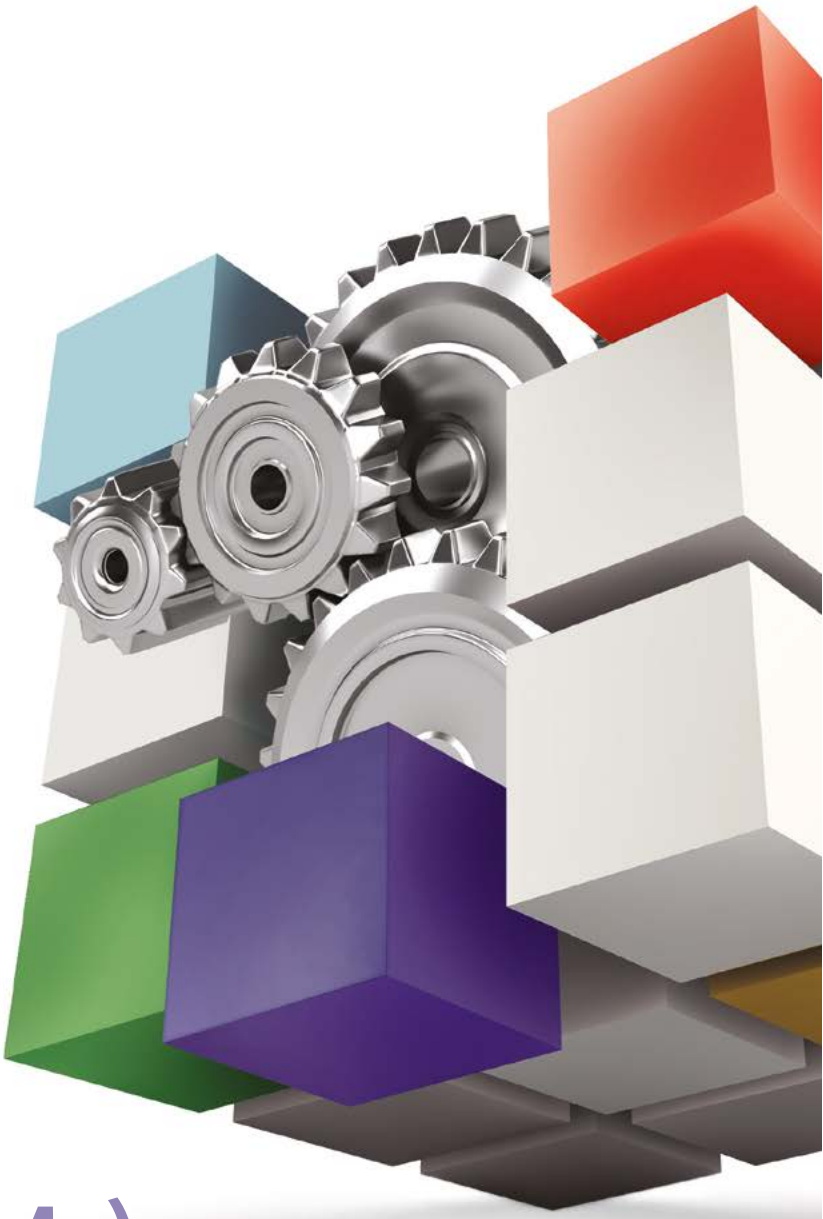
BTEC

Pearson BTEC Level 3 National in Engineering

Unit 3: Engineering Product Design and Manufacture



Sample Assessment Materials (SAMs)

For use with:

- *Certificate, Extended Certificate, Foundation Diploma, Diploma and Extended Diploma in Engineering*
- *Diploma and Extended Diploma in Electrical and Electronic Engineering*
- *Diploma and Extended Diploma in Mechanical Engineering*
- *Diploma and Extended Diploma in Computer Engineering*
- *Diploma and Extended Diploma in Manufacturing Engineering*
- *Diploma and Extended Diploma in Aeronautical Engineering*

First teaching from September 2016 **Issue 3**

Pearson

Edexcel, BTEC and LCCI qualifications

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These Sample Assessment Materials (SAMs) are Issue 3. Key changes are sidelined. We will inform centres of any changes to this issue. The latest issue can be found on our website.

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.)

BTEC

Pearson BTEC Level 3 Nationals

Write your name here

Surname	Forename

Level 3

Engineering

Unit 3: Engineering Product Design and Manufacture

Part A

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

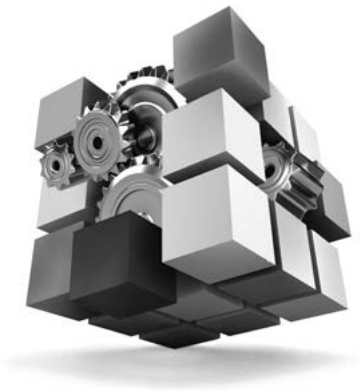
Sample assessment material for first teaching September 2016

Instructions

- **Part A** contains material for the completion of the preparatory work for the set task.
- **Part A** should be undertaken over no more than 3 hours in a period of 1 week as timetabled by Pearson.
- **Part A** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part B** materials must be issued to learners during the period specified by Pearson.
- This **Part A** task booklet must not be returned to Pearson.

Information

- In **Part B**, the task should be undertaken in 8 hours under supervision over no more than 5 consecutive days. The supervised sessions take place in the two-week period timetabled by Pearson.



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Instructions to Teachers/Tutors

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.

Part A should be issued to learners one week prior to undertaking **Part B** of the assessment.

Learners will be expected to conduct research.

Research is expected to be carried out over three hours. Centres must advise learners of the timetabled sessions during which they can carry out the research. It is expected that scheduled lessons or other timetable slots will be used for some or all of this work. Learners can produce individually prepared research notes (maximum of two sides of A4) to take into the **Part B** supervised assessment.

Teachers cannot give any support to the production of the notes and the work must be completed independently by the learner.

For **Part B**, centres are free to arrange the supervised assessment period how they wish provided the 8 hours for producing final outcomes are completed over no more than 5 consecutive days, are under the level of supervision specified and in accordance with the conduct procedures.

Refer carefully to the instructions in this task booklet and the Instructions for Conducting External Assessments (ICEA) document to ensure that the preparatory period is conducted correctly and that learners have the opportunity to carry out the required activities independently.

Learner notes will be retained securely by the centre after **Part B** and may be requested by Pearson if there is suspected malpractice

Instructions for Learners

Read the set task information carefully.

This contains **Part A**, which is the information you need to prepare for the set task.

You will need to carry out your own research over the next week and you can take up to two A4 sides of individually prepared research notes into **Part B** of the set task.

You will then be given the set task to complete under supervised conditions.

For **Part A**, you must work independently and must not share your work with other learners.

Your teacher will give guidance on when the preparation should be completed.

Your teacher cannot give you feedback during the preparation period.

Set Task Brief

A manufacturer has been approached by one of its clients for whom it manufactures brackets used in tunnels. The client has asked the manufacturer to optimise the design of the product, which is a bracket.

You will research the design and manufacturing requirements that are relevant to the bracket and its application. Your research should consider:

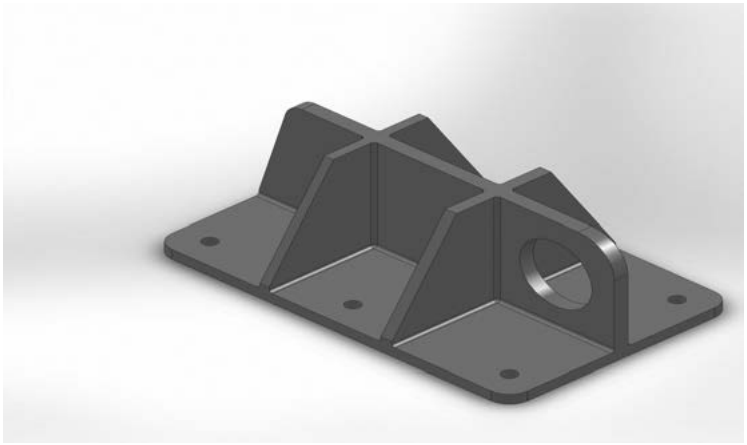
- existing designs for brackets
- the manufacturing processes and technologies that are being used and possible alternatives
- the health and safety requirements for the manufacturing processes and technologies
- environmental considerations including sustainability
- material requirements and suitable material properties
- any other relevant factors, such as ease of fitting.

In Part B you will be given further information on the specific issues with the existing bracket that will allow you to redesign the bracket and evaluate your solution against the issues. You will be able to take up to two sides of individually prepared A4 research notes into Part B of the set task.

Part A Set Task Information

The bracket is attached mechanically to a metal support within a tunnel. The purpose of the machined bracket is to provide support for a high voltage insulated electrical cable, which runs the length of the tunnel. The electrical cable goes through the 65mm diameter hole. The number of brackets that are needed depends on the length of the tunnel, but they are generally manufactured in thousands.

Currently, the bracket is machined from low carbon steel, which has a paint finish applied to it.



L = 318mm, W = 200mm, H = 115mm

Pearson BTEC Level 3 Nationals

Engineering

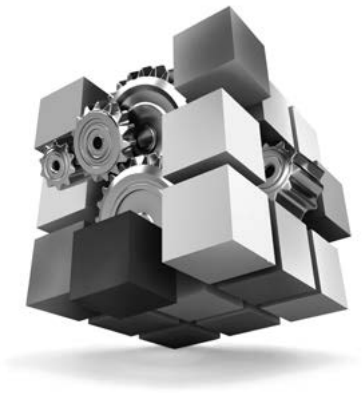
Unit 3: Engineering Product Design and Manufacture

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

- You will need the information in this booklet to complete the tasks in Part B.
- Read the information carefully.
- You must **not** write your answers in this booklet.
- Only your answers given in the task booklet in **Part B** will be marked.



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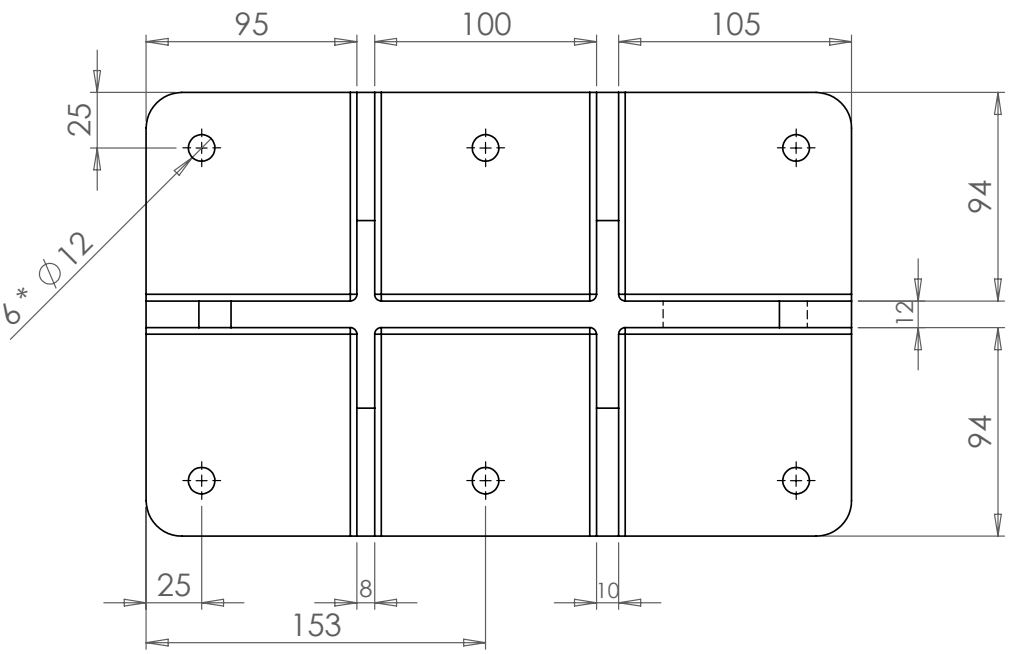

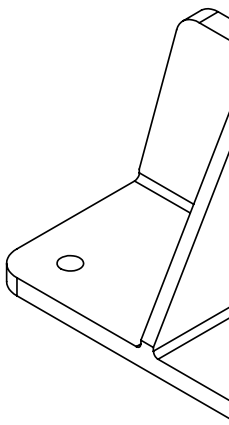

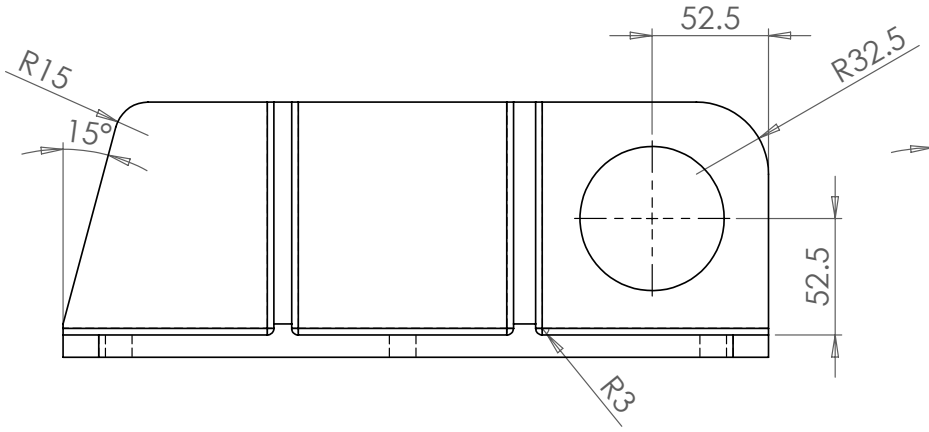

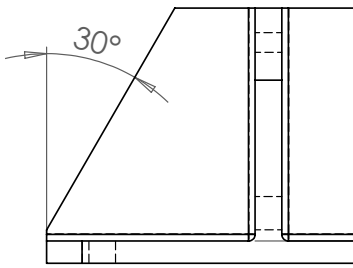

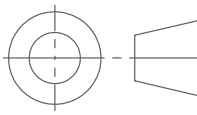

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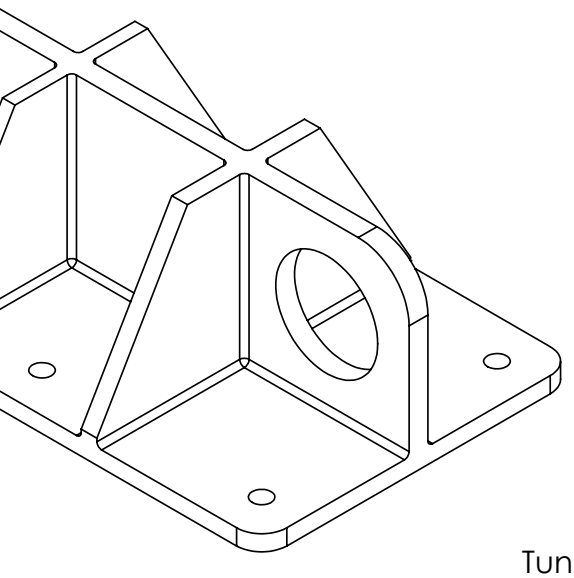
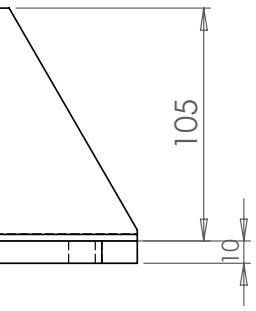
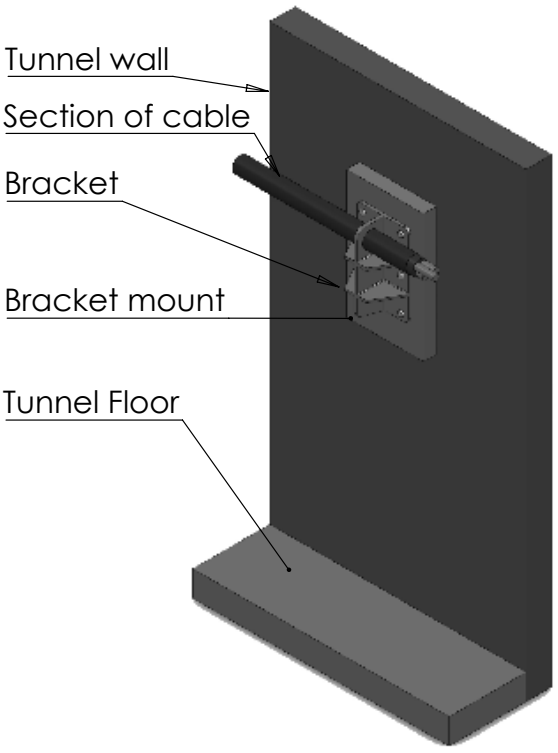






A View of one Cable Bracket in Operation

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:				DEBUR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE		TITLE: Cable Bracket	
DRAWN	Pearson					
CHK'D	BTEC					
APPV'D						
MFG						
Q.A				MATERIAL: Low Carbon Steel	DWG NO.	A3
				WEIGHT:	SCALE:1:5	SHEET 1 OF 1

Pearson BTEC Level 3 Nationals

Write your name here

Surname	Forename

Level 3

Learner Registration Number

Centre Number

Engineering

Unit 3: Engineering Product Design and Manufacture

Part B

Marks

Supervised hours 8

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

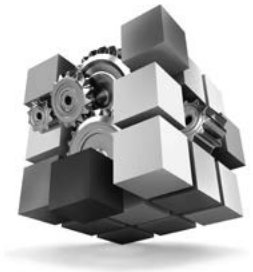
Sample assessment material for first teaching September 2016

Instructions

- You must have: Information Booklet containing engineering drawings, **black** ink or ball point pen, HB or B pencil, ruler, eraser, drawing instruments and calculator.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- You will need your research notes from **Part A** (maximum two A4 sides).
- **Part B** should be undertaken in 8 hours under supervision over no more than 5 consecutive days. The supervised sessions take place in the two-week period timetabled by Pearson.
- **Part B** contains material for the completion of the set task under supervised conditions.
- **Part B** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part B** should be kept securely until the start of the 8-hour supervised assessment period.
- You must not submit your research notes to Pearson.
- Complete **all** activities.
- Answer the activities in the spaces provided *– there may be more space than you need.*

Information

- The total mark for this paper is 60.



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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 in this task booklet, using additional sheets, in a supplied template.

Learners can use individually prepared research notes (maximum two sides of A4) to support the supervised assessment (**Part B**). These research notes must be kept secure once the supervised assessment has begun.

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

Centres are free to arrange the supervised assessment period how they wish, provided the 8 hours for producing final outcomes are under the level of supervision 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 B** the assessment must be completed in a 5 day period.

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 in place appropriate checks to ensure that only permitted material is introduced into the supervised environment.

Maintaining security

- For **Part B**, learners **must not** have access to computers or the internet.
- Learners can only access their work under supervision.
- Any work learners produce under supervision must be kept secure.
- Any materials being used by learners must be collected in at the end of each session, stored securely and handed back at the beginning of the next session.

Outcomes for submission

One task booklet will need to be submitted by each learner, which includes the following tasks:

- the project planning and product design changes made during the development process
- interpretation of the brief into operational requirements
- a range of initial design ideas based on the client brief
- a modified product proposal with relevant design documentation
- an evaluation of the design proposal.

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

Learner notes will be retained securely by the centre after **Part B** and may be requested by Pearson if there is suspected malpractice.

Instructions for Learners

Read the set task information carefully.

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

You may use your preparatory work from **Part A** to complete the set task in **Part B**.

Your preparatory notes from Part A must not be submitted with the task booklet from Part B. Only your task booklet from Part B will be submitted to Pearson for marking.

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

For **Part B**, you **must not** use computers or the internet.

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

In the information booklet you will be provided with drawings of the bracket and a sectional view showing the bracket in operation.

Outcomes for submission

You will need to submit one task booklet on completion of the supervised assessment period, which includes the following activities:

- a record of project planning and design changes made during the development process
- an interpretation of the brief into operational requirements
- a range of initial design ideas based on the client brief
- a modified product proposal with relevant design documentation
- an evaluation of the design proposal.

A fully completed authentication sheet must also be submitted; any prepared notes must not be submitted with the final outcomes to Pearson.

Set Task

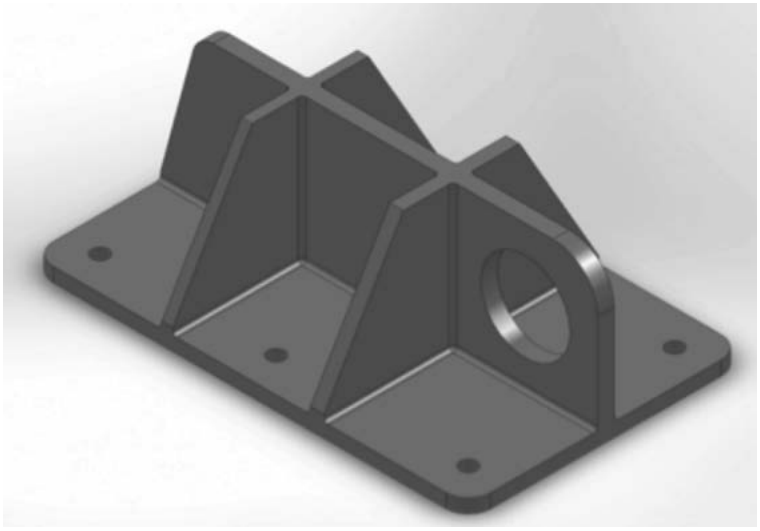
You must complete ALL activities.

For **Part A** of the supervised task you should have researched and prepared notes on the design, materials and manufacturing processes for similar products. You are allowed to use your individually prepared notes to support you during the **Part B** supervised assessment period.

The product is a bracket which is mechanically attached to a metal support within a tunnel. The purpose of the machined bracket is to provide support for a high voltage insulated electrical cable, which runs the length of the tunnel. The electrical cable goes through the 65mm diameter hole. The number of brackets that are needed depends on the length of the tunnel, but they are generally manufactured in thousands.

Currently, the bracket is machined from low carbon steel, which has a paint finish applied to it.

Existing Cable Support Bracket



Length = 318mm, Width = 200mm, Height = 115mm

In the information booklet refer to the orthographic projection of the existing support bracket. It also provides a sectional view showing the bracket in operation (the position of the hole in service in relation to the wall and a metal support).

Client brief

The client is aware that the current design has a number of issues, but the redesign has been triggered by the bracket fracturing in service. The client had intended the life cycle of the bracket to be 25 years. The client needs the manufacturer to identify the stage in the life cycle when the brackets begin to exhibit signs of fracture and design a solution that will reduce the likelihood of the brackets fracturing in service.

Based on simulations and testing, the client has provided the following information in Table 1, which can be used to perform a statistical analysis of the service conditions that the brackets are used in.

The client has asked the manufacturer to come up with an alternative solution that can also take into account the most efficient use of materials and manufacturing processes; however, the manufacturer also has an opportunity to optimise the design in terms of form, sustainability and other factors.

The bracket must:

- have a 65mm hole with a dimensional tolerance of +/– 2mm
- be manufactured so that the 65mm hole is in the same position as the original bracket (see sectional view of the bracket in operation)
- have at least three mounting points.

Table 1 – Outcome of simulations and testing on the existing brackets

Bracket	Minimum temperature inside tunnel (degrees Celsius)	Maximum temperature inside tunnel (degrees Celsius)	Humidity inside the tunnel (percentage)	Distance from the tunnel entrance/exit (metres)	Life cycle (years)									
					Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
A	–10	18	40%	20	25	27	15	22	30	24	26	19	24	28
B	–6	19	50%	40	20	22	26	17	23	13	18	19	28	20
C	–2	22	60%	60	15	17	11	13	16	14	21	9	27	16
D	0	26	80%	80	7	19	16	11	7	1	9	14	23	11
E	3	30	80%	100	8	4	7	16	12	22	6	7	2	9

Redesign of the product

Activity 1

At the start of the task create a short project time plan in your task booklet. During the development process you should also record in your task booklet:

- Why changes were made to the design during each session
- action points for the next session.

Total for Activity 1 = 6 marks
Suggested time 45 minutes

Activity 2

Interpret the brief into operational requirements, to include:

- product requirements
- opportunities and constraints
- interpretation of numerical data
- key health and safety, regulatory and sustainability factors.

Total for Activity 2 = 6 marks
Suggested time 45 minutes

Activity 3

Produce a range of (three or four) initial design ideas based on the client brief, to include:

- sketches
- annotations.

Total for Activity 3 = 9 marks
Suggested time 1 hour 15 minutes

Activity 4

Develop a modified product proposal with relevant design documentation.

The proposal must consider:

- a solution
- existing products
- materials
- manufacturing processes
- sustainability
- safety
- other relevant factors.

Total for Activity 4 = 30 marks
Suggested time 4 hours

Activity 5

Your final task booklet entry should evaluate:

- success and limitations of the completed solutions
- indirect benefits and opportunities
- constraints
- opportunities for technology-led modifications.

Total for Activity 5 = 9 marks
Suggested time 1 hour 15 minutes

END OF TASK **TOTAL FOR TASK = 60 MARKS**

Activity 1

At the start of the task create a short project time plan in your task booklet.
During the development process you should also record in your task booklet:

- why changes were made to the design during each session
- action points for the next session.

Total for Activity 1 = 6 marks

Activity 2

Interpret the brief into operational requirements, to include:

- product requirements
- opportunities and constraints
- interpretation of numerical data
- key health and safety, regulatory and sustainability factors.

Total for Activity 2 = 6 marks

Activity 3

Produce a range of (three or four) initial design ideas based on the client brief, to include:

- sketches
- annotations.

Total for Activity 3 = 9 marks

Activity 4

Develop a modified product proposal with relevant design documentation. The proposal must consider:

- a solution
- existing products
- materials
- manufacturing processes
- sustainability
- safety
- other relevant factors.

Total for Activity 4 = 30 marks

Activity 5

Your final task booklet entry should evaluate:

- success and limitations of the completed solutions
- indirect benefits and opportunities
- constraints
- opportunities for technology-led modifications.

Total for Activity 5 = 9 marks

END OF TASK

TOTAL FOR TASK = 60 MARKS

Unit 3: Engineering Product Design and Manufacture - 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 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

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Carry out an iterative development process	**0**	**1-2**	**3-4**	**5-6**	**n/a**
	Level of response not worthy of credit	• Entries demonstrate an unstructured or linear approach to the design process. • Development activities lead to design refinements that may not be relevant to the brief. • A limited justification of the changes made in order to fulfil the requirements of the brief. • Action points are vague, incomplete or not present.	• Entries demonstrate some evidence of an iterative approach to the design process. • Development activities lead to design refinements that are partially linked to the requirements of the brief. • Some justification of the changes made throughout the development process to fulfil the requirements of the brief. • Action points for the next external assessment session are identified but not well defined or prioritised.	• Entries demonstrate a logical and iterative approach to the design process. • Development activities lead to design refinements that are coherently linked to research and the requirements of the brief. • Thorough justification of changes made throughout the development process to fulfil the requirements of the brief. • Well defined, logical and prioritised action points for the next external assessment session are identified.	

Activity 2: Interpret the brief into operational requirements

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Interpreting brief into operational requirements	**0**	**1-2**	**3-4**	**5-6**	**n/a**
	Level of response not worthy of credit	• Interpret the brief into some key product requirements, opportunities and/or constraints that partially meet the brief and are not cohesively linked. • Limited calculation and interpretation of numerical data that may include some errors. • Consideration of some health and safety, regulatory and/or sustainability factors with limited relevance to the given context.	• Interpret the brief into a cohesive set of product requirements, opportunities and constraints that meets the brief. • Mostly accurate calculation and interpretation of numerical data that may include minor errors. • Consideration of key health and safety, regulatory and sustainability factors with some relevance to the given context.	• Interpret the brief into a cohesive and comprehensive set of product requirements, feasible opportunities and constraints that meets the brief and considers enhanced product performance. • Accurate calculation and interpretation of numerical data. • Consideration of key health and safety, regulatory and sustainability factors with relevance to the given context.	

Activity 3: Produce a range of initial design ideas based on the client brief

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Initial design ideas	**0**	**1-3**	**4-6**	**7-9**	**n/a**
	Level of response not worthy of credit	• Limited range of basic ideas that address some aspects of the brief. • Ideas communicated at a simplistic level with limited technical terms. • Ideas that have limited feasibility and may not be fit for purpose.	• A range of appropriate ideas that address most aspects of the brief. • Ideas communicated clearly and suitable use of technical terms that mostly link to the brief. • Ideas that are mostly feasible and fit for purpose, but may include some unrealistic design elements.	• A range of appropriate ideas that comprehensively address the brief. • Ideas communicated with clarity and concisely and appropriate use of technical terms that link to the brief. • Ideas that are feasible and fit for purpose.	

Activity 4: Develop a modified product proposal with relevant design documentation

Assessment focus	Subtask	Band 0	Band 1	Band 2	Band 3	Band 4
Develop a modified product proposal (form, materials and/or manufacturing processes)	Solution	**0**	**1-6**	**7-12**	**13-18**	**19-24**
		Level of response not worthy of credit	• The solution shows a simple variation in form and/or approach from the brief. • The design proposal shows little or no reference to existing alternative products. • Material/s selection is inappropriate compared to the requirements of the brief. Limited investigation of options. • Selection of manufacturing process/es is inappropriate compared to the requirements of the brief. Limited investigation of options. • Design proposal show a limited consideration of	• The solution is feasible but doesn't represent an improvement from the original product and shows variation in form and/or approach from the brief. • The design proposal shows some reference to existing alternative products. • Material/s selection is appropriate to the brief and partially justified by an investigation that considers limited options. • Selection of manufacturing process/es is appropriate to the brief and partially justified by an investigation that considers limited options. • Design proposal show some consideration of sustainability at some stages of the product life	• The solution is an improvement from the original product, showing a clear variation in form and/or approach from the brief. • The design proposal is informed, based on some understanding of existing alternative products. • Material/s selection is appropriate to the brief and mostly justified by an investigation of options. • Selection of manufacturing process/es is appropriate to the brief and mostly justified by an investigation of options. • Design proposal show some consideration of sustainability at most stages of the product life	• The solution is optimised, demonstrating a justified variation in form and/or approach from the brief. • The design proposal is informed, based on a thorough understanding of existing alternative products. • Material/s selection is appropriate to the brief and fully justified by balanced investigation of options. • Selection of manufacturing process/es is appropriate to the brief and fully justified by balanced investigation of options. • Design proposal considers sustainability at all stages of the product life cycle.

Assessment focus	Subtask	Band 0	Band 1	Band 2	Band 3	Band 4
			sustainability at some stages of the product life cycle. • Ideas have little reference to the safety of the design and/or designing out risk.	cycle. • Ideas show limited reference to the safety of the design and designing out risk.	cycle. • Ideas show some references to the safety of the design and designing out risk.	• Ideas clearly reference the safety of the design and designing out risks.
	Design Documentation	**0**	**1**	**2-3**	**4-5**	**6**
		Level of response not worthy of credit	• Limited formal documentation used to communicate the solution. • Little or no annotation used. • The use of technical terminology is attempted but it is largely inaccurate.	• Formal documentation used to communicate the solution. • Annotation used to identify some key features of the solution which would allow a competent third party to understand the purpose of the solution. • Technical terminology is limited and accurate.	• An appropriate range of formal documentation used to communicate the solution effectively. • Sufficient annotation of the key features of the solution which would allow a competent third party to interpret how to manufacture the solution. • Some accurate technical terminology is used.	• A comprehensive range of relevant formal documentation to communicate the solution effectively. • Concise annotation of the solution which would allow a competent third party to effectively interpret how to manufacture the solution. • Technical terminology is used accurately throughout.

Activity 5: Evaluate the design proposal

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Validating the design proposal	**0**	**1-3**	**4-6**	**7-9**	**n/a**
	Level of response not worthy of credit	Superficial appraisal of: • Success and limitations of completed solutions • Indirect benefits and opportunities • Constraints. • Provides a limited rationale for the design solution, which may not relate directly to the brief. • Little or no further technology-led modifications communicated.	Some appraisal, which may be unbalanced or incomplete, of: • Success and limitations of completed solutions • Indirect benefits and opportunities • Constraints. • Provides a partial rationale for why the design solution is more effective in relation to some aspects of the brief. • Further technology-led modifications are communicated with some evidence of how they could improve the effectiveness of the solution.	Balanced and thorough appraisal of: • Success and limitations of completed solutions • Indirect benefits and opportunities • Constraints. • Provides a sound rationale for why the design solution is more effective in relation to the brief. • Further technology-led modifications are communicated with detailed evidence of how they could optimise the solution.	

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