

Pearson BTEC Level 3 Nationals Extended Certificate

January 2020

Paper Reference **31708H**

Engineering

Unit 3: Engineering Product Design and Manufacture

Part A

You do not need any other materials.

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 working days. The supervised sessions take place in the two-week period timetabled by Pearson.

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Instructions to Teachers

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 3 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 working 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 *BTEC Nationals 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 research 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

You are advised to spend a maximum of 3 hours doing your research.

A client has asked you, as a technician engineer, to optimise the design of a bracket for a modular induction motor system. The modular induction motor system can be used to power, for example, compressors, pumps and conveyors by attaching them to the drive shaft.

You will research the design and manufacturing requirements that are relevant to the bracket and its use. 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 product, user and manufacturing processes
- environmental considerations including sustainability
- material requirements and suitable material properties
- any other relevant factors, such as designing out risks, types of fit and vibrations caused by moving parts.

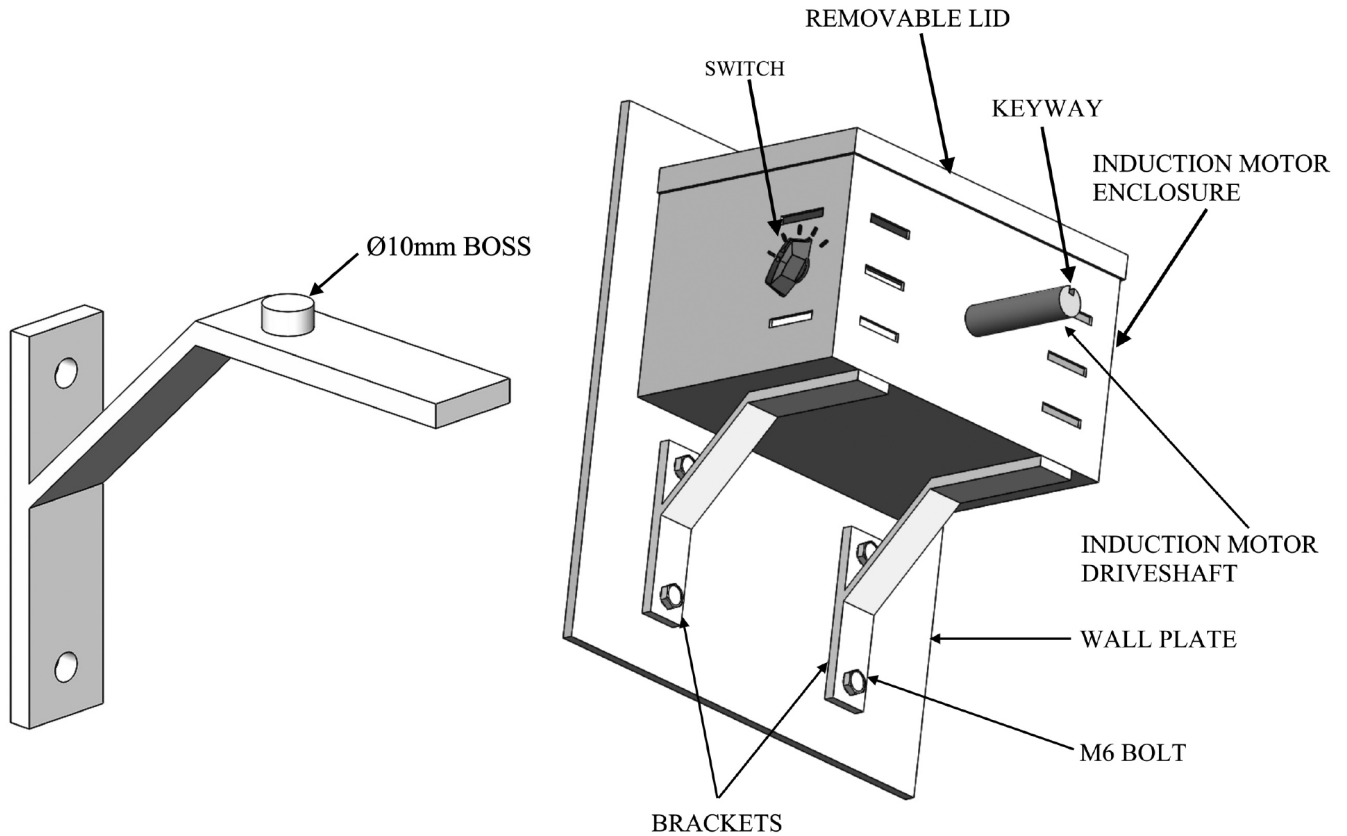
In **Part B** you will be given further information on the specific issues with the bracket that will allow you to redesign the bracket and evaluate your solution against the issues. Therefore, you are advised **not** to undertake any design work during **Part A** (the research stage).

You will be able to take up to two sides of individually prepared A4 research notes from **Part A** into **Part B** of the set task.

Part A Set Task Information

The product is a bracket for a modular induction motor system. The holes in the base of the induction motor enclosure locate onto the 10 mm boss on each bracket using a transition fit. The brackets are bolted to a wall plate using M6 bolts. The modular induction motor system is mass produced, so the brackets will be manufactured in batches of 5000.

The brackets are cast from low carbon steel and powder coated.



Bracket dimensions: L= 115 mm, W= 20 mm, H=100 mm

Pearson BTEC Level 3 Nationals Extended Certificate

Window for Supervised Period:

Wednesday 8 January 2020 – Wednesday 22 January 2020

Controlled hours: 8 hours

Paper Reference **31708H**

Engineering

Unit 3: Engineering Product Design and Manufacture

Part B

Information Booklet

Do not return this Information Booklet with the question paper.

Instructions

- You will need the information in this booklet to complete the task.
- 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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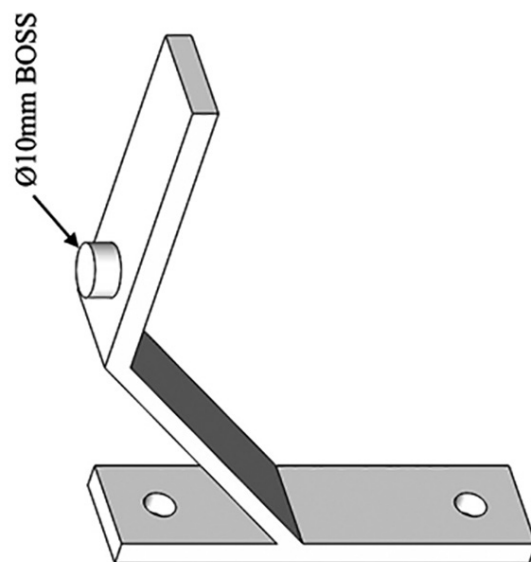
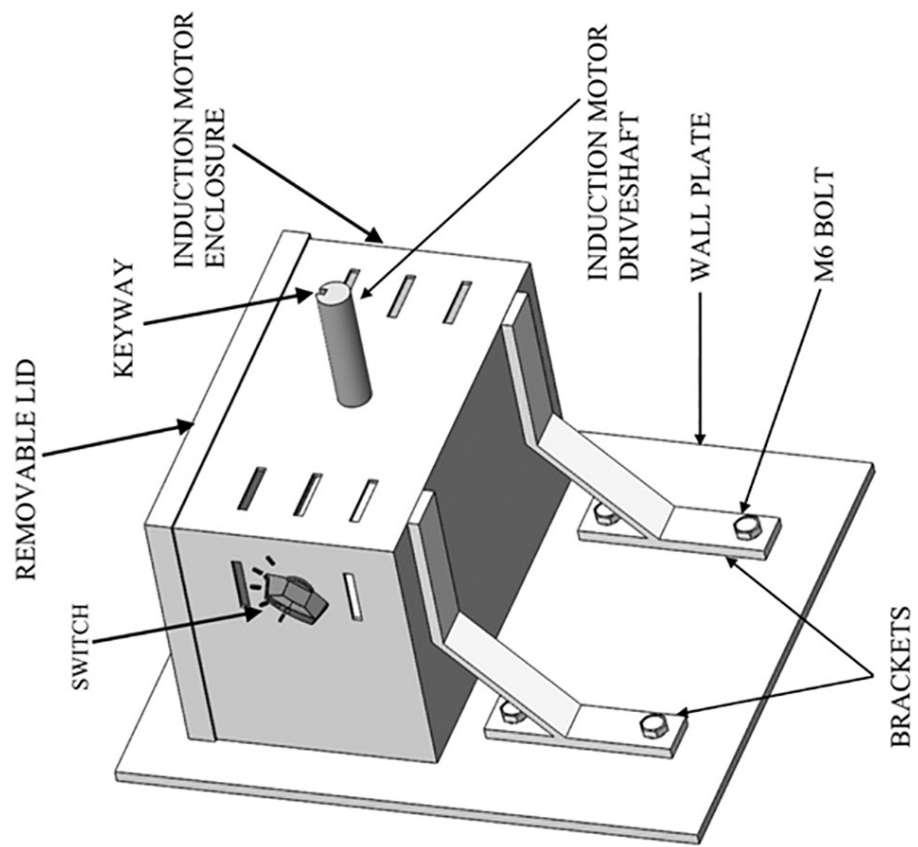
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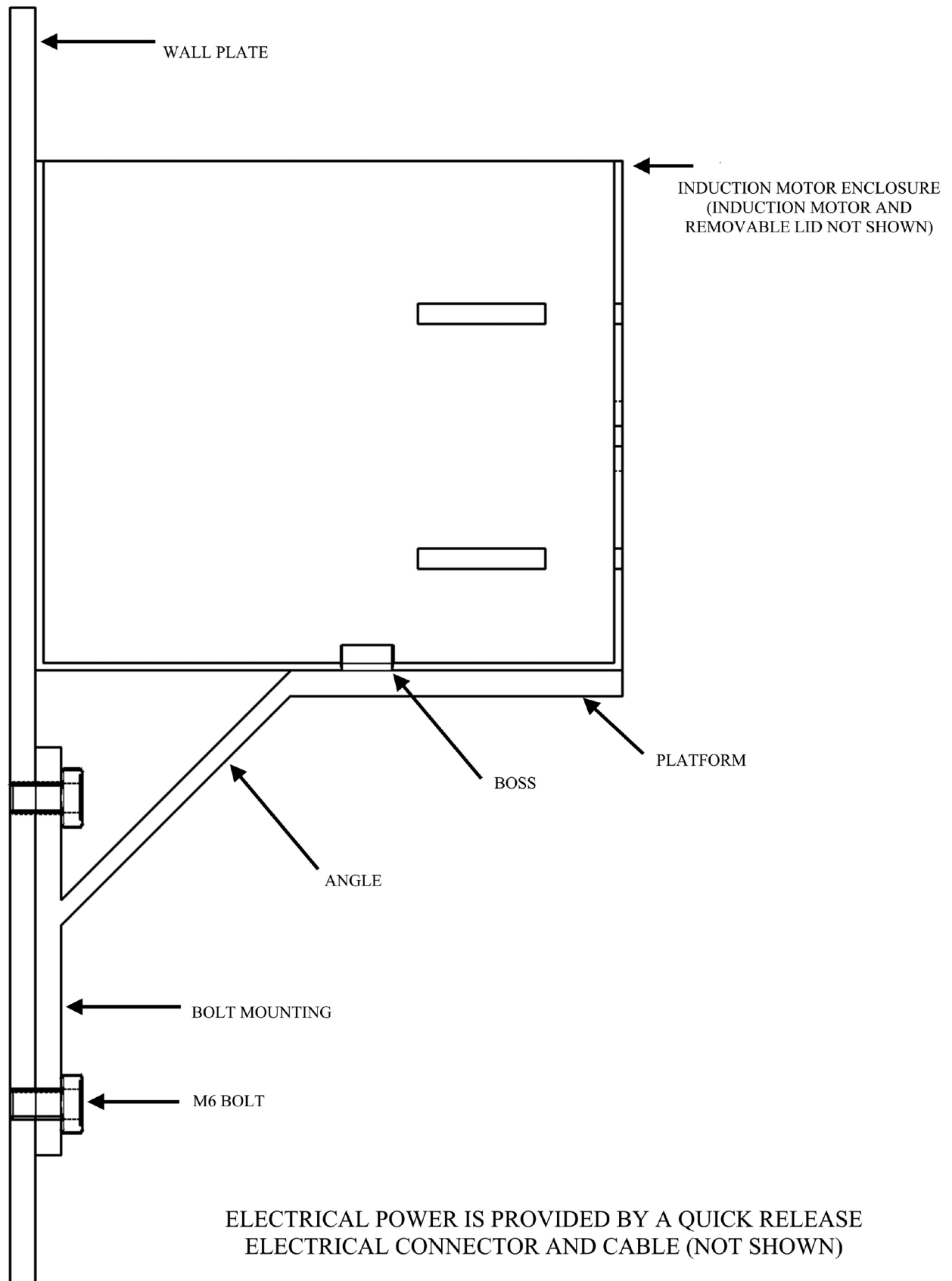
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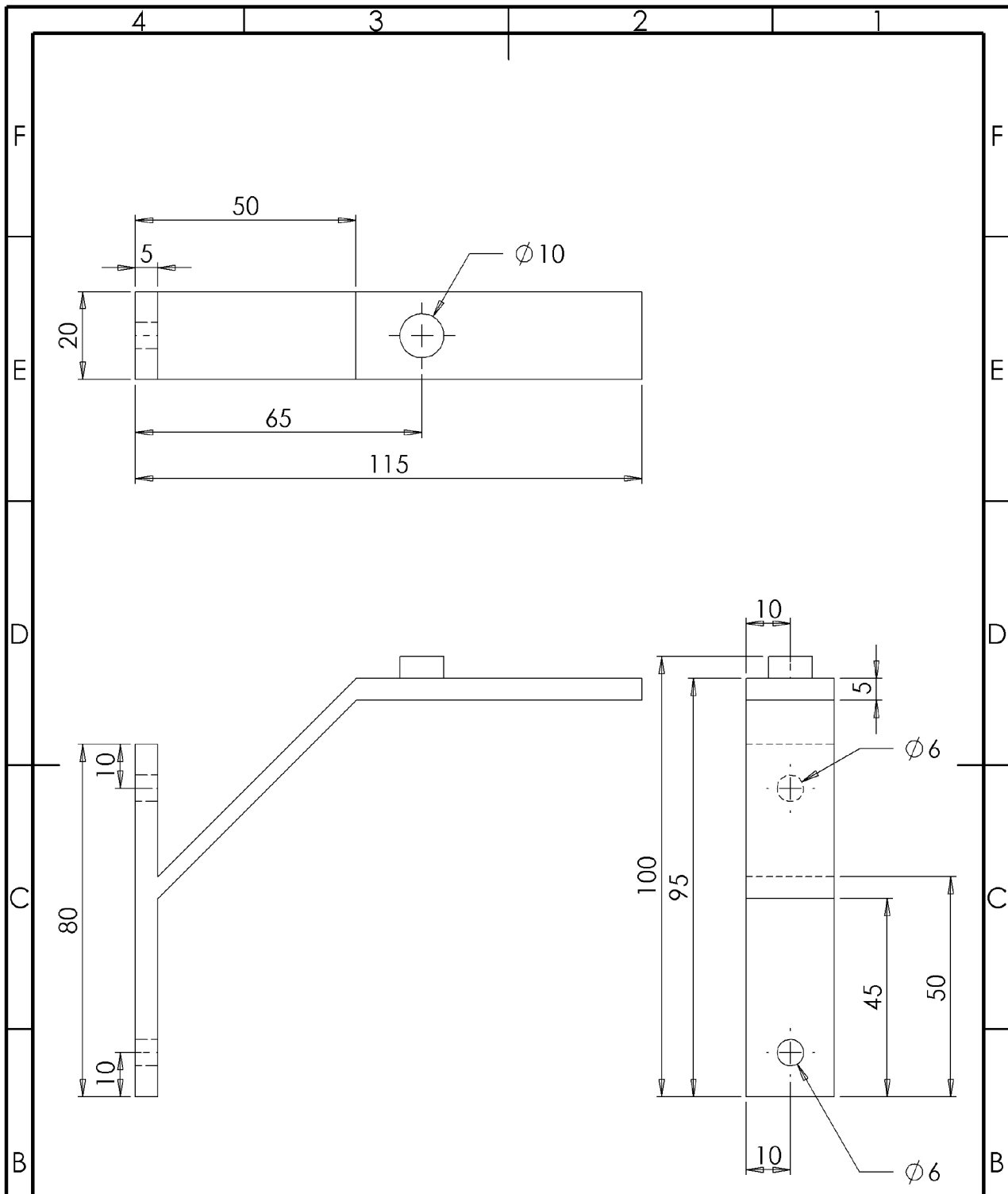


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CUT AWAY VIEW OF INDUCTION MOTOR ENCLOSURE AND BRACKET ASSEMBLY





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DRAWN	I. HUNTER	<i>I Hunter</i>		3/2/19	
CHK'D	M.T. HOOPLE	<i>M Hoople</i>		4/2/19	
APPV'D	P. WATTS	<i>P Watts</i>		5/2/19	
MATERIAL:				DWG. NO.	A4
LOW CARBON STEEL				BTEC-DRG-320F	
WEIGHT:				SCALE:1:2	SHEET 1 OF 1

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson BTEC
Level 3 Nationals
Extended
Certificate

Centre Number

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Learner Registration Number

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Window for Supervised Period:

Wednesday 8 January 2020 – Wednesday 22 January 2020

Controlled hours: 8 hours

Paper Reference **31708H**

Engineering

Unit 3: Engineering Product Design and Manufacture

Part B

You must have:

Information Booklet containing engineering drawings (enclosed),
HB or B pencil, ruler, eraser, drawing instruments and calculator.

Total Marks

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Instructions

- Use **black** ink or ball-point pen.
- **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 working 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.
- Answer **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.
- The marks for **each** question 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 question.
- Check your answers if you have time at the end.

Turn over ►

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Instructions to Teachers 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 if needed.

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 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 5 consecutive working days.

Refer carefully to the instructions in this task booklet and the *BTEC Nationals 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 your knowledge and 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.

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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
- an interpretation of the brief into operational requirements
- a range of (three or four) 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 research notes will be retained securely by the centre after **Part B** and may be requested by Pearson if there is suspected malpractice.

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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 must not share your work with other learners.

In the Information Booklet you will be provided with drawings of:

- 1) the bracket
- 2) the induction motor enclosure and bracket assembly.

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 the project planning and product design changes made during the development process
- an interpretation of the brief into operational requirements
- a range of (three or four) 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 research notes must not be submitted with the final outcomes to Pearson.

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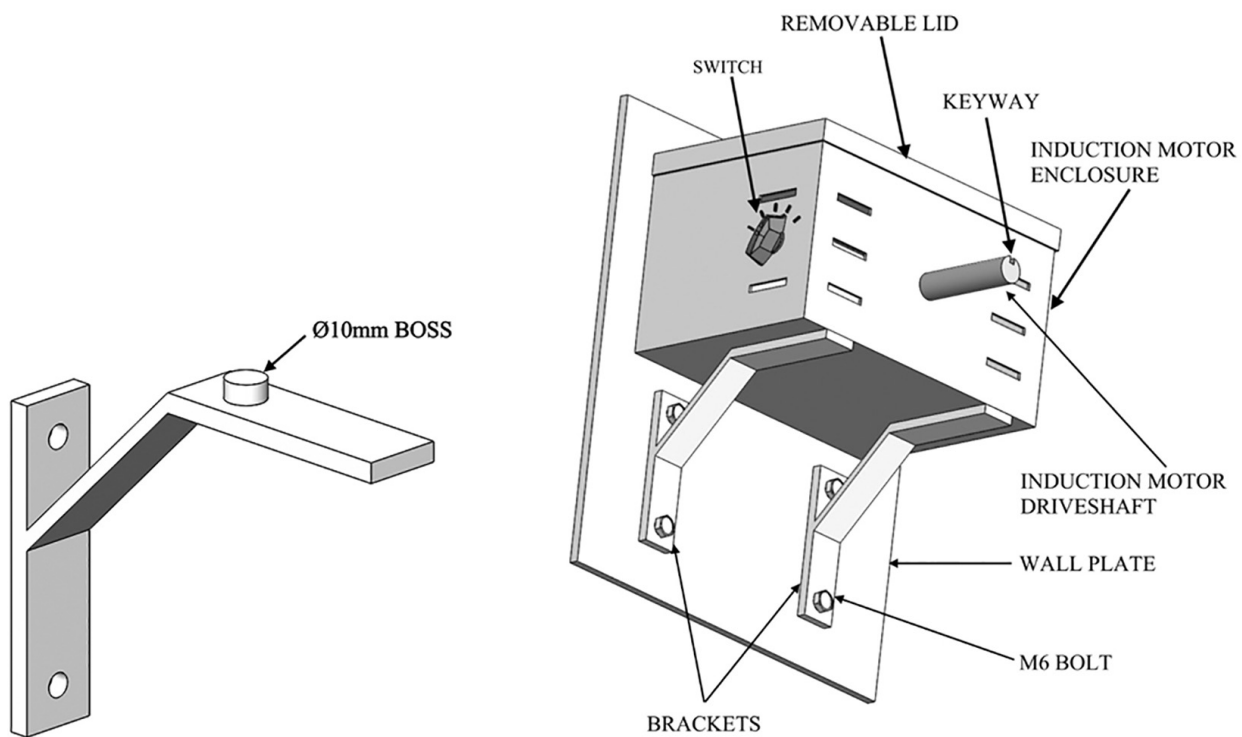
Part A Set Task Brief

A client has asked you, as a technician engineer, to optimise the design of a bracket for a modular induction motor system.

Part A Set Task Brief Information

The product is a bracket for a modular induction motor system. The holes in the base of the induction motor enclosure locate onto the 10 mm boss on each bracket using a transition fit. The brackets are bolted to a wall plate using M6 bolts. The modular induction motor system is mass produced, so the brackets will be manufactured in batches of 5000.

The brackets are cast from low carbon steel and powder coated.



Bracket dimensions: L= 115mm, W= 20mm, H=100mm



Part B Set Task Information

For **Part B**, you are allowed to use your individually prepared notes from **Part A** to support you during the supervised assessment period.

In the Information Booklet you will be provided with drawings of:

- 1) the bracket
- 2) the induction motor enclosure and bracket assembly.

Client brief

The modular induction motor system can be used to power, for example, compressors, pumps and conveyors by attaching them to the drive shaft. The induction motor enclosure can be moved to other locations where there are other brackets.

The client is aware that the current design for the brackets has a number of issues, but the redesign has been triggered by concerns about the appearance of the brackets. The sides of the boss have developed deep grooves and the powder coating has worn away on the top of the platform after a short amount of time. In addition, both the platform and the angle on the bracket appear to be fracturing and bending away from the bolt mounting.

The client believes that the source of the issues is vibrations from the induction motor as it operates, which is causing its enclosure to oscillate on the brackets. Redesign of the induction motor enclosure is not possible. The induction motor driveshaft can be used to rotate compressors, pumps and conveyors, so maintaining the structural integrity of the bracket is important. The client had intended the life cycle of the bracket to be 10 years.

The client needs you to identify when and under what conditions the bracket fails and to design a solution that will reduce the likelihood of this happening before the end of the intended life cycle.

Based on tests, the client has provided the following information in Table 1, which can be used to perform a statistical analysis of the in-service use of the bracket.

The client has asked you to come up with an alternative solution for the bracket that can take into account the most efficient use of materials and manufacturing processes. You also have an opportunity to reduce the issues with the existing design of the bracket by considering equipment interfaces and retrofitting extra, low cost components.

The bracket **must**:

- include a secure method of mounting onto the wall plate
- be able to safely support the existing induction motor enclosure
- not restrict access to the induction motor driveshaft
- allow the existing induction motor enclosure to be easily removed to allow it to be used in another location
- be capable of being manufactured in batches of 5000.

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Table 1 – Outcomes of tests on the bracket

Bracket	Bracket material	Speed of rotating motor driveshaft (revs/min)	Mass of rotating attachment on motor driveshaft (kg)	Life cycle to failure (in years)								
				Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	
A	Aluminium alloy	1000	0.5	1	2	2	3	2	2	1	3	2
B	Aluminium alloy	1000	0.4	3	4	2	3	2	2	2	3	4
C	Medium carbon steel	1000	0.4	4	2	4	3	3	3	4	3	2
D	High carbon steel	1400	0.3	4	4	6	4	4	4	2	4	4
E	High carbon steel	2000	0.3	5	6	5	4	5	5	3	5	4
F	High carbon steel	2000	0.2	5	6	5	8	5	5	7	5	4



P 6 0 1 7 7 A 0 7 4 0

Redesign of the product

Activity 1

At the start of the task create a short outline project time plan in your task booklet.

During the other activities (2 to 5), you should also record **in the Activity 1 section** of your task booklet:

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

(Total for Activity 1 = 6 marks)

Suggested time 45 minutes

Activity 2

Interpret the client 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 1 = 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

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Activity 4

Develop a modified product proposal with relevant design documentation.

The proposal **must** include:

- a solution including a final drawing.

The proposal **must** consider:

- 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 **must** 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



Activity 1

At the start of the task create a short outline project time plan in your task booklet.

During the other activities (2 to 5), you should also record **in the Activity 1 section** of your task booklet:

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

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Lined writing area for activity 1.

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(Total for Activity 1 = 6 marks)



Activity 2

Interpret the client brief into operational requirements, to include:

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

(6)

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(Total for Activity 2 = 6 marks)

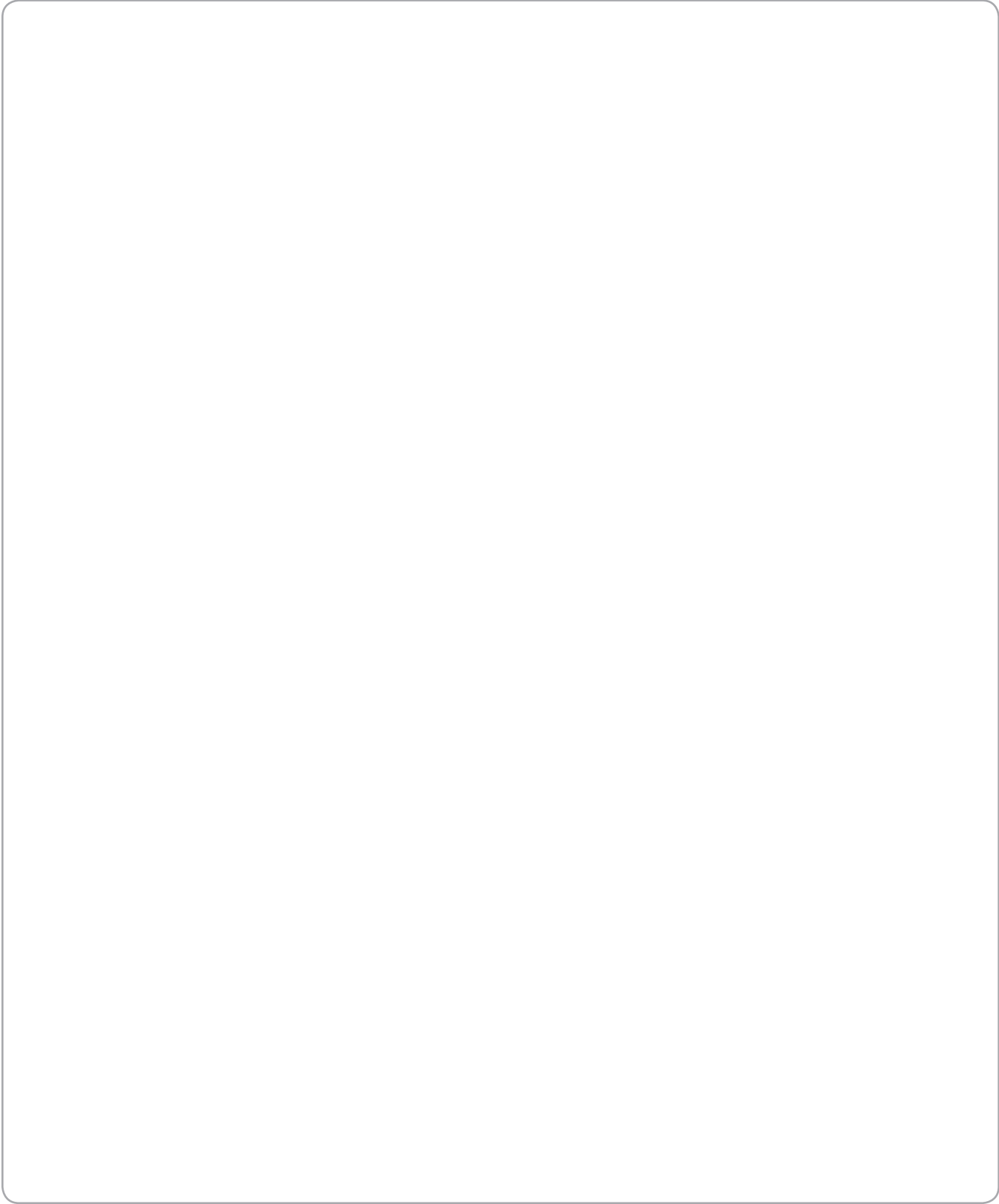


Activity 3

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

- sketches
- annotations.

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(Total for Activity 3 = 9 marks)



Activity 4

Develop a modified product proposal with relevant design documentation.

The proposal **must** include:

- a solution including a final drawing.

The proposal **must** consider:

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

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(Total for Activity 4 = 30 marks)



Activity 5

Your final task booklet entry **must** evaluate:

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

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(Total for Activity 5 = 9 marks)

TOTAL FOR TASK = 60 MARKS

