Engineering Science (National 5): Question Paper

Commentary on candidate evidence

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Candidate 1

The evidence for this candidate has achieved the following marks for each question of this course assessment component.

Question	Marks available	Mark awarded	Comments
1(a)	1	0	Incorrect response. The symbol is for a simple rather than a compound gear train.
1(b)	1	1	Idler correctly stated.
2(a)	1	1	Correct response given.
2(b)	1	1	Candidate stated the correct type of control.
3	2	2	Full marks awarded for the correct final answer with unit expressed to appropriate number of significant figures.
4(a)	1	1	1 mark for the switching action.
4(b)	1	1	Emitter correctly stated.
5(a)	2	2	Full marks given for the correct final answer expressed to appropriate number of significant figures. No units for strain but the candidate was not penalised for using metres.
5(b)	2	2	1 mark for material choice. 1 mark for identification of both properties.
6(a) (i)	1	0	Incorrect response. Electronic rather than the electrical engineer for the design of the wind speed sensing circuit.
6(a) (ii)	1	1	1 mark for correctly stating structural engineer.
6(a) (iii)	1	1	Correct response.
6(b)	1	1	1 mark for describing a valid role, ensuring the environmental legislation is being met.
Q7	2	2	1 mark for 2500 N line with arrow drawn nose to tail on the end of the given 4000 N vector. 1 mark for 4700 N line with arrow forming a triangle.
Q8	2	2	1 mark for each given environmental impact.
Q9(a)	10	8	1 mark for pin 0 decision with Y/N, and loop with arrow. 1 mark for pin 7 high and low. 0 mark for 0.5s total delay – unit missing. 0 mark for both delays – only one shown. 1 mark for x3 loop decision. 1 mark for fixed loop with arrow. 1 mark for pin 6 high and low.

Question	Marks available	Mark awarded	Comments
			1 mark for pin 1 decision with Y/N, and loop with arrow. 1 mark for continuous loop with arrow. 1 mark for all symbols.
Q9(b)	1	1	Valid description on the resetting of the program.
Q9(c)	2	0	No valid cause (loop to line 1) or effect (resetting count to 0) in this response.
Q10(a)	4	4	1 mark for increase in thermistor resistance. 1 mark for voltage increases. 1 mark for transistor/relay switching. 1 mark for both LEDs and buzzer turning on.
Q10(b)	2	1	No cause described (adjusting the resistance). 1 mark for effect (alter the temperature that gives a warning).
Q10(c)	3	2	1 mark for substitution. 1 mark for transposition. 0 mark for final answer due to incorrect value for unit (31 kΩ or 31 000 Ω)
Q10(d)	1	1	Correct value and unit.
Q10(e)	4	4	1 mark for gear ratio 1 (96/16) 1 mark for gear ratio 2 (120/12) 1 mark for transformation. 1 mark for final answer with units.
Q11(a) (i)	3	2	No mark for substitution. 1 mark for transposition with an allowance for follow through error. 1 mark for final answer from given working with unit.
Q11(a) (ii)	2	2	1 mark for substitution with an allowance for follow through error from Q11(a) i. 1 mark for final answer with unit from given working.
Q11(b) (i)	1	0	Incorrect response. No offices on the railway covered walkway.
Q11(b) (ii)	1	0	No economic impact described.
Q11(b) (iii)	1	0	Lacking in detail for a descriptive response. The mark could have been awarded if cost had included a reference to installation or maintenance.
Q11(c)	3	2	1 mark each for the input and losses energy type and value. The output energy type, as given the question stem, is potential rather than kinetic.

Question	Marks available	Mark awarded	Comments
Q12(a)	3	3	Full marks as all output columns in truth table have been correctly completed.
Q12(b)	3	3	1 mark for L and M wired to AND gate. 1 mark for N wired to NOT gate. 1 mark for OR gate wired to output Y with inputs joined to NOT and AND outputs.
Q12(c)	2	2	Each of the statements describes an appropriate advantage.
Q12(d) (i)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q12(d)ii.	1	0	Incorrect response. Tension rather than compression.
Q12(e)	1	0	Incorrect response. The stress will reduce rather than increase.
Q13(a)i.	2	2	1 mark for substitution with both values expressed in the same unit (Ω or kΩ). 1 mark for final answer from working and with unit. (4 s.f. acceptable rounding.)
Q13(a)ii.	2	2	1 mark for voltmeter symbol. 1 mark for wiring in parallel to the 910 Ω resistor.
Q13(a)iii.	1	1	Correct position indicated.
Q13(b)	4	4	1 mark for calculating 11.2 V. 1 mark for 24.8 V calculation. 1 mark for Ohm's Law transposition. 1 mark for final answer from working with unit (12.4 Ω).
Q13(c)	2	2	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q13(d)	2	2	1 mark for cause (sticking to speed limit). 1 mark for the effect (increased road safety).
Q14(a)	5	4	1 mark for inputting a flow rate. 1 mark for activating motor/gear/gate. 1 mark for the effect on the water level reaching the required level. 1 mark for sensor measuring water rate. No description of the control sub-system comparison.
Q14(b)	3	2	1 mark for substitution. 1 mark for transposition. 0 mark for final answer because no unit (revs min^{-1}) given.
Q14(c)	1	1	Correct response.

Question	Marks available	Mark awarded	Comments
Q14(d)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q14(e)	2	0	No valid cause described (no greenhouse gasses released). No effect of the cause given (no increase/reduction in climate change).
Q15(a)	5	4	1 mark for the port-to-port piping of valve 1 to valve 2 and to the pilot actuator on the 5/2. 1 mark for the port-to-port piping of valve 3 to pilot actuator on the 5/2. No pilot air shown to a 5/2 actuator. 1 mark for port 2 piped to the double acting cylinder. 1 mark for port 4 piped to double acting cylinder.
Q15(b)	2	1	0 mark for the uni-directional restrictor symbol – missing adjuster on restrictor. 1 mark awarded for the orientation of the awarded for symbol.
Q15(c)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q15(d)	2	1	1 mark for the cause (piston rod area). 0 mark for the effect (instroke force less).

Candidate 2

The evidence for this candidate has achieved the following marks for each question of this course assessment component.

Question	Marks available	Mark awarded	Comments
Q1(a)	1	0	Incorrect name. The symbol is for a simple rather than a compound gear train.
Q1(b)	1	1	The correct gear train name was stated.
Q2(a)	1	1	Noise is an acceptable answer for the output.
Q2(b)	1	1	The correct control type was stated.
Q3	2	1	1 mark for substitution. 0 mark correct final answer because of the missing unit (J).
Q4(a)	1	1	1 mark for electronic switch.
Q4(b)	1	NR	No response – 0 mark.
Q5(a)	2	1	1 mark for substitution. The final answer (48000) is incorrect.
Q5(b)	2	2	1 mark for material choice. 1 mark for identification of both properties.
Q6(a) (i)	1	0	Incorrect response. Electronical not accepted for an electronic engineer.
Q6(a) (ii)	1	1	Correct engineer stated.
Q6(a) (iii)	1	1	Correct response.
Q6(b)	1	1	1 mark for describing the role; monitoring the effect on the wildlife.
Q7	2	0	0 mark for 2500 N line due to tail-to-tail connection to the given 4000 N line. 0 mark for 4700 N line as it does not form a triangle, so equilibrium condition not met.
Q8	2	2	1 mark awarded for each environmental impact description.
Q9(a)	10	8	0 mark for pin 0 decision – no question, Y/N route or loop with arrow. 1 mark for pin 7 on & off. 0 mark for 0.5s delay total – unit missing. 1 mark for both delays. 1 mark for x3 loop decision with Y/N route. 1 mark for fixed loop back with arrow. 1 mark for pin 6 on & off. 1 mark for pin 1 decision with Y/N, loop with arrow. 1 mark for continuous loop with arrow. 1 mark for all symbols.
Q9(b)	1	0	Incorrect statement. Resetting the counter.
Q9(c)	2	1	1 mark for cause with the inferred looping to incorrect line/position. 0 mark for the effect (resetting count to 0).

Question	Marks available	Mark awarded	Comments
Q10(a)	4	1	0 mark for decrease in thermistor resistance. Follow through error applied to candidate's thermistor resistance statement (voltage V_1 decreasing) but this was not made – 0 mark. 1 mark transistor/relay switching. No statement on both LEDs and the buzzer switching on.
Q10(b)	2	1	No cause given (adjust resistance). 1 mark for effect (change the temperature of the warning turning on).
Q10(c)	3	0	No correct substitution or transposition. Final answer is incorrect from given working.
Q10(d)	1	1	Correct value and unit.
Q10(e)	4	3	1 mark for gear ratio 1 (16/96). 1 mark for gear ratio 2 (12/120). Intermediate value of 16/96 (1.6° recurring) was incorrectly rounded to 0.16 rather than 0.17. 1 mark for final answer from working with unit (follow through error applied).
Q11(a) (i)	3	1	No correct substitution or transposition. 1 mark for final answer from given working with unit (follow through error applied).
Q11(a) (ii)	2	0	No substitution or final answer with unit.
Q11(b) (i)	1	0	Insufficient response; generic and does not relate to the given context.
Q11(b) (ii)	1	0	No economic impact described.
Q11(b) (iii)	1	1	Cost related to installation.
Q11(c)	3	1	1 mark for input energy type and value. Incorrect type of output energy (movement). Energy losses, correct type (heat) but value should be 12 kJ rather than 11 kJ.
Q12(a)	3	3	All output columns in truth table have been correctly completed.
Q12(b)	3	3	1 mark for L and M wired to AND gate. 1 mark for N wired to NOT gate. 1 mark for OR gate wired to output Y with inputs joined to NOT and AND outputs.
Q12(c)	2	0	Descriptive responses required. No mark for just stating faster or cheaper.
Q12(d) (i)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q12(d) (ii)	1	1	Correct statement.
Q12(e)	1	1	Correct description.

Question	Marks available	Mark awarded	Comments
Q13(a) (i)	2	2	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q13(a) (ii)	2	1	1 mark for voltmeter symbol. 0 mark for wiring in series with 910 Ω resistor.
Q13(a) (iii)	1	1	Correct position indicated for the ammeter.
Q13(b)	4	4	1 mark for substitution. 1 mark for transposition. 1 mark for 18(Ω) value. 1 mark for answer from working with unit.
Q13(c)	2	1	1 mark for substitution. 0 mark for final answer due to the use of 5 significant figures (the data values in the question mean that four is the maximum permissible). The final unit (N) is also incorrect.
Q13(d)	2	1	1 mark for cause (driver error). No effect of the driver error described.
Q14(a)	5	2	1 mark for the control sub-system comparison. 1 mark for turning on the motor/mechanism. Inputting set water flow rate not described. No description of the effect of the water level reaching the required flow rate. No detail on the sensor measuring water rate.
Q14(b)	3	3	Full marks for the correct final answer with unit expressed to appropriate significant figures. (The written form of the unit is an acceptable alternative to revs min^{-1}.)
Q14(c)	1	0	Vague response as it is unclear what is easier to change – hardware or program.
Q14(d)	3	1	0 mark for substitution. 0 mark for transposition. 1 mark for answer from working with unit.
Q14(e)	2	1	1 mark for cause (no CO^2 produced). No effect of this cause offered.
Q15(a)	5	2	1 mark for pilot line type on a 5/2 actuator. 1 mark for port 4 piped to double acting cylinder.
Q15(b)	2	1	0 mark for the uni-directional restrictor symbol – missing arrowhead. 1 mark awarded for the orientation of the symbol.
Q15(c)	3	3	Full marks for the correct final answer with unit expressed to appropriate significant figures.
Q15(d)	2	0	0 mark for the cause (piston rod area). 0 mark for the effect (instroke force less).

Candidate 3

The evidence for this candidate has achieved the following marks for each question of this course assessment component.

Question	Marks available	Mark awarded	Comments
Q1(a)	1	0	Incorrect response.
Q1(b)	1	0	Incorrect name for gear A.
Q2(a)	1	1	Sound correctly identified.
Q2(b)	1	0	Incorrect control type named.
Q3	2	2	Full marks for the correct final answer with unit expressed to an appropriate number of significant figures.
Q4(a)	1	0	Incorrect description of the function of a transistor.
Q4(b)	1	0	Emitter not stated.
Q5(a)	2	1	1 mark for substitution. The rounding of the final answer is incorrect and should be 5×10^{-4}.
Q5(b)	2	2	1 mark for material choice. 1 mark for identification of both properties.
Q6(a) (i)	1	0	Incorrect response. An electronic rather than the electrical engineer would design of a wind speed sensing circuit.
Q6(a) (ii)	1	0	Incorrect response. A structural rather than civil engineer would design the tower.
Q6(a) (iii)	1	1	1 mark for stating correct engineer.
Q6(b)	1	0	This response relates to an activity the engineer would complete prior to the construction phase rather than during it.
Q7	2	0	0 mark for 2500 N line due to tail-to-tail connection to the given 4000 N line. Despite the chance to apply a follow through error, 0 mark was awarded for the 4700 N line because direction was not indicated.
Q8	2	1	1 mark for taking up wildlife areas but second point on the manufacture is insufficient and doesn't relate to any environmental impact.
Q9(a)	10	0	0 mark for pin 0 decision - omitted. 0 mark for pin 7 on & off – no pin numbers. 0 mark for 0.5s delay total – 0.25s only. 0 mark for both delays – single delay. 0 mark for x3 loop decision – no decision. 0 mark for fixed loop – no arrow. 0 mark for pin 6 on & off – no pin numbers. 0 mark for pin 1 decision - omitted. 0 mark for continuous loop - omitted. 0 mark for all symbols – delay shown as a parallelogram.

Question	Marks available	Mark awarded	Comments
Q9(b)	1	0	Incorrect description as resetting relates the count rather than the program returning to the start.
Q9(c)	2	0	Incorrect cause. The effect does not relate to the given cause.
Q10(a)	4	0	0 mark for decrease in thermistor resistance. No reference to voltage (V_1). No transistor/relay switching. No buzzer switching on with LEDs.
Q10(b)	2	0	No valid cause described. No description of the effect of a cause.
Q10(c)	3	3	1 mark for substitution. 1 mark for transposition. 1 mark for final answer from given working.
Q10(d)	1	0	Incorrect value stated.
Q10(e)	4	0	Neither of the gear ratios expressed. No correct transposition. 0 mark for final answer as unit is incorrect (revs min $^{-1}$ and not RPM).
Q11(a) (i)	3	0	No correct substitution or transposition. Final answer and units are both incorrect for given working – 0 mark.
Q11(a) (ii)	2	2	Applying a follow through error from Q11(a) (i). the substitution is correct, and the final value (1452 N) comes from the given working.
Q11(b) (i)	1	1	Sufficient detail given which relates to the context (station).
Q11(b) (ii)	1	0	No economic impact described.
Q11(b) (iii)	1	0	Insufficient detail and not related to context.
Q11(c)	3	2	Incorrect input energy type. 1 mark for both the output and losses details.
Q12(a)	3	3	All three output columns correctly completed.
Q12(b)	3	3	Logic diagram completed correctly.
Q12(c)	2	1	1 mark for the advantage of speed with failing components. Insufficient detail on second advantage and this information could also be gained from testing a prototype.
Q12(d) (i)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q12(d) (ii)	1	0	Incorrect statement with a strut being under compression rather than tension.
Q12(e)	1	0	Incorrect description.
Q13(a) (i)	2	2	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.

Question	Marks available	Mark awarded	Comments
Q13(a) (ii)	2	2	1 mark for voltmeter symbol. 1 mark for wiring it in parallel with the 910 Ω resistor.
Q13(a) (iii)	1	1	The correct position for the ammeter has been indicated on the diagram.
Q13(b)	4	4	1 mark for calculating 11.2V. 1 mark for 24.8V calculation. 1 mark for Ohm's Law transposition. 1 mark for final answer (12.4 Ω) from working with unit expressed to an appropriate number of significant figures.
Q13(c)	2	1	1 mark for substitution. 0 mark for final answer due to inappropriate significant figure use (5 s.f). The data values in the question mean that four is the maximum permissible.
Q13(d)	2	2	1 mark for cause (software failure). 1 mark for the effect (crash) on road safety.
Q14(a)	5	3	1 mark for user sets water flow rate. 1 mark for turning on the motor/gate. 1 mark for sensor measuring water flow rate. No control sub-system comparison description or statement on the effect of the water reaching required flow rate.
Q14(b)	3	2	1 mark for substitution. 1 mark for transposition. 0 mark for final answer as unit is incorrect (revs min $^{-1}$ and not RPM).
Q14(c)	1	0	Insufficient detail on both the size and using less wires responses.
Q14(d)	3	3	Full marks for the correct final answer with unit expressed to appropriate number of significant figures.
Q14(e)	2	0	No valid cause or effect given on the impact on climate change.
Q15(a)	5	1	Only the piping of port 2 on the 5/2 to the double acting cylinder is correct – 1 mark. No pilot line piped to an actuator on the 5/2.
Q15(b)	2	0	Incorrect symbol and invalid orientation.
Q15(c)	3	2	Correct substitution and transformation but incorrect value in the final answer.
Q15(d)	2	1	Outstroking force greater (effect) – 1 mark. No cause.