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Cambridge **NATIONALS LEVEL 1/2**

Cambridge NATIONALS

ENGINEERING SYSTEMS

Combined feedback on the January 2018 exam paper (including selected exemplar candidate answers and commentary)

Unit R113 – Electronic principles

Version 1

ocr.org.uk/engineering

CONTENTS

INTRODUCTION

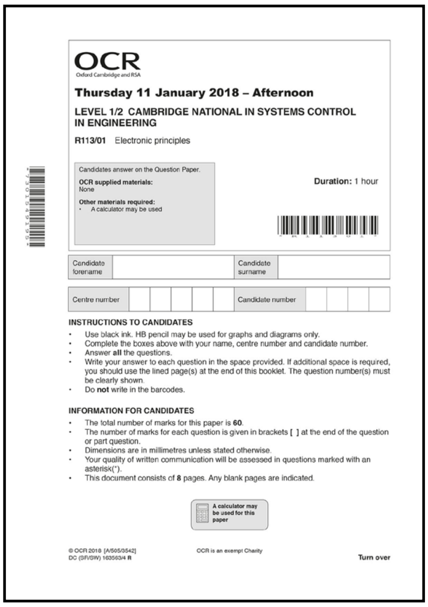
This resource brings together the questions from the January 2018 examined unit (Unit R113), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

We have also included exemplar candidate answers with commentary for Questions 4(b), 5(b), 6(b) and 6(c).

The marking guidance and the examiner's comments are taken from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:

https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250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Thursday 11 January 2018 – Afternoon

LEVEL 1/2 CAMBRIDGE NATIONAL IN SYSTEMS CONTROL IN ENGINEERING

R113/01 Electronic principles

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- A calculator may be used

Duration: 1 hour

Candidate forename		Candidate surname	
Centre number		Candidate number	

INSTRUCTIONS TO CANDIDATES
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES
- The total number of marks for this paper is **60**.
- The number of marks for each question is given in brackets [ ] at the end of the question or part question.
- Dimensions are in millimetres unless stated otherwise.
- Your quality of written communication will be assessed in questions marked with an asterisk(*).
- This document consists of **8** pages. Any blank pages are indicated.

A calculator may be used for this paper

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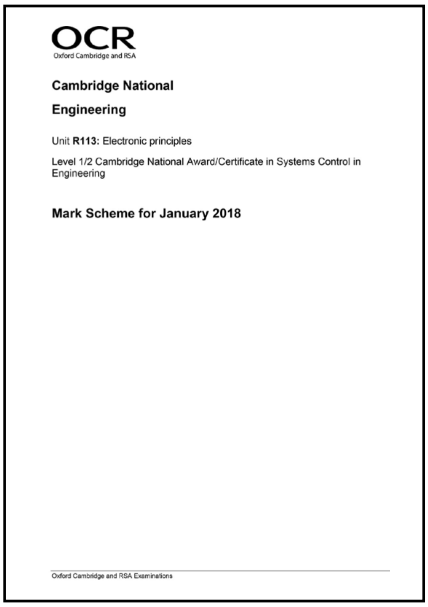
Turn over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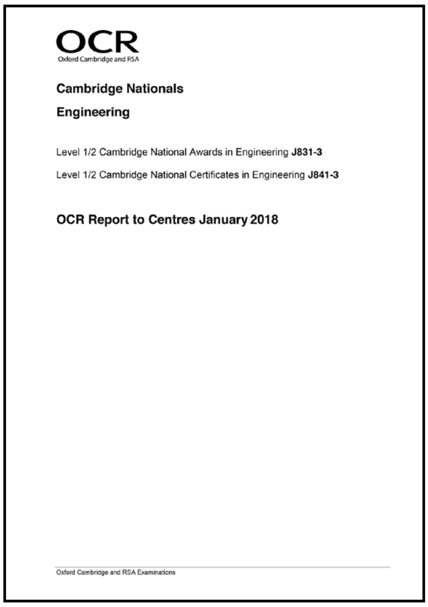
Engineering

Unit **R113:** Electronic principles

Level 1/2 Cambridge National Award/Certificate in Systems Control in Engineering

Mark Scheme for January 2018

Oxford Cambridge and RSA Examinations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Cambridge Nationals

Engineering

Level 1/2 Cambridge National Awards in Engineering **J831-3**

Level 1/2 Cambridge National Certificates in Engineering **J841-3**

OCR Report to Centres January 2018

Oxford Cambridge and RSA Examinations

GENERAL EXAMINER COMMENTS ON THE PAPER

Most candidates attempted all six questions.

In some cases candidates had clearly failed to read the question fully and went on to provide a response that was not actually relevant to the question. Candidates should be advised to read the complete question before attempting a question.

There are times when candidates are not addressing the command verbs in the question. When a question command verb is 'describe' or 'explain' candidates are answering with one word responses which limits their ability to access the full range of marks available.

Resources which might help address the examiner comments:

From the link below, you'll find 'The OCR guide to examinations' (along with many other skills guides)
http://www.ocr.org.uk/i-want-to/skills-guides/

Questions 1 and 2(a)

Answer **all** the questions.

1 **(a)** Complete the table by naming the unit for each quantity shown.

Quantity	Unit
Energy	Watt-hour (Wh) or kilowatt-hour (kWh) or joule (J)
Electro Motive Force	Volt (V)
Frequency	Hertz (Hz)
Inductance	Henry (H)

[4]

(b) Two resistors of value 3 Ω and 2 Ω are connected in parallel to a 6 V supply.

Calculate:

(i) total circuit resistance

$R_1 = 2\ \Omega$ and $R_2 = 3\ \Omega$
$1/R = 1/R_1 + 1/R_2$
$1/R = 1/2 + 1/3$
$1/R = (2 + 3)/6$
$R = 6/5$
$R = 1.2\ \Omega$

[3]

(ii) total power used in the circuit.

$P = I^2R$
$I = V/R \quad 6 \div 1.2 = 5$ A
$P = 5^2 \times 1.2$
$P = 25 \times 1.2$
$P = 30$ W

[3]

2 **(a)** Explain the difference between a polarised capacitor and a non-polarised capacitor.

Differences between polarised capacitor (PC) and non-polarised capacitor (NPC):

- PC must be connected into a circuit the correct way round
- PC is usually larger than NPC
- PC has a higher leakage current than NPC
- PC has a lower frequency response than NPC.

[2]

Mark Scheme Guidance

Question 1(a):

Award one mark for each correct unit.

Accept correct unit abbreviations.

Question 1(b)(i):

Award one mark for:

$1/R = 1/R_1 + 1/R_2$.

Award one mark for workings.

Award one mark for 1.2 or 1.2 Ω.

Award three marks for correct answer 1.2 or 1.2 Ω. without working.

Question 1(b)(ii):

Allow ecf from 1(b)(i) for R

Award one mark for $P = I^2R$.

Award one mark for workings.

Award one mark for 30 or 30 W.

Award three marks for correct answer 30 or 30 W without working.

Accept other correct methods.

Question 2(a):

Award two marks for one correct statement.

Accept other correct responses.

Examiner comments

Question 1(a) – Generally well answered but the unit for e.m.f. and inductance was not well known.

Question 1(b)(i) – The formula for calculating the total resistance of parallel circuit was generally well known with a high proportion of candidates obtaining high marks.

Question 1(b)(ii) – The formula for calculating the total power used in the circuit was reasonably well known with a number of candidates being awarded full marks.

Question 2(a) – The difference between a polarised capacitor and a non-polarised capacitor was reasonably well known.

Questions 2(b), (c) and (d)

(b) **(i)** State the type of capacitor shown in Fig. 1.

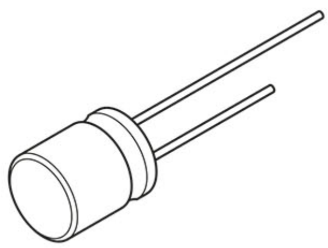

Fig. 1

Polarised/electrolytic **[1]**

(ii) Give the reason for one capacitor leg being shorter than the other.

The shorter leg indicates the negative leg/cathode **[1]**

(c) **(i)** Explain what is meant by voltage rating in a capacitor.

The voltage rating on a capacitor is the maximum amount of voltage that a capacitor can safely be exposed to.

[2]

(ii) Explain the meaning of tolerance in a capacitor.

Tolerance is the maximum and minimum expected range in capacitance compared to its listed value.

[2]

(d) A 100 μF capacitor has a tolerance of ±20%.

Calculate the maximum and minimum values for the capacitor.

Maximum value
= 100 + (20% of 100)
= 100 + 20
= 120 μF.

Minimum value
= 100 - (20% of 100)
= 100 - 20
= 80 μF.

[2]

Mark Scheme Guidance

Question 2(b)(i):

Accept either correct response.

Question 2(c)(i):

Award one mark for reference to 'maximum amount of voltage' and one mark for 'listed value'.

Accept other correct responses.

Question 2(c)(ii):

Award one mark for reference to maximum and one mark for reference to minimum.

Accept other correct responses.

Question 2(d):

Correct answer only with or without units.

Examiner comments

Question 2(b)(i) – The type of capacitor shown was well known.

Question 2(b)(ii) – The feature that the shorter leg indicates the negative leg/cathode was well known. (c)(i) The voltage rating on a capacitor is the maximum amount of voltage that a capacitor can be safely exposed to was reasonably well known but a minority of candidates confused voltage with a number of other quantities.

Question 2(c)(ii) – The meaning of tolerance in a capacitor was reasonably well known.

Question 2(d) – Generally well answered with a high proportion of candidates achieving maximum marks.

Question 3

3 Fig. 2 shows a block diagram of a control system for varying the set level of temperature.

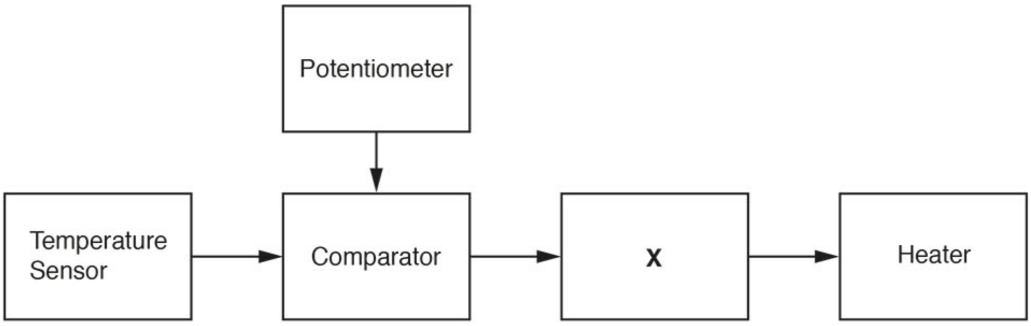

Fig. 2

The 230 V mains controlled heater switches on when the temperature falls below a set value.

(a) State which of the blocks is:

(i) an input

Temperature sensor or Potentiometer .. **[1]**

(ii) an output

Heater .. **[1]**

(iii) a process

Comparator or X .. **[1]**

(iv) a control for varying the temperature.

Potentiometer .. **[1]**

(b) State the block in which:

(i) a relay could be used

X .. **[1]**

(ii) a thermistor could be used

Temperature sensor .. **[1]**

(iii) an operational amplifier (op-amp) could be used.

Comparator .. **[1]**

(c) Explain why the 230 V 1000 W heater is not directly connected to the comparator.

Reasons why the heater is not connected directly to the comparator:

- Because the current from the comparator is very low it would not turn the heater on.
- The heater is rated at 230 V 1000 W which gives a current of I = P/V = 1000/230 = 4.4 A.
- The relay is an electronically operated switch with voltage differences.
- The current flowing in the relay coil circuit causes the opening or closing of relay output contacts, switching the heater on or off.

.. **[3]**

Mark Scheme Guidance

Question 3(a)(ii):

Correct answer only.

Question 3(a)(iv):

Correct answer only.

Question 3(b)(i):

Correct answer only.

Question 3(b)(ii):

Correct answer only.

Question 3(b)(iii):

Correct answer only.

Question 3(c):

Three marks for explanation that includes three points.

Allow two marks for single point fully explained.

Examiner comments

Question 3(a) – All parts of this question were generally well answered with many candidates achieving high marks.

Question (b) – All parts of this question were generally well answered with many candidates achieving high marks.

Question (c) – A high proportion of candidates did not give a reason why the heater is not connected directly to the comparator. A few candidates tried to explain that because the current from the comparator is low it would not turn the heater on but could not continue with the concept of using a relay to complete the circuit.

Question 4

4 **(a)** State the full names of the switches given as initials.

(i) SPDT

single pole double throw **[1]**

(ii) SPST

single pole single throw **[1]**

(iii) DPDT

double pole double throw **[1]**

(iv) DPST

double pole single throw **[1]**

(b)* Discuss the function and applications of a momentary action switch and a latching switch.

Level 3 (5–6 marks)
- Detailed discussion showing a thorough understanding of the function and applications of a momentary action switch and a latching switch in electronic circuits.
- Information is presented clearly and accurately, with correct use of appropriate technical language and engineering terminology.
- Accurate use of spelling, punctuation and grammar.

Level 2 (3–4 marks)
- Adequate discussion showing some understanding of the function and applications of a momentary action switch and a latching switch in electronic circuits.
- Information is presented clearly with some accuracy.
- Appropriate technical language and engineering terminology is used on some occasions.
- Occasional errors in spelling, punctuation and grammar.

Level 1 (1–2 marks)
- Basic discussion showing limited understanding of the function and applications of a momentary action switch and a latching switch in electronic circuits.
- Information presented is basic and may be ambiguous or badly presented.
- There will be little or no use of technical language and engineering terminology.
- Errors in spelling, punctuation and grammar may be intrusive.

Level 0 (0 marks)
- A response that is irrelevant and/or not worthy of a mark.
- Annotate with 'Seen' at end of response.

[6]

Mark Scheme Guidance

Question 4(a):

Award one mark for each correct response.

Question 4(b):

Momentary switches are switches that don't save their state when you press the button.

When you press the button the circuit is on.

When you release the button the circuit is off.

Discussion of applications could include:

- keys on a keyboard
- doorbells
- anti-theft alarms
- laser pointers
- lifts
- microcontroller boards.

A Latching Switch is a switch that once triggered on stays on until the power that goes into it is removed or disabled. Unlike other switches, which operate only when pressed, latches remain on even after the button which triggers it is turned on. A latch, essentially, "latches on" and does not turn off until the power is completely removed from it. Pressing the button which triggers a latch has no effect to turn it off.

Many devices operate with latches, so they have widespread application within circuits. Think of the major applications of alarms, which function with latches. Once alarms are triggered, they remain on indefinitely, until the whole system is disabled. This is the case for most alarms, including burglar alarms and fire alarms.

Examiner comments

Question 4(a) – The majority of candidates stated correctly the full names of the switches given as initials.

Question 4 (b) – This question was not a well answered. A high proportion of candidates gave a very limited understanding of the function a momentary switch and a latching switch. The applications named by the candidate were wide ranging and mostly incorrect. In general terms it seemed that the use of spelling, punctuation and grammar had improved in this area.

Exemplar candidate work
Question 4(b) – Low level answer

(b)* Discuss the function and applications of a momentary action switch and a latching switch.

A latching switch function is used in ~~for~~ car ~~doors~~ door's and ~~boots~~ trunks for example a light on the driver dash board would light up warning of a open door due to circuit being opened. a function of a latching to attach it to ~~something~~ something and active when it is closed and then switch off when opened. a function of a momentary action switch is that it ~~ha~~ turns on temporily ~~a on~~ then turn off, it is used in the car engine on the spark plugs this saves the car battery **[6]**

Commentary

The answer is low level because the candidate showed limited understanding of the function and applications of a momentary switch and a latching switch in electronic circuits.

For a medium level answer the candidate needed to give an adequate discussion showing some understanding of a momentary switch and a latching switch in electronic circuits.

The response requires at least one application for each type of switch, such as, keys on a keyboard for momentary and fire alarm for latching.

Exemplar candidate work
Question 4(b) – Medium level answer

(b)* Discuss the function and applications of a momentary action switch and a latching switch.

Momentary:
• energy efficient because it only connects the current when a force is applied and will break if the force is released
• Is a normally closed switch and won't waste power if unattended.
• examples, doorbell, Keyboard keys
Latching:
• you can keep the circuit on if you let go of the Switch meaning it's more productive.
• More cost efficient
examples, Light Switch, Plug Socket Switch

[6]

Commentary

The answer is medium level because the candidate showed an adequate understanding of the function and applications of a momentary switch and a latching switch in electronic circuits.

For a high level answer the candidate needed to give a detailed discussion showing a thorough understanding of a momentary switch and a latching switch in electronic circuits.

The information needed to be presented in a clear and accurate manner, with the correct use of appropriate technical language and engineering terminology.

The response requires applications all covering both types of switch.

Well known examples of applications are:

- Keys on a keyboard
- Doorbells
- Lift button
- Fire alarm
- Burglar alarm

Exemplar candidate work
Question 4(b) – High level answer

(b)* Discuss the function and applications of a momentary action switch and a latching switch.

A momentary action switch is a switch that is only open / closed for a small ammount of time when it is pressed. These switches may be used in door bells, mobile phone home buttons (Iphone's) and alarm systems.

Latching switches are switches that stay open / closed when pressed by 'latching', this allows the curent to contionally flow / be continually broken. These switches can be used in light switches, power buttons on electronic devises and electronic locking systems such as those in safe's. **[6]**

Commentary

The answer is high level because the candidate gave a good detailed discussion showing understanding of the function and applications of a momentary switch and a latching switch in electronic circuits.

For a full high level answer the candidate needed to give a detailed discussion showing a thorough understanding of a momentary switch and a latching switch in electronic circuits.

The information needed to be presented in a clear and accurate manner, with the correct use of appropriate technical language and engineering terminology.

The response requires accurate applications all covering both types of switch.

Question 5

5 (a) Complete the table with a tick (✓) to identify which **four** items can be used to test an electronic circuit for faults.

Test Equipment	✓
Power Supply Unit	✓
Diode	
Logic probe	✓
Relay	
Signal Generator	✓
Solenoid	
Multimeter	✓

[4]

(b) Describe, in detail, how a continuity test can be carried out on an electronic circuit.

Up to six marks for a detailed description which could include:

Selection of the correct mode on a multimeter e.g.:

- Turn the dial to Continuity Test mode/lowest setting of Ohms Ω possible. Use the beep continuity tester.
- Check the correct mode has been selected e.g. with the test probes separated, the multimeter display may show OL and Ω. When the probes touch notice the very low Ω reading.

Correct positioning/ordering of test leads e.g.:

- First insert the black test lead into the COM jack.
- Then insert the red lead into the V Ω jack.

Connection of test leads to component e.g.:

- With the circuit de-energized.
- Connect the test leads across the component being tested. The positioning of the test leads doesn't matter.

Output of test e.g.:

- The digital multimeter will emit a sound if a continuity path is detected/if the circuit is open, the switch is in the OFF position and the digital multimeter will not emit sound.

Finishing the test e.g.:

- When testing is finished the test leads should be removed in reverse order.
- Turn the multimeter OFF to preserve battery life.

[6]

Mark Scheme Guidance

Question 5(a):

Award one mark for each correct item of test equipment up to a maximum of four marks.

Question 5(b):

Accept other suitable points made.

Examiner comments

Question 5(a) – A high proportion of candidates completed the table correctly identifying the four items of test equipment that could be used to test an electronic circuit for faults.

Question 5(b) – This question was not answered well. A high proportion of candidates gave a very limited description of how a continuity test could be carried out on an electronics circuit. The use of a multimeter did not seem to be well known.

Exemplar candidate work
Question 5(b) – Low level answer

(b) Describe, in detail, how a continuity test can be carried out on an electronic circuit.

You must break the circut and Put the ~~Probs~~ red and black Probes on be conelt the curcuit and IF It make a long beeping Scund then youre finished your test.

[6]

Commentary

The answer is low level because the candidate had little understanding of how a continuity test would be carried out on an electric circuit.

For a medium level answer the candidate needed to state the first thee actions in carrying out such a test.

They are:

- Selection of the correct mode on the multimeter
- Correct positioning of the test leads
- Connection of test leads to the component/circuit

Exemplar candidate work
Question 5(b) – Medium level answer

(b) Describe, in detail, how a continuity test can be carried out on an electronic circuit.

A Continuty test can be carried out by:

- getting a multimeter and ~~changing~~ attaching the the testing wires to the meter
- Then you get the red wire and touch it on your componet
- Get the black wire and touch something metal
- If you hair a buzz theres continuity, if not there isnt

[6]

Commentary

The answer is medium level because the candidate showed an adequate understanding of how a continuity test would be carried out on an electric circuit.

For a high level answer the candidate needed to give a detailed discussion showing a thorough understanding of how a continuity test would be carried out on an electric circuit.

The information needed to be presented in a clear and accurate manner, with the correct use of appropriate technical language and engineering terminology.

For a high level answer the candidate needs to state and explain all of the actions in carrying out a continuity test.

They are:

- Selection of the correct mode on the multimeter
- Correct positioning of the test leads
- Connection of test leads to the component/circuit
- Outcomes of test
- Completing the test.

Exemplar candidate work
Question 5(b) – High level answer

(b) Describe, in detail, how a continuity test can be carried out on an electronic circuit.

First, Turn on your multimeter and set it to the continuity setting. Remove the battery and turn off the circuit. Decide which area of the circuit you want to test. Connect the negative probe to the negative part that will be tested and the positive probe to the positive part that will be tested. If a value over zero is read on the multimetre then it has passed the test. The multimetre could also make a noise if it passes. If the multimeter shows zero then it has failed the test.

[6]

Commentary

The answer is high level because the candidate gave a good detailed discussion showing an understanding of how a continuity test would be carried out on an electronic circuit.

For a high level answer the candidate needed to give a detailed discussion showing a thorough understanding of how a continuity test would be carried out on an electronic circuit.

The information needs to be presented in a clear and accurate manner, with the correct use of appropriate technical language and engineering terminology.

For a full mark high level answer the candidate needs to state all of the actions in carrying out a continuity test.

They are:

- Selection of the correct mode on the multimeter
- Correct positioning of the test leads
- Connection of test leads to the component/circuit
- Outcomes of test
- Completing the test.

Along with this list of actions, the candidate would need to give a full and detailed description of each action in the list.

Question 6

6 (a) State **six** benefits of pick and place robots in manufacturing processes.

1 ....

Benefit stated of pick and place robots e.g.:
- The production costs are reduced.
- More efficient/accurate/reliable/consistent.
- More work carried out in a shorter time.
- Quality and reliability are improved.
- Takes up less floor space.
- Very little waste made.
- Can work 24/7 with low maintenance costs.
- Workers are safer because they do not come into direct contact with materials or machines.
- Multiple applications can be performed by one robot.

2 ....

3 ....

4 ....

5 ....

6 ....

[6]

(b) Calculate the current, in amperes, taken from a pick and place robotic motor rated at 2 kW 230 V.

I = P/V
= 2000/230
= 8.7 A

[2]

(c) Calculate the energy consumed in 10 hours by a robot arm servomechanism that is rated at 4 kW.

Energy (W) = Pt
= 4 × 10
= 40 kWh

[2]

Mark Scheme Guidance

Question 6(a):

Award one mark for each correct benefit up to a maximum of six.

Accept other valid responses.

Question 6(b):

Award one mark for I = P/V or 2000/230.

Award one mark for 8.7 A or 8.7 or 8.7 with any unit.

Award two marks for correct answer without workings.

Question 6(c):

Award one mark for W = Pt or 4 × 10.

Award one mark for 40 kWh or 40 or 40 with any unit.

Award two marks for correct answer without workings.

Examiner comments

Question 6(a) – The benefits of the pick and place robot in the manufacturing process was generally well known with a high proportion of candidates being awarded high marks.

Question 6(b) – The formula for calculating the current was well known with many candidates achieving high marks.

Question 6(c) – The formula for energy = power x time was not well known. The most straightforward solution was W = Pt = 4 × 10 = 40 kWh. Candidates however chose many obtrusive methods often resulting in very limited marks. The units of energy do not seem to be well known i.e. J, Ws, Wh and kWh.

Exemplar candidate work

Question 6(b) – Low level answer

(b) Calculate the current, in amperes, taken from a pick and place robotic motor rated at 2 kW 230 V.

2kw × 100 = 200 w I = P × V = 200 × 230 = 46,000 ÷ 100

460 A **[2]**

Commentary

The answer is low level because the candidate did not use the correct formula for current.

For a medium level answer the candidate needed to state the correct formula for current (I = V/R) and substituted the given values (I=2000/230).

Question 6(b) – High level answer

(b) Calculate the current, in amperes, taken from a pick and place robotic motor rated at 2 kW 230 V.

P = IV I = P/V I = 2 × 1000 / 230

= 8.695652

= 8.67 Amps (8.7) **[2]**

Commentary

This answer is a full mark high level answer because the candidate stated the correct current formula (I = V/R), performed the correct substitution (I = 2000/230) giving a correct answer of 8.7 A.

The unit of current was stated correctly as the ampere A.

Exemplar candidate work

Question 6(c) – Low level answer

(c) Calculate the energy consumed in 10 hours by a robot arm servomechanism that is rated at 4 kW.

Energy = power x time   Energy = 40000 W

P = E/t

Energy = 4000 W x 10 hrs .... **[2]**

power = energy/time   Energy = power x time

Commentary

The answer is low level because the candidate did not state the correct unit for energy.

For a medium level answer the candidate needed to use the correct formula for energy (W = Pt) and substituted the given values of 10 hours and 4 kW.

Question 6(c) – High level answer

(c) Calculate the energy consumed in 10 hours by a robot arm servomechanism that is rated at 4 kW.

4kW X 10 =

~~40k~~ 40 kW .... **[2]**

Commentary

The answer is full mark high level because the numerical answer is correct using the formula W = Pt.

The small print

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