# Pearson BTEC Level 3 Nationals in Engineering

First teaching September 2016

## Sample Assessment Materials

## Unit 6: Microcontroller Systems for Engineers

For use with Extended Diploma

Issue 3

**Edexcel, BTEC and LCCI qualifications**

Edexcel, BTEC and LCCI qualifications are awarded by Pearson, the UK's largest awarding body offering academic and vocational qualifications that are globally recognised and benchmarked. For further information, please visit our qualifications website at qualifications.pearson.com. Alternatively, you can get in touch with us using the details on our contact us page at qualifications.pearson.com/contactus

**About Pearson**

Pearson is the world's leading learning company, with 35,000 employees in more than 70 countries working to help people of all ages to make measurable progress in their lives through learning. We put the learner at the centre of everything we do, because wherever learning flourishes, so do people. Find out more about how we can help you and your learners at qualifications.pearson.com

*References to third-party material made in this specification are made in good faith. We do not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Material may include textbooks, journals, magazines and other publications and websites.)*

*All information in this document is correct at time of publication*

ISBN 978 1 446 95884 1

# Summary of Pearson BTEC Level 3 National in Engineering SAMS Issue 3 changes

| Summary of changes made between previous issue and this current issue | Page number |
|---|---|
| Information booklet added on resistor colour codes | 1 |
| Instructions for teachers/tutors/invigilators and learners updated | 5 |
| Task brief clarified about the rules of the task | 8 |
| Sample marking grids refined | 21 |

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Pearson BTEC Level 3 Nationals

# Engineering

## Unit 6: Microcontroller Systems for Engineers

**Part S**

Extended Certificate, Foundation Diploma, Diploma, Extended Diploma in Engineering and all titles – Manufacturing/Aeronautical/Computer/Electrical and Electronic/Mechanical Engineering

**Sample assessment material for first teaching September 2016**

**Information Booklet**

**Instructions**

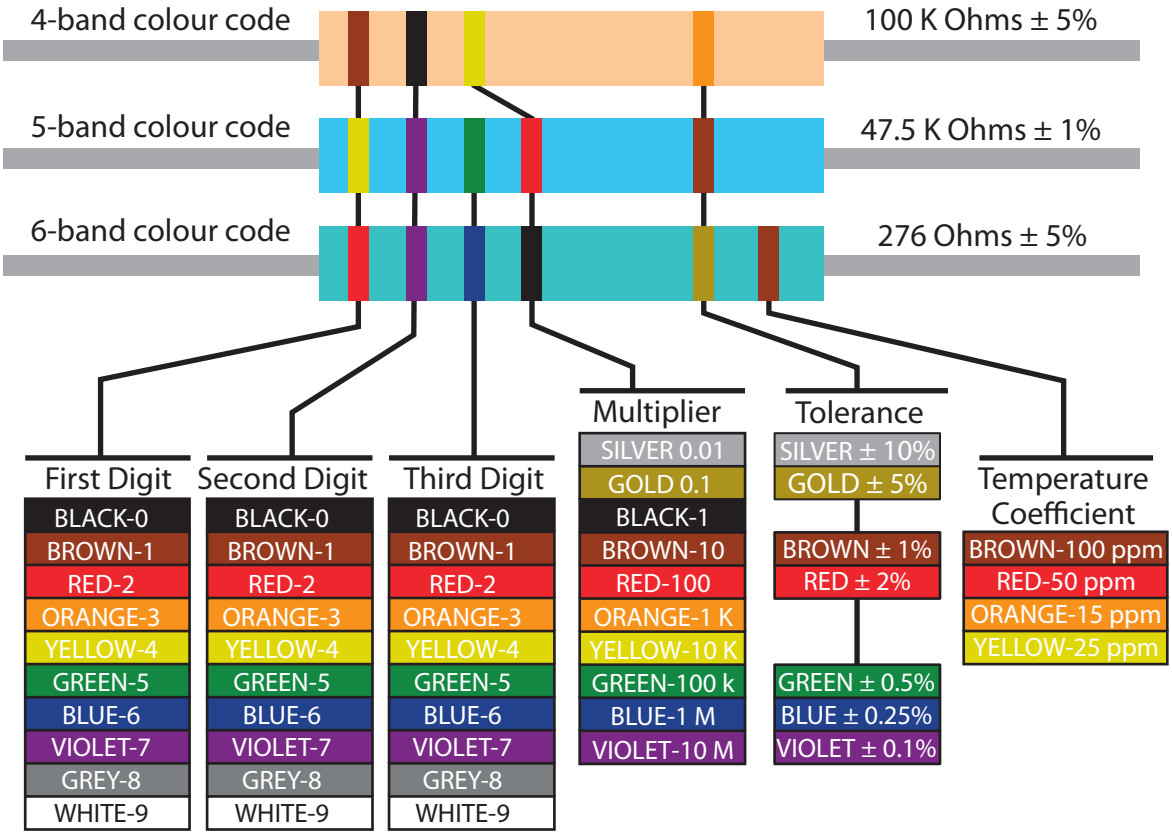
- This information may be required for learners producing a solution to the task using individual electronic components and/or a prototyping board. **It is not required by learners producing a solution to the task using only modular electronic devices and/or project boards.**
- Read the information carefully.
- You must **not** write your answers in this information booklet.
- Only your answers given in the electronic task booklet and audio-visual file will be marked.

Paper Reference (s)

XXXX/XX

PXXXXXA

## Resistor Colour Code



## Original Equipment Manufacturer's (OEM) Data Sheets

- You can refer to data sheets for individual electronic devices, e.g. Liquid Crystal Display (LCD) screens and humidity sensors, so that you can assemble your prototype solution in an appropriate way.

Pearson BTEC Level 3 Nationals

# Engineering

## Unit 6: Microcontroller Systems for Engineers

**Part S**

Level 3

Total marks 80

Supervised hours 12

Extended Diploma in Engineering and all titles – Manufacturing/Aeronautical/Computer/Electrical and Electronic/Mechanical Engineering
**Sample assessment material for first teaching September 2016**

- **Part S** should be undertaken in 12 hours under supervision over no more than five consecutive working days. The supervised sessions take place in the two-week period timetabled by Pearson.
- **Part S** contains material for the completion of the set task under supervised conditions.
- **Part S** is specific to each series and this material must be issued only to learners who have been entered to undertake the task in the relevant series.
- **Part S** should be kept securely until the start of the 12-hour supervised assessment period.
- Answer **all** activities.
- Answer the activities in the spaces provided.

**Information**

- The total mark for this paper is 80.
- The marks for **each** activity are shown in brackets
  *- use this as a guide as to how much time to spend on each question.*

**Advice**

- Read each question carefully before you start to answer it.
- Try to answer every activity.
- Check your answers if you have time at the end.

Paper Reference (s)
XXXX/XX
PXXXXA

## Instructions to teachers/tutors and/or invigilators

This paper must be read in conjunction with information on conduct for the task in the unit specification and the BTEC Nationals *Instructions for Conducting External Assessments (ICEA)* document. For further details please see the Pearson website.

The set task should be carried out under supervised conditions.

Work should be completed on a computer using appropriate hardware and software as listed in the unit content. Learners should complete the electronic task booklet provided by Pearson. This can be downloaded from the Pearson website. Learners must not have access to the internet. One task booklet and one audio-visual recording must be submitted to Pearson on a USB memory stick or a compact disc (CD) for each learner.

Learners will need access to suitable audio-visual recording equipment and the footage should be recorded in an appropriate file format. The recording must be readable through one of the following software applications: Windows Movie, Real Time, VLC or Quick Time. You must save the recordings in one of the following file types: MPEG, FLV, MOV, WMV or RM.

Centres must make sure that all electronic documents are backed up securely and kept until the end of the post-result service window.

All learner work must be completed independently and authenticated by the teacher/tutor and/or invigilator before being submitted to Pearson.

Centres are free to arrange the supervised assessment period however they wish provided the 12 hours for producing final outcomes are under the level of control specified, and in accordance with the conduct procedures. The assessment must take place in a two-week period set by Pearson, once the learner has started **Part S**, the assessment must be completed in five consecutive working days.

If learners are to produce a solution to the task using individual electronic components and/or a prototyping board, they may need the Part S Information Booklet. Centres **can** also provide learners with Original Equipment Manufacturers' data sheets for individual electronic devices, e.g. Liquid Crystal Display (LCD) screens and humidity sensors, so that learners can assemble their prototype solution in an appropriate way, but the data sheets **must** not contain any other extraneous hand written information on them.

Refer carefully to the instructions in this task booklet and the *Instructions for Conducting External Assessments (ICEA)* document to ensure that the assessment is supervised correctly. An authentication statement will be required confirming that learner work has been completed as directed.

Learners must not bring anything into the supervised environment or take anything out without approval. Centres are responsible for putting appropriate checks in place to ensure that only permitted material is introduced to the supervised environment

**Maintaining security**

- For **Part S**, learners **must not** have access to the internet.
- During any break, materials must be kept securely.
- User areas must be accessible only to the individual learner and to named members of staff.
- Learners can access their work only under supervision.
- Learner work must be backed-up regularly.
- Any work that learners produce under supervision must be kept secure.
- Any materials being used by learners must be collected in at the end of each period, stored securely and handed back at the beginning of the next period.

**Outcomes for submission**

Each learner will need to submit:

a) an electronic task booklet (in PDF format), that contains the following evidence:

- task planning and system design changes made during the development process
- technical specification with operational requirements
- test plan
- details and justifications of input/output devices and hardware selected
- system connection diagrams/schematics
- design of the program structure
- annotated copy of all the code
- test data and analysis

b) an audio-visual file (recording) with a maximum length of three minutes.
Each learner will need to submit evidence using the file names below.

- Electronic task booklet: booklet_[Registration number #]_[surname]_[first letter of first name]
- Audio-visual file: file_[Registration number #]_[surname]_[first letter of first name]

A fully-completed authentication sheet must be completed by each learner.

## Instructions for learners

Read the set task information carefully.

This contains all the information you need to complete each activity in the set task.

You will be given more than one timetabled period to complete these tasks in controlled conditions.

You must plan your time accordingly and be prepared to submit all the required evidence by the date specified.

You will complete this set task under supervision and your work will be kept securely during any breaks taken.

You may use a calculator and will have access to a computer but not to the internet.

You must work independently throughout the supervised assessment period and you must not share your work with other learners.

Your teacher/tutor may clarify the wording that appears in this task but they cannot provide any guidance on how to complete the task. You may need to use the Information Booklet.

**Outcomes for submission**
You will need to submit:

a) an electronic task booklet that contains the following evidence:
- task planning and system design changes made during the development process
- technical specification with operational requirements
- test plan
- details and justifications of input/output devices and hardware selected
- system connection diagrams/schematics
- design of the program structure
- annotated copy of all the code
- test data and analysis

b) an audio-visual file (recording) with a maximum length of three minutes.
You will need to submit evidence using the file names below.

- Electronic task booklet: booklet_[Registration number #]_[surname]_[first letter of first name]
- Audio-visual file: file_[Registration number #]_[surname]_[first letter of first name]

You must submit a fully-completed authentication sheet.

## Set Task brief

**Scenario**
You are employed as a software engineer by a consumer electronic product manufacturer that specialises in the design of embedded microprocessor-based products. You have been presented with the client brief to develop a professional egg timer for hotel kitchens.

**Client brief**
Tooley-Lober Hotels has 275 hotels worldwide, with almost 185,000 rooms. A high-quality cooked breakfast is an important part of the guest experience. Boiled eggs are a popular choice at breakfast but guest requirements vary greatly in terms of the degree of cooking required. The head chef has contracted your company to design a professional egg timer to be installed in the hotel kitchens to help with the difficulties that staff have with timing the perfect boiled egg for their demanding customers. Each egg-boiler station cooks one egg at a time and the head chef wants to have one egg timer per station.

Customers often specify the number of minutes they would like their egg to be cooked. For example, from a soft-boiled 'two minute egg' to a hard-boiled 'six minute egg'. Guests may request any number of minutes between these two times.

The hotel kitchen environment is noisy and frenetic and multiple chefs are often multi-tasking when preparing table orders, with several items needing to be ready for service at the same time. It must be apparent, therefore, that the timer is running and what the amount of time remaining is so that they can get their timings right. Once it has finished timing, to avoid overcooking, the device must be able to gain attention and remain obvious until attended. Sometimes there are errors or changes to customer orders and boiled eggs may be cancelled.

To overcome the problem, the client would like:
- an indicator to show that the timer is operating
- a safe system to monitor the cooking time remaining for an egg from cooking times of two to six minutes
- an indicator to show that the cooking time is complete.

You need to:
- produce a record of task planning and system design changes made during the development process
- interpret the brief as to operational requirements
- design a test plan based on operational requirements
- select and describe appropriate input/output components and how they will work together
- design the program structure
- produce a functional system
- annotate a program or code to demonstrate understanding
- test the system and analyse the outcomes from testing
- produce an audio-visual recording of the system that is no longer than three minutes.

## Set Task

**Task**
Design, assemble, program and test a safe prototype system to monitor the cooking time for the eggs that meets the requirements of the client brief.

To overcome the problem, the client would like:
- an indicator to show that the timer is operating
- a safe system to monitor the cooking time remaining for an egg from cooking times of two minutes to six minutes cooking time
- an indicator to show that the cooking time is complete.

You must follow an appropriate development process and use a microcontroller.
You will have a total of 12 hours to complete your prototype system (including testing, documentation and audio-visual recording), which may be split into several shorter periods.

**The operation and testing of the professional egg timer does not require the use of water (boiling or otherwise).**

The stages below will help you to structure your development work.

**Activity 1**

**Task planning and system design changes**

You are advised to spend no longer than 1.5 hours on this activity.

- At the start of the task, create a short project time plan/Gantt chart and use it to monitor your progress throughout the rest of the task and make any adjustments as required.
- During the other activities (2 to 5), you should also record in the Activity 1 section of your electronic task booklet:
  - what you did in the session
  - details of any issues encountered and solutions discovered
  - action points for the next session.

Total for Activity 1 = 10 marks

**Activity 2**

**Analysis of the client brief**

You are advised to spend no longer than 1.5 hours on this activity.

- By interpreting the client brief as operational requirements, prepare a technical specification for a user-friendly system that can handle some unexpected events.
- Prepare a test plan to check the functionality of the final solution against the technical specification and include some unexpected events.

Total for Activity 2 = 9 marks

**Activity 3**

**System design**

You are advised to spend no longer than 2.5 hours on this activity.

Prepare a user-friendly system design that can handle some unexpected events, including:
- the selection and justification of suitable input and output devices
- a description of the system design, covering input and output devices and microcontroller connections
- a plan for the program structure, detailing key system operations.

Total for Activity 3 = 16 marks

**Activity 4**

**System assembly and programming**

You are advised to spend no longer than 2.5 hours on this activity

Develop a user-friendly system that is well organised, structured and formatted, including:
- producing the software program and annotating the code
- the assembly of any hardware (if required)
- refining the system so that it operates as expected and can handle some unexpected events.

Once completed, insert the annotated code into the electronic task booklet.

Total for Activity 4 = 16 marks

**Activity 5**

**System testing and result analysis**

You are advised to spend no longer than 1.5 hours on this activity.

- Test your system against your test plan (from Activity 2) and include some unexpected events.
- Record the outcome of each test in the template provided.
- Analyse the test results and evaluate your system for conformance against the client brief.

Total for Activity 5 = 9 marks

**Activity 6**

**System in operation**

You are advised to spend no longer than 2.5 hours on this activity.

Produce an audio-visual recording that demonstrates the system in operation, which should include:

- your name, learner registration number and centre number at the start
- a commentary explaining the operation of the user-friendly system and how its behaviour is linked with your chosen hardware and the software program
- recorded evidence of the outcome from suitable tests, including some unexpected events (from Activity 5).

Total for Activity 6 = 20 marks

---

TOTAL FOR TASK = 80 MARKS

**Complete your work in this task booklet**

**Activity 1**

**Task planning and system design changes**

- At the start of the task, create a short project time plan/Gantt chart and use it to monitor your progress throughout the rest of the task and make any adjustments as required.
- During the other activities (2 to 5), you should also record in the Activity 1 section of your electronic task booklet:
  - what you did in the session
  - details of any issues encountered in this session and solutions discovered
  - action points for the next session.

**(10)**

Initial Task Plan

Instruction – during each session, please complete the following logbook, duplicating the table as required for each session (cut and paste the table as required).

| | |
|---|---|
| Remember to update the project time plan/Gantt chart at the start of each session | |
| Date: | |
| What have I done this session: | |
| Issues encountered in this session and solutions with justification: | |
| Action points for the next session: | |

**Activity 2**

**Analysis of the client brief**

- By interpreting the client brief into operational requirements, prepare a technical specification for a user-friendly system that can handle some unexpected events.
- Prepare a test plan to check the functionality of the final solution against the technical specification and include some unexpected events.

**(9)**

**Test Plan Template (Activity 2)**

Tests can include unexpected events (i.e. non-routine) that are outside the normal operation of the system.

| Test number | Purpose of test | Test condition | Expected result |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Activity 3**

**System design**

Prepare a user-friendly system design that can handle some unexpected events, including:

- the selection and justification of suitable input and output devices
- a description of the system design, covering input and output devices and microcontroller connections
- a plan for the program structure, detailing key system operations.

For Activity 3, you could provide written notes, annotated diagrams, flow charts, images, schematics, pseudocode and tables.

**(16)**

**Activity 4**

**System assembly and programming**

Develop a user-friendly system that is well organised, structured and formatted, including:

- producing the software program and annotating the code
- the assembly of any hardware (if required)
- refining the system so that it operates as expected and can handle some unexpected events.

Once complete, insert the annotated code into the electronic task booklet.

For Activity 4, you could provide written notes, screenshots, annotated programs/flow charts and images.

**(16)**

**Activity 5**

**System testing and result analysis**

- Test your system against your test plan (from Activity 2) and include some unexpected events.
- Record the outcome of each test in the template provided.
- Analyse the test results and evaluate your system for conformance against the client brief.

**(9)**

**Test Plan Template (Activity 5)**

Tests can include unexpected events (i.e. non-routine) that are outside the normal operation of the system.

Copy and paste your test plan from Activity 2 into the table below and complete the Activity 5 columns.

| Activity 2 | | | | Activity 5 | |
|---|---|---|---|---|---|
| **Test number** | **Purpose of test** | **Test condition** | **Expected result** | **Actual result** | **Comments and justification** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Activity 6**

**System in operation**

Produce an audio-visual recording that demonstrates the system in operation, which should include:

- your name, learner registration number and centre number at the start.
- a commentary explaining the operation of the user-friendly system and how its behaviour is linked with your chosen hardware and the software program.
- recorded evidence of the outcome from suitable tests, including some unexpected events (from Activity 5).

**Please note that the evidence for this activity should be in a separate audio-visual recording of no more than three minutes.**

**Do not add any comments for Activity 6 to the electronic task booklet.**

**(20)**

# Unit 6: Microcontroller Systems for Engineers – sample marking grid

## General marking guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the marking grid not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks if the learner's response is not rewardable according to the marking grid.
- Where judgement is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

## Specific marking guidance

The marking grids have been designed to assess learner work holistically.
Rows within the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

- Examiners should first make a holistic judgement on which band most closely matches the learner response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band depending on how they have evidenced each of the descriptor bullet points.

**Activity 1: Planning and design changes made during the development process**
**Evidence:** Electronic task booklet – development approach (to be completed throughout all activities).

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| Carry out an iterative development process | **0** | **1–4** | **5–7** | **8–10** | **n/a** |
| | Level of response not worthy of credit | • Entries demonstrate an unstructured approach to the development process.<br>• Development activities may not have been carried out in an appropriate order.<br>• The use of technical terminology is attempted but it is largely inaccurate.<br>Entries are largely narrative and include:<br>• an identification of limited changes made to the original system design, hardware and program during the process.<br>• If present, a justification may not be linked clearly to evidence of testing.<br>• Action points are vague incomplete or not present. | • Entries demonstrate a structured approach to the development process.<br>• Development activities have mainly been carried out in an appropriate order.<br>• Some accurate technical terminology is used.<br>Entries are descriptive and include:<br>• a supported justification of most of the changes that have been made to the original designs, hardware and program during the process.<br>• The justification shows some incomplete chains of reasoning between formative testing and the changes made.<br>• Action points for the next external assessment period are identified but not well defined or prioritised. | • Entries demonstrate a structured approach to the development process.<br>• Development activities have been carried out in an appropriate order.<br>• Technical terminology is used accurately throughout.<br>Entries are concise and evaluative and include:<br>• an identification of most of the changes that have been made to the original design, hardware and program during the process.<br>• A thorough and supported justification demonstrates logical chains of reasoning between formative testing and the changes made.<br>• Well-defined, logical and prioritised action points for the next external assessment period are identified. | |

**Activity 2: Analysis of the client brief**
**Evidence:** Electronic task booklet – technical specification

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| Technical specification | **0** | **1-3** | **4-6** | **7-9** | **n/a** |
| | Level of response not worthy of credit | • Interpret the brief into limited operational requirements that partially meet the brief.<br>• An outline test plan has been produced with parameters that demonstrate a limited understanding of the system. | • Interpret the brief into a set of operational requirements that mainly meet the brief.<br>• A test plan has been produced with parameters that are designed to confirm a fully-functioning system under normal conditions. | • Interpret the brief into a comprehensive set of operational requirements that fully meet the brief and consider enhanced user experience.<br>• A comprehensive test plan has been produced with parameters that demonstrate an understanding of the system under normal conditions and consider unexpected events. | |

**Activity 3: System design**

**Evidence:** Electronic task booklet **–** input/output devices, hardware selected, system connection diagrams/schematics and program structure.

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| System design | **0** | **1–4** | **5–8** | **9–12** | **13–16** |
| | Level of response not worthy of credit | • Hardware input and output device selection is mostly appropriate for the operational requirements.<br>• Limited description of the function of the input and output devices, excluding the microcontroller connections.<br>• The use of technical terminology and industry standard conventions is attempted but may be partially inaccurate.<br>• Evidence of program design is limited. | • Hardware input and output device selection is generally appropriate for the operational requirements.<br>• Brief description of the function of the input and output devices including the microcontroller connections.<br>• The use of technical terminology and industry standard conventions is limited but where used they are appropriate.<br>• An outline for the program structure considers some key operations. | • Hardware input and output device selection is appropriate for the operational requirements.<br>• A description of the function of the input and output devices including the microcontroller connections.<br>• Technical terminology and industry standard conventions are used appropriately.<br>• Design for the program structure breaks down key operations into relevant constructs that mostly link together. | • Hardware input and output device selection is appropriate and justified for the operational requirements.<br>• Detailed and accurate description of the function of the input and output devices including the microcontroller connections.<br>• Technical terminology and industry standard conventions are used appropriately throughout.<br>• A detailed design for the program structure breaks down key operations into relevant constructs that link logically including the handling of some unexpected events. |

**Activity 4: System assembly and programming**
**Evidence:** Electronic task booklet **–** annotated code

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| Program quality | **0** | **1–4** | **5–8** | **9–12** | **13–16** |
| | Level of response not worthy of credit | • The program comprises limited and simple constructs, most of which may have been inappropriately selected or used incorrectly.<br>• Annotation is limited but demonstrates some understanding of the key areas of the program.<br>• The program structure lacks organisation and formatting. | • The program comprises simple but appropriate constructs that have been used inefficiently.<br>• Annotation is mostly appropriate but focused in one area of the program and demonstrates incomplete understanding of the key areas of the program.<br>• The program structure may have inconsistencies in organisation and/or formatting. | • The program comprises a range of appropriate constructs that have mainly been used correctly. The program is efficient.<br>• Annotation is appropriate and demonstrates understanding of the key areas of the program and the constructs used.<br>• The program is well organised and formatted so that a competent third party could interpret and update the program. | • The program comprises a range of appropriate constructs that have been used correctly. The program is efficient and has the facility to handle some unexpected events.<br>• Annotation is consistent and suitable and demonstrates thorough understanding of the key areas of the program and the constructs used.<br>• The program is well organised, structured and formatted so that a competent third party could interpret and update the program efficiently. |

**Activity 5: System testing and results analysis**

**Evidence:** Electronic task booklet (test data, and analysis of data) and the audio-visual recording (to make a judgement on the outcome from many tests and the system in operation).

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| Test results and analysis | **0** | **1–3** | **4–6** | **7–9** | **n/a** |
| | Level of response not worthy of credit | • Test results demonstrate that minimal testing has been carried out.<br>• The evaluation of the system against the client brief is limited and/or is not supported by test results. | • Test results demonstrate that some suitable testing has been carried out.<br>• The evaluation of the system against the client brief is partially supported by test results. | • Test results demonstrate that structured testing has been carried out that includes some unexpected events.<br>• The evaluation of the system against the client brief is comprehensively supported by test results. | |

**Activity 6: System in operation**

**Evidence:** Audio-visual recording (to make a judgement on the outcome of most tests and the system in operation).

| Assessment focus | Band 0 | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|---|
| System in operation | **0** | **1–5** | **6–10** | **11–15** | **16–20** |
| | Level of response not worthy of credit | • The audio-visual recording shows a system that has limited functionality<br>• Audio-visual commentary shows limited or incomplete understanding of how the system operates and the relationship between the hardware and the program.<br>• If present, the use of technical terminology is limited and/or largely inaccurate. | • The audio-visual recording shows a partially functioning system that meets some of the requirements of the brief.<br>• Audio-visual commentary shows a basic understanding of how the system operates and the relationship between the hardware and the program.<br>• Technical terminology is sometimes present and may be accurate. | • The audio-visual recording shows a functioning system that mostly meets the requirements of the brief. The system shows some consideration of the user experience.<br>• Audio-visual commentary shows an understanding of how the system operates and the relationship between the hardware and the program.<br>• Some accurate technical terminology is used. | • The audio-visual recording shows a functioning system that meets the requirements of the brief. The system shows consideration of the user experience and the handling of unexpected events.<br>• Audio-visual commentary shows thorough understanding of how the system operates and the relationship between the hardware and the program.<br>• Technical terminology is used accurately throughout. |