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GCE

Sample Assessment Materials

Edexcel Advanced Subsidiary GCE in Engineering (Single Award: 8371)

Edexcel Advanced GCE in Engineering (Single Award: 9371)

First assessment June 2010

Issue 2 – May 2009

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Authorised by Roger Beard
Prepared by Phil Myers

Publications code UA015761

Contents

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear

  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter

  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Engineering

Unit 1: Engineering Materials, Processes and Techniques

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
6931/01

You must have:
Pencil, pen

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care on these questions with your spelling, punctuation and grammar, as well as the clarity of expression.*

Advice

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

Turn over ▶

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Answer ALL questions.

The questions in this paper relate to a petrol powered motorcycle, shown below in Figure 1.

Figure 1

1 A number of different processes are used to manufacture the motorcycle.

Complete the following table by giving

- **one** hazard/risk involved in each process
- **one** precaution/control measure which will prevent this risk resulting in an injury

Each answer **must** be different.

The first line of the table has been completed for you.

Process	**Hazard/Risk**	**Precaution/Control Measure**
Testing exhaust pipe	Inhalation of exhaust gases	Work in a ventilated area
Spot welding		
Use of epoxy adhesives		
Soldering		
Milling		

(Total for Question 1 = 8 marks)

2 Engineering materials can be grouped into classes.

Complete the following table by giving

- **one** specific material for each class of material listed
- **one** significant property of that material

Class of material	**Specific material**	**Significant property of material**
Non-ferrous metal		
Ferrous metal		
Composite		
Ceramic		

(Total for Question 2 = 8 marks)

3 Some parts of the motorcycle are galvanised or electroplated.

(a) (i) Describe how galvanising is carried out.

(3)

(ii) Describe how electroplating is carried out.

(3)

(b) State **one** reason for using these processes.

(1)

(Total for Question 3 = 7 marks)

4 (a) (i) Identify a suitable material to use for the spokes of the motorcycle wheels.

(1)

(ii) Explain why your chosen material is suitable.

(2)

(b) (i) Identify **two** materials that could be used for the headlight lens of the motorcycle.

(2)

Material 1:

Material 2:

(ii) Compare, using advantages and disadvantages, the properties of your chosen materials.

(4)

(Total for Question 4 = 9 marks)

5 The following table lists properties for some of the materials that were considered for use in the manufacture of the motorcycle.

Material	Density kg m^{-3}	Electrical resistivity Ω m	Tensile strength MN m^{-2}	Thermal conductivity W m^{-1} K^{-1}	Material cost, relative to aluminium alloy
Low carbon steel	7860	10.6×10^{-8}	690	63	0.2
Copper	8960	1.68×10^{-8}	215	385	0.95
Aluminium alloy	2800	2.85×10^{-8}	500	180	1.0
Nickel alloy	7990	85.5×10^{-8}	350	29	3.0
Stainless steel	7930	72.3×10^{-8}	570	70	1.1

(a) For each of the following applications, identify an appropriate material from the table above and explain the reason for your choice.

(i) The handlebars.

Material:

(1)

.....

Reason:

(2)

.....

.....

.....

(ii) The electrical wiring.

Material:

(1)

Reason:

(2)

(iii) The lightest motorcycle frame.

Material:

(1)

Reason:

(2)

(iv) The lowest cost material for the mudguard.

Material:

(1)

Reason:

(2)

(b) The engine casing is manufactured using gravity die casting.

(i) Name a suitable material for the engine casing.

(1)

(ii) Describe the process of gravity die casting.

(4)

(c) Explain **two** benefits of using stainless steel for the exhaust pipe.

(4)

(Total for Question 5 = 21 marks)

6 The mudguard is manufactured from carbon fibre reinforced plastic.

(a) Describe the process of making the mudguard using carbon fibre reinforced plastic.

(5)

(b) Give **one** advantage of using carbon fibre reinforced plastic to make the mudguard.

(1)

(Total for Question 6 = 6 marks)

7 The motorcycle mirrors are attached to the handlebars with adjustable fixings.

The mirrors can be adjusted to suit different people.

Using sketches and notes, design a bracket that will attach the arm of a mirror to the motorcycle handlebars and allow adjustment up and down and from side to side.

Use the following information in your design:

- Diameter of mirror arm – 10mm
- Diameter of handlebars – 25mm

Your annotated design must include methods of attachment, adjustment and dimensions relating to handlebars and mirror arm.

(Total for Question 7 = 10 marks)

8 Testing the hardness of materials requires special equipment and techniques.

(a) (i) Name a standard test used to measure the hardness of metals.

(1)

.....

(ii) In the space below, draw and label a diagram showing how the hardness of a metal is measured using your chosen standard test.

(3)

(iii) Describe how your chosen standard test is carried out.

(4)

.....

.....

.....

.....

(b) Name the unit of hardness or the hardness scale for your chosen standard test.

(1)

.....

(Total for Question 8 = 9 marks)

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9 (a) A tensile test is to be carried out on the steel used for the frame of the motorcycle.

(i) Sketch the shape of the steel sample that would be used for this test.

(2)

(ii) Explain how the following quantities could be obtained from a Load – Extension tensile test.

Stress

(2)

Strain

(2)

*(b) The results of a tensile test on two different materials are shown in Figure 2. The specimen sizes are identical for the two materials.

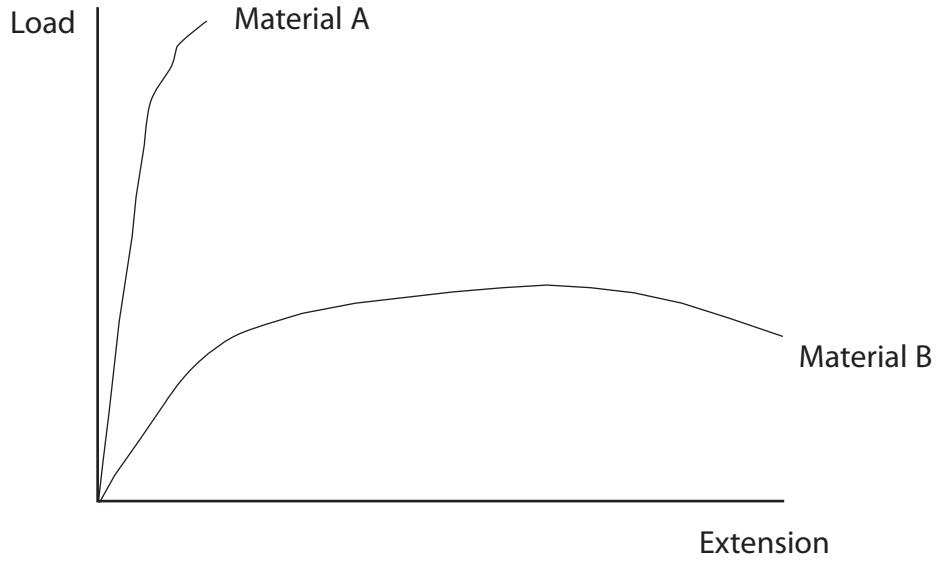

Figure 2

Compare and contrast the stiffness **and** ductility of materials A and B. Use evidence from the graph in Figure 2 to support your answer.

(6)

.....

.....

.....

(Total for Question 9 = 12 marks)

TOTAL FOR PAPER = 90 MARKS

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Sample Mark Scheme

Unit 1: Engineering Materials, Processes and Techniques

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1</td><td>Allow 1 mark for each correct box

<table>
<tr><th>Hazards</th><th>Risk</th><th>Precaution/Control Measure</th></tr>
<tr><td>Spot welding</td><td>• Sparks into eyes
• cuts
• electric shock
• burns</td><td>• Goggles/face shield
• wear gloves
• ensure welder is insulation tested</td></tr>
<tr><td>Use of epoxy adhesives</td><td>• Skin irritations
• fumes</td><td>• Wear gloves/protect hands
• ventilation</td></tr>
<tr><td>Soldering</td><td>• Fumes into lungs
• skin burns</td><td>• Fume extraction
• Place iron in stand when not in use</td></tr>
<tr><td>Milling</td><td>• Small pieces of swarf flying off
• workpiece flying off
• tool coming off</td><td>• Guard and/or goggles
• clamp workpiece
• clamp tool</td></tr>
</table>

Allow suitable alternative answers

(8 x 1)</td><td>(8)</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>2</td><td>1 mark for each correct box.

<table>
<tr><th>Class of material</th><th>Specific material</th><th>Significant property of material</th></tr>
<tr><td>Non-ferrous metal</td><td>• Brass
• Copper
• Aluminium
• Zinc
• Tungsten
• Duralumin
• Tin</td><td>Non –magnetic, good conductor</td></tr>
<tr><td>Ferrous metal</td><td>• Any Steel
• cast iron</td><td>High melting point or high tensile strength</td></tr>
<tr><td>Composite</td><td>• Rubber
• Carbon fibre</td><td>• Flexible
• Compressive strength</td></tr>
<tr><td>Ceramic</td><td>• Porcelain
• borosilicate glass/pyrex</td><td>Brittle or high melting point</td></tr>
</table>

Allow suitable alternative answers
(8 x 1)</td><td>(8)</td></tr>
</table>

If specific material is incorrect, 1 mark can be allowed for an appropriate property of the material.

Question Number	Answer	Mark
3(a)(i)	Galvanising • The steel (1) should be chemically cleaned (1) (allow pickling) in a caustic solution (1) first. Steel is then dipped into molten zinc (1). Any 3 points (3 x 1)	**(3)**

Question Number	Answer	Mark
3(a)(ii)	Electroplating • The metal (1) should be chemically cleaned (1). The metal is put into a chemical bath (1) containing salts of the metal to be deposited. A dc (1) electric current is passed (1) through the bath, with the object to be coated as an (1) electrode. Any 3 points (3 x 1)	**(3)**

Question Number	Answer	Mark
3(b)	Reason • To prevent corrosion/rusting/oxidation of the metal • Aesthetic reasons Any 1 point	**(1)**

Question Number	Answer	Mark
4(a)(i)	• Any steel (1) • Stainless Steel (1) • Carbon Fibre (1) (1 x 1)	**(1)**

Question Number	Answer	Mark
4(a)(ii)	• Resist Oxidisation (1) • High tensile strength (1) (not "strong") • Inexpensive (1) • Aesthetic (1) (2 x 1)	**(2)**

Question Number	Answer	Mark
4(b)(i)	• Perspex (1) • Glass (1) • Acrylic (1) • Polycarbonate (1) (2 x 1)	**(2)**

Question Number	Answer	Mark
4(b)(ii)	• Glass has disadvantage of being brittle (1) but advantage of being scratch proof (1) • Acrylic has advantage of being easier to manufacture (1) and of being a lower cost (1) *If part (b)(i) is incorrect, but the follow through in (b)(ii) is appropriate for the learner's materials, marks must be allowed for part (b)(ii).* (4 x 1)	**(4)**

Question Number	Answer	Mark
5(a)(i)	Material • Low carbon steel (1) OR • Aluminium alloy Reason • Low carbon steel - high tensile strength (1), low cost (1). • Aluminium alloy - high tensile strength (1), light weight (1) and is corrosion resistant (1). (3 x 1)	**(3)**

Question Number	Answer	Mark
5(a)(ii)	Material • Copper (1) Reason • Lowest electrical resistivity and flexible for wiring (2). (3 x 1)	**(3)**

Question Number	Answer	Mark
5(a)(iii)	Material • Aluminium alloy (1) Reason • Lowest density, but has suitably high tensile strength (2). (3 x 1)	**(3)**

Question Number	Answer	Mark
5(a)(iv)	Material • Low carbon steel (1) Reason • Lowest relative cost (1), easily formed (1) (3 x 1)	**(3)**

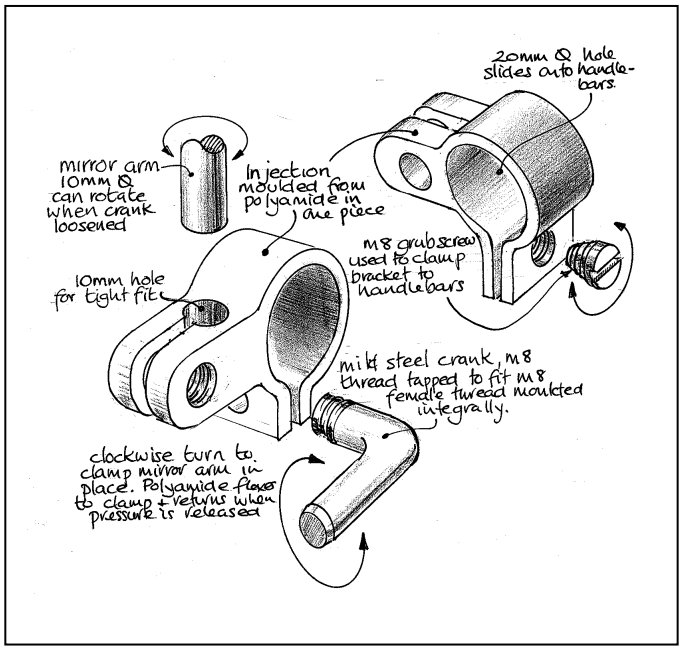
Question Number	Answer	Mark
5(b)(i)	• Aluminium alloy	**(1)**

Question Number	Answer	Mark
5(b)(ii)	• Molten metal (1) is poured into the die under gravity (1). The die is usually made of steel (1). After cooling the die is split if needed (1) and the part removed. Removal of any excess (1). Allow to cool (1) (4 x 1)	**(4)**

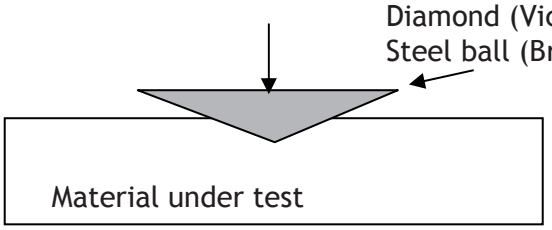
Question Number	Answer	Mark
5(c)	• Stainless steel will not rust or corrode (1), so will not need to be replaced frequently (1) • Stainless steel is self- finishing (1), saving costs of coating (1) • Stainless steel is aesthetically pleasing, adding to the appeal of the motorcycle (1). • Stainless steel has high tensile strength(1), corrosion resistant (1). (4 x 1)	**(4)**

Question Number	Answer	Mark
6(a)	• A mould (1) of the surface is needed, and a release agent (1) is coated onto the mould. Onto this layers of carbon fibre (1) are laid, interspersed with resin (1). The direction can be changed, to give strength in all directions 1) of the surface. The composite is then cured (1) and finally removed from the mould (1). For safety, goggles (1) should be used and the area should be ventilated well (1). A colour pigment may also be used (1). *Any 5 suitable points* (5 x 1)	**(5)**

Question Number	Answer	Mark
6(b)	• High tensile or compressive strength • Resistance to corrosion • Light weight (1 x 1)	**(1)**

Question Number	Answer	Mark
7	Marks will be awarded for design features relating to those below. • **Method of fixing bracket to handlebars (2)** *fully workable (2) partially workable (1)* • **Method of adjustment (2)** *fully workable (2) partially workable (1)* • **Method of fixing mirror arm to bracket** (2) *fully workable (2) partially workable (1)* • **Method of adjustment (2)** *fully workable (2) partially workable (1)* • **Appropriate dimension to accommodate handlebars (1)** • **Appropriate dimension to accommodate mirror arm (1)** An example of an appropriate design solution is shown below.  	**(10)**

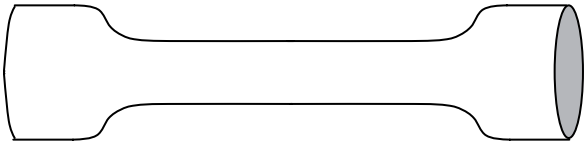
Question Number	Answer	Mark
8(a)(i)	• Vicker's test (1) • Brinell test (1) • Rockwell (1) (1 x 1)	**(1)**

Question Number	Answer	Mark
8(a)(ii)	 • Indenter (diamond or steel ball) (1) • Force shown (1) • Material (1) (3 x 1)	**(3)**

Question Number	Answer	Mark
8(a)(iii)	Brinell: • A hardened (1) steel ball (1) is used to indent the surface (1). A force F, (1) from 1 to 100 kgf (1) is used, and the area, A (1) of indent is measured, in square mm (1). Vicker's: • A diamond indenter (1) is used, with a pyramid (1) shape of 136 degrees (1) • The hardness is then given by HV = F/A (1) or from a look-up table, using diameter of indentation (1) (4 x 1)	**(4)**

Question Number	Answer	Mark
8(b)	A suitable unit or scale, e.g. N/m^2 or BHN (Brinell Hardness number) or Rockwell scale, HB (1)	**(1)**

Note: Up to 3 marks may be allowed for a good description of scratch test.

Question Number	Answer	Mark
9(a)(i)	•  Any 2 points from: • Showing the centre uniform section (or mention of gage length) (1) (Not a tube) • Showing larger end pieces (1) • Showing a taper or radius between centre and ends. (2 x 1)	**(2)**

Question Number	Answer	Mark
9(a)(ii)	Stress • $\frac{Force}{Cross-sectional\ area}$ (2) Strain • $\frac{elongation}{original\ length}$ (2)	**(4)**

<table>
<tr><td>Question Number</td><td colspan="2">Answer</td></tr>
<tr><td>9(b)
QWC (i-iii)</td><td colspan="2">Evaluation to address the following issues:
<table>
<tr><th>Indicative answer</th><th>Evidence from graph</th></tr>
<tr><td>A is stiffer than B/B is more flexible than A</td><td>For a given load, the extension for A is less than B/accept the converse

The gradient for A is steeper than for B/accept the converse</td></tr>
<tr><td>B is more ductile than A/B is not as ductile as A</td><td>The area under the graph for A is less than B/accept the converse</td></tr>
<tr><td>A Is brittle/B is not brittle</td><td>A deforms less than B/accept the converse</td></tr>
</table></td></tr>
<tr><td>Level</td><td>Mark</td><td>Descriptor</td></tr>
<tr><td></td><td>0</td><td>No rewardable material</td></tr>
<tr><td>Level 1</td><td>1-2</td><td>The candidate identifies the area(s) of comparison with no development OR identifies and develops one area. Shows limited understanding of the comparison. The candidate uses everyday language and the response lacks clarity and organisation. Spelling, punctuation and the rules of grammar are used with limited accuracy.</td></tr>
<tr><td>Level 2</td><td>3-4</td><td>The candidate identifies some areas of comparison with associated developments showing some understanding of the comparison. The candidate uses some specialist terms and the response shows some focus and organisation. Spelling, punctuation and the rules of grammar are used with some accuracy.</td></tr>
<tr><td>Level 3</td><td>5-6</td><td>The candidate identifies a range of areas of comparison with associated developments showing a detailed understanding of the comparison. The candidate uses appropriate specialist terms consistently and the response shows good focus and organisation. Spelling, punctuation and the rules of grammar are used with considerable accuracy.</td></tr>
</table>

Edexcel GCE

Engineering

Unit 4: Applied Engineering Systems
Candidate Brief

Sample Assessment Material

Paper Reference
6934/01

You do not need any other materials.

Advice to Candidates

- This brief is the **only** vehicle for the assessment of this unit.
- Apart from this document there will be **no examination paper** for this unit.
- Candidates' work must be carried out individually in a suitable environment, such as the workshop, and under strictly controlled/managed conditions.
- The three practical activities may be started at anytime after the brief has been published on the Edexcel website, at the centre's discretion.
- Candidates should spend no more than a total of ten hours in completing the three practical activities.
- You must enter your details and sign and date the candidate authentication document stating it is your own work.
- Task labelled with an asterisk (*) is one where the quality of your written communication will be assessed.

Advice to Centre Staff

- The evidence to be submitted for assessment must demonstrate compliance with the requirements of the assessment criteria grid.
- Assessment will be carried out by centre assessors, whose decisions will be subject to moderation by Edexcel's external moderators. For this purpose, Edexcel will require a sample of the candidates' work and moderation will take place during the June examination series.
- The candidates' work must be completed, assessed and submitted to the designated moderator by the end of the published deadline.
- The candidates' mark must be entered on the appropriate OPTEMS forms and returned to Edexcel by the published deadline.
- **Centres should note that the marks and candidate work can only be submitted in the June examination series.**
- Centre staff must sign and date the candidate authentication document and return it with the candidate's work.
- Candidates' marks must be recorded on the Unit 4 Mark Record Sheet, which must be attached to the candidates' work when submitted to Edexcel for moderation. This form can be found on page 7 of the Candidate Brief.

Turn over ▶

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Practical activity brief

Activity 1

It is important for engineers to know the forces acting in the members of load bearing structures and the strength of the materials from which they are made. In this activity you will be asked to carry out a destructive tensile test on a structural material to determine its load bearing properties. You will also be asked to analyse a loaded framed structure to determine how its members react and whether it is in a safe condition.

You are required to complete the following tasks and submit evidence of your work.

Task (a) (i)
Measure and record the behaviour of samples of high carbon steel by subjecting a standard sample of the metal to a destructive tensile test.

Produce a load/extension graph for the material and record the dimensions of the sample.

Task (a) (ii)
Plot a graph of stress v strain and from it determine

- the ultimate tensile strength of the material
- the modulus of elasticity of the material

Compare these values with published data for the metal. (Note that it is quite reasonable for your values to vary by 20% or more from the published values, owing to factors such as slight variations in the composition of the metal.)

The members of the structure in Figure 1 are made from four solid rods (circular cross-section) of the metal that you have tested. They are fixed to a wall, to make a simple crane. You may assume that they are pin-jointed at their ends.

The load supported is to be 75 kg.
You may assume that g = 9.8 ms^{-2}

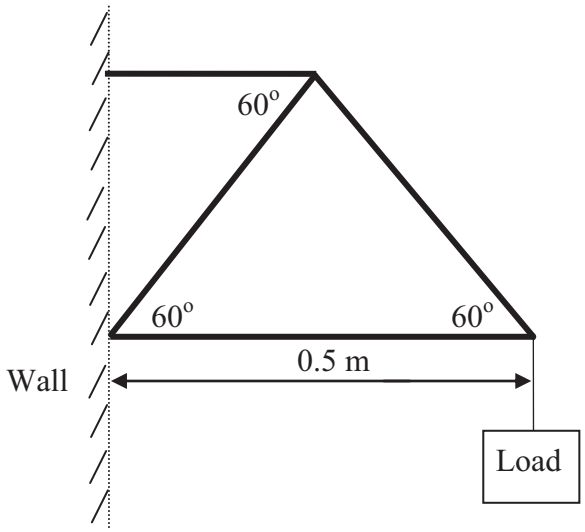

Figure 1

Task (a) (iii)
Determine the magnitude and nature of the forces present in the above structure.

Task (a) (iv)
Assuming a safety factor of 6 is required for the member under greatest strain, calculate a suitable diameter for the rods.

Task (a) (v)
Determine the dimensional change that occurs in the member under greatest strain as a result of the loading.

You may assume that the modulus of elasticity of the material is the same in tension and compression.

(Total for Activity 1 = 16 marks)

Activity 2

Electro-mechanical systems are to be found in everyday life. They include domestic appliances, power tools and some items of laboratory and office equipment. In this activity you will be asked to explain the function and investigate the design of a given electro-mechanical system.

Pneumatic systems are widely used where automatic (or controlled) movement is required.

Figure 2 shows the symbol for a double acting cylinder.

You are required to complete the following tasks and submit evidence of your work.

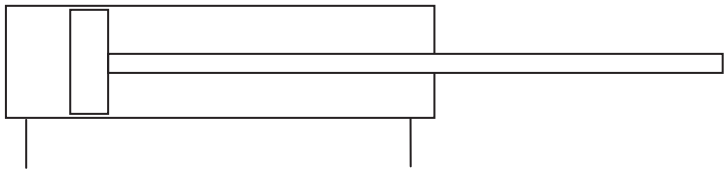

Figure 2

Task (b)
Explain the purpose and function of a double acting cylinder.

If the pressure in a cylinder of diameter 60 mm is 0.2 Nmm^{-2}, calculate the force on the piston.

(6)

Task (c)
Draw a pneumatic circuit diagram that shows how a double acting cylinder can be used to open and close a sliding door.

The power source for the system is an electrically powered air compressor.

Give a detailed explanation of the energy transfers that occur within the overall system.

(10)

Task (d)
Provide a detailed example of an alternative design solution, based on a purely electro-mechanical system, that provides the same basic function as the pneumatic system. Compare fitness for purpose of the two systems.

(6)

(Total for Activity 2 = 22 marks)

Activity 3

Process variables, such as temperature, pressure, speed and light intensity, amongst others, often need to be monitored and controlled. Design a suitable monitoring or control system which fulfils the requirements of the given design brief.

Design brief
Design a computer control system that monitors and records noise levels in the range 50 dB to 120 dB. The system must monitor noise levels over a period of 1–2 days.

The noise level must be recorded for one minute out of every ten minutes.

You are required to complete the following tasks and submit evidence of your work.

***Task (e)**
Produce a feasible design solution for the system, which should include

- block diagrams showing the system elements
- signal pathways, inputs and outputs
- a detailed explanation of how your system functions
- how it meets the requirements of the design brief and takes into account health and safety considerations
- details of the circuit for the sensor and how it is linked to the computer

(18)

Task (f)
Select suitable materials and components for your design which take into account

- production constraints
- safety considerations

(4)

(Total for Activity 3 = 22 marks)

TOTAL FOR PAPER = 60 MARKS

Authentication Statement

Authentication Statement
GCE Engineering
External Test

The statement below **MUST** be completed for each candidate where a Unit Test specifies that a candidate's work must be handed in with the question paper. Failure to do so will result in the candidate receiving **zero marks** for the whole test.

Unit Number	6934
Unit Name	Applied Engineering Systems
Level	Advanced

Candidate's Declaration

I certify that the work submitted for this unit is my own.

Name of Candidate		Date	
Signature of Candidate			

Teacher's Declaration

I certify that the candidate named above has completed the work submitted.

Name of Teacher		Date	
Signature of Teacher			

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Appendix E: Edexcel GCE in Engineering — Unit 4 Mark Record Sheet

Centre no:	Centre name:	Internal moderator name:
Candidate no:	Candidate name:	
Series number:		

Unit 4: Applied Engineering Systems							
Assessment evidence	**Annotation and page number**	**Mark band**			**Centre mark**	**Edexcel use only**
		1	**2**	**3**		
(a)		0-8	9-12	13-16		
(b)		0-2	3-4	5-6		
(c)		0-4	5-7	8-10		
(d)		0-2	3-4	5-6		
*(e)		0-9	10-14	15-18		
(f)		0-2	3	4		
		Final total				

Edexcel moderator use only		
AA number:	Name:	Signature:

* Learners will be assessed on Quality of Written Communication (QWC) - (i-iii)

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Assessment criteria

	Mark band 1		Mark band 2	Mark band 3	Mark awarded
(a) (AO1) (AO2)	• A limited understanding of using the equipment. Data is inaccurate **and** cannot determine tensile strength and modulus of elasticity. • Some aspect of structural loading determined but analysis is weak and incomplete. **(0-4)**	• Successful use of the equipment with reliable data extraction but with little understanding of processing the data to determine either tensile strength **or** modulus of elasticity. • Some structural loading correctly determined. **(5-8)**	• Successful use of the equipment with reliable data extraction to determine accurate tensile strength **or** modulus of elasticity. • All the main materials properties and effects of structural loading determined. **(9-12)**	• Successful use of the equipment with reliable data extraction to determine accurate tensile strength **and** modulus of elasticity. • Fully determines and evaluates the relevant materials and determines the full effects of the structural loading. **(13-16)**	**16**
(b) (AO1)	• A limited understanding of the electro-mechanical system. **(0-2)**		• Some understanding of the electro-mechanical system, with some aspects of the key functions explained. **(3-4)**	• Most aspects of the function of the electro-mechanical system understood and explained in detail. **(5-6)**	**6**
(c) (AO2)	• Block diagram contains only basic and general information and identifies some of the internal workings of the system. **(0-4)**		• Block diagram contains some relevant information with a broad explanation of the internal workings of the system. Some consideration of energy transfer within the system. **(5-7)**	• Block diagram contains most relevant information with a detailed explanation of the internal workings and energy transfer within the system. **(8-10)**	**10**

	Mark band 1		Mark band 2	Mark band 3	Mark awarded
(d) **(AO3)**	• Alternative design solution that partially meets the operational requirements, where the outcome is unlikely to function. **(0-2)**		• Alternative design solution is appropriate and meets some of the operational requirements, where the outcome could broadly functions. **(3-4)**	• A workable alternative design solution that meets most of the operational requirements and is likely to function. **(5-6)**	**6**
(e) **(AO3)** **QWC (i-iii)**	• Design solution is superficial and contains only a few specified requirements. A health and safety aspect is considered. • Uses everyday language and the response lacks clarity and organisation. Spelling, punctuation and the rules of grammar are used with limited accuracy. **(0-4)**	• Design solution is feasible and takes into account some of the specified requirements. Some health and safety aspects considered. • Uses everyday language but there are occasional uses of specialist vocabulary. The response lacks clarity and organisation although some attempt at focus is evident. Spelling, punctuation and the rules of grammar are used with occasional accuracy. **(5-9)**	• Design solution is feasible and takes into account most of the specified system requirements. Some relevant health and safety aspects are considered and explained. • Uses some specialist terms and the response shows some focus and organisation. Spelling, punctuation and the rules of grammar are used with some accuracy. **10-14)**	• Detailed workable design solution that takes into account most of the specified system requirements. Most relevant health and safety aspects are considered and explained. • Uses appropriate specialist terms consistently and the response shows good focus and organisation. Spelling, punctuation and the rules of grammar are used with considerable accuracy. **(15-18)**	**18**

	Mark band 1	Mark band 2	Mark band 3	Mark awarded
(f) **(AO1)**	• Materials and components identified and selected without consideration of production constraints, cost and health and safety issues. **(0–2)**	• Some appropriate materials and components selected, with some consideration of production constraints, cost and health and safety issues. **(3)**	• Most materials and components selected, with justification that includes a consideration of production constraints, costs and health and safety issues. **(4)**	**4**
			Total marks	**60**

(For description of AOs see *Performance descriptions* in the specification, *Appendix D*.)

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