$E_p = mgh$ $110 \times 10^3 = m \times 9.8 \times 43$ $m = \frac{110 \times 10^3}{9.8 \times 43}$ $m = 261.0346464$ $m = 260 \text{ kg (2 sf)}$	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
	(e)		$\text{Efficiency} = \frac{E_{\text{out}}}{E_{\text{in}}}$ $0.32 = \frac{140}{E_{\text{in}}}$ $E_{\text{in}} = \frac{140}{0.32}$ $E_{\text{in}} = 437.5$ $E_{\text{in}} = 440\,000 \text{ J (440 kJ) (2 sf)}$	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
10.	(a)		When the user covers the LDR... The light level will decrease. This will cause the resistance of the LDR to increase. The voltage V_{in} will increase. The transistor will then switch on. The solenoid will activate.	5	Descriptive response. 1 mark for light level decreases. 1 mark for LDR resistance increasing. 1 mark for V_{in} increasing. 1 mark for transistor switching on. 1 mark for solenoid switching on. Apply FTE between each statement.

Question			Expected response	Max mark	Additional guidance
10.	(b)		$\frac{V_1}{V_2} = \frac{R_1}{R_2}$ $\frac{V_1}{1.8} = \frac{110}{19}$ $V_1 = \frac{110}{19} \times 1.8$ $V_1 = 10.42105263 \text{ (V)}$ $V_s = 10.42105263 + 1.8$ $V_s = 12.22105263$ $V_s = 12 \text{ V (2 sf)}$ Alternative $V = I R$ $1.8 = I \times 19$ $I = \frac{1.8}{19}$ $I = 0.09473684211 \text{ (mA)}$ $R_t = 110 + 19$ $R_t = 129 \text{ (k}\Omega\text{)}$ $V_s = 129 \times 0.09473684211$ $V_s = 12.22105263$ $V_s = 12 \text{ V (2 sf)}$	4	1 mark for substitution. 1 mark for transposition. 1 mark for voltage V_1. Ignore unit. 1 mark for correct answer from given working with unit. Apply FTE from value calculated for V_1. 1 mark for transposition. 1 mark for correct answer from working. Ignore unit. 1 mark for total resistance. Ignore unit. 1 mark for correct answer from given working with unit.
	(c)		Replace the (fixed) resistor with a variable resistor.	1	Descriptive response.

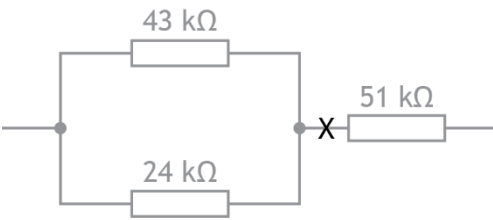
Question			Expected response	Max mark	Additional guidance
10.	(d)		Design a gearbox (to link the motor to the drive wheel). Calculate the output speed of the gearbox/motor. Simulate the gearbox (to ensure it turns in the correct direction).	2	Descriptive response linked to an appropriate development task on specific aspect of the motorised conveyor belt. 1 mark for each task. Do not accept development as an appropriate task. Accept build/make reference only if linked to the testing of a prototype. Tasks described must be different activities/aspects. If tasks are similar, 1 mark max. Calculate the VR... Calculate the output speed...

Question			Expected response	Max mark	Additional guidance
11.	(a)		Non-concurrent/parallel (forces)	1	
	(b)		$\Sigma CWM = \Sigma ACWM$ $(1500 \times 1.2) = (780 \times 1.8) + (F \times 3.6)$ $1800 = 1404 + (F \times 3.6)$ $1800 - 1404 = (F \times 3.6)$ $F = \frac{396}{3.6}$ F = 110 N (2 sf)	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
	(c)			1	Dashed box separating the external input and output from the internal sub-systems. The system boundary must clearly cross the input and output arrows.
	(d)		The horizontal level is set... The control unit compares the actual level with the set horizontal level. If the camera is not level, the motor will turn on. The level sensor detects the actual level/ feeds back to the control unit. If the camera is level the motor will turn off.	4	Descriptive response. 1 mark for control unit comparing both levels. 1 mark for motor switching on when at incorrect level/an error is detected. 1 mark for the level sensor detecting the actual level or sensor feeding back to control unit. 1 mark for motor switching off when at correct level/no error is detected.
	(e)			3	1 mark for diode symbol. 1 mark for connection in parallel with the relay. 1 mark for orientation.

Question			Expected response	Max mark	Additional guidance									
12.	(a)		<pre>graph TD Start([start]) --> Pin1{pin 1 on?} Pin1 -- no --> Pin4Off[/pin 4 off/] Pin4Off --> Pin1 Pin1 -- yes --> Pin2{pin 2 on?} Pin2 -- no --> Pin5On[/pin 5 on/] Pin5On --> Wait05s[wait 0.5s] Wait05s --> Pin5Off[/pin 5 off/] Pin5Off --> Wait04s[wait 0.4s] Wait04s --> Done20{done 20 times?} Done20 -- no --> Pin5On Done20 -- yes --> Pin1 Pin2 -- yes --> Pin4On[/pin 4 on/] Pin4On --> Pin1</pre>	10	Each decision must include a question mark. If 1/0 is used rather than on/off, then an equal sign is required. If flowchart is redrawn then the yes/no routes and arrows must match that given. 1 mark - Pin 1 on? decision in correct position. 1 mark - Pin 2 on? decision in correct position. 1 mark - Pin 4 on in correct position. 1 mark - loop after pin 4 on back to start with arrow. 1 mark - Pin 5 on and off in correct position. 1 mark - 0.5s and 0.4s delay with Unit. 1 mark - x 20? decision with Y/N. 1 mark - decision no route with arrow to before pin 5 on. 1 mark - decision yes route with arrow back to start. 1 mark - all drawn symbols correct. Ignore any additional steps.									
	(b)		<table><tr><th>part</th><th>motion symbol</th><th>motion name</th></tr><tr><td>motor</td><td></td><td>rotary</td></tr><tr><td>toothbrush head</td><td></td><td>oscillating</td></tr></table>	part	motion symbol	motion name	motor		rotary	toothbrush head		oscillating	2	1 mark for motor rotary motion. Accept rotational/rotating. 1 mark for toothbrush head oscillating motion.
part	motion symbol	motion name												
motor		rotary												
toothbrush head		oscillating												

Question			Expected response	Max mark	Additional guidance
12.	(c)		$V = IR$ $V = 11 \times 10^{-3} \times 330$ $V = 3.63$ $V = 3.6 \text{ V (2 sf)}$	2	1 mark for substitution. 1 mark for correct answer from given working with unit.
	(d)		Replacement heads are expensive. Ongoing charging increases electricity costs. Dental costs could be reduced.	1	Descriptive positive or negative economic response relating to using an electric toothbrush on the basis of ongoing running costs. Do not accept initial cost of the electric toothbrush.

Question			Expected response	Max mark	Additional guidance
13.	(a)		No natural gas/fossil fuel will be burnt to heat the home ... so there will be fewer greenhouse gasses released.	2	Explanation must relate to climate change. 1 mark for cause (reduction in gas being used). 1 mark for effect (fewer greenhouse gasses produced). Apply FTE. For full marks the effect must relate to the given cause. Accept any named greenhouse gas or reference to reducing the carbon footprint. Do not award a mark for pollution.
	(b)		$\sigma = \frac{F}{A}$ $14 = \frac{220}{A}$ $A = \frac{220}{14}$ $A = 15.71428571$ $A = 16 \text{ mm}^2 \text{ (2 sf)}$	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
	(c)		$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$ $R_p = \frac{43 \times 24}{43 + 24}$ $R_p = 15.40298507 \text{ (k}\Omega\text{)}$ $R_t = 15.40298507 + 51$ $R_t = 66.40298507$ $R_t = 66\,000 \Omega \text{ (66 k}\Omega\text{) (2 sf)}$	3	1 mark for substitution into correct formula. 1 mark for correct answer from given working (unit not required). 1 mark for correct answer for addition of 51 kΩ. Apply FTE.

Question			Expected response	Max mark	Additional guidance
13.	(d)	(i)	$V = IR$ $48 = I \times 51 \times 10^3$ $I = \frac{48}{51000}$ $I = 0.0009411764706$ $I = 0.00094 \text{ A (0.94 mA) (2 sf)}$	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
		(ii)		1	1 mark for correct series position of ammeter, indicated on the wire. Accept X on the wire at either side of the 51 kΩ resistor. Accept ammeter symbol in correct position. Do not accept X on a node.
	(e)		Air source heat pump will be more reliable with a microcontroller (less components that could fail). It would be easier to fault find with a microcontroller (as an error code could be displayed). The air source heat pump control software can be reprogrammed/updated (to improve efficiency). A hardwired electronic control circuit would be more difficult to update (remotely).	2	Descriptive response must relate to a positive advantage of microcontroller use in the operation of the air source heat pump. 1 mark for each description. Do not accept description of initial programming of microcontroller. Marks can be awarded for maintenance related advantages but not installation/manufacture. Do not accept easier to replace parts on its own.

Question			Expected response	Max mark	Additional guidance
14.	(a)	(i)		5	Port to port pipe connections. 1 mark for piping valve 1 and valve 2 to the shuttle valve. 1 mark for piping up the shuttle valve to left hand pilot actuator on the 5/2 valve. 1 mark for piping valve 3 to right hand pilot actuator on 5/2 valve. (Apply FTE for 5/2 actuator piping). 1 mark for piping 5/2 to both DAC ports. 1 mark for all airline types to 5/2 valve correct.
		(ii)	Diaphragm.	1	
	(b)		$P = \frac{F}{A}$ $P = \frac{65}{420}$ $P = 0.1547619048$ $P = 0.15 \text{ Nmm}^{-2} \text{ (2 sf)}$	2	1 mark for substitution. 1 mark for correct answer from given working with unit.
	(c)		$E_w = Fd$ $E_w = 34 \times 0.18$ $E_w = 6.12$ $E_w = 6.1 \text{ J (2 sf)}$	2	1 mark for substitution. 1 mark for correct answer from given working with unit.

Question			Expected response			Max mark	Additional guidance																										
14.	(d)			<table><tr><td>D</td><td>E</td><td>Z</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table>	D	E	Z	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	1	1	1	0	1	3	1 mark for column D (A AND B). 1 mark for column E (NOT C). 1 mark for column Z (D OR E). Apply FTE.
D	E	Z																															
0	1	1																															
0	0	0																															
0	1	1																															
0	0	0																															
0	1	1																															
0	0	0																															
1	1	1																															
1	0	1																															

[END OF MARKING INSTRUCTIONS]