

T Level Technical Qualification in Design and Development for Engineering and Manufacturing (8714-33)

Control and Instrumentation (323)

**Guide standard exemplification
material**

Threshold competence – Sample

First teaching from September 2022

Version 1.1

Version and date	Change detail	Section
1.1 January 2023	Formatting of Task 1 evidence requirements	Task 1

Contents

Introduction	3
Grade descriptors	4
Task 1 – Design	5
1a) Design specification	6
1b i) Annotated sketches, block and wiring diagrams.....	8
1b ii-iii) Options for the sensors and pre alarm temperatures with justifications, and calculations.....	10
1c) Outcomes of the virtual modelling.....	12
1d) Bill of materials.....	14
Notes	15
Task 2 – Manufacture and test	16
2a) Risk assessment.....	17
2b) Manufacture of the prototype.....	19
2c) Testing and verification	25
Task 3 – Peer review	28
Peer review feedback form	29
Task 4 – Evaluation and implementation.....	30
4a) Outcomes of virtual modelling.....	31
4b) Revision control document.....	32
4c) Evaluation and implementation report	34

Introduction

The sample assessment materials within this document refer to the T Level Technical Qualification in Design and Development for Engineering and Manufacturing - Control and instrumentation engineering sample occupational specialism assignment. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to minimal threshold competence. The examples provided do not reflect all evidence from the sample assignment as the focus of this material is the quality and standards that need to be achieved rather than the volume of exemplar evidence provided. However, the examples provided are representative of all tasks in the sample assignment. The evidence presented here has been developed to reflect minimal threshold competence within each task but is not necessarily intended to reflect the work of a single candidate. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and the standard of performance will vary across tasks. Minimal threshold competence will be based on a synoptic mark across all tasks.

The materials in this Guide Standard Exemplification Material (GSEM) are separated into three sections as described below. Materials are presented against a number of tasks from the assignment.

Task

This section details the tasks that the candidate has been asked to carry out, what needs to be submitted for marking and any additional evidence required including any photographic evidence. Also referenced in this section are the assessment themes the candidates will be marked against when completing the tasks within it. In addition, candidate evidence that has been included or not been included in this GSEM has been identified within this section.

In this GSEM there is candidate evidence from:

Task 1

Task 2

Task 3

Task 4

Candidate evidence

This section includes exemplars of candidate work, photographs of the work in production (or completed) and practical observation records of the assessment completed by centre assessors. This will be exemplar evidence that was captured as part of the assessment and then internally marked by the centre assessor.

Commentary

This section includes detailed comments to demonstrate how the candidate evidence attests to the standard of minimal threshold competence by directly correlating to the grade descriptors for this occupational area. Centres can compare the evidence against the performance indicators in the marking grid descriptors within the assessor packs, to provide guidance on the standard of knowledge, skills and understanding that need to be met for minimal threshold competence.

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

Grade descriptors

To achieve a pass (threshold competence), a candidate will typically be able to:

Demonstrate a basic use of software / technologies to model, evaluate and produce engineering diagrams and simulations that meets the requirements of the brief.

Demonstrate basic technical skills when developing models and prototypes, resulting in a model that may require some modifications.

Apply basic knowledge and understanding of testing processes, resulting in a model that has been tested against most of the design criteria.

Interpret information, plan, assess risk and follow safe working methods appropriately when applying practical skills to an acceptable standard in response to the requirements of the brief.

Apply basic knowledge and understanding of the design principles required for control and instrumentation resulting in proposals and solutions that meet the minimum requirements of the brief.

Work safely showing an understanding and suitable level of awareness in the preparation and application of processes, selection and use of tools and manufacturing materials and components, resulting in tasks that are carried out with some minor errors.

Use industry and technical terminology accurately most of the time in both written and verbal contexts.

Task 1 – Design

(Assessment themes: Health and safety, Design and planning)

For task 1, candidates need to produce the following pieces of evidence:

- a) design specification
- b)
 - i) annotated sketches, block and wiring diagrams
 - ii) design options for the sensors with justifications, and calculations
 - iii) selection of appropriate pre alarm temperatures with justifications and calculations, including all workings
- c) outcomes of the virtual modelling of the proposed system design, either as screen captures or printouts
- d) bill of materials.

For Task 1, the following additional evidence may also be submitted:

- any notes produced of research undertaken including citation of sources and internet search history.

1a) Design specification

Candidate evidence

Design requirements:	How the requirements will be met:
<i>Automatic monitoring and regulation of temperature and lighting within the process.</i>	A PID (proportional, integral and derivative) controller is to be integrated into the system. The PID controller will allow the system to be kept at the required operating limits, as well as reducing any overshoot issues. The operating limits are the setpoints that the system will work and maintain within, so the PID controller will be an integral part of the design.
<i>Temperature control system must not exceed three overshoots on first switching on from a 30°C start.</i>	The PID controller aids with overshoot issues and the reduction of overshoot through derivative control. This will also improve the system stability along with regular maintenance and monitoring. The derivative control will allow for quicker responses of the system and loop, therefore more stability is obtained than if this was not used.
<i>Temperature alarm when range limits are nearing.</i>	This will be achieved through the implementation of auxiliary alarms and bulbs which will illuminate to indicate when the temperature operating limits are near.
<i>Visual display of the lighting and temperature levels in real time.</i>	A VDU (visual display unit) will be implemented to the system. The VDU which will have the capability to display current measurements and readings, storing the information and enabling the user to access the system history and parameters.
<i>Recording of the parameters.</i>	Depending on the selected user interface, the parameters of the system can be stored and accessed.
<i>Changing of set points for different applications and processes.</i>	Selecting the PID controller allows for the setpoints to be easily changed and calculated, enabling the system to be used for different applications and processes.
<i>Detection of light level below 10,000 lux.</i>	Appropriate sensor to be chosen which will be connected to the alarm system, so when the light level does drop below the specified value, the system will be able to indicate this.
<i>Operationalisation of the prototype</i>	The design and prototype will be in line with the operational requirements through the components and equipment types selected for the process and how they meet the design criteria.
<i>Health and safety</i>	Health and safety will be managed through the correct application and use of the equipment and components.

Commentary

The candidate has produced a clear and detailed design specification. The candidate has included a definition of operating limits and provided some explanation of how system stability will be achieved. This demonstrates the candidate has interpreted the task requirements correctly. To further the response, the candidate could have provided more detail on how system stability will be achieved, expanding on the analysis provided.

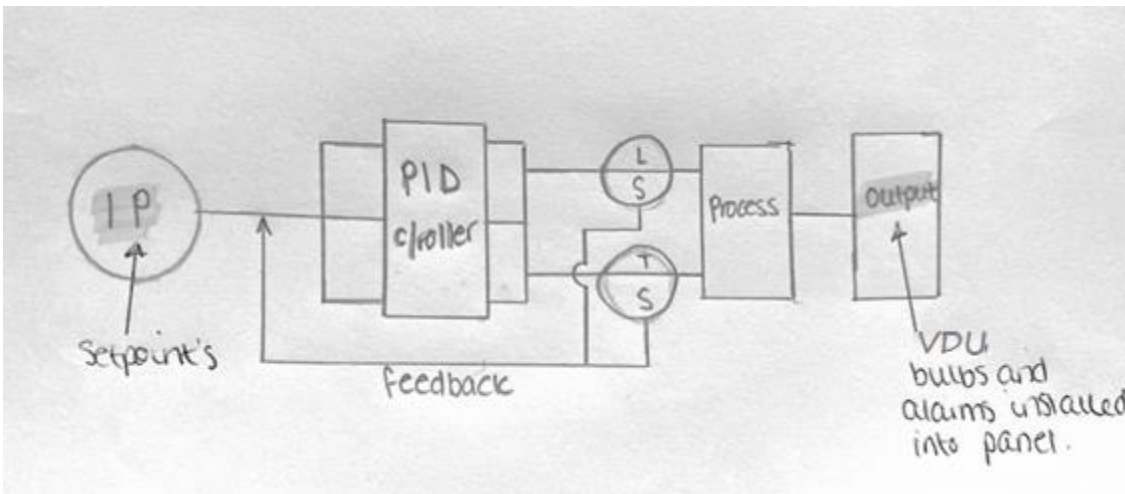
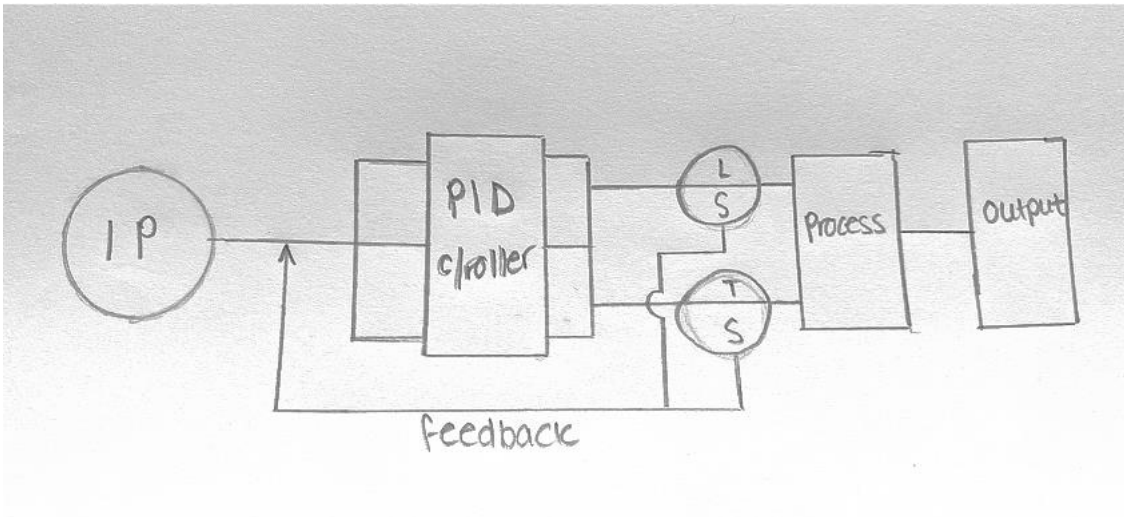
The candidate has selected the use of components that would meet the specifications of the design, reflecting that the candidate has an understanding of the design requirements and the brief. The candidate has provided some basic, but valid justifications to reflect their design choices. For example, showing how use of the derivative control will improve overall stability by allowing for quicker responses in the system. The candidate could have developed their response further by providing more detail on the design choices applied and through further expansion of the justifications provided.

There has been limited consideration of the overall structure of the design specification. Health and safety is mentioned as a consideration, but not explored in detail. The information presented is accurate but could have benefitted from further development into a more coherent and logical structure reflective of the development of the design.

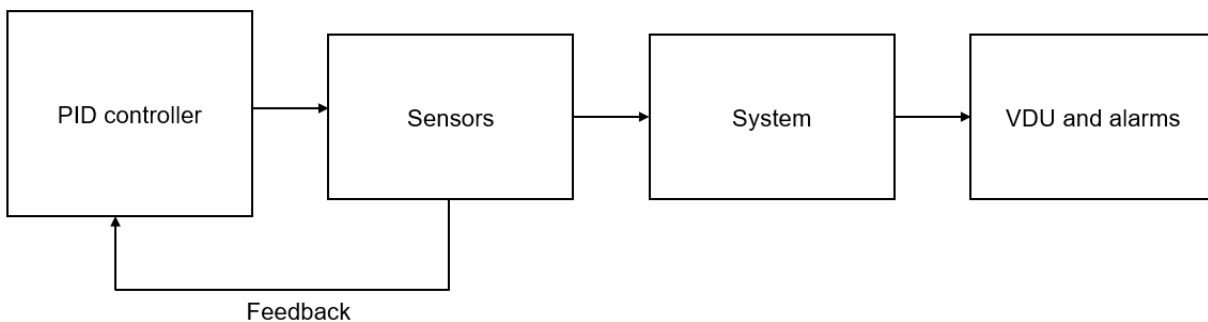
Candidate evidence

1b i) Annotated sketches, block and wiring diagrams

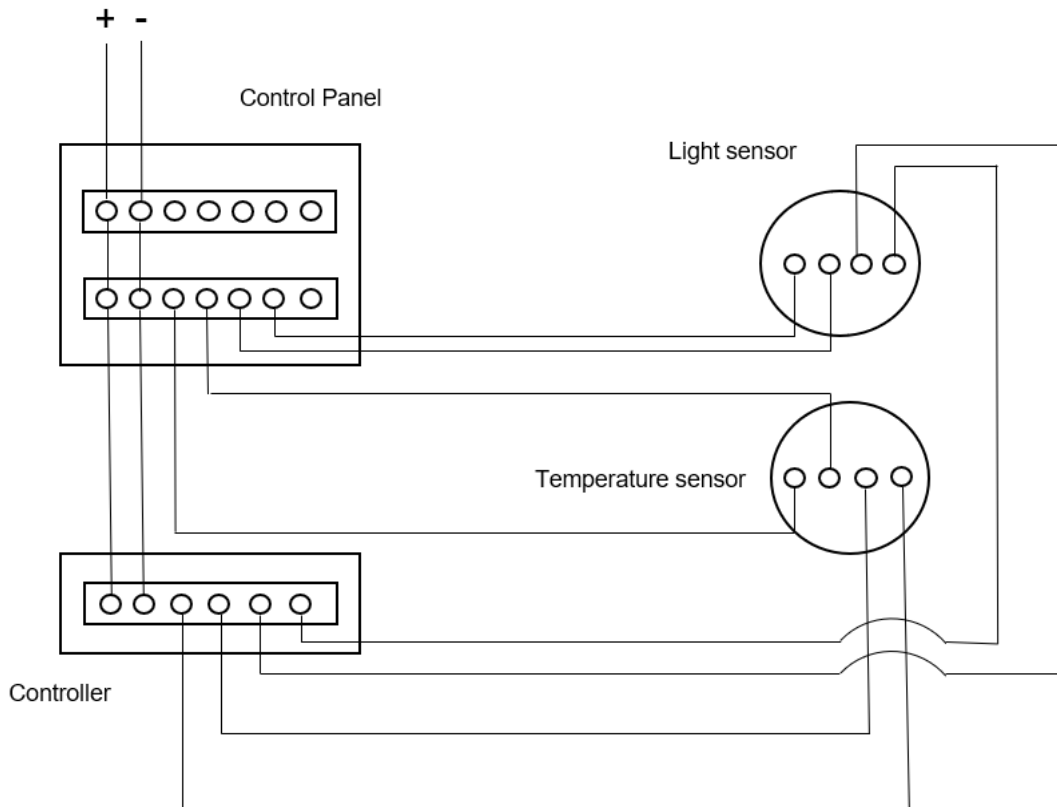
Annotated sketches



Block diagram



Wiring diagram



Commentary

The candidate has developed sketches and diagrams in order to demonstrate the function of their overall design of control system. Together, these provide a clear, but basic overview of the intended system.

The sketches are clear and include brief annotations as well as some relevant information in terms of the connections and signal flow between each subsystem. The candidate has correctly labelled the diagram and provided some basic annotations to identify information that is not evident within the sketches themselves, for example, the location of the Visual Display Unit and bulbs. The candidate could have developed their response further by providing more detailed annotations to support a third party to understand the design in a greater level of detail.

The block diagram produced shows a simple top-down overview of the overall system, but with limited detail surrounding the individual subsystems blocks and their function. The candidate could have developed the block diagram further by including further information about the feedback loop and reference inputs. For example, summing points and the effects of the output signals on the input.

A simple wiring diagram has been produced which shows the approximate physical locations of the main system blocks and how they are connected to each other. The diagram is laid out well and the connections and terminals can be identified easily by a third-party user reviewing it. To develop the diagram further, the candidate could have demonstrated how the Visual Display Unit is connected to the control panel, for example via a HDMI cable and provided more information and labelling, such as identifying the voltage and the positive and negative terminals.

1b ii-iii) Options for the sensors and pre alarm temperatures with justifications, and calculations

Light sensor

As the system must be able to detect when the light levels are below 10,000 lux a sensor with a measuring range of up to 10,000 lux must be selected. The light sensor selected for this process is the EM500-LGT. This type of sensor can withstand harsh environments including cultivation environments.

The datasheet for this sensor shows that it has a tolerance of +/- 3% for the measurements taken.

For example, for a reading of 10,000 lux:

Maximum possible value = $10,000 + (10,000 \times 0.3) = 13,000$ lux

Minimum possible value = $10,000 - (10,000 \times 0.3) = 7,000$ lux

Temperature sensor

PT1000 TES temperature has been selected for the process which has a measuring range of -50°C to 120°C. The temperature range exceeds the specifications in the brief so will work efficiently within the limits required. This type of temperature is recommended for HVAC systems. Full data sheet can be found SN1.06-Tes.fm (syxthsense.com).

This sensor makes use of 10 kΩ at 25°C negative temperature coefficient (NTC) thermistors within the main sensor element. The beta value is 3455 for this type of thermistor.

The resistances at the maximum and minimum temperature range values given in the criteria are as follows:

At 18°C:

$$t_1 = 18^\circ\text{C}$$

$$t_2 = 25^\circ\text{C}$$

$$3455 = \ln(R_2 / R_1) \times (t_2 \times t_1) / (t_1 - t_2)$$

$$3455 = \ln(10000 / R_1) \times (25 \times 18) / (18 - 25)$$

$$3455 = \ln(10000 / R_1) \times -64$$

$$e^{[3455 / -64]} = 10000 / R_1$$

$$\text{So } R_1 = 10000 / e^{-53.98}$$

$$R_1 = 27869 \Omega \text{ at } 18^\circ\text{C}$$

At 24°C:

$$t_1 = 24^\circ\text{C}$$

$$t_2 = 25^\circ\text{C}$$

$$3455 = \ln(R_2 / R_1) \times (t_2 \times t_1) / (t_1 - t_2)$$

$$3455 = \ln(10000 / R_1) \times (25 \times 24) / (24 - 25)$$

$$3455 = \ln(10000 / R_1) \times -600$$

$$e^{[3455 / -600]} = 10000 / R_1$$

$$\text{So } R_1 = 10000 / e^{-5.758}$$

$$R_1 = 31682 \Omega \text{ at } 24^\circ\text{C}$$

Pre alarm temperatures

The pre alarm levels will be set at 19°C and 23°C. When reached the LED/bulbs will illuminate to indicate the setpoints are almost reached. The visual indication/warning will allow for the process to be addressed before the audio alarms sound.

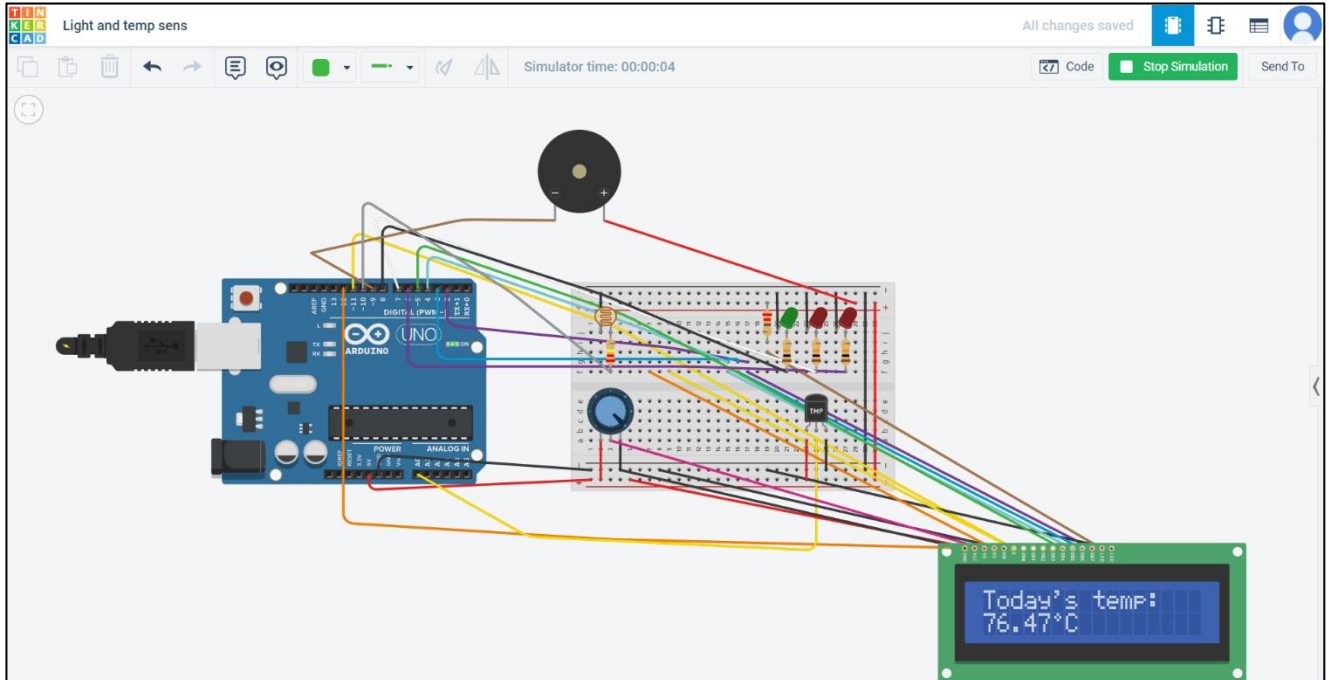
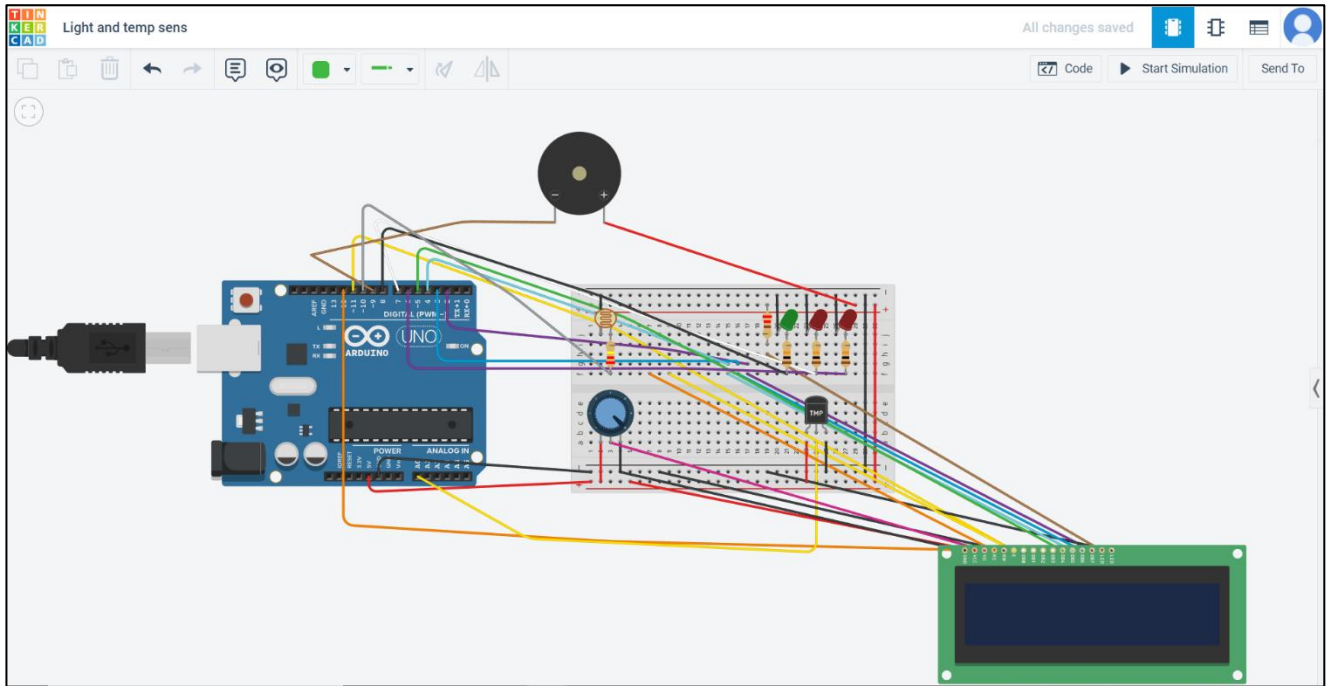
Commentary

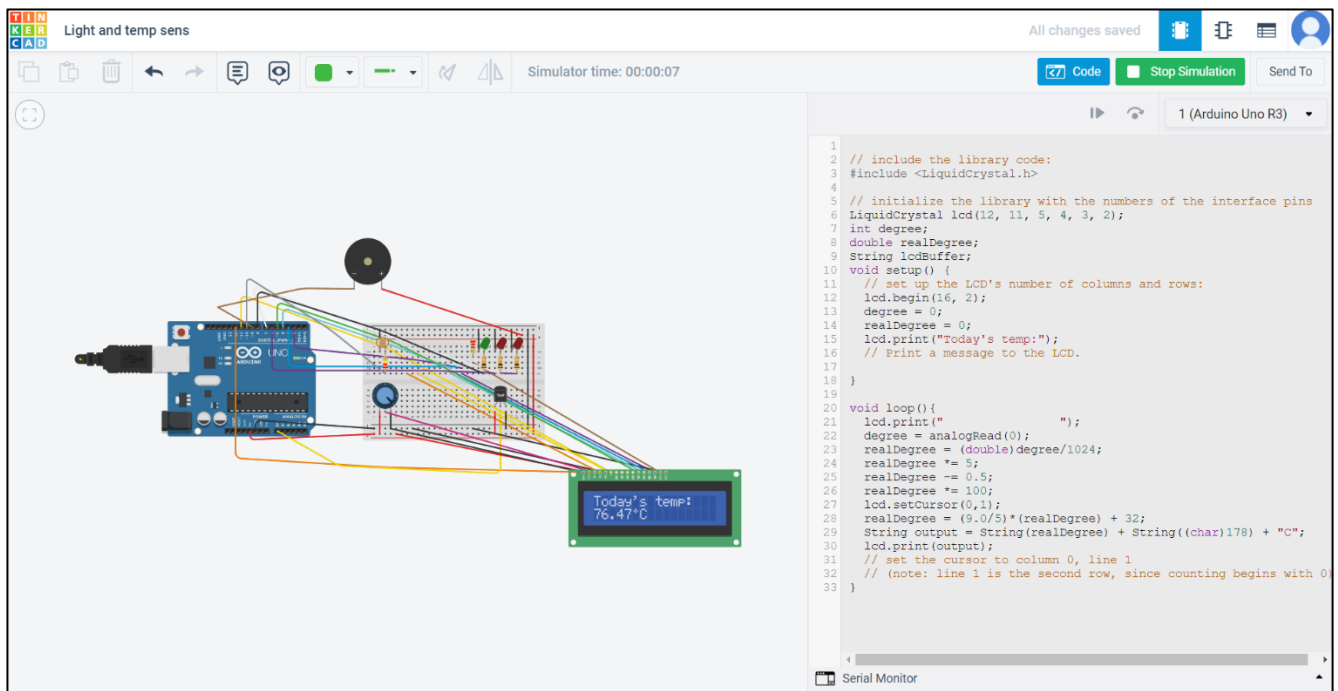
The candidate has demonstrated understanding of the design requirements by identifying and selecting a range of sensors that are appropriate for the task. The candidate has provided some rationale that shows an understanding of the parameters that the system needs to operate within, and how the selected sensors will support this. However, the rationale is generally fairly limited and tends to repeat information that has been provided in the brief and design criteria. To develop the response further, the candidate could have provided a more detailed technical rationale for use of each sensor and an explanation of their choice against other available options.

The candidate has used calculations that show an understanding of methodology and approach. Whilst the method used is correct, there have been some errors in final calculation. For the light sensor, there is an error made using 0.3 instead of 0.03 hence resulting in inaccurate answers. The candidate has not identified that this error has resulted in a large variation between the maximum and minimum possible values, which would not meet the requirements of the brief as stated if correct. For the temperature sensor, the candidate has not included the Kelvin conversion, leading to inaccurate answers.

1c) Outcomes of the virtual modelling

Candidate evidence





Commentary

The candidate has produced a functional but simple virtual model, demonstrating basic knowledge of virtual modelling tools, including simple drawing, simulation and use of virtual instruments.

It shows how the overall system and some of the subsystem blocks work to achieve some of the required outcomes.

The virtual model meets some but not all of the requirements of the design criteria in the brief. For example, no time and date displayed/programmed and there is no visual output to indicate the light/lumen level displayed on the LCD. A photoresistor / photocell has been used to measure the lumens and programmed to suit the requirements. In order to improve further, the candidate could have written in the program and used a switch to activate different display items on the LCD.

A potentiometer is used to adjust the LCD display. It would have been more beneficial to use this to replicate temperature and/or lumens.

The wiring has been placed correctly but could have been routed more neatly by curving around the breadboard.

1d) Bill of materials

Candidate evidence

Equipment	Quantity/details
Hand tools and equipment	Hand tools to include: <ul style="list-style-type: none">• Wire cutters• Pliers• Screwdrivers (various)• Crimping tool Equipment to include: <ul style="list-style-type: none">• Power drill• Test equipment (multimeter, voltage indicator) 1 of each type of tool
Light sensor LXT - TRM	1
Temperature sensor TES PT1000	1
Bulbs	4
Alarm sounders (Piezo sirens)	4
Wire 1.5mm Black and Red	4m of each
PID controller	1
VDU interface	1
Technical documentation	Manuals, sketches and diagrams
Fastenings and fixings	Various
Panel	1

Commentary

The candidate has presented a basic bill of materials and considered the different aspects of the design, laying the materials list out neatly in a table. The candidate has expanded on some of the tools and equipment required. The focus of the bill of materials is the development of the design. To develop the response further, the candidate could have broadened the focus of the bill of materials, by considering the installation of the prototype, listing tape measures and levels as well as considering that a power source will be required.

The candidate has clearly considered the components required and included the type of sensors in the list, as well as consideration for the length of wire and the amounts of each component. To develop further, the candidate could have provided further specific detail on the types of bulbs, VDU and PID controller.

The candidate has included documentation that will be required to complete the design which demonstrates the candidate understands the need for technical documentation and how this can be used to complete a task. To develop the response further, the candidate could have listed Health and Safety documentation, such as Risk Assessment and detailed specifically which manuals will be used.

Notes

Website example:

Pt1000 Temperature Sensor for Extreme Conditions (TES-PT1000) (syxthsense.com)

Principles of PID Control and Tuning | Eurotherm by Schneider Electric

EM500-LGT | LoRaWAN Light Sensor | Milesight - IoT Solution Provider

Task 2 – Manufacture and test

(Assessment themes: Health and safety, Manufacturing, Reports)

For task 2, candidates need to produce the following pieces of evidence:

- a) Risk assessment
- b) Prototype
- c) Test and verification records.

- Assessor observation of:
 - Construction of prototype
 - Testing and verification

Photographic evidence which shows:

- Sequence of photos during the construction of the prototype to include:
 - Results of tool selection and usage (photographs 1 & 2)
 - Wiring – dressing of cables (photographs 7 & 8)
 - Control hardware, interfaces and sub-assemblies (photographs 3-4)
 - Final prototype (photograph 4)

Video evidence which shows:

- Functionality of the prototype

2a) Risk assessment

Candidate evidence

Hazard	Risk	Control	Likelihood	Severity
Working area when designing, developing and testing the control system prototype	Slips, trips and falls.	Ensure area is clean and tidy before beginning the build, during the activity and upon completion.	1	1
Manual handling of tools and equipment	Back injury.	Do not lift over maximum lifting limit when moving and installing panels. Ensure correct training has been received.	1	1
Working with stored energy / temperature when developing the prototype of the control system	Burns, scalds.	Ensure that correct procedures are followed when working on the system once it is heating up and powered on. Allow sensors to cool before removing.	3	2
Using general hand tools and equipment for developing the prototype	Cuts, abrasions, general hand injury.	Ensure proper use of tools and equipment, particularly wire cutters, strippers, screwdrivers and crimpers. Ensure correct PPE is obtained and worn, such as gloves when working with hot components and safety glasses to protect from flying debris e.g. when snipping wires.	1	1
Electricity (mains and low voltage) when working on and testing the prototype in a live system	Electrocution.	Safe isolation following ELV guidance.	2	1
Equipment malfunction / faulty components	Issues with system whilst modifying / installing new equipment.	Safe isolation following ELV guidance.	2	2

Likelihood		Severity	
1	Very unlikely to happen	1	Minor injury
2	Unlikely to happen	2	Major injury
3	Possible to happen	3	Loss of limb
4	Likely to happen	4	Death of an individual
5	Very likely to happen	5	Multiple deaths

Commentary

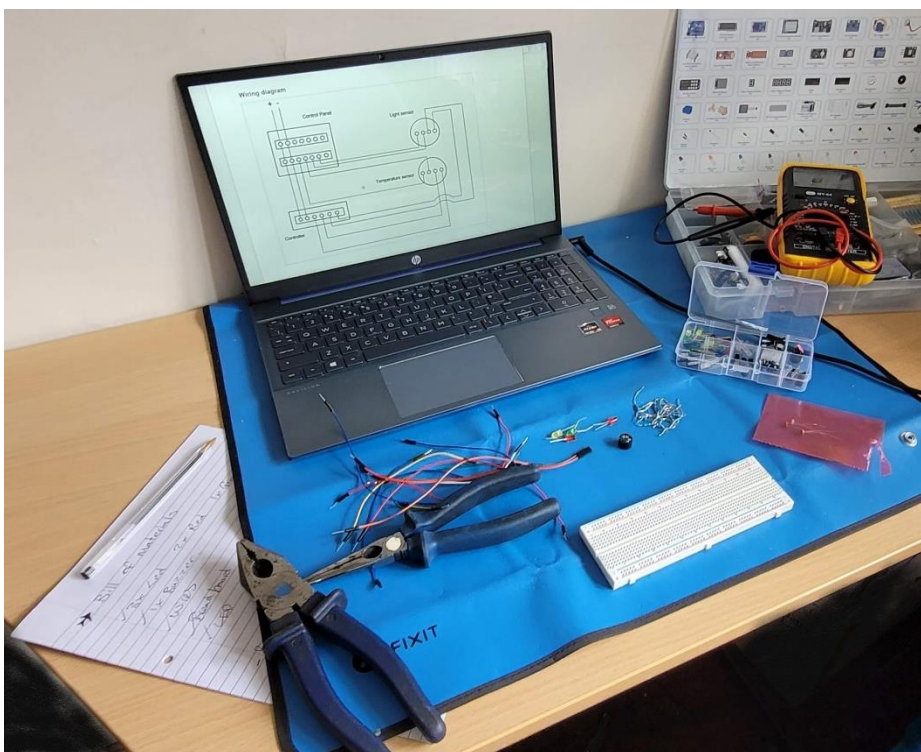
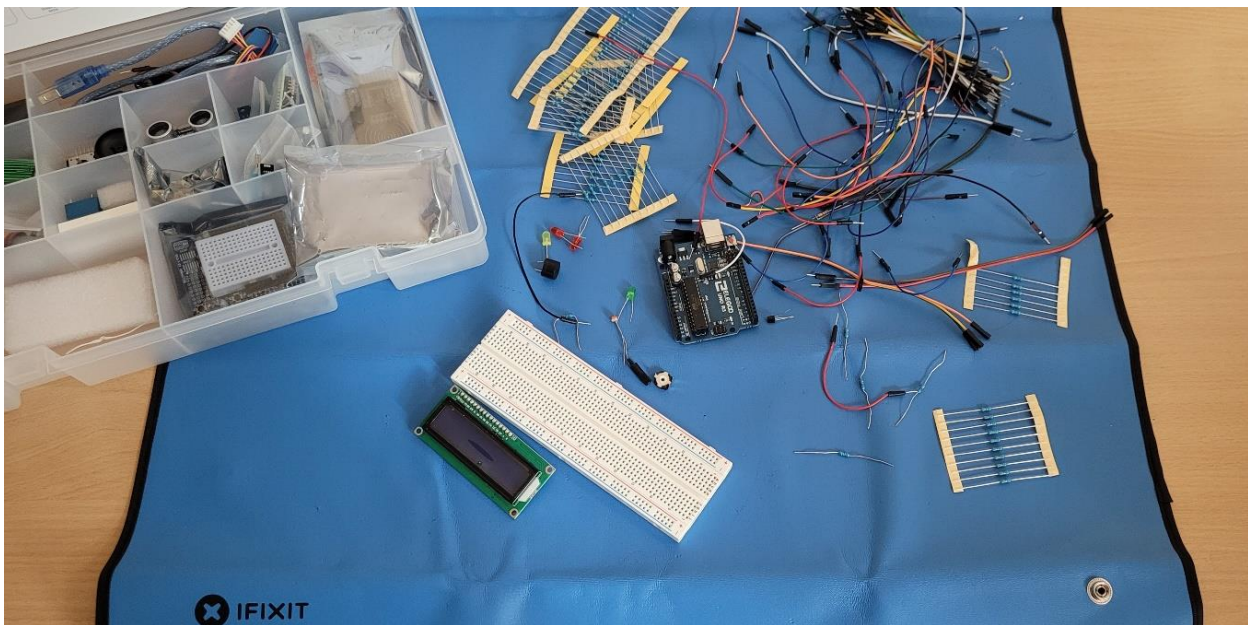
The candidate has considered and identified a wide range of hazards and related risks that are specific to the developing of the prototype, in order to ensure that safe working is followed. In order to develop the response further, the candidate could categorise each element of the activity and identify hazards for each part, demonstrating a deeper understanding of risks and hazards in the workplace to ensure the safety of themselves and others. For example, the specific hazards related to the different stages of developing the prototype – installation, powering up, function testing and powering down.

Control measures are appropriate and include relevant detail specific to the task, such as extra low voltage (ELV) guidance, however lacking comprehensive detail, for example IET guidance. They have demonstrated acceptable knowledge for risk mitigation techniques to work safely but would need to add further detail into their risk assessment to develop their response. For example, visual inspection of tools and equipment before use.

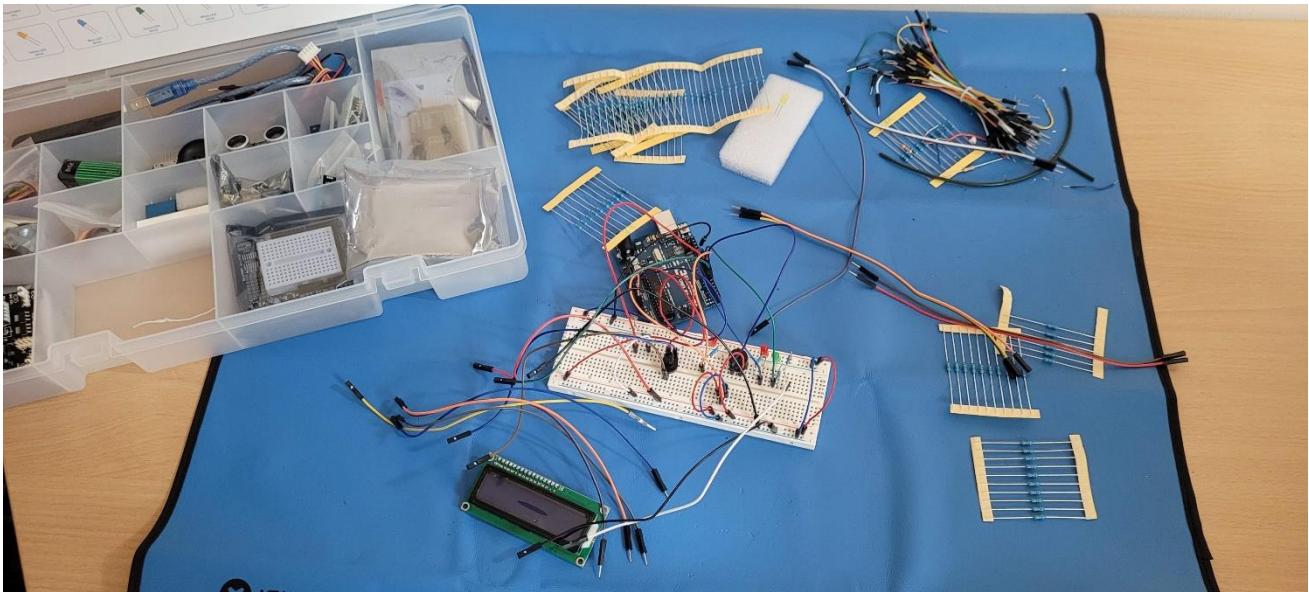
The candidate has labelled the likelihood severity for each risk and hazard, with some accuracy which demonstrates an acceptable standard of understanding and awareness of risk assessment and mitigation, and therefore safe to work. The candidate could have developed their response further by considering the likelihood/severity of all identified hazards and risks with a higher degree of accuracy. For instance, acknowledgement that risks may only cause minor injury, but would be of a higher likelihood rating (e.g. general hand tools and equipment should be rated as 2 for likelihood, and 1 for severity, rather than 1 for both).

2b) Manufacture of the prototype

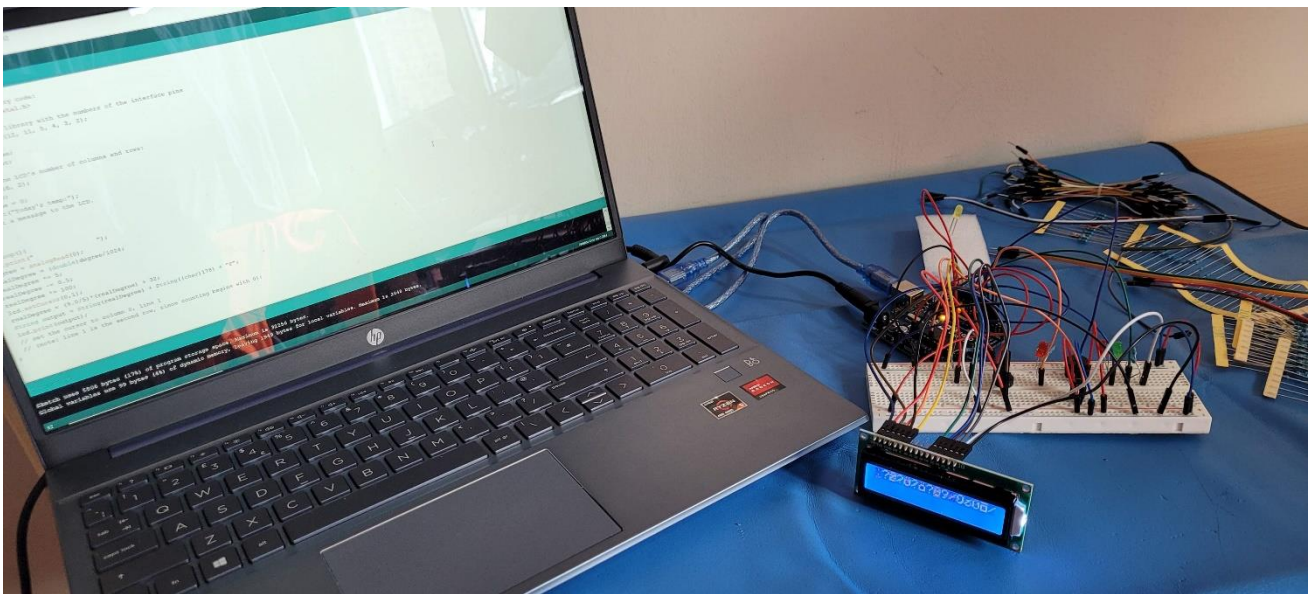
Photographic/video evidence



Photographs 1 & 2 show the prepared work area. The candidate has gathered the tools and resources required for the task. These have been placed in the work area but are not placed in a logical order and are untidily placed which will not provide the most efficient working approach. The technical documentation has been loaded and is displayed on the computer.



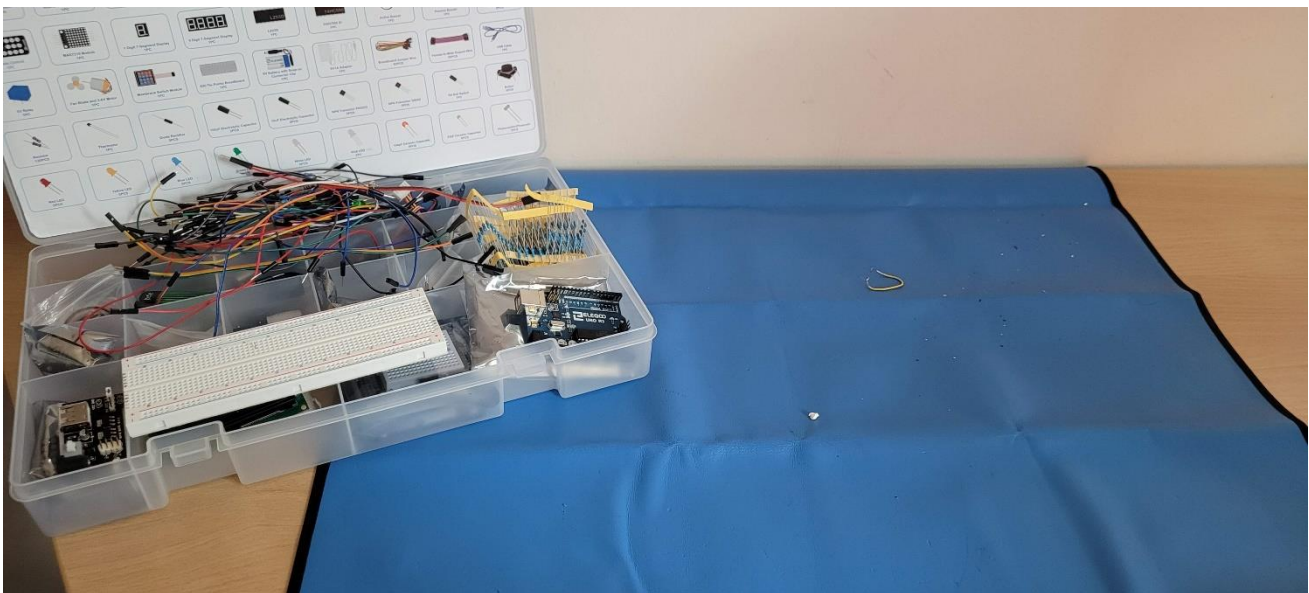
Photograph 3 shows the basic development of the control hardware. The photograph demonstrates that the candidate has undertaken basic assembly of the hardware, with consideration of the positioning of the interfaces and sub-assemblies. The assembly and wiring are of an adequate standard, and the work area is overall untidy.



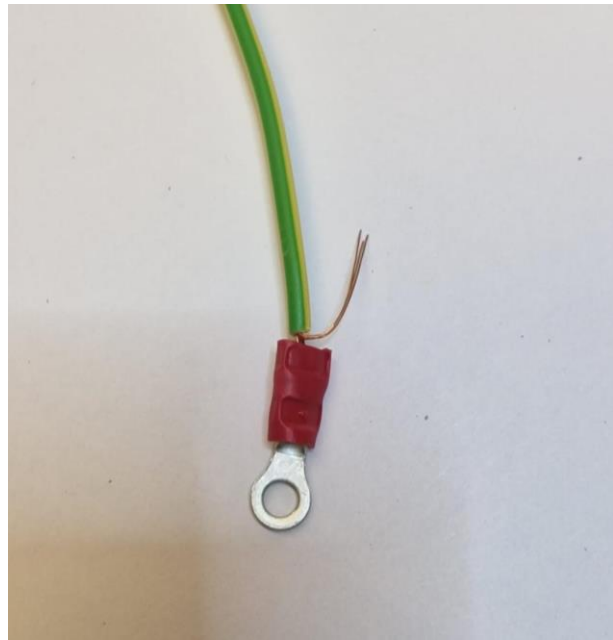
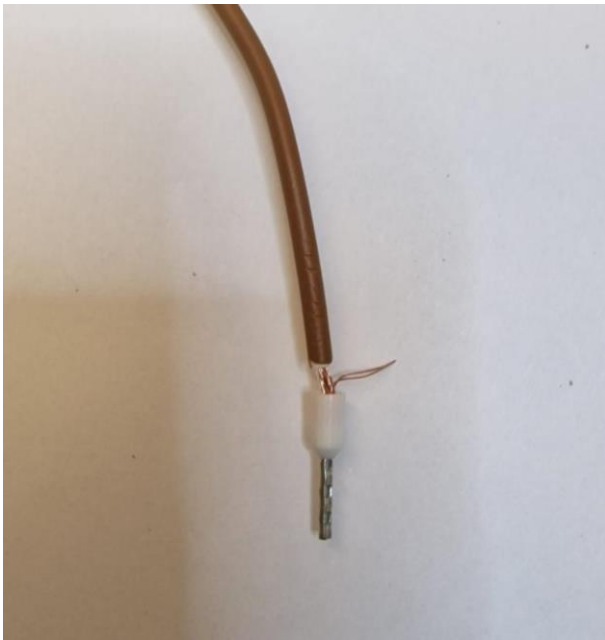
Photograph 4 shows the assembled and working prototype. There is an error with the wiring causing incorrect display on the LCD. By the candidate correcting the wiring and re-setting the Arduino, the display rectified itself and displayed current temperature.



Photograph 5 shows a broken pin that occurred during the assembly. This occurred on disassembly of the circuitry, due to not using the correct tooling, as the candidate used their hands rather than tools.



Photograph 6 shows that the candidate has returned all of the tools and resources to the toolbox. This has been left untidy and will not close as expected, as the wires outside their designated compartments would get damaged if forced under the lid. The breadboard is also not placed in its correct compartment and the resistors are overhanging and need to be placed back into the box. The overall work area has been tidied but there is some wire and other debris laying around.



Photographs 7 & 8 show exposed wires that were observed during the assembly. The wires were dressed correctly but finished poorly. The wires have been moved for imaging purposes.

Video showing the functionality of the prototype:



CI TC video 1.mp4

Practical observation form – Prototype

Assessment ID	Qualification number
8714-323	8714-33
Candidate name	Candidate number
Candidate A	CG12345
Centre name	Assessment theme
City & Guilds	Health and Safety Manufacturing

Complete the table below referring to the relevant marking grid, found in the assessment pack. **Do not** allocate marks at this stage.

Task	Notes – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
Prototype	<p>Prior to starting work on the prototype, the candidate used their bill of materials to gather the required tools, equipment and PPE needed for the task. Some basic visual checks of the condition of the equipment were noted, and the candidate checked the calibration date of each. The candidate undertook some basic visual checks of the work area. They made a note that others were working at nearby workstations but did not advise them of the work that they were intending to undertake.</p> <p>The candidate placed technical information, including their risk assessment, within reach of the working area and ensured that all basic controls were checked before starting work.</p> <p>The candidate was observed undertaking basic wiring of light and temperature sensors. The overall output supported the functional use of the prototype, but there were notable areas for improvement in quality to finish, for example the equipment layout was not tidy and with a number of wires left exposed. The candidate also broke a pin during the assembly process.</p> <p>The candidate mostly used accurate measurements when cutting and assembling wires. On several occasions the candidate had to re-measure and re-cut but was able to rectify the mistake at the second attempt.</p> <p>The overall control system was assembled in order to meet the design specification. The candidate used materials and consumables correctly. The initial attempt at assembling the sub-system and system blocks was met with some challenge, however the candidate was able to work through to rectify and assemble the system blocks correctly in order to reflect the wiring diagram.</p> <p>The candidate checked the final prototype and undertook basic visual and constructive checks to ensure that it met the initial design specification.</p> <p>Throughout the task, the candidate was noted observing health and safety practices. PPE was worn at all times. At the end of the session, the candidate put all tools and equipment back into the toolbox as found, but this was left</p>

Task	Notes – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
	untidily, with the box not shutting properly due to tangled wires. The candidate did a basic final visual check of the work area. Waste was disposed of, but the area used was not cleaned thoroughly.

Assessor signature	Date
Assessor A	03/04/2022

Commentary

The candidate was observed undertaking the construction of the prototype. The overall production was adequate in developing a finished prototype that reflected the initial design specification. The work was undertaken safely, with some consideration given to pre-work checks and with safe working practices followed during the construction of the prototype.

The candidate was able to undertake all stages of the construction successfully. Tools and equipment were used appropriately. The candidate could improve by displaying more accurate hand skills and measurement skills, using a multimeter or appropriate equipment. This would have improved the finish of some of the wiring and components. Further accuracy would have supported a higher quality of finish. The candidate could have developed their response further by working in a more logical and methodical way and leaving the area tidier and cleaner.

2c) Testing and verification

Test record

Engineer's name: Candidate A	System: Lighting and temperature system (prototype)	
Test	Pass/Fail	Comments
Does the system power on?	Pass	Confirmed. There is power to the control panel, controller, and sensors.
Do the lights illuminate at the required points?	Pass	The lights illuminated at the pre-alarm temperatures (19°C and 23°C)
Does the alarm sound at the required setpoints as per the brief requirements?	Pass	The alarm sounded at the alarm temperatures (18°C and 24°C).
Does the visual display unit work?	Pass	The VDU is powered on and displaying readings as expected. This verifies correct installation and operational working condition.
Do the measurements reflect the inputted values from the process?	Pass	The measurements obtained were compared to the inputted values. This confirms that the measurements inputted and outputted are accurate.
Are the inputted temperatures displayed on the VDU?	Pass	Yes, the VDU is displaying the temperature that has been inputted.
Does the system detect when the light level is below 10,000 lux?	Pass	Tested by setting the lighting level to 8,000 lux.
Are there any problems or issues that need to be reported?	Pass	No issues or problems to be reported. All tests produced the results expected with no issues.

Practical observation form – Testing of the prototype

Assessment ID	Qualification number
8714-323	8714-33
Candidate name	Candidate number
Candidate A	CG12345
Centre name	Assessment theme
City & Guilds	Health and Safety Manufacturing

Complete the table below referring to the relevant marking grid, found in the assessment pack. **Do not** allocate marks at this stage.

Task	Notes – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
Testing of the prototype	<p>Following the development of the prototype, the candidate set the work area up in order to carry out testing. The candidate undertook some basic pre-testing visual checks to confirm the continued integrity of the work area. Before starting, the candidate briefly rechecked the design criteria.</p> <p>The candidate undertook a range of basic functional tests. The candidate checked that the temperature sensors would sound an alarm when the prototype was subject to temperatures out of the indicated range. The candidate checked that a pre-alarm illuminated at 19°C and 23°C. The pre-alarm bulbs illuminated at both lower and higher temperatures.</p> <p>The candidate visually checked that the system could record different parameters relevant to its operation. The candidate was observed checking that the prototype visually displayed a current temperature and light level measurement.</p> <p>The candidate tested whether the system detects when the light level dropped below 10,000 lux by setting the light level at 8,000 lux. Whilst the system did detect the low light, the testing should have been carried out at a light level closer to the threshold of 10,000 lux.</p> <p>The tests were undertaken following basic testing methods. The steps were followed, and the candidate recorded the results on a test sheet with brief comments. The candidate used equipment correctly to measure.</p> <p>When the testing had been completed, the candidate returned equipment correctly to its location in the workspace.</p>

Assessor signature	Date
Assessor A	03/04/2022

Commentary

The candidate has completed all required fields provided within the test record. The candidate has stated whether the test has passed, which in all cases it had. The candidate has provided clear comments, with some explanations on how the tests were deemed a pass. For example, explaining how the panel, controller and sensors were all switched on when the power was provided to the circuit.

The candidate has included the values at which the pre-alarm and the alarms ranges were detected. To develop the response further, the candidate may have expanded on the comments, however through some explanations and including of values, allows the test record to meet threshold competence.

The observation report completed demonstrates how the candidate worked in a logical order, by addressing and preparing the working area first before beginning to build the prototype. The candidate completed function testing of the equipment first, before proceeding with the specified test in the reports, allowing the candidates understanding and knowledge for the testing procedures for the prototype. To have developed this further, the candidate may have worked in a more organised manner, for example ensuring the equipment layout was tidy and neat during set up and testing.

Task 3 – Peer review

(Assessment themes: Reports)

For task 3, candidates need to produce the following pieces of evidence:

- Candidate notes on the candidate feedback record form

The candidate notes are not included in this document as the notes will vary from candidate to candidate and are not used to inform any other task.

- peer review feedback form.

This is supporting evidence for assessors to see what feedback the candidate received and how they used it in their review for task 4 and will not be marked.

Peer review feedback form

Candidate name	Candidate number
Candidate B	CG01234
Centre name	Centre number
City & Guilds	12345

Question	Feedback
How well does the design meet the requirements in the brief?	<i>The design meets the requirements of automatic regulation and monitoring of the lighting and temperature ranges. The design uses visual alarms to indicate when the temperature is nearing the limits and audio alarms to indicate when the range has been reached.</i>
How appropriate is the equipment proposed for the design?	<i>The selection of the sensors is appropriate to the required ranges specified in the brief. The PID controller allows for the process to be automatically controlled. Implementing a VDU is an efficient way of obtaining parameters, readings, and measurements in real time. All of the equipment to be implemented into the new design is appropriate.</i>
What are the implications to the business of the proposed maintenance schedule?	<i>The system optimises the performance of the facility and in turn will save on money and time. However, the design will initially be expensive to purchase and set up, but quality of the process and product will be improved, so will counterbalance the initial costs eventually.</i>
How can the design be optimised/improved?	<i>Introducing a remote monitoring system such as IRIS would enable the process to be monitored via a device. This would allow the state of the panel to be observed and controlled remotely.</i>

Task 4 – Evaluation and implementation

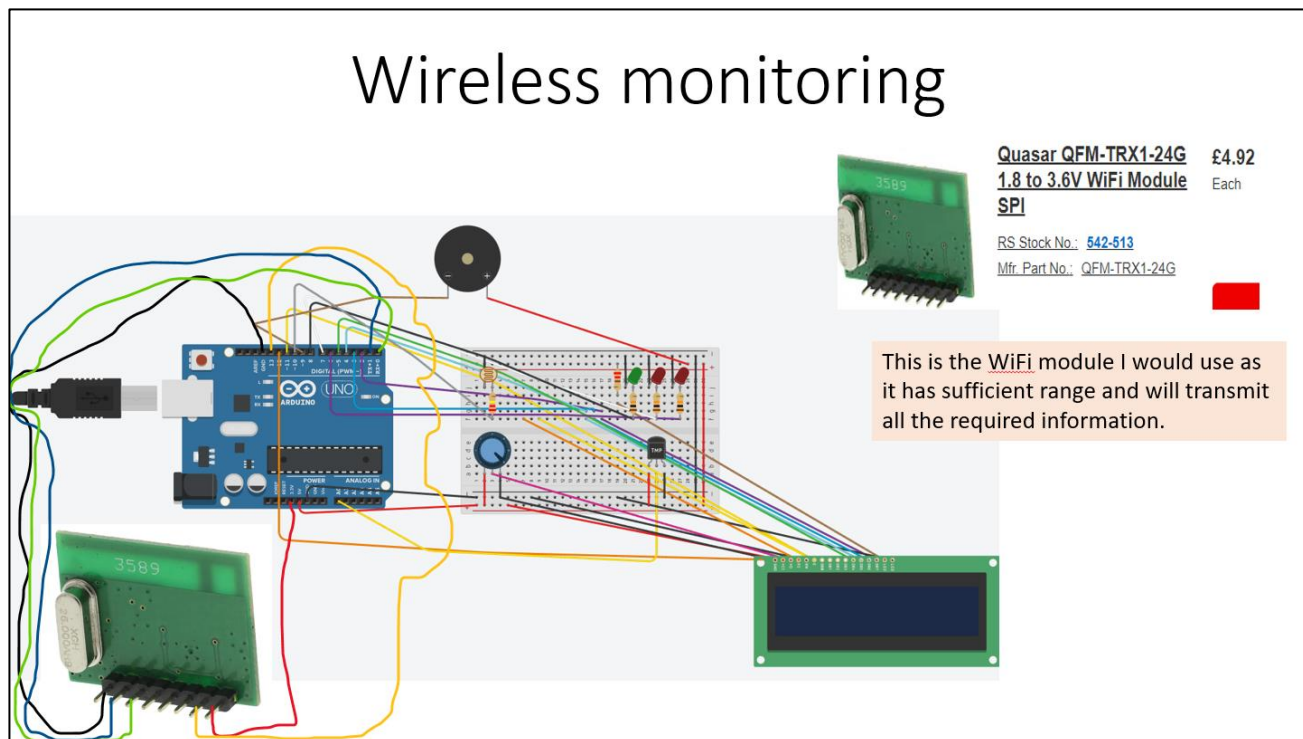
(Assessment themes: Health and safety, Design and planning, Reports)

For task 4, candidates need to produce the following pieces of evidence:

- a) Outcomes of virtual modelling
- b) Revision control document
- c) Evaluation and implementation report.

4a) Outcomes of virtual modelling

Candidate evidence



Commentary

A wireless remote monitoring module has been fitted to this Arduino set, however this may not be the best system to use for this purpose.

The candidate has added what was suggested in the peer review and wired this in appropriately to the current system. New coding would also be required but this has not been presented.

To develop their response further, the candidate could have provided a detailed and clearer wiring diagram and also present the associated coding to demonstrate functionality of the system. There is no mention of an app that would be used or PDA that works on the correct frequency – yet again to demonstrate functionality and knowledge of the requirements of the system.

4b) Revision control document

System type	Temperature and lighting control system
System TAG number	XXXXXX
Department responsible for equipment	Design and Development department
System designed by:	Candidate A

Design description:

The design produced is to update the current process and implement a better design that will increase system stability as well as allowing for the automatic monitoring and control of both the lighting and the temperature of the system. This will be done by using different sensors and a PID controller which will reduce overshoot issues.

The automatic control of the lighting and temperature will ensure that the process is maintained which will in turn increase production and efficiency of the process by reducing waste or batches that have been produced when the system was working out of operating limits. The system will alarm if operating limits are nearing which will highlight if there is an issue with the system. This will in turn enable any investigation and rectification to the process before the system get to the stage where it is working out of specification.

The alarms are accessed through the control panel. The control panel consists of visual and audio alarms to indicate the setpoints and when they are nearly reached. The VDU will also indicate the light and temperature levels that the process is currently working at. The measurements and values can then be recorded and stored for maintenance purposes.

Changes to existing system:

The system currently has a cooling and heating process installed. It has been decided that the new design will be installed separately to the current system. The design will involve the addition of a Wi-Fi module via a new system, feeding back to the controller and a control panel that is separate from the heating and cooling system. Through the alarms, this will then allow for investigation and rectification of the heating and cooling process to be acknowledged and addressed. The cooling and heating system currently installed will require less attendance as the temperatures and light levels will no longer need to be manually obtained.

Upon reviewing of the peer feedback, a mobile monitoring system such as IRIS would be a definite consideration for the future. It has been decided that this will not be implemented at this stage as it is important that the system is trialled and up and running before enhancing any further costing. Once the new design has been approved and has been proven beneficial for the process and the company alike, then a system such as IRIS will optimise the efficiency of the design furthermore.

Changes to existing technical documentation:

There will be changes made to the following documents:

- Equipment layout drawings will need to be updated.
- Existing maintenance schedules – the new process to be maintained on the same schedule and to the same level as the current heating and cooling system, at the same time.
- Risk Assessment as there is a change in the working area, with more electrical panels and components now present, posing more hazards.

- New documents will need to be produced, which will include the wiring diagram for the new process and maintenance schedule.

Comments:

All document revisions to be recommended and approved before implementation.

New documents will need to be reviewed and authorised.

The addition to the process will need to be merged with the current maintenance schedule for the pre-existing heating and cooling system.

Validation performed by:

Assessor 1

Prototype approved by:

Assessor 1

Date:

16/06/2022

Commentary

The candidate has demonstrated the ability to produce a basic revision control document. The document produced is of an acceptable standard that gives an overview of the main changes made to the system. The candidate has structured their response to reflect that the changes made to the existing system would need to be updated and reflected in the appropriate technical documentation. The document provides a sufficient level of detail on the changes required and offers some justification of these changes.

The candidate could have developed their response by providing a greater depth of explanation of the changes identified. This could have been expanded through providing a greater insight into the technical detail of the changes. For example, the addition of sensors is explained in general terms and does not detail the specific components that are required.

4c) Evaluation and implementation report

Implementation –

Upon review and approval of the prototype, the design can now be implemented. A method of installation will need to be produced as well as appropriate guidance and documentation obtained. The implementation will involve the installing of each of the components and the fixing of the panel to the wall. The temperature sensor and the light sensor need to be installed in situ with the process.

The components to be installed are as follows:

- Control panel installed to the wall.
- Wiring up of the components within the panel, including the bulbs, alarms, sensors and the VDU. All the wiring will be installed as per the IET Regulations. The power requirements for the system are 24vDC. The wire used will be 1.5mm wire.
- All terminations to be crimped with the appropriate-sized ferrules and cable identification markers will be attached.
- The controller will be situated separately to the control panel but attached to the wall.
- The sensors to be fixed to the process and connected to the controller. The controller will be connected to the control panel.

It is important that the connecting to power is not completed until all the dead tests, inspections and checks have been completed on the system. It is important that all wiring is checked for accuracy again before the commissioning stage and continuity is proved between all of the connections.

The system will be commissioned as follows:

- Power to the system.
- Visual and sensory checks for any obvious signs of issues.
- Complete checks including ensuring all the bulbs work.
- Ensure power to the sensors and the sensors are feeding back to the controller.
- Ensure correct operating limits are set.
- Complete a period of observation before varying the temperature and light levels, recording, and noting the response at the control panel to ensure working within specification.
- Ensure the VDU is displaying the correct levels of temperature and light.

All health and safety requirements to be acknowledged and complied with throughout the installation and the commissioning. Upon completion of the installation, the correct tests will need to be re carried out, inclusive of the test report to ensure that the process has met the design requirements and functions as required.

If any changes are to be made ensure that these are recorded and reported.

Evaluation –

During the implementation process, it was clear that the BOM was not accurate. The BOM lacks consideration for the power supply which became obvious when this step was covered in the implementation. For future designs this will be considered as this affected planning for the installation and commissioning. The BOM could also have been more helpful to the implementation process if the fixings, including sizes were detailed. The BOM also did not list the installation equipment, such as measuring tools to help with the installation of the panels and the positioning of the sensors and controller.

During the implementation process it was also discovered that the process could have been ran from the control panel for the existing heating and cooling system. This would have meant that there was no extra panel taking up less room and meaning the two systems could be inspected, maintained, and monitored more easily.

The process would benefit from a remote monitoring system as discussed through the peer review. This became obvious during implementation, although manual monitoring of the process is now reduced, there are still elements of that require the operator or engineer to attend the panel physically. This would also reduce the amount of time that staff need to spend on the factory floor, ultimately improving cost factors from the company's perspective.

The location of the panel is accessible and is easily viewed as it is in close range to the process. The sensors are appropriately located, again easily accessible should they need to be moved or swapped out.

Regarding the system overall, it meets the requirements and the specifications that were provided in the design brief. The design does improve the overall efficiency of the system although some further improvements could be made as discussed. The system is, however, fully operational, and fully functional which has been confirmed through tests. The sensors have the capability for any future upgrades to the system and allow for any parameter changes should the manufacturing/batch production need changed. The controller also allows for any future changes to the system and will work with different types of sensors.

Commentary

The candidate has produced a clear implementation and evaluation report, considering the approach to be taken and the steps that need to be considered during installation and the commissioning. The candidate has identified that a further set of steps should be produced to aid with the installation. To develop this further, the candidate may have used more appropriate technical language and discussed the development of a method statement or work instruction to support the statement.

The candidate has completed the implementation report with some detail of the components that are to be installed. The sequence of steps is mostly logical, which is demonstrated through the consideration of the panel being installed first. However, it lacks further technical detail, such as the consideration of terminal blocks and the cable types that will be used to connect the sensors, controller, and control panel together. The candidate has appropriately referred to the IET Regulations, although to develop the response further, they could have been more specific and stated the BS7671 Wiring Regulations. The candidate has satisfied safety through their discussion of the compliance with health and safety, as well as acknowledging that the system should not be powered up until all relevant checks, inspections and tests have been completed.

Through the evaluation process, the candidate has demonstrated how they have analysed the system and the actions completed, through acknowledgement of how the system may have been integrated with the existing heating and cooling system. This demonstrated the candidate's ability to evaluate the design process as a whole and suggest improvements. The candidate has also acknowledged the peer review feedback by stating that the system may be upgraded in the future.

The candidate has provided a brief evaluation for the overall system, stating how it meets the requirements and specifications of the brief, however, to develop their response further, it would have needed to provide more in depth justification and specific explanations on how the design meets the requirements.

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