N5 National Qualifications 2015

2015 Engineering Science
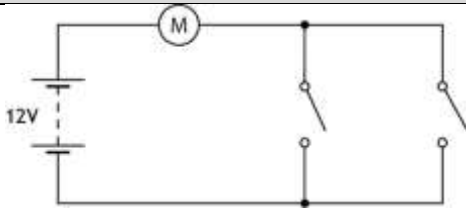
National 5

Finalised Marking Instructions

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 <u>always</u> 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 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) Full marks are always given for a correct answer but 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).

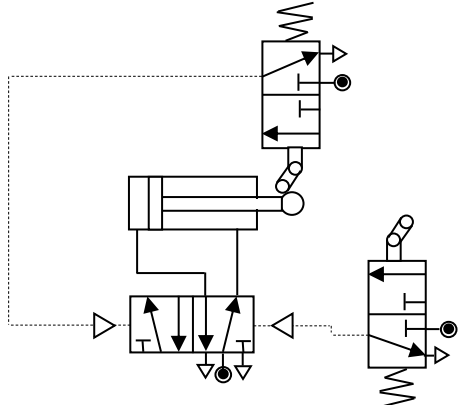**Detailed Marking Instructions for each question**

Section 1

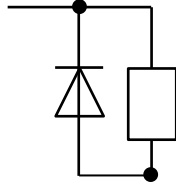| Question			Expected Answer(s)	Max Mark	Additional Guidance
1.				2	1 mark for motor and switch symbol. 1 mark for correct positions of three components. Ignore any additional symbols.

Question			Expected Answer(s)	Max Mark	Additional Guidance
2.			$R = \dfrac{V}{I}$ $R = \dfrac{7.2}{0.7}$ (1 mark for substitution) = 10.29Ω (1 mark for correct answer from given working with unit)	2	

Question			Expected Answer(s)	Max Mark	Additional Guidance
3.	(a)		Sub-system (diagram)	1	
	(b)		To amplify the current (signal) To power the heater/output	1	Not switch on or drive the heater
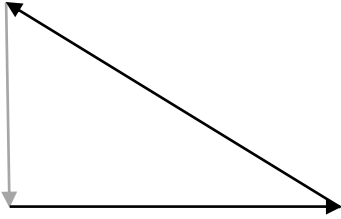
Question			Expected Answer(s)	Max Mark	Additional Guidance
4.	(a)		VR = 260/104 = 2.5 (2.5:1 5:2 etc)	2	1 mark for substitution 1 mark for correct calculation from given working (ignore any units)
	(b)		An extra gear between the driver and driven / use an idler gear.	1	Descriptive response. Do not accept just 'add another gear' without statement on where it should be added.

Question			Expected Answer(s)	Max Mark	Additional Guidance
5.	**(a)**		Easier / quicker / simpler to develop than design a complex electronic circuit. Easier/quicker to update/modify.	1	Easier / quicker / simpler must be qualified. Descriptive responses only. Not smaller.
	(b)		The circuits will be manufactured more quickly and more cheaply due to fewer components/ easier to wire. One controller could be used in a number of products.	1	Smaller/cheaper/reliable/quickly must be qualified. Other suitable descriptive responses with qualifying statements accepted.

Question			Expected Answer(s)	Max Mark	Additional Guidance
6.			 1 mark for piping (Port to port) x2	2	Do not penalise for no pilot lines or extra pipes. 1 mark where 3/2 valves are piped to the incorrect 5/2 pilot ports.

Question			Expected Answer(s)	Max Mark	Additional Guidance
7.			 1 mark for correct symbol 1 mark for correct position & orientation	2	Do not accept LED for symbol. Do not penalise if line through triangle is missing.

Question			Expected Answer(s)	Max Mark	Additional Guidance
8.	(a)		Planning the turbines, valves, pumping systems (moving parts).	1	1 mark for any appropriate descriptive answer (Mechanical Engineering based activity and aspect) - accept design.
	(b)		Checking and monitoring the construction of the roads/station/ chimney, coordinating the drilling of holes to allow water to be pumped under the ground.	1	1 mark for any appropriate descriptive answer (Civil Engineering based activity and aspect).
	(c)		Checking the amount of electricity being output from the station to ensure it meets the demand. Monitoring the operation to see if it is safe /efficient.	1	1 mark for any appropriate descriptive answer (Electrical Engineering based activity and aspect).

Question			Expected Answer(s)	Max Mark	Additional Guidance
9.	(a)			1	1 mark for both correctly drawn vectors. To scale and with both arrows.
	(b)		5000N	1	1 mark for a numerical value with unit. (Ignore nature). Allow follow through error (FTE).

Section 2

Question			Expected Answer(s)	Max Mark	Additional Guidance
10.	**(a)**	**(i)**	No need to remove fossil fuels from the ground. No CO_2 produced during use. Clean source of energy.	**1**	Descriptive positive environmental response. Not renewable on its own.
		(ii)	Effect on the landscape or wild life or construction issues.	**1**	Descriptive negative environmental response. Not - uses a lot of space/land.
		(iii)	Installation is expensive. Inexpensive long term electricity because the source is free. Brings money to the area due to job creation. Efficiency not as high as fossil fuel so more expensive.	**2**	Single economic explanation based response - cause (1) and valid effect (1) – apply FTE.
	(b)		The maximum safe wind speed is set. Set level is compared with the actual wind speed detected by the wind speed sensor. If the wind speed is too fast then the output driver will activate the brake / if the wind speed is within safe levels the brake is not applied.	**3**	1 mark for each correct descriptive based statement (3)
	(c)		Compact size with a large speed changes possible.	**1**	Descriptive response

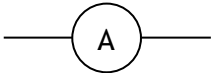| Question			Expected Answer(s)	Max Mark	Additional Guidance
	(d)		Velocity Ratio = $\dfrac{12}{48}$ X $\dfrac{8}{56}$ (1 mark for substitution) Velocity Ratio = $\dfrac{1}{28}$ Velocity Ratio = 1:28 (1 mark for correct answer from given working) Velocity Ratio = $\dfrac{\text{Speed of input}}{\text{Speed of output}}$ Input speed = $\dfrac{1}{28}$ X 308 (1 mark for substitution – allow FTE) Input speed = 11 revs min^{-1} (1 mark for correct answer from candidate's working)	4	Alternative method In_{speed} x in_{size} = out_{speed} x out_{size} In_{speed} x 56 = 308 x 8 - 1 mark In_{speed} = **44** (ignore unit) - 1 mark In_{speed} x 48 = **44** x 12 - 1 mark (allow follow through error) In_{speed} = 11 revs min^{-1} (1 mark for answer from given working with unit) Do not accept rpm.
11.	(a)		$E_k = \frac{1}{2} mv^2$ = $\frac{1}{2}$ x 7750 x 3^2 (1 mark for substitution) = 34875J (1 mark for correct answer from given working with unit)	2	
	(b)	(i)	$E_p = mgh$ = 7750 x 9·8 x 15 (1 mark for substitution) = 1139250J (1 mark for correct answer from given working with unit)	2	

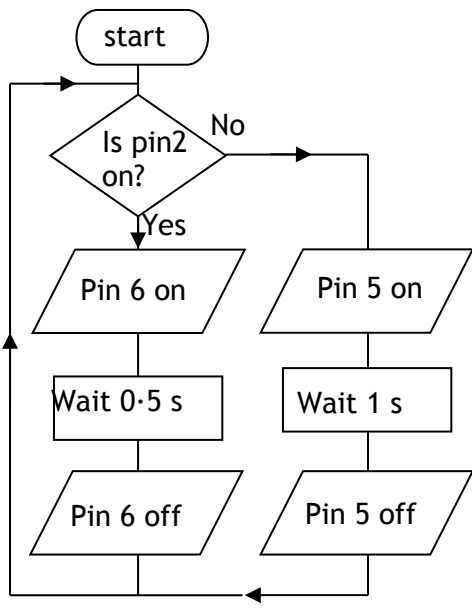| Question			Expected Answer(s)	Max Mark	Additional Guidance
	(b)	(ii)	Efficiency = $\dfrac{Eout}{Ein}$ $= \dfrac{1 \cdot 14}{2 \cdot 50}$ (1mark for substitution) $= 0 \cdot 456 \ (0.46)$ Or $45 \cdot 6\% \ (46\%)$ (1 mark for correct answer from given working)	2	Allow FTE from (b) (i)
	(c)		Loss of energy/heat/sound 1 mark due to friction 1 mark	2	Explanation Cause – 1 mark effect – 1 mark
	(d)		$\varepsilon = \Delta l \ / \ l$ $0 \cdot 00375 = \Delta l \ /15$ (1 mark for substitution) $\Delta l = 0 \cdot 00375 \times 15$ (1 mark for transposition) $= 0 \cdot 056 m \ (0.06 m)$ (1 mark for correct answer with units from given working)	3	Units required

Question			Expected Answer(s)	Max Mark	Additional Guidance
12.	(a)		Light Dependant Resistor	1	Not LDR
	(b)		As the light level decreases the resistance of the LDR increases/ increasing the voltage dropped across it/ sensitivity can be adjusted by the variable resistor. As the voltage across the LDR increases / 0.7V /reaches the correct voltage the transistor will switch on. The LEDs switch on.	4	1 mark for each correct descriptive statement 2 marks Voltage division 1 mark Transistor 1 mark Output No mark for dark sensor without description of voltage divider operation.
	(c)	(i)	They will all have the same brightness/voltage. Overall more light will be produced. If one goes out the rest will stay on. Easy to fault find /repair because damage component can be clearly seen.	1	1 mark for one correct description
		(ii)	LEDs uses less energy – LEDs are more efficient – LEDs longer lasting – LEDs are more robust - LEDs are smaller – LEDs output is brighter	1	1 mark for one correct descriptive response Not cheaper

Question			Expected Answer(s)	Max Mark	Additional Guidance
	(d)		6 – 0·7 = 5·3V	4	
			(1 mark for calculating V across variable resistor)		
			$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$		
			$$\frac{0.7}{5.3} = \frac{R_1}{5.5}$$		
			(1 mark for substitution of 3 values – allow FTE for 6V if 5.3V is not determined)		
			$R_1 = 0.13 \times 5.5$		
			(1 mark for transposition)		
			$R_1 = 0.726 \ k\Omega \quad 726\Omega$		
			(1 mark for correct answer from given working with unit)		

Question			Expected Answer(s)	Max Mark	Additional Guidance
13.	(a)		Choosing the correct materials to use. Designing the supporting structure (specific aspect). Research loadings (roller coaster and external – wind etc)	2	1 mark per correct descriptive response
	(b)		To simulate control circuits, safety systems, lighting, braking systems, program/flowchart and test their operation. (1 mark for any relevant answer)	1	Statement based response
	(c)		$(A + B) \cdot \overline{C} = Z$	3	(1 mark OR with bracket, 1 mark AND, 1 mark NOT) Other correct Boolean equations are acceptable
	(d)		(see table below)	3	1 mark for each correct column Allow FTE for column L and M; L = NOT K M = H AND L
	(e)		(see working below)	3	

Question 13 (d):

K	L	M
0	1	0
0	1	1
1	0	0
1	0	0
1	0	0
1	0	0
1	0	0
1	0	0

Question 13 (e):

$\Sigma CWM = \Sigma ACWM$

$(R_1 \times 3\cdot5) = (1\cdot25 \times 4.0) + (1\cdot0 \times 2\cdot5) + (1\cdot0 \times 1\cdot5)$

(1 mark for substitution)

$R_1 = 9\cdot0/3\cdot5$

(1 mark for transposition)

$R_1 = 2\cdot57kN$ (2571 N)

(1 mark for correct answer from given working with unit)

Question			Expected Answer(s)	Max Mark	Additional Guidance
14.	(a)		When the solenoid and push button are both activated pilot air is sent to Valve 3. (1 Mark) This causes the cylinder to outstroke slowly. (1 Mark) When the cylinder has outstroked air is sent to the reservoir via the uni-directional restrictor creating a time delay. (1 Mark) Pilot air is then sent to valve 3 causing the cylinder to instroke. (1 Mark)	4	1 mark for AND control. 1 mark for speed control when outstroking. 1 mark for Time Delay. 1 mark for instroking.
	(b)		$A_{rod} = \dfrac{\pi d^2}{4}$ $= \dfrac{3\cdot14 \times 15^2}{4} = 176.6 \ (mm^2)$ A_{piston} $= \dfrac{3\cdot14 \times 80^2}{4} = 5024 \ (mm^2)$ (1 mark for correct calculation of either area - ignore units) $A_{effective} = A_{piston} – A_{rod}$ $= 5024 – 176\cdot6$ $= \mathbf{4847\cdot4} \ mm^2$ (1 mark for correct answer from given working - ignore units) $P = F/A$ $= 1460/4847\cdot4$ (1 mark for substitution) $= 0\cdot3 Nmm^{-2}$ (0.3 MPa) (1 mark for correct answer from given working with unit)	4	

Question			Expected Answer(s)	Max Mark	Additional Guidance
	(c)		$R_T = \dfrac{R_1 \times R_2}{R_1 + R_2}$ $R_T = \dfrac{300 \times 100}{300 + 100}$ (1 mark for substitution) $R_T = 75\,\Omega$ (1 mark for correct answer from given working with unit)	2	Apply similar mark allocation if the other version of the formula is used.
	(d)	(i)		1	
		(ii)	X should indicate a wire between solenoid and lamp. Can be top or bottom of branch. Series connection only.	1	

Question			Expected Answer(s)	Max Mark	Additional Guidance
15.	**(a)**			6	Allow FTE for incorrect pin being switched on. Ignore any additional steps *Pause 1000* (PBASIC) or *Delay 1000* (C) accepted as wait 1s etc
			1 mark for decision -(pin) 2, with Y or N labelled 1 mark for both (pin) 6 on/off 1 mark for both (pin) 5 on/off 1 mark both pauses 1 mark for continuous loop with arrow 1 mark for all symbols correct		
	(b)		Continuous / infinite loop	1	Named or Described
	(c)		$\sigma = \dfrac{F}{A}$ $0.095\,Nmm^{-2} = \dfrac{88N}{A}$ (1 mark for substitution) $A = \dfrac{88}{0\cdot095}$ (1 mark for transposition) $A = 926\cdot3\,mm^{2}$ (1 mark for correct answer from given working with unit)	3	

Question			Expected Answer(s)	Max Mark	Additional Guidance
	(d)		Reduces greenhouse gases / CO2 (1 mark). Due to reduced use of fossil fuels (1 mark).	**2**	Explanation Cause – 1 mark effect – 1 mark Not pollution / gases on own

[END OF MARKING INSTRUCTIONS]