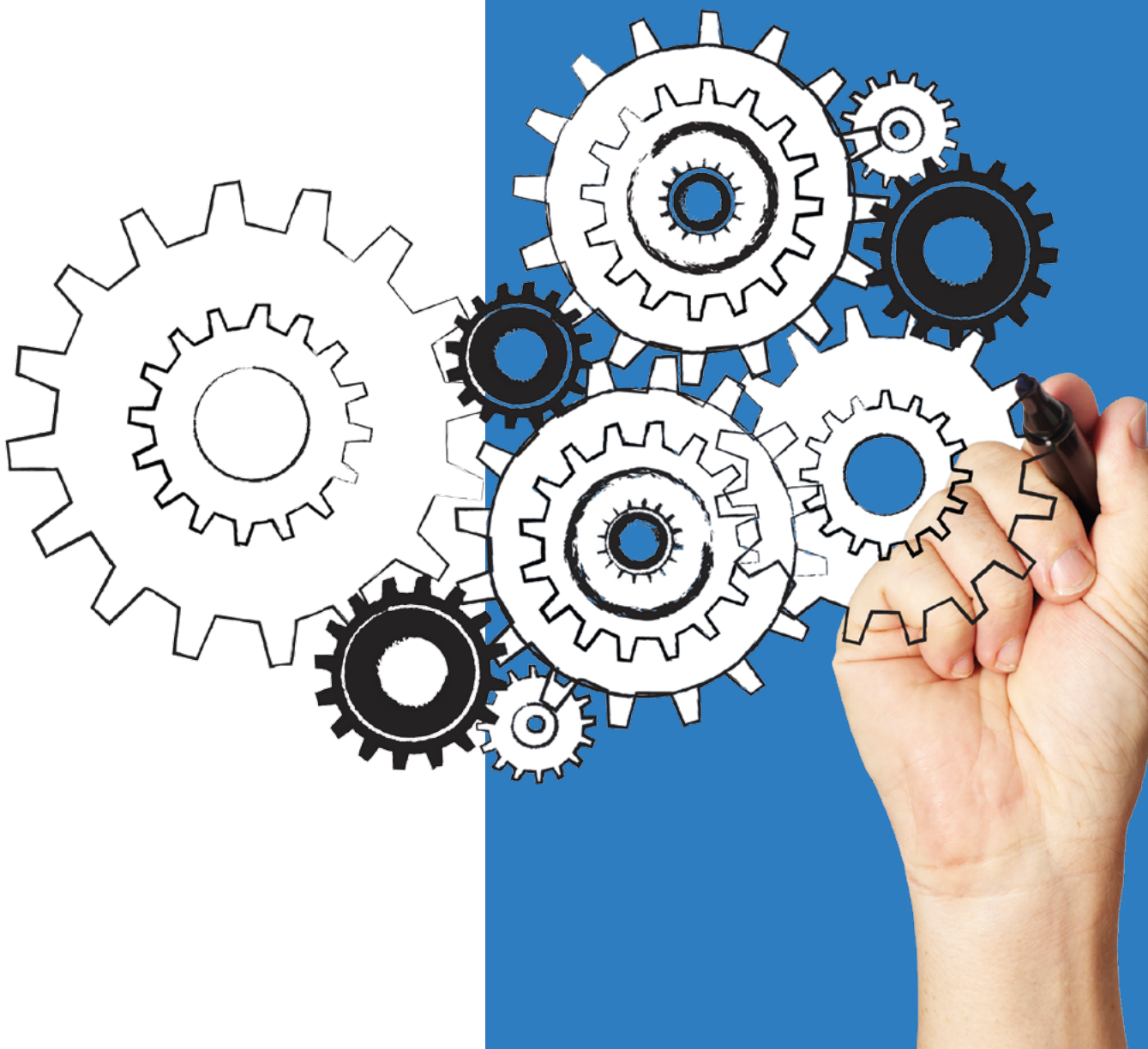
AQA
Realising potential

GCSE ENGINEERING (8852)

Written paper 8852/W
Understand how different levels are achieved and what makes an exemplary answer.

EXAMPLE RESPONSES



Whilst every attempt has been made to show a range of student responses, the following responses and examiner comments provide teachers with the best opportunity to understand the application of the mark scheme. They are not intended to be viewed as 'model' answers and the marking has not been subject to the usual standardisation process.

0 1 The following questions are about materials, their properties and how they can be used to make a range of engineering products.

0 1 . 1 The list below shows a range of different metals. Shade the lozenge next to the **three** metals which are **Non-Ferrous**.

[3 marks]

A Cast Iron ⬭

B Aluminium ⬬

C Copper ⬬

D Stainless Steel ⬭

E Bronze ⬬

F Low Carbon Steel ⬭

A correctly answered question. Students need to read questions of this type carefully and meet all the requirements ie three metals, all non-ferrous.
[3 marks]

0 1 . 2 Which **one** of the following properties allows copper to be drawn into long wire without breaking?

[1 mark]

A Compressive strength ⬭

B Ductility ●

C Toughness ⬭

D Brittleness ⬭

Only one answer can be correct in this case. In common with most Multiple Choice Questions, (MCQs). [1 mark]

0 1 . 3 Shade the correct lozenge to complete the sentence below.

Low Carbon Steel has a _____ strength to weight ratio than Carbon Fibre Reinforced Polymer.

[1 mark]

A Higher ⬭

B Lower ●

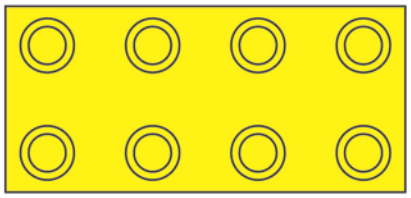
C Similar ⬭

Here the student has selected the correct answer. As this part of the paper will be automatically marked, the lozenge needs to be shaded, rather than filling in the missing word in the sentence. [1 mark]

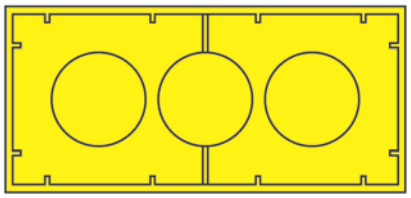
0 1 . 4 A toy brick is shown in **Figure 1**.

Figure 1

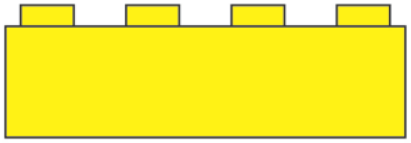
Top view



Bottom view



Side view



What process would be used to manufacture this brick?

[1 mark]

A Vacuum forming ○

B Extrusion ○

C Injection moulding ●

D Blow moulding ○

The correct response has been made. Provided the student understands orthographic views, they should see that there is no draft angle, which excludes vacuum forming, and has a complex interior form which rules out extrusion and blow moulding.
[1 mark]

0 1 . 5 Complete the following statement using the word bank provided.

Polymers are split into two categories. These are thermosetting and thermoplastic. Thermoplastics can be heated, which causes them to soften, allowing the material to be formed into a range of products. An advantage of using thermoplastics is that products can be easily recycled when the product is finished with.

Word bank

harden, burn, cut, disposed of, soften, formed, thermosetting, recycled, thermosoftening

[4 marks]

A four-mark answer, where the student needs to select the correct word from a word bank, to complete the statement. This displays both the correct answers and a useful technique. The student underlined each applicable word as it has been used.
[4 marks]

0 2 . 1 Stainless Steel and Low Carbon Steel can be used to make kitchen equipment.

Compare the two materials and their suitability for this purpose in terms of the following.

[6 marks]

Differences

Low Carbon Steel rusts. Stainless does not rust, so can be used where there is water and steam.

Stainless steel costs more than Low Carbon Steel.

Shared characteristics

Both are steel made from iron (fe) which means they are ferrous

Both have high melting points so would not be affected by kitchen temperatures or flames

Ease of manufacture

Stainless steel is harder than low Carbon steel, so is harder to shape

Stainless is far harder to solder or weld than low carbon.

Because stainless is harder it is more difficult to machine.

An extended answer question. The student needs to respond by comparing two steels. Much of this question is application of knowledge rather than recall. Although it starts with a simple statement, that is not qualified, the response for stainless does amply qualify why it would be suitable in a kitchen environment. Ability to withstand heat is the next response, again the qualification and explanation are both adequate. The final response about working qualities clearly displays ample knowledge for full marks to be awarded.
[6 marks]

0 2 . 2 A sheet of stainless steel is to be used in the manufacture of kitchen saucepans.

The sheet measures 3 metres by 2 metres and is 3 mm thick. Its density is given as 7.7 tonnes/m^3.

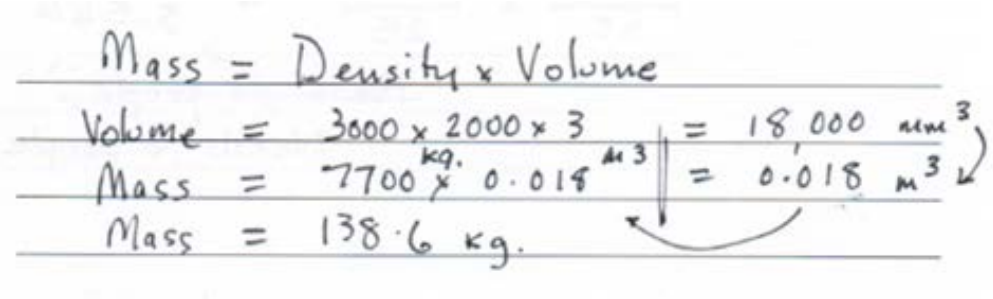
Using the formula Mass = Density x Volume:

$m = \rho \times v$

calculate the mass of the stainless steel. Show your working.

Give your answer in kilograms (kg).

[3 marks]



The correct formula is used, but this has been provided. Formula are used in three ways in GCSE Engineering.

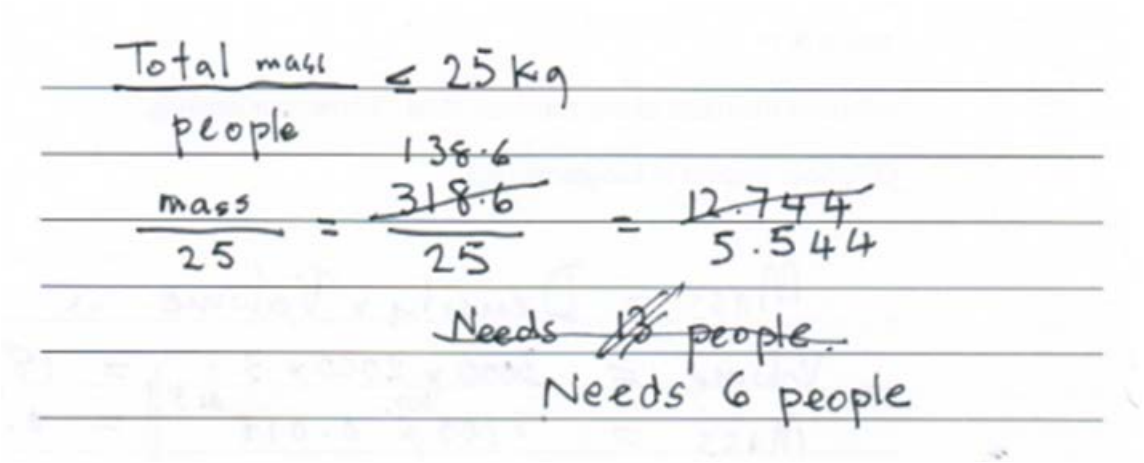
Recall of a formula – normally allocated a single mark.
Recall and application – which attracts higher marks.
Application of a given formula – no mark for the formula, but marks are allocated for correct use.

The student has provided working that is easy to follow and the correct answer and units means this would get full marks from the examiner.
[3 marks]

0 2 . 3 The maximum mass that can safely be lifted by one person is 25 kg.

What is the minimum number of people that would be required to lift the sheet of stainless steel safely? Show your working.

[2 marks]



The student has realised that a mistake has been made when carrying forward the answer from 2.2. The crossing out makes it clear to the examiner which figures are to be looked at.
However, if the correction had not been made, the student would not have been penalised for a carry forward error, as such a mistake is easy to make in the pressurised atmosphere of an examination room.
Clearly the student realises the importance of providing sensible answers, rather than decimal point perfection, by rounding up to the nearest person.
[2 marks]

0 2 . 4 The steel sheet costs £2.80 per m^2.

To make 1 pan, the manufacturer uses:

- 0.25 m^2 of stainless steel
- one handle
- two rivets.

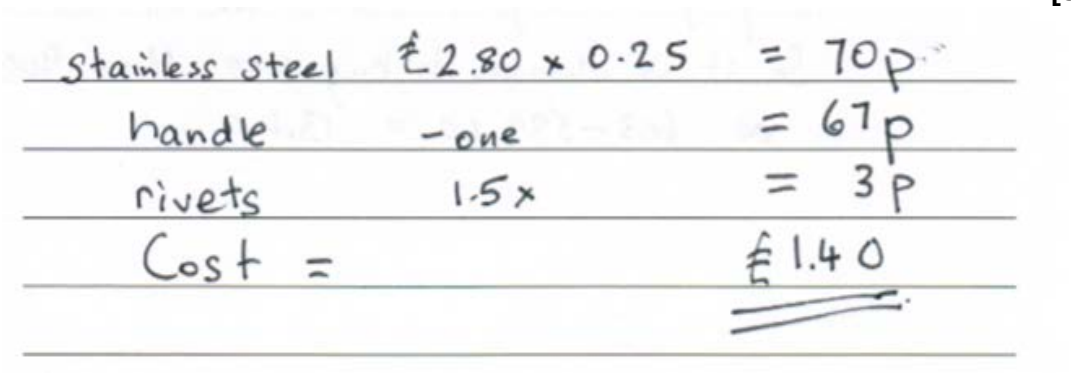
The cost of materials is shown in **Table 1**.

Table 1

Item	Cost (each)
Stainless steel	£2.80 per m^2
Handle	67p
Rivet	1.5p

Calculate the cost of each stainless steel pan. Show your working.

[3 marks]

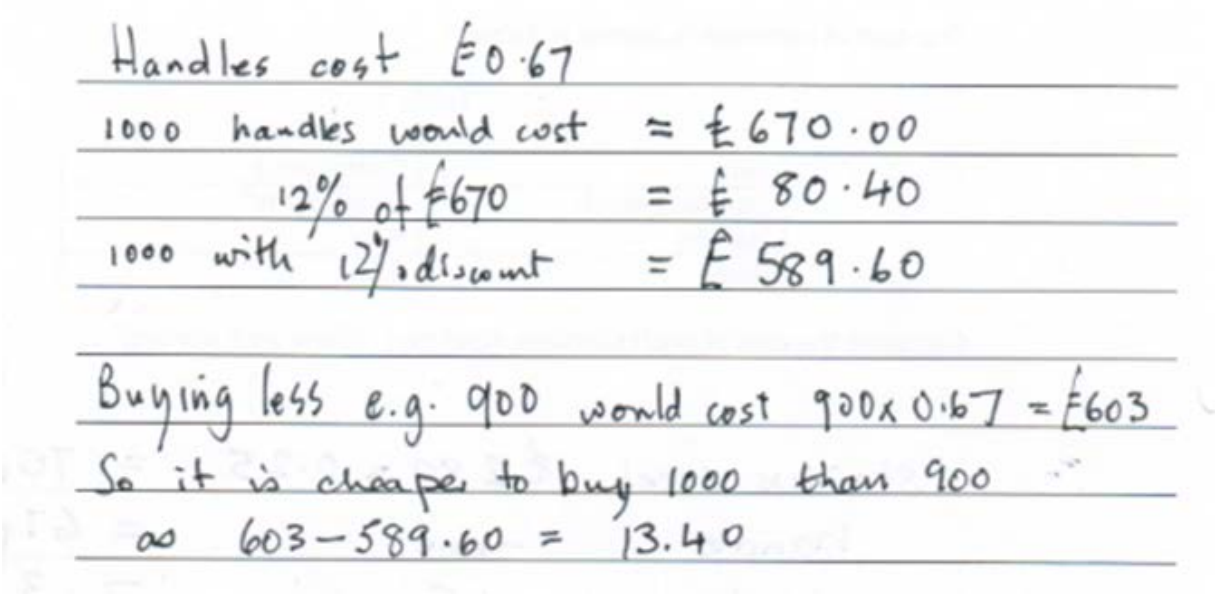


A straightforward calculation aimed at the grade 1–4 student. The need to use data in this way is common when pricing manufacturing.
[3 marks]

0 2 . 5 A manufacturer needs to make 900 pans.

If the supplier of handles offers a 12% discount on orders of 1000 units what would be the most cost effective number of handles for the manufacturer to buy and what would the saving be?

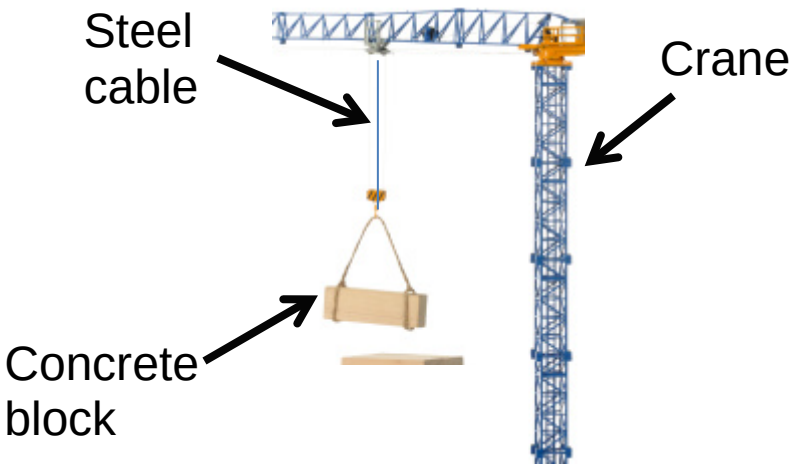
[3 marks]



A slightly more complex calculation. Following the working shows the student has calculated the cost of 1000 handles, then subtracted the discount, comparing the result to the cost of 900 bought at normal cost. Even though there is a need to buy a greater quantity, there is still a cost saving. In this case the mark scheme does not require the final answer to be expressed in pounds.
[3 marks]

0 3 **Figure 2** shows a crane lifting a concrete block.

Figure 2



The crane uses a steel cable to lift the concrete block.

The cable is 10 metres long but stretches to 10.2 metres when the block is being lifted.

0 3 . 1 Calculate the strain in the cable. Show your working.

[4 marks]

Strain = change in length / original length.

original length = 10.000 m.
stretched length = 10.200 m
Change = 0.2 m
Strain = $\frac{0.2}{10}$ = 0.02

In this question, the student needs to recall the formula for strain. It is always worth remembering that strain figures tend to be very small, so large answers should be discounted.
The working is easy to follow, and the formula has been recalled correctly so this answer would gain full marks.
[4 marks]

0 3 . 2 The cable has a diameter of 29 mm and the force applied by the block is 1500 N.

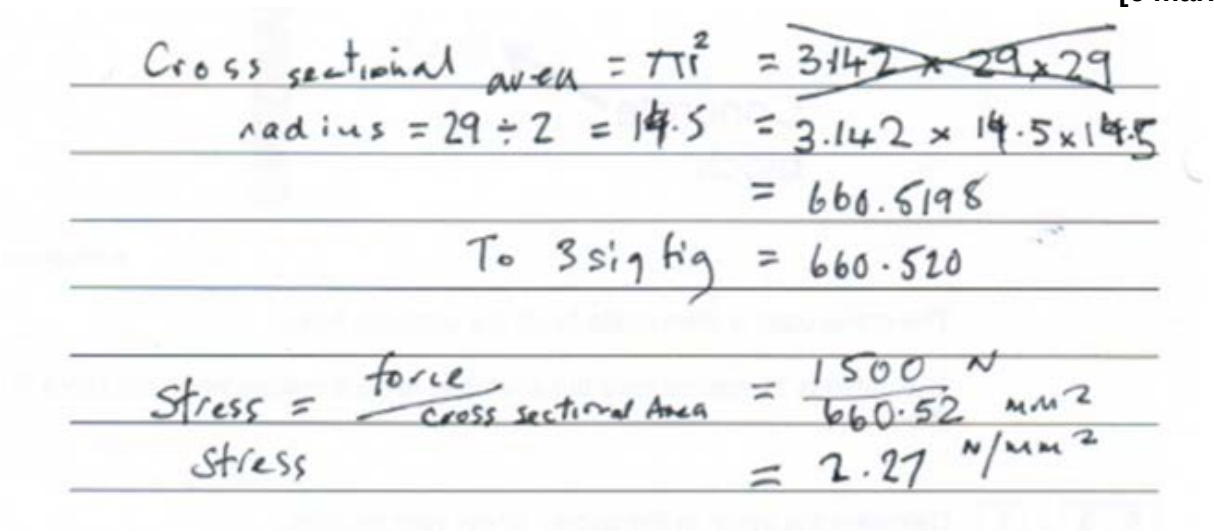
Calculate the stress applied to the cable as it lifts the block using the following formulae:

Cross sectional area = πr^2
Stress = Force/Cross sectional area.

Give your answer to **three** significant figures.

Show your working.

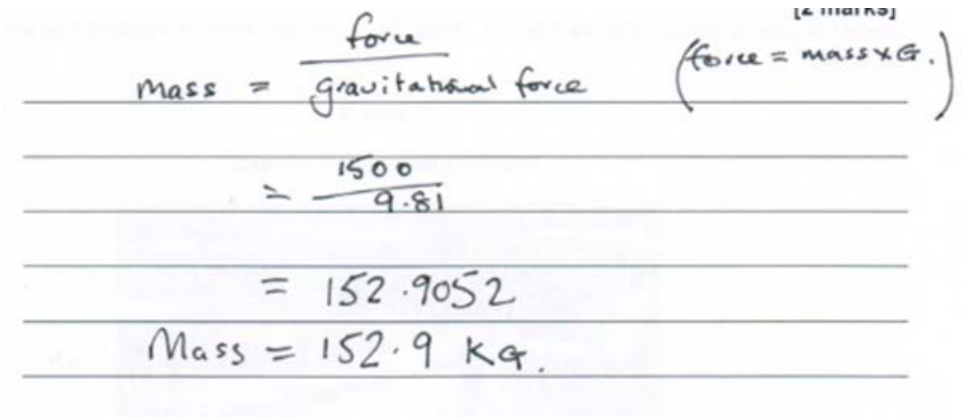
[6 marks]



Here the student has made a mistake on the first line. They have corrected this, calculating the radius on the second line. By crossing out clearly, the examiner will be able to understand which work is to be marked.
The altering of the calculator answer to three significant figures is a requirement of the question, but is a step often missed by students.
[6 marks]

0 3 . 3 What is the mass, in kilograms, of the block in **Figure 2**? Show your working. You should assume a value for gravity of 9.81.

[2 marks]

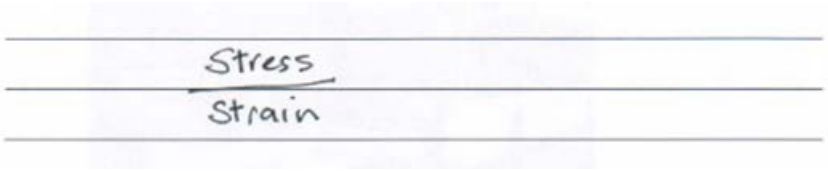


An example of recall and application of a formula, as an equation. The student shows a high level of both recall and understanding, including substituting the given value for gravity.
Sensible reduction to one decimal point in the answer. This does show the need for all students to take a calculator (non-programmable) into the examination.
[2 marks]

0 3 . 4 Young's modulus is used when designing engineered solutions to make sure a material is stiff enough for its intended purpose.

State the formula for Young's Modulus.

[1 mark]



Formula/equation correctly recalled.
[1 mark]

Questions 03.5 and 03.6 are about the design of a traffic control system using a bollard.

Study the photographs in **Figure 3** below. These show the operation of a bollard that allows access for buses.

Figure 3

Showing bollard fully raised

Showing bollard fully lowered

The final part of Question 3 is concerned with a control situation, so a context is described that will enable students to make informed judgements.

0 3 . 5 Analyse the bollard system in **Figure 3** and give two operating requirements for the bollard control system.

Explain the reason why each requirement is important.

Below is an example of how to answer.

Requirement: The bollard should remain in the raised position until the correct code is entered on a keypad, or a swipe card is presented.

Reason: To prevent unauthorised vehicles using the road.

[4 marks]

Requirement 1 Bollard must not allow traffic other than buses to pass.

Reason 1 That is the purpose, to only allow buses.

Requirement 2 Bollard must stay lowered until bus is completely passed.

Reason 2 Bollard must not damage the underside of the bus.

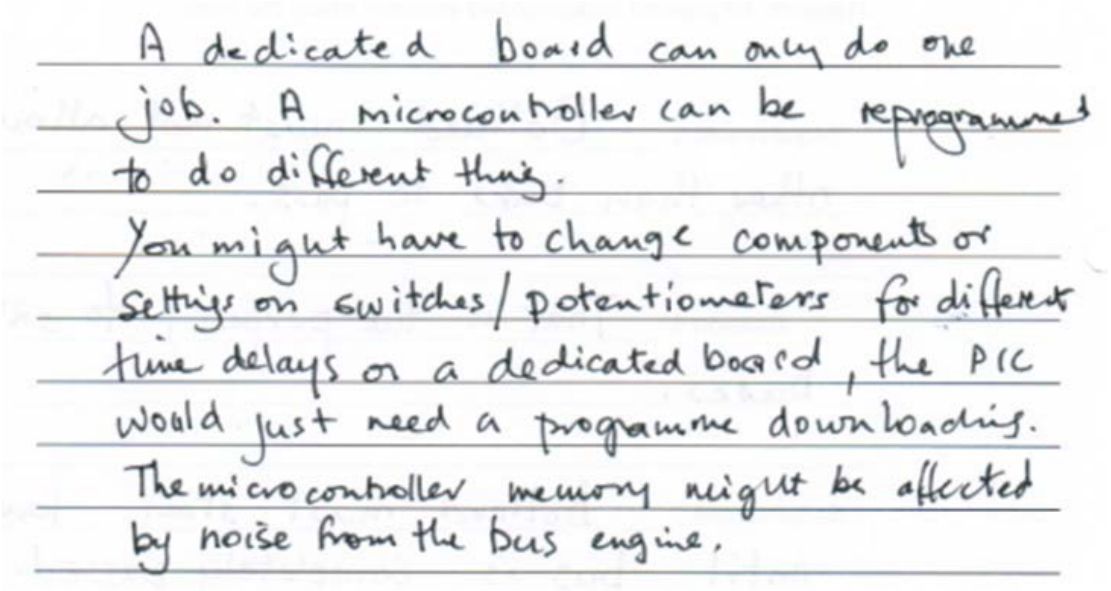
Although the student has answered all of the question, the first reason given is simply a repeat of the question. Other responses might have been that it should operate in all weathers, or it should prevent other vehicles from following closely behind the bus as a means of defeating the system.
[2 marks]

0 3 . 6 The bollard is controlled by an electronic system mounted on a circuit board.

The designer has to choose between using **either** a dedicated board using timer, logic and counter integrated circuits **or** a microcontroller (PIC) based circuit board.

Evaluate these **two** alternatives giving reasons for the selection of the most suitable system.

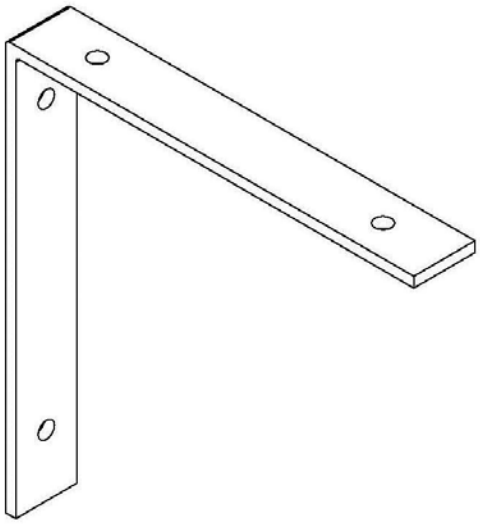
[3 marks]


A dedicated board can only do one job. A microcontroller can be reprogrammed to do different things.
You might have to change components or settings on switches / potentiometers for different time delays on a dedicated board, the PIC would just need a programme downloading.
The microcontroller memory might be affected by noise from the bus engine.

The question requires the two alternative systems to be evaluated. Students will need to rely on their knowledge and understanding to be able to answer this question fully. This response does offer a lot of sensible suggestions, with some detail. The final part of the answer would have been improved by a reference to 'electro-magnetic noise'. Even without that addition, this is a top mark band answer.
[3 marks]

0 4 Shelf brackets like the one shown in **Figure 4** are commonly used.

Figure 4



Identify a suitable material for a shelf bracket and explain why the material might be used.

[3 marks]

Material Low carbon steel

Explanation Strong enough to take load without bending.
Steel can be either bent to shape hot or cold depending on its thickness.
Steel can be finished with plastic coat, or painted or galvanised if it is used in a shed or outdoors.
Steel can be drilled easily.

Here the student needs to look carefully at the provided illustration to decide which materials would be suitable. As it is a shelf bracket, steel would be a sensible choice, but needs to be qualified as it would require a finish, compared with some other possibly suitable materials.
[3 marks]

0 5 A range of engineered products are manufactured using composite materials.

Carbon fibre reinforced polymer is an increasingly popular material.

0 5 . 1 Name **two** composite materials other than carbon fibre reinforced polymer.

[2 marks]

Composite 1 GRP

Composite 2 Plywood

These responses are correct, any correct composite name would be accepted with the exception of Carbon Fibre Reinforced Polymer.
[2 marks]

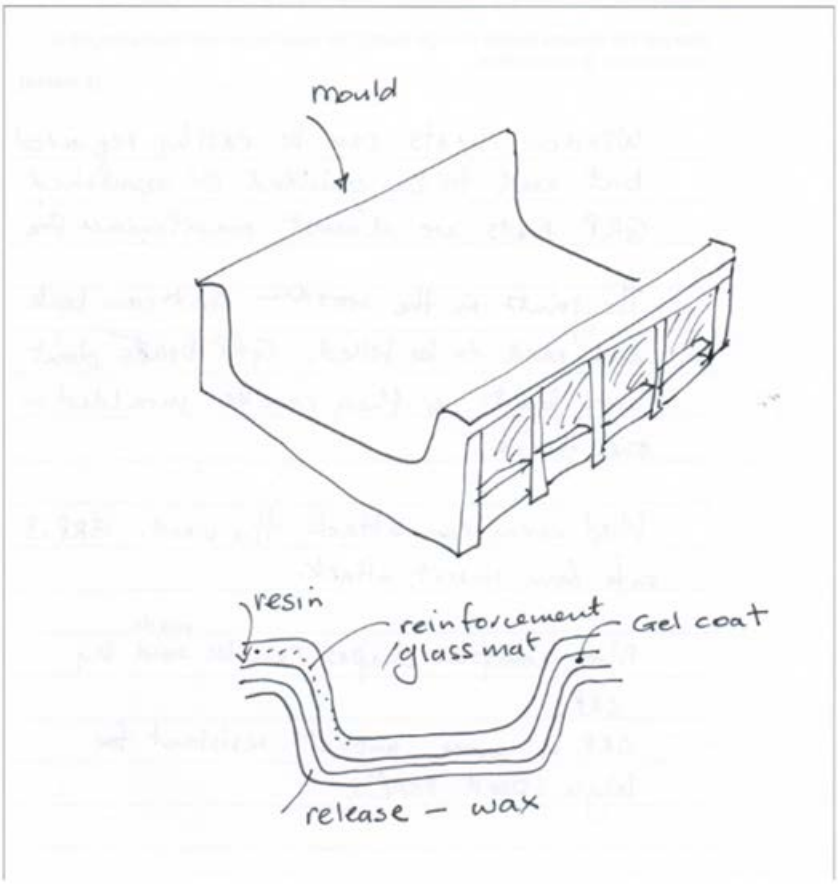
0 5 . 2 Using notes and/or sketches in the space below and on **page 21**, describe the lay up process.

[6 marks]

1. A mould is prepared - it is the negative of the required shape.
2. The mould is covered with a release agent - wax
3. Coloured resin is painted onto the wax
4. clear resin is added to the mould and then glass matting is pushed into the resin.
5. the resin is left to harden.
6. other layers may be added if needed

The resin is mixed with an accelerator which acts as a catalyst and speeds up the setting.

The finished moulding is removed and trimed to shape.

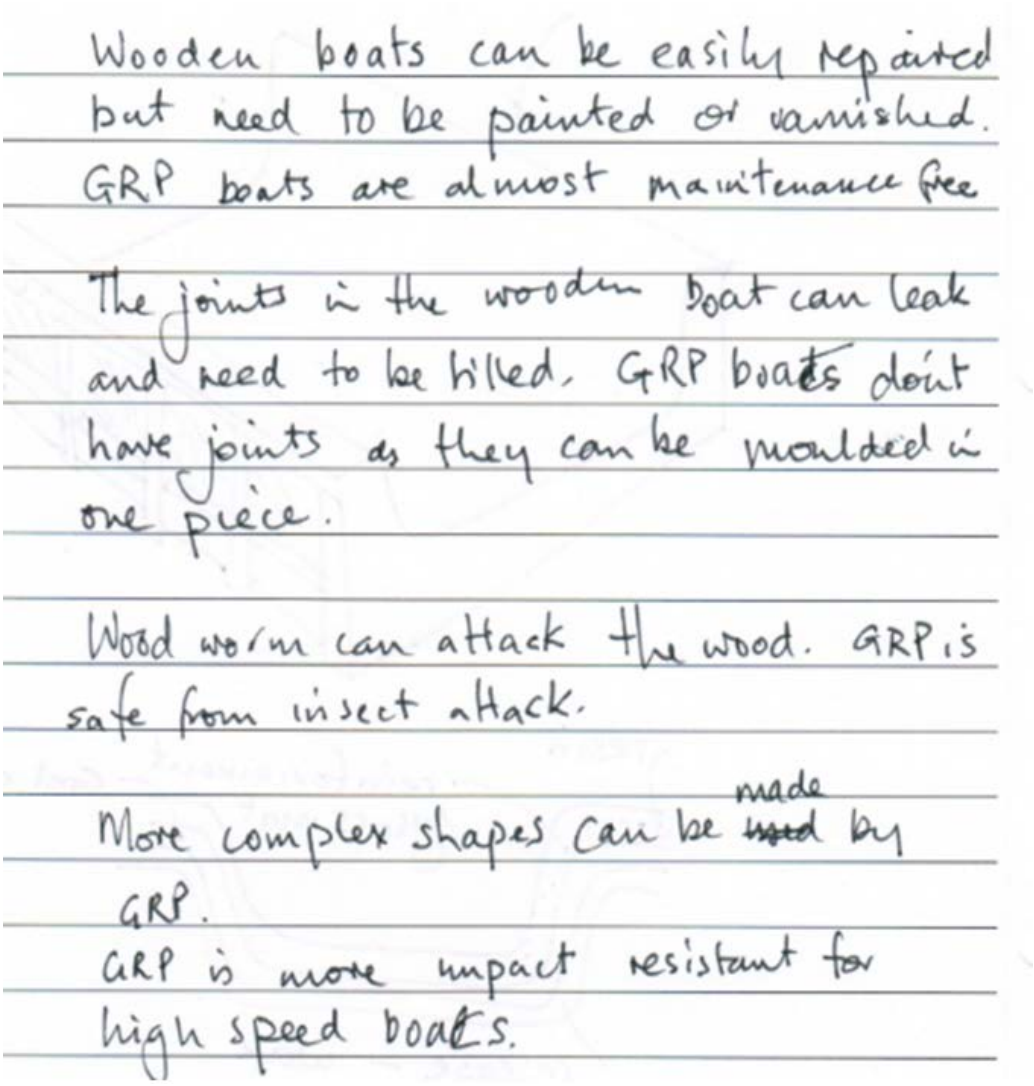


A well answered question, all stages are well described. However, the student has missed that this question is a continuation of the beginning of Question 5 where carbon fibre reinforced polymer was introduced as the specific material. The student is mentioning glass fibre matting. This is not a major issue, possibly one mark, and if a proportion of students made the same error the mark scheme would be adapted.
[6 marks]

0 5 . 3 Traditionally, boats were constructed from strips of wood held together by copper rivets. More recently there has been a change to using reinforced polymers.

Analyse the reasons for this change stating the advantages and disadvantages of each method of construction.

[6 marks]



Wooden boats can be easily repaired but need to be painted or varnished. GRP boats are almost maintenance free

The joints in the wooden boat can leak and need to be filled. GRP boats dont have joints as they can be moulded in one piece.

Wood worm can attack the wood. GRP is safe from insect attack.

More complex shapes can be ~~used~~ made by GRP.

GRP is more impact resistant for high speed boats.

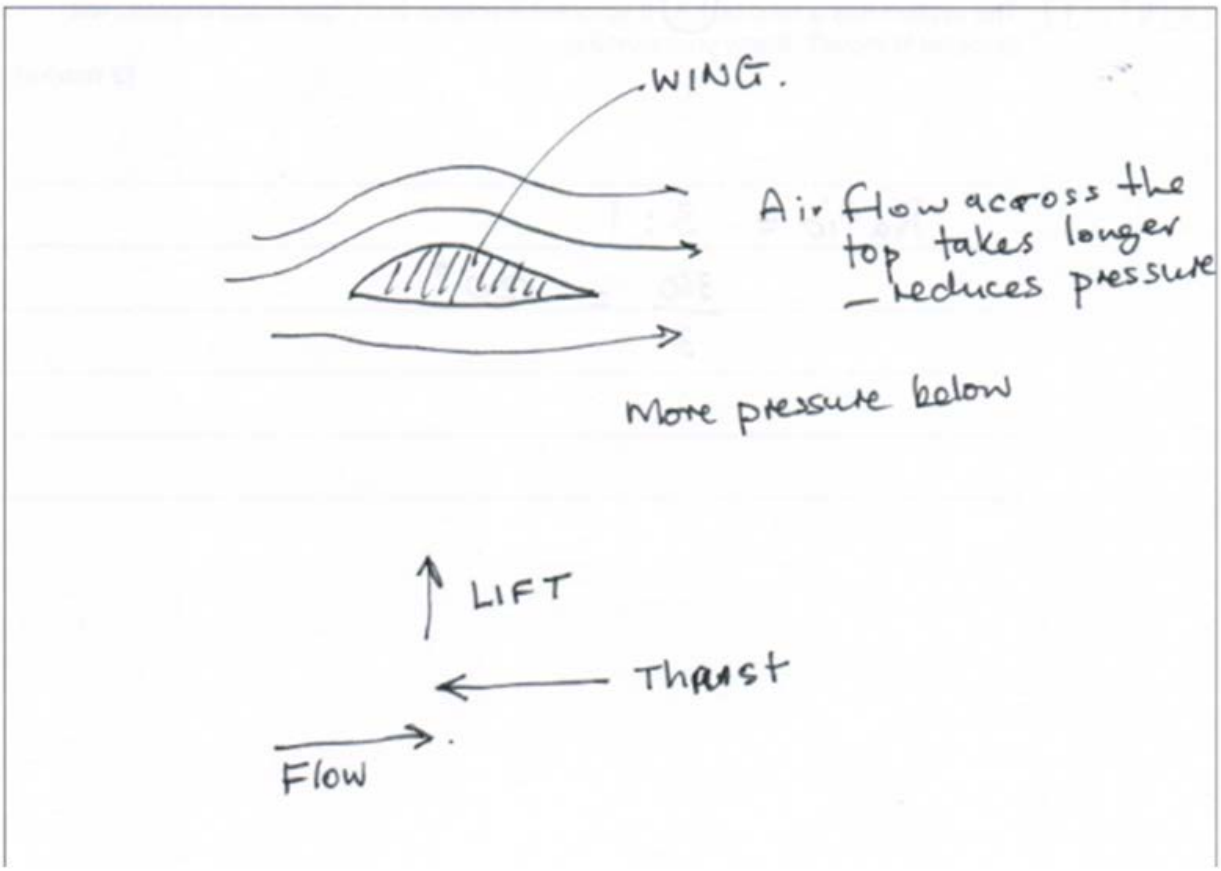
A good answer that displays sufficient knowledge. However, although four valid points have been made with regard to: maintenance, lack of joints that could lead to leakage and insect attack, other points really need further qualification. This could have been more complex shapes being possible with GRP, although true explaining that they can be produced, as it is possible to produce smaller bends with GRP, would have added considerably to the answer. Likewise, some reference to relative strength would have improved the last part.
[5 marks]

0 5 . 4 Explain the term aerodynamic lift. You may use sketches in your answer.

[2 marks]

Wing lifts as pressure is greater underneath.

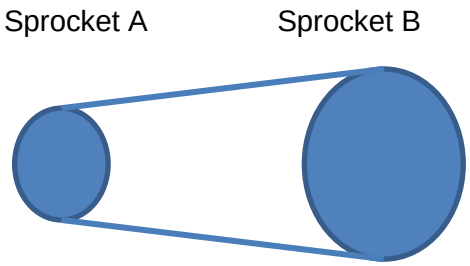
Space for sketches for **Question 5.4**



Although the written response is brief, it contains the salient points. The diagram however absolutely clarifies the response.
[2 marks]

0 6 **Figure 5** shows a chain and sprocket system similar to that used in machinery.

Figure 5



0 6 . 1 The system has a ratio of 1:3. If sprocket A rotates 360°, how many degrees will sprocket B move? Show your working.

[2 marks]

Ratio = 3 : 1

$\frac{360}{3} = 120°$

The ratio should be 3:1 not 1:3. Although the question does not specify which is the driver or driven pulley. The response above is correct although an intermediate step has been missed in the working. [1 mark]

0 6 . 2 Cams and followers can be used to convert rotary motion to reciprocating motion.

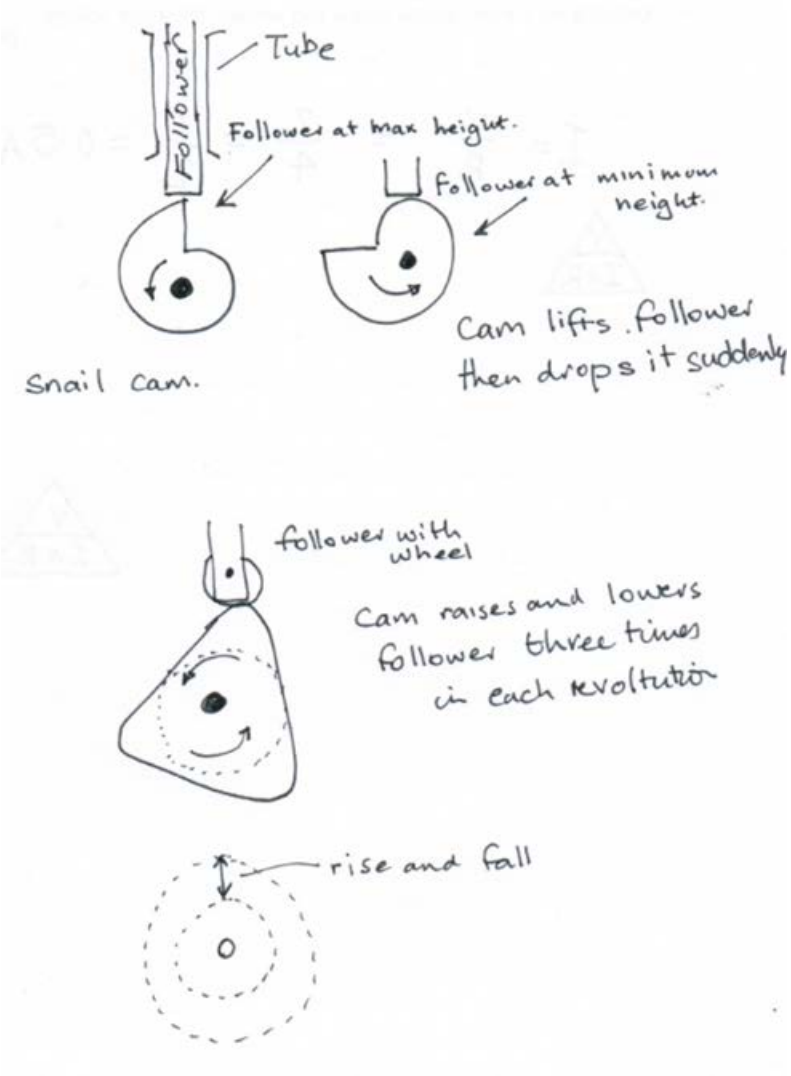
Using notes and sketches in the space below and on **page 27** describe how a cam and follower system works.

[6 marks]

Snail and other cams are placed on a shaft - cam shaft.
as the shaft turns (rotary) the follower is fitted in a tube and rises and falls depending on the shape of the cam. This up and down motion is called reciprocation.
Cams can lift once or several times each rotation depending on their shape

The written answer and sketches (following page) combined, give an excellent response to the question. Explaining in detail, and showing knowledge of at least two different forms of cams. The function of the cam shaft is touched upon and could have been explained further. Full marks can be awarded to responses of this quality.
[6 marks]

Space for sketches for question **6.2**



0 7 . 1 Bicycle headlights sometimes use lamps. The lamp has a resistance of 4 ohms and a supply of 2 volts.

Using notes and sketches in the space below and on **page 27** describe how a cam and follower system works.

[4 marks]

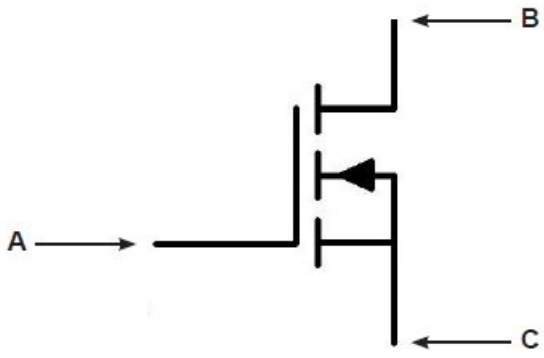
$I = \frac{V}{R} = \frac{2}{4} = \frac{1}{2} = 0.5\,A.$

The equation for Ohm's law is not evident in written form but the graphic suffices. The calculation is straightforward and the majority of students remembering the equation should gain full marks.
[4 marks]

0 7 . 2 Name the three connections of the Field Effect Transistor shown in **Figure 6**.

[3 marks]

Figure 6



A Gate
B Source
C Drain

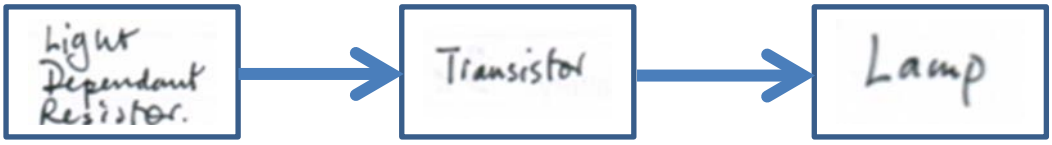
Here, the student has confused the drain and source connections. A useful tip is to always look at the direction of the arrows on symbols.
Another frequent error is to confuse FETs with Bi-polar transistors and label as collector, emitter and base.
[1 mark]

0 7 . 3 **Figure 7** is a systems diagram that represents a bicycle headlight which automatically turns on at night.

Figure 7

Complete **Figure 8** with the names of suitable components which would allow the system to operate.

Figure 8



[3 marks]

Although the mark scheme is looking for a more sophisticated response, such as Analogue to Digital Converter or microcontroller, this is an adequate answer as the circuit based on this block diagram would function as required.
[3 marks]

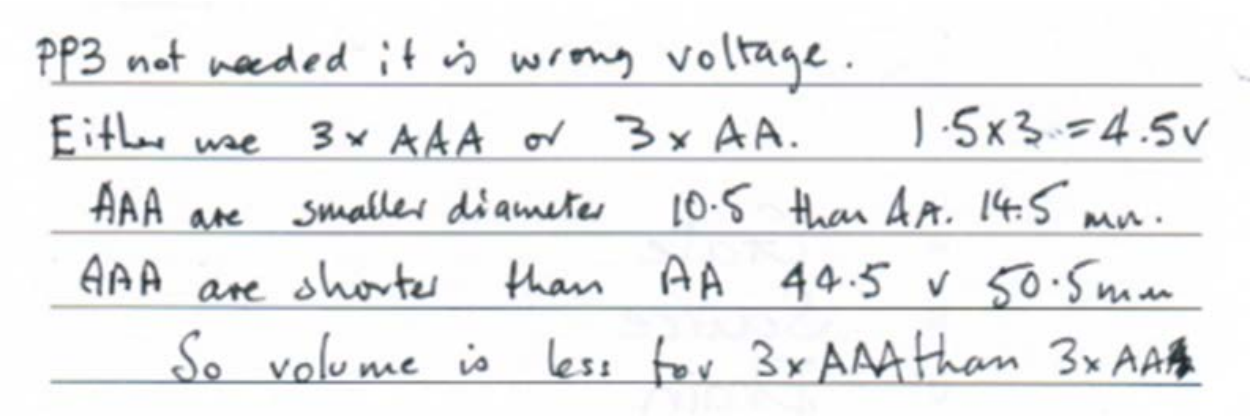
0 7 . 4 The headlight needs a minimum of 4.5 volts to operate. **Table 3** shows a range of suitable batteries.

Using the information in the table recommend the most space-efficient way of powering the headlight. Show your working.

Table 2

Type of battery	Voltage (v)	Size (mm)	Weight (g)
PP3	9	26.5 x 17.5 x 48.5	46
AAA	1.5	10.5 (dia) x 44.5	14
AA	1.5	14.5 (dia) x 50.5	15

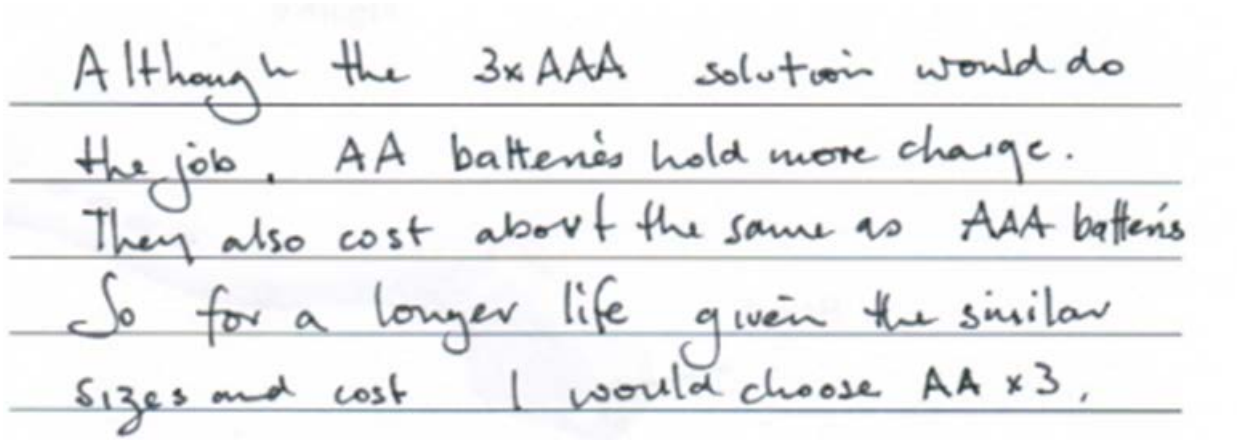
[5 marks]



The student has not carried out formal calculations, which might reduce the mark slightly. However, the judgements are sound and based on the available evidence, so this response would score highly. The statement regarding the inappropriate voltage of the PP3 is correct. It would be pointless proceeding any further with that line of enquiry.
[4 marks]

0 7 . 5 Using the information in **Table 2** and other considerations, state which battery type you would choose for the headlight and give reasons for your choice.

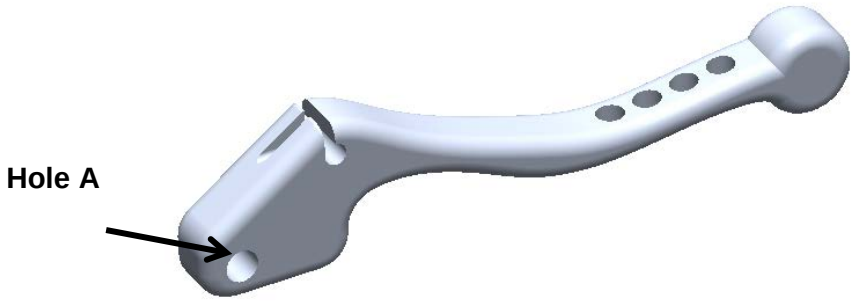
[5 marks]



This seems an entirely rational response, two reasons are given, although the last point is simply a repeat.
[2 marks]

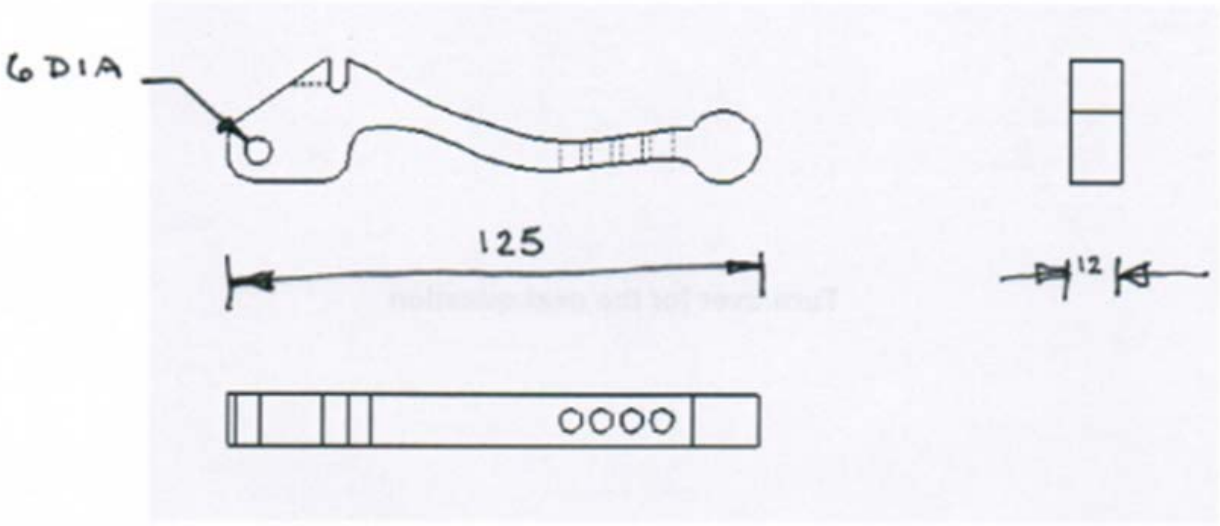
0 7 . 6 **Figure 9** shows a brake lever from a bicycle. The lever is 12mm wide and has an overall length of 125mm. The pivot hole (labelled Hole A) has a radius of 3mm.

Figure 9



Using standard conventions, add **two** dimensions to **Figure 10** below.

Figure 10



[4 marks]

Two correct dimensions, but no leader lines, some arrow heads not filled, diameter not correctly dimensioned.
[2 marks]

0 7 . 7 Complete **Table 3** to create a production plan listing five major operations needed to manufacture the brake lever. Some parts have been completed for you. Select the others from the list given on **page 35** by inserting the identification **letter (A – J)** in the appropriate box.

[10 marks]

Table 3

Order	Operation	Tools/Equipment	Description
1	Cast the blank lever	E	I
2	Machine the lever to correct size and tolerances	B	H
3	Make holes for brake cable and ventilation	K	A
4	Deburr holes	F	J
5	Finish surface	C	G

Another two-page spread question, students need to identify the tools and equipment used, and description of the process placing them in the corresponding box for the listed manufacturing operation. The correct solution is shown, the accompanying information is shown on the following page.
[10 marks]

Place lever into vice ensuring correct level. Remove excess material. **H**

Pillar drill
6mm dia. drill bit
K

Abrasive sheets and Buffing wheel
C

Pillar drill
Countersink bit
F

Cope/Drag
Split pattern
Runner/Riser
Sprue
Crucible
E

Use vice to secure work piece and prevent drill bit from slipping.
A

Place pattern into casting boxes. Compact sand and remove pattern.
Pour Aluminium.
I

Vertical Milling machine
Cutting tool
Vice
B

Remove scratches and polish until shiny. **G**

Remove any sharp edges created by drilling the holes. **J**

Create drawing using Computer Aided Design (CAD) **D**

Turn over for the next question

0 7 . 8 Once manufactured, the brake lever needs to be checked for tolerance. Name a tool that could be used to check the tolerance of the brake lever and describe how this tool would be used to check the tolerance.

[3 marks]

Tool Digital Vernier

How is the tool used?

Switched on and set to Zero.
Jaws opened and then closed on object
Reading recorded and compared with tolerance
The tolerance would give a maximum and
minimum acceptable measurement
for the part.

Good answer, but it fails to explain how the measurement would actually be read, as the display is not mentioned.
[2 marks]

0 7 . 9 A single lever has been sandcast as a prototype. This is now going into production. Discuss **three** advantages of using pressure die casting instead of sandcasting to make this component.

[3 marks]

1 Quicker, no need to set up casting box for each casting.

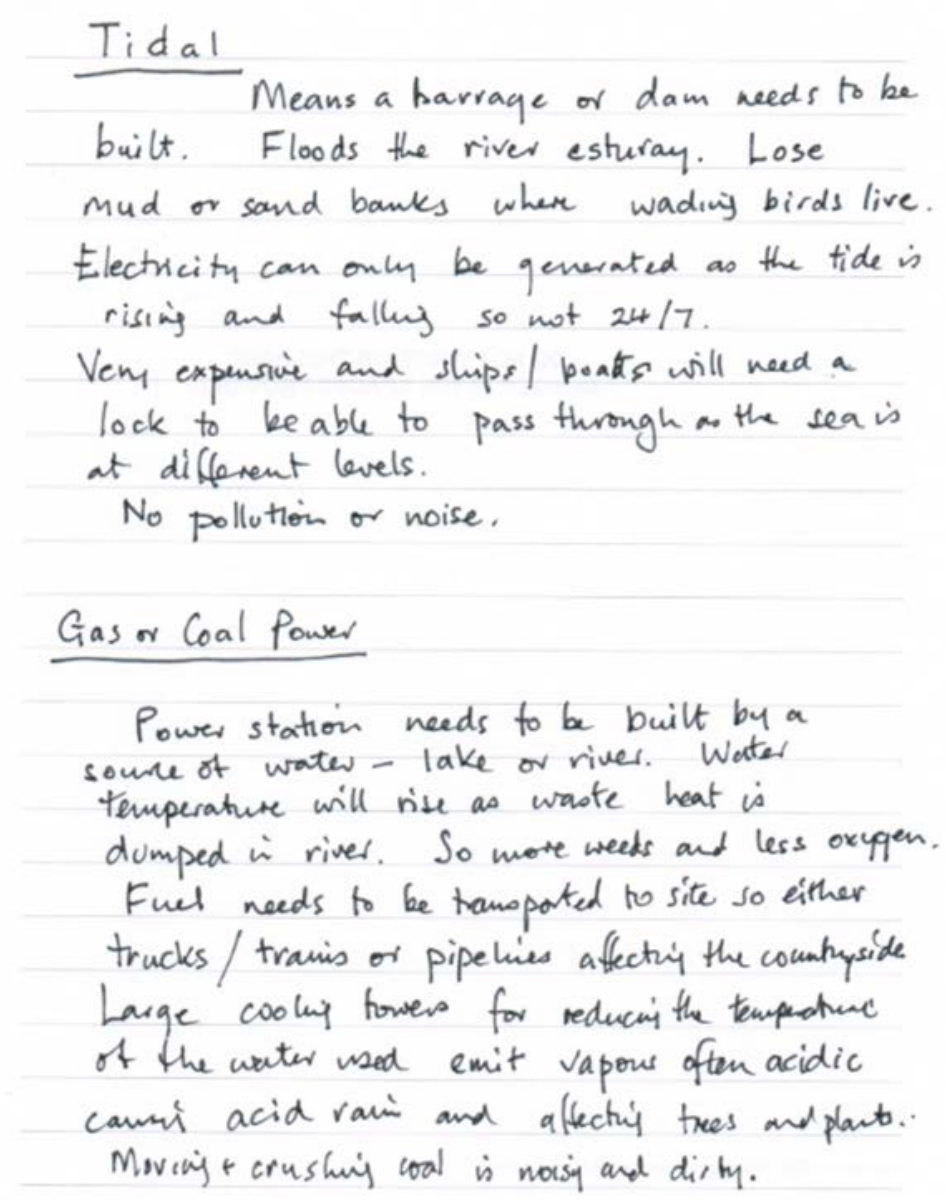
2 Less waste, no need for big runner and risers.

3 less to clean off and no sand texture on casting.

Brief but explicit answers, covering three clear advantages, and showing good understanding of both methods.
[3 marks]

0 8 Manufacturing equipment can be powered using main electricity which can be generated using a variety of different methods. Considering at least two methods, evaluate the environmental impact of generating electricity.

[3 marks]



Tidal

Means a barrage or dam needs to be built. Floods the river estuary. Lose mud or sand banks where wading birds live. Electricity can only be generated as the tide is rising and falling so not 24/7.
Very expensive and ships / boats will need a lock to be able to pass through as the sea is at different levels.
No pollution or noise.

Gas or Coal Power

Power station needs to be built by a source of water – lake or river. Water temperature will rise as waste heat is dumped in river. So more weeds and less oxygen.
Fuel needs to be transported to site so either trucks / trains or pipelines affecting the countryside
Large cooling towers for reducing the temperature of the water used emit vapour often acidic causing acid rain and affecting trees and plants.
Moving + crushing coal is noisy and dirty.

Both parts contain four or more good points well explained so this would be a top mark band answer. More methods with less points each could gain similar marks. It is important that all points relate to environmental impact only.
[8 marks]