National Qualifications 2014

2014 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 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) 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).

Marking Instructions for each question

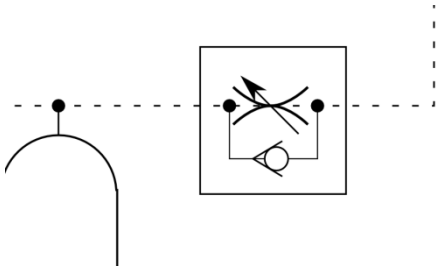
Section 1

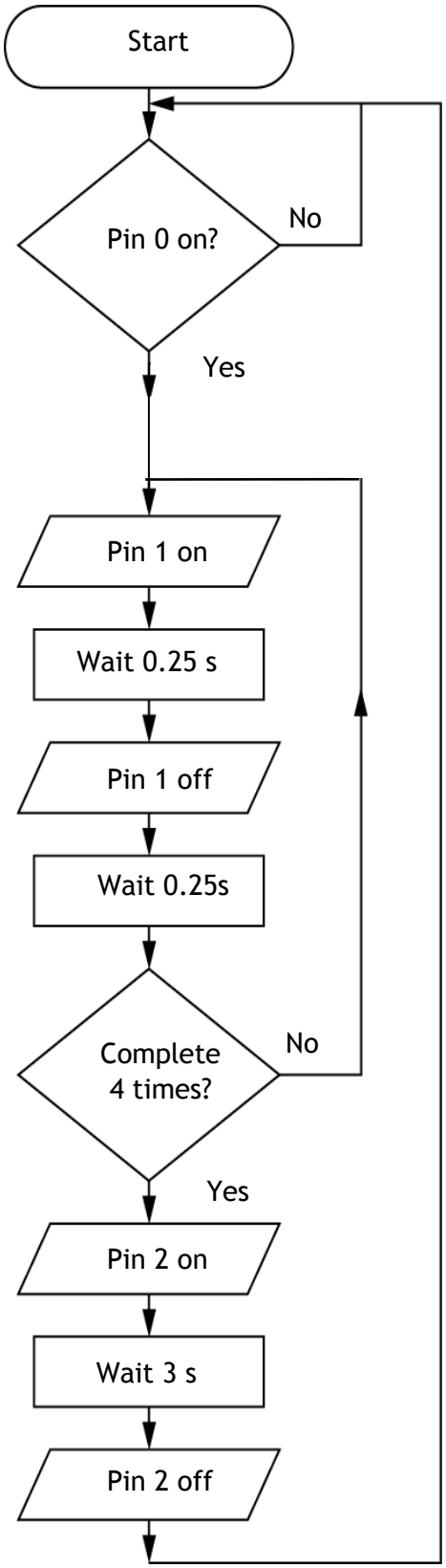
Question			Expected Answer(s)	Max Mark	Additional Guidance
1.			Feedback loop into control sub-system with arrow Speed sensor (label or specific - tachogenerator or tacho)	**2**	1 mark 1 mark Not speedometer
2.			$R_t = \frac{R_1 \times R_2}{R_1 + R_2}$ $R_t = \frac{6800 \times 2200}{6800 + 2200}$ $R_t = \frac{14960000}{9000}$ $=1662.22\ \Omega$ 1.7kΩ	**2**	1- substitution 1 - correct answer from working with unit
3.	(a)		Mechanical	**1**	
	(b)		Chemical	**1**	
4.	(a)		Switch on lamp/act like a switch	**1**	Accept amplification
	(b)		High temperature (warm/hot) Temperature above set level Input voltage to transistor = 0.7V	**1**	Any one in a descriptive response

Question			Expected Answer(s)	Max Mark	Additional Guidance
5.			$\epsilon = \Delta l / l$ $\epsilon = 3/2000$ $= 0.0015$	**2**	 1 mark for substitution, 1 mark for correct answer from working (ignore any units)
6.	(a) (b)		main air symbol in correct position (either state) diaphragm in correct position (both arrows required and pilot line)	**1** **1**	1 mark 1 mark
7.			Fewer parts Reduced materials Reduced stock one IC (standard component) used in multiple products Quicker manufacture time	**2**	1 mark for each **economic** based valid answer Not easy to repair or cheaper Not smaller/reprogrammable (flexible) **without** economic reason
8.			Cam: rotary / rotational Follower: reciprocating	**2**	1 mark for each correct answer
9.	(a)		Tension	**1**	Named or inferred (downward) Not gravity or strain on its own
	(b)		It is rigid / strong shape / resists forces /support loads / stable	**1**	Any one for 1 mark
10.			Row 2 - 0 Row 7 – 1	**2**	1 mark for each correct answer

Section 2

Question			Expected Answer(s)	Max Mark	Additional Guidance
11	(a)		The user will set the required output. The control unit will compare the required output with feedback value. The control unit will send signals to the boiler. The boiler will produce steam to power the turbine. The turbine will drive the generator. The generator will produce electricity/output voltage. The sensor monitors the value of the output voltage.	**4**	1 mark for each valid description of the operation (3 marks max) Not – send a signal between boiler – turbine - generator 1 mark for the description of the closed loop aspect (feedback or comparing by control sub-system) - 2 marks max
	(b)		Closed loop	**1**	
	(c)		Less pollution/cleaner/less waste gas fewer greenhouse gases/CO2 reduce the causes of climate change	**2**	1 mark per **positive** environmental **impact** described Not – will not run out Not - fossil fuels pollute on its own
	(d)		Eout = Ein x eff = 13MJ x 0.44 = 5.72MJ	**2**	1 for substitution 1 for answer with unit from given working

Question			Expected Answer(s)	Max Mark	Additional Guidance
12	(a)			**3**	1 mark for correct symbol (ignore rectangle) 1 mark for correct position 1 mark for correct orientation
	(b)		1 mark for describing the function of A 1 mark for describing outstroke conditions 1 mark for describing instroke conditions	**3**	1 mark for each valid descriptive point up to 3
	(c)		$A = \Pi r^2$ $= 3 \cdot 14 \times 10 \times 10$ $= 314 mm^2$ $P = \frac{F}{A}$ $F = PA$ $= 2 \times 314$ $= 628N$	**3**	Calculation of area (no units) – 1 Substitution with area value **calculated** above (FTE) – 1 Answer from given working with unit - 1

Question			Expected Answer(s)	Max Mark	Additional Guidance
13.				10	**Pin number must be correct where applicable** Pin 0 on? – 1 mark for decision with y/n **and** loop Pin1 on/off – 1 mark for **both** boxes Wait – 1 mark for **both** - 1 mark **both** times totalling 0.5 s x 4 decision with y/n – 1 mark decision loop return point – 1 mark Pin2 on/off – 1 mark for **both** Wait 3s – 1 Continuous loop – 1 All **marked** symbols correct – 1 (additional boxes ignored) Credit given for a series of flashes done without fixed loop. (1 mark)

Question			Expected Answer(s)	Max Mark	Additional Guidance
14	(a)		voltmeter symbol connecting voltmeter in parallel to the variable resistor.	**2**	1 mark 1 mark
	(b)		$\frac{V_1}{V_2} = \frac{R_1}{R_2}$ = $\frac{V_1}{V_s} = \frac{R_1}{R_t}$ $\frac{Vout}{3 \cdot 7} = \frac{750}{1170}$ $Vout = 3 \cdot 7 \times 0 \cdot 641$ $= 2 \cdot 37V$ $(2.4V)$ $I = \frac{V}{R}$ $= \frac{3 \cdot 7}{1170}$ $= 3 \cdot 16mA$ $Vout = 0 \cdot 00316 \times 750$ $= 2 \cdot 37V$ (2.4V)	**3**	Substitution – 1 Transposition – 1 Answer from given working with unit – 1 Alternative method 1 for substitution 1 for answer from working 1 for answer from working with unit
	(c)		$P = V^2/R$ $= 3^2/750$ = 12mW (0.012W)	**2**	Substitution – 1 Answer from given working with unit – 1
	(d)		Use less material in their construction. Lower power/energy used to run. Smaller size/weight means less fossil fuel burned during transportation.	**1**	1 mark for any acceptable **environmental descriptive** answer Not – easier to recycle

Question			Expected Answer(s)	Max Mark	Additional Guidance
15	(a)		$Ek = 0 \cdot 5mv^2$ $= 0 \cdot 5 \times 80 \times 8^2$ $= 2560J$ (2.6kJ)	**2**	Substitution – 1 mark Answer from given working with unit – 1 mark
	(b)		$E_h = mc\Delta T$ $\Delta T = \frac{E_h}{mc}$ $= \frac{2560}{0 \cdot 4 \times 900}$ $= 7 \cdot 1°C$ Final temp $= 10 + 7 \cdot 1 = 17 \cdot 1°C$	**4**	Transposition – 1mark Substitution {FTE from (a)} – 1 mark Answer from given working – 1 mark Final answer and unit – 1 mark
	(c)		$\sigma = \frac{F}{A}$ $= \frac{1200}{200}$ $= 6Nmm^{-2}$ (6MPa)	**2**	Substitution – 1 mark Answer from given working and unit – 1 mark Not Pa unless m^2 used
	(d)		Increase (cross sectional) area Increase thickness/use solid bar the same diameter/outside diameter larger	**1**	1 mark for a correct descriptive response. Not – Make A bigger, change material
	(e)		Design/testing the... Mechanical aspect: Gears, sprocket, chain, brakes, materials, wheel, bearings, pedals, suspension	**2**	Descriptive response Activity – 1 mark (max) Not - development Mechanical aspect – 1 mark (max) Not - frame

Question			Expected Answer(s)	Max Mark	Additional Guidance
16.	(a)	(i)	*As the temperature increases:* the resistance of the thermistor drops the voltage across the thermistor drops the voltage across the variable resistor (Vin) increases	**2**	1 mark for each valid descriptive point Change in resistance / voltage must refer to a component / position in circuit
		(ii)	The transistor switches on **when** the temperature/voltage reaches the set level. The relay switches on when the transistor is on. When the relay is on the motor will spin.	**2**	1 mark for any valid descriptive point relating to the transistor Not –'transistor switches on' without reference to temperature/voltage 1 any for any valid descriptive point relating to the relay/motor
	(b)	(i)	Allows the 5V/low voltage circuit to control the more powerful circuit.	**1**	1 mark for any valid descriptive response Not – powers electrical circuit or connects/links electronic to electrical circuit.
		(ii)	Protects the transistor	**1**	1 mark for any valid descriptive response Not - protect the relay/prevents back emf
	(c)		Allows same gear ratio in a smaller space. Allows large gear ratio with small gears.	**1**	1 mark for any valid descriptive response Not smaller (compact) or more efficient
	(d)		**1st pair;** 10 x 250 = 50 x T T = 50 rev min^{-1} **2nd pair;** 50 x 20 = 60 x T T = 16.7 rev min^{-1} **Alternative using VR;** 250 x (10/50 x 20/60) = 16.7 rev min^{-1}	**4**	Substitution – 1 mark Answer from working – 1 mark Substitution – 1 mark Answer with unit from working – 1 Alternative ; Substitution for individual VRs – 1 mark **each** Substitution into combined eqn – 1 mark Answer with unit from working – 1

Question			Expected Answer(s)	Max Mark	Additional Guidance
	(e)		Lubricate moving parts. Smoother materials could be used where mechanisms interact. Add bearings to the shaft	**1**	1 mark for any suitable descriptive response (what **and** where). No single word answers.
17.	(a)		Free body	**1**	Not F.B.D.
	(b)		ΣACWM = ΣCWM Fb x 3.7 = 650x1 + 750x2.2 Fb = 2300/3.7 Fb = 621.6N	**3**	Substitution – 1 Transposition – 1 Answer from given working with units – 1
	(c)		ΣFv = 0 Fa + 621.6 = 650 + 750 Fa = 1400 – 621.6 =778.4N	**2**	Substitution – 1 Follow through error from (b) Answer from given working with units – 1
	(d)		$\Delta l = 2 \times 0 \cdot 0015$ $= 0 \cdot 003m$	**2**	Substitution – 1 Answer from given working with unit -1
	(e)		M = Ā·(B+C)	**3**	1 mark for correct use of ● ( ) 1 mark for correct use of + 1 mark for correct use of ¯ Other correct equations are acceptable

[END OF MARKING INSTRUCTIONS]