T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Metrology Sciences

Assignment 3 - Distinction

Guide standard exemplification materials

v1.1: Specimen assessment materials
September 2021
603/6989/9

Internal reference: SCI-GSEM-17

NCFE CACHE

T Level Technical Qualification in Science
Occupational specialism assessment

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Metrology Sciences

Assignment 3

Contents

Introduction

The material within this document relates to the Metrology Sciences occupational specialism sample assessment. These exemplification materials are designed to give providers and students an indication of what would be expected for the lowest level of attainment required to achieve a pass or distinction grade.

The examiner commentary is provided to detail the judgements examiners will undertake when examining the student work. This is not intended to replace the information within the qualification specification and providers must refer to this for the content.

In assignment 3, the student must correct a technical drawing, produce an inspection cost per part and write a plan to measure the produced part.

After each live assessment series, authentic student evidence will be published with examiner commentary across the range of achievement.

Assignment 3

Task 1 – customer drawing query

Scenario

You have been contacted by a potential customer who has supplied a drawing and asked you to provide a quote for producing the parts. You have noticed faults and missing information with the drawing provided.

Task

Complete the diagram key so the customer understands the information on the diagram

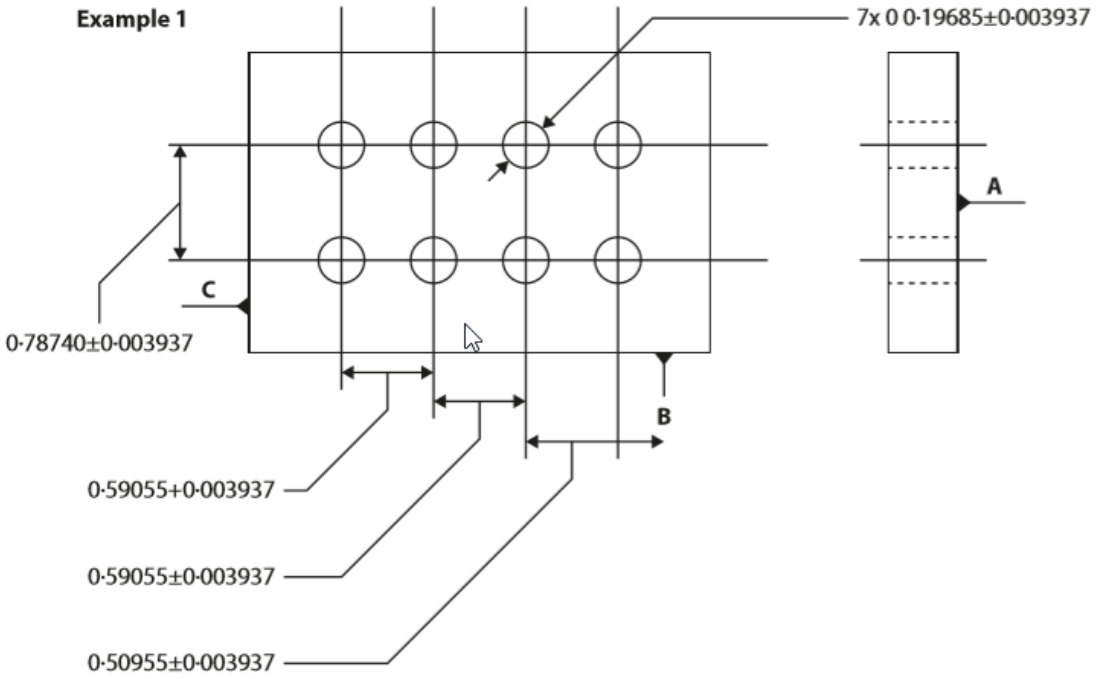
and

correct any incorrect or missing information in the drawings provided by the customer:

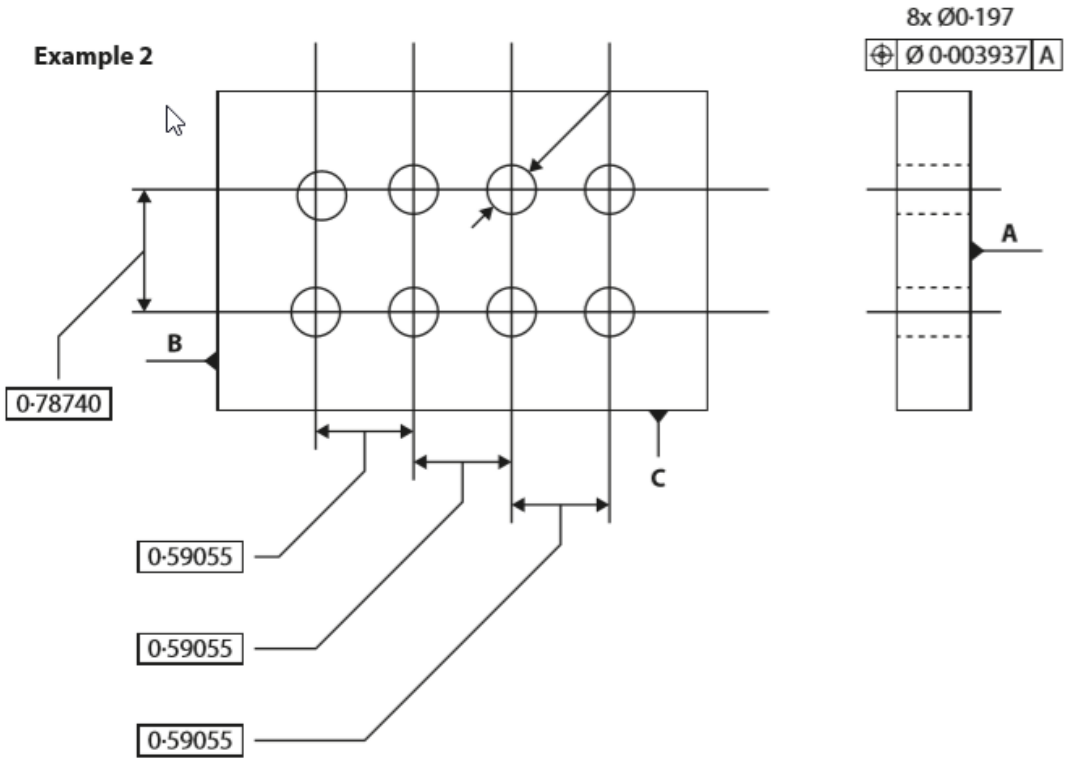
Student evidence

Symbol	Geometric characteristic	Tolerance type
	Straightness	
	Angularity	
		Location
	Total runout	Runout
		Location
	Perpendicularity	
	Profile of a surface	Location
	Cylindricity	Form

▱		Form



All measurements in centimetres unless otherwise stated.



Student evidence

Symbol	Geometric characteristic	Tolerance type
	Straightness	Form
	Angularity	Orientation
	Profile of a line	Location
	Total runout	Runout
	True position	Location
	Perpendicularity	Orientation
	Profile of a surface	Location
	Cylindricity	Form
	Flatness	Form

Issues with the diagrams:

Example 1: only showing 7 circular holes not 8, 1 of the spacings between the holes is different to the other 2, B and C labels are different, one of the spacings between the holes has a + symbol and not the +/- symbol as required, the labelling for the 7 holes (which should be 8) is showing as 7x0 0 and not the geometric symbol as required

Example 2: one of the arrows is not finished, one of the circles is not drawn properly, labelling for the 8 holes has been incorrectly rounded, full data required

Centre Lines should be shown as long dash / short-dash

Task 2 – calculating inspection cost

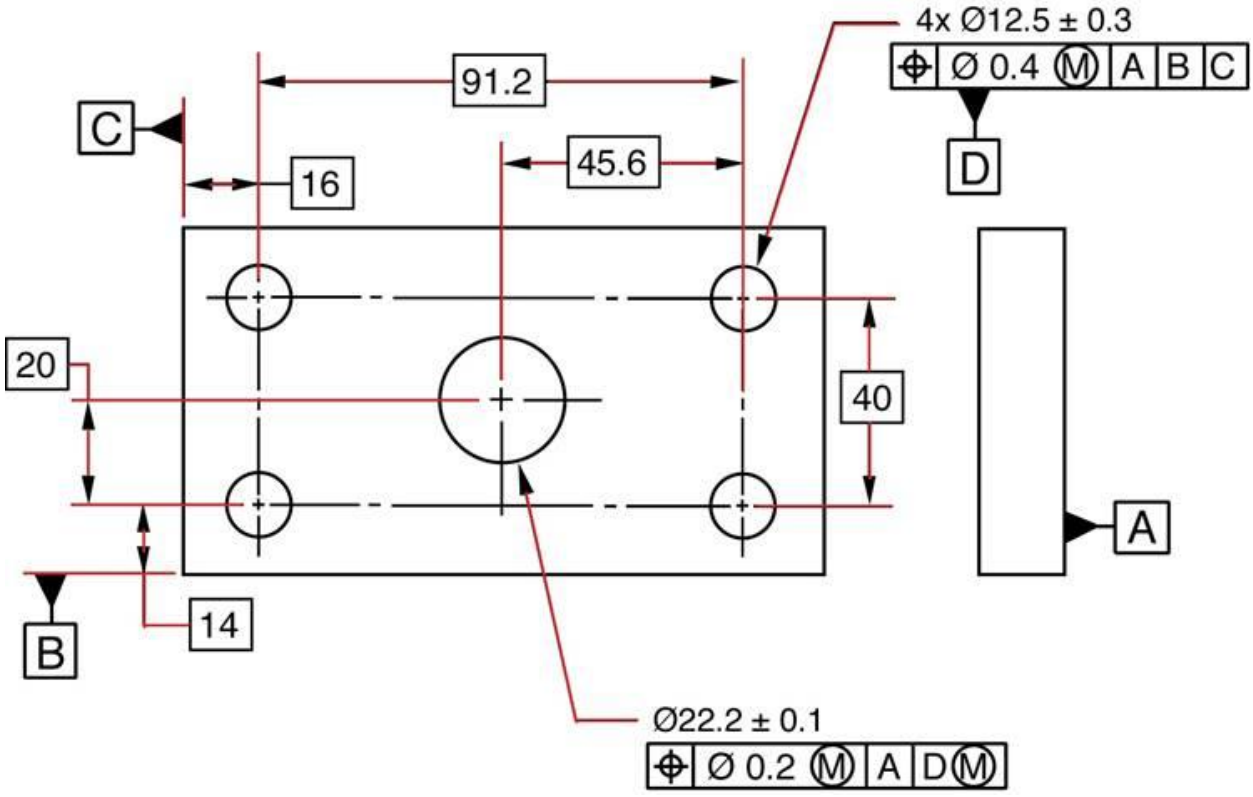
Scenario

The sales department for Precision Engineers has received an enquiry from AirRow Parts Ltd to inspect machined components from supplied die casting parts. As part of your role, you have been asked to produce an estimate for the inspection of these parts, based on the customer requirements and drawing provided.

Task

Produce a cost per product and a total cost for an inspection of a batch of 100 units. A template has been provided to support you. If you wish, you may make your own template, as long as it meets the needs of the task.

The estimate should include each key feature in the drawing and should show the equipment required, with reference to any uncertainty associated with the equipment.



All measurements in centimetres unless otherwise stated.

Student evidence

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
40		Distance between hole	40	mm	+0.4 = 40.4	-0.4 =39.6	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of each hole. The radius of each hole will then need to be measured and added on. Since this length will take into account 3 measurements, then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
14		Distance from an edge to a hole	14	mm	+0.2 =14.2	-0.2 =13.8	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of the hole and the edge of the part. The radius of the hole will then need to be measured and added on. Since this length will take into account 2 measurements, then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
16		Distance from an edge to a hole	14	mm	+0.2 =16.2	-0.2 =15.8	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of the hole and the edge of the part. The radius of the hole will then need to be measured and added on. Since this length will take into account 2 measurements, then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
20		Distance between holes	20	mm	+0.3 =20.3	-0.3 =19.7	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of each hole. The radius of each hole will then need to be measured and added on. Since this length will take into account 3 measurements, then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
45.6		Distance between holes	45.6	mm	+0.3 =45.9	-0.3 =45.3	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of each hole. The radius of each hole will then need to be measured and added on. Since this length will take into account 3 measurements, then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
91.2		Distance between hole	91.2	mm	+0.4 91.6	-0.4 90.8	Vernier callipers. The calibration of the vernier callipers will need to be checked.	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of each hole. The radius of each hole will then need to be measured and added on. Since this length will take into account 3 measurements then there is a greater scope of uncertainty. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
22.2		Diameter of hole	22.2	mm	+0.1 22.3	-0.1 22.1	Vernier callipers. The calibration of the vernier callipers will need to be checked.	Rear jaws on vernier callipers used to measure the internal diameter of the holes. Care to be taken to make sure that the verniers are measuring the hole diameter and not an edge of the hole. Also, the diameter of the hole may not be consistent so multiple readings at different angles around the hole should be taken. +-0.01mm uncertainty per measurement	0.5 minutes	3	0.5 minutes	1.5 minutes

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
12.5		Diameter of hole	12.5	mm	+0.3 12.8	-0.3 12.2	Vernier callipers. The calibration of the vernier callipers will need to be checked.	Rear jaws on vernier callipers used to measure the internal diameter of the holes. Care to be taken to make sure that the verniers are measuring the hole diameter and not an edge of the hole. Also, the diameter of the hole may not be consistent so multiple readings at different angles around the hole should be taken. +-0.01mm uncertainty per measurement	0.5 minutes	12	0.25 minutes	3 minutes
							Total		4 minutes			13.5 minutes

Task 2 template – inspection cost template

Rate at £110/hr	
Total time	**1750 minutes = 1750/60 = 29.16 hours**
Time per part	**17.5 minutes**
Total cost	**29.16 x 110 = £3207.60**
Cost per part	**3207.60/100 = 32.076 which is rounded to £32.08**

Any additional notes not displayed in quote table:

Task 3 – designing a plan for inspection

Scenario

Your estimation for the inspection of the 100 parts has been accepted and you have been provided with all 100 parts, based on the customer requirements. Before you inspect them, you need to create an inspection procedure and define how the parts will be measured. The procedure shall highlight any issue which may occur with repeatability.

Task

Use the drawing of the part from task 2 to create working instructions detailing your plan. Your plan should include:

- how you will inspect every critical feature
- your sampling method to ensure all aspects are recorded
- the data collection method selected
- creation of a suitable uncertainty budget
- how you will ensure calibration of equipment selected
- appropriate tooling and equipment selection, with justification, taking consideration of the relative uncertainty of measurement of the equipment selected for each measurement
- how you will ensure environmental factors are dealt with
- how you will be minimising the impact of hazards and complying with relevant health and safety, law and legislation
- any other relevant inclusions

Student evidence

Having been provided with 100 parts to inspect, the process for measuring them will need to be efficient, with emphasis on the accuracy and repeatability of the measurements. An alternative to measuring all 100 parts would be to take a sample of, for example, 10 parts.

There are a number of different geometries which need to be measured. For all of the measurements, I will use a vernier calliper; however, the method in which the vernier calliper is used to attain the final result is very different.

The table below explains the processes for each of the measurements and the uncertainties for each:

Distance between 2 holes	In order to accurately make this measurement, the vernier callipers should be used to measure between the outer edge of each hole, as well as the radii. The radius of each hole will then need to be measured and added on. Since this length will take into account 3 measurements, then there is a greater scope of uncertainty.
Distance between a hole and an edge	In order to accurately make this measurement, the vernier callipers should be used to measure between the inner edge of the hole and the edge of the part. The radius of the hole will then need to be measured and added on. Since this length will take into account 2 measurements, then there is a greater scope of

	uncertainty.
Diameter of a hole	Rear jaws on vernier callipers used to measure the internal diameter of the holes. Care to be taken to make sure that the verniers are measuring the hole diameter and not an edge of the hole. Also, the diameter of the hole may not be consistent so multiple readings at different angles around the hole should be taken.

I will check each measurement on each critical feature 3 times. This is because if a mistake in measurement is made, then doing it 3 times should identify if any mistakes have been made. If I made 1 measurement, then a mistake could be made, and it would be completely unnoticed. If I made 2 measurements and they did not agree, then I would not know which one is correct. But when taking 3 measurements, if 2 results agree and 1 does not, then it is most likely that the 1 measurement which does not agree would be wrong.

Uncertainty is the doubt that exists for each measurement. When completing an uncertainty calculation, we quantify the amount of doubt in the measurement.

In these measurements, there is uncertainty due to the measurement tool, the environment and the operator skill.

There are 2 ways to estimate the uncertainties. These are:

- type A evaluations – uncertainty measurements using statistics
- type B evaluations – uncertainty measurements from other information such as previous experience

I think that type A evaluations are much more suitable for calculating the uncertainty budget. In the example of the vernier callipers, the uncertainty of the equipment was +-0.01mm, so every length measured by the vernier calliper will have this uncertainty associated with it. Some measurements, such as the distance between holes, relied on 3 separate measurements so the uncertainty is 3 times the uncertainty of a single measurement (3 x +-0.01mm = +0.03mm).

To reduce the uncertainty in the equipment used, I would make sure that it has an up to date calibration certificate. Also, I would ensure that the temperature of the workshop was stable. This is because the size of the material will change very slightly with changes in temperature due to thermal expansion of the material. To prevent this, I will make sure that the air conditioning in the workshop is set to 20 degrees and that no windows are opened.

As I will be working in the workshop, I will have to comply with all relevant health and safety. I will follow the risk assessment for the workshop. To minimise the risk of tripping, I will make sure that when not using inspection equipment, I store it safety and orderly, therefore reducing the risks of tripping. Depending on the weight of the parts and the working environment, then personal protective equipment such as safety boots may be required to be worn.

Examiner commentary

The student has comprehensively identified key metrological information, which is demonstrated through both tasks 1 and 2.

The student has correctly labelled all the key geometric characteristics, providing details on missing symbols, names and tolerance types. There are no omissions or errors.

The student has highlighted the key issues with the example technical drawings, including highlighting incorrect leader information, incorrect dimension termination, missing leader line, incorrect hole position and inconsistent labelling of datums B and C. They have gone on to highlight incorrect rounding, geometric symbol omission and the centre lines not being the correct line type. The student has suitably corrected these issues on the drawings provided or commented on the required changes.

In task 2, the student has estimated the cost for all of the key features, as well as the other features that are relevant. The student has selected equipment to complete the inspection and the preparation required before inspection and measurement has been included in the plan. The student has made a consideration of uncertainty for each measurement, including the tolerances of the equipment selected. The student has arrived at a realistic estimation of time and planned for a suitable number of measurements required for the feature being measured, considering the time and cost of the activity.

The student has completed a very detailed plan which provides very detailed information relating to the needs of the brief and is presented in a very logical format. The plan demonstrates extensive metrological understanding of approaches associated with basic measurement tasks.

The student has completed a plan which outlines the key equipment planned to be used and demonstrates the thought process undertaken to arrive at the decision of which methods to use. The decisions made by the student are correct, and a justification of the methods selected is provided. The student has considered the equipment used for different parts of the component to be measured, and this is demonstrated in the plan. Considerations have been given regarding how to mitigate uncertainty and environment factors, and recommendations on how to reduce this are clearly provided and rationalised.

Overall grade descriptors

The performance outcomes form the basis of the overall grading descriptors for pass and distinction grades.

These grading descriptors have been developed to reflect the appropriate level of demand for students of other level 3 qualifications and the threshold competence requirements of the role, and have been validated with employers within the sector to describe achievement appropriate to the role.

Occupational specialism overall grade descriptors

Grade	Demonstration of attainment
Pass	The evidence is logical but displays minimal knowledge of basic metrological content in response to the demands of the brief.
	The student makes some use of relevant knowledge and understanding of how metrology informs practices in many sectors and demonstrates a limited understanding of perspectives or approaches associated with basic measurement tasks and principles.
	The student makes adequate use of facts/theories/approaches/concepts and attempts to demonstrate breadth and depth of metrological knowledge and understanding.
	The student is able to identify some metrological information from appropriate sources and makes use of appropriate information/appraises relevancy of information and can combine information to make decisions.
	The student makes minimal judgements/takes appropriate action/seeks clarification with metrological sources of guidance and is able to make limited progress towards solving non-routine problems in real life measurement activities/situations.
	The student attempts to demonstrate metrological skills and knowledge of the relevant concepts and techniques reflected in a measurement services role and generally applies this across different contexts and measurement skill sets.
	The student shows adequate understanding of unstructured measurement-related problems that have not been seen before, using limited knowledge to find solutions to problems and make justification for strategies for solving problems, explaining their reasoning.
Distinction	The metrological evidence is precise, logical and provides a detailed and informative response to the measurement-related demands of the brief.
	The student makes extensive use of relevant knowledge and understanding of how metrology informs practices in many sectors and demonstrates an understanding of perspectives or approaches associated with basic measurement tasks and principles.

	The student makes decisive use of facts/theories/approaches, demonstrating extensive breadth and depth of metrological knowledge and understanding, and selects highly appropriate skills/techniques/methods.
	The student is able to comprehensively identify metrological information from a range of suitable sources and makes exceptional use of appropriate information/appraises relevancy of information and can combine information to make coherent measurement decisions.
	The student makes well founded judgements/takes appropriate action/seeks clarification with metrological sources of guidance and is able to use that to reflect on real life measurement activities/situations.
	The student demonstrates extensive metrological skills and knowledge of the relevant concepts and techniques reflected in a measurement services role and precisely applies this across a variety of contexts and tackles unstructured problems that have not been seen before, using their knowledge and measurement skill sets to analyse and find suitable solutions to the measurement problems.
	The student can thoroughly examine metrological data/information in context and apply appropriate analysis in confirming or refuting conclusions and carrying out further work to justify strategies for solving problems, giving concise explanations for their reasoning.

Task 2 template – inspection cost template

Number	Ref location	Characteristic designator	Requirement	Unit	Upper limit	Lower limit	Equipment and preparation required	Accuracy/ uncertainty consideration	Estimation of prep time	Estimation of number of measurements	Estimation of time per measurement	Total time
							Total					

Rate at £110/hr	

Total time	
Time per part	
Total cost	
Cost per part	

Any additional notes not displayed in quote table:

Document information

The T Level Technical Qualification is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.

Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Published final version.		June 2021
v1.1	NCFE rebrand		September 2021