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Pearson
Edexcel GCE

Centre Number

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Candidate Number

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Engineering

Unit 1: Engineering Materials, Processes and Techniques

Monday 16 May 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference

6931/01

You do not need any other materials.

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.*
- You may use a calculator.

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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PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some of the questions in this paper relate to a pod from a Passenger Rapid Transport system (PRT), as shown in Figure 1.



(Source: Skybum, Wikipedia UK)

Figure 1

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1 The table below lists four processes used in manufacturing the PRT pod.

Complete the table by giving:

- **one** risk involved in each process
- **one** different precaution/control measure to prevent injury.

Each answer must be different.

Process	Risk	Precaution/Control measure
Soft soldering		
Milling		
Sand casting		
Moving heavy loads		

(Total for Question 1 = 8 marks)



2 The materials used to manufacture the PRT pod can be grouped into classes.

From the materials listed, complete the following table by naming:

- **one** specific material for each class
- **one** significant property of each material.

Each answer must be different.

Class of material	Specific material	Significant property of material
Thermoplastic polymer		
Thermosetting polymer		
Elastomer		
Non-ferrous metal		

(Total for Question 2 = 8 marks)



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3 The table below shows the properties of some materials used in the manufacture of the pod.

Material	Density (kg m ⁻³)	Electrical resistivity (ohm-m)	Tensile strength (MN m ⁻²)
Rubber	1200	$>10^{11}$	30
Low carbon steel	7860	10.6×10^{-8}	690
Stainless steel	7930	72.3×10^{-8}	570
Aluminium	2700	27.0×10^{-8}	82
Copper	8960	1.68×10^{-8}	215
PVC	1040	1011	50
Urea formaldehyde (UF)	1250	$>10^{11}$	70

Using the information in the table and your knowledge of materials, select the most appropriate material to use for the following parts of the pod and explain your choice.

(a) The roller bearing that allows a wheel to rotate around the axle

(i) Material

(1)

(ii) Explanation

(2)



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(b) The front bumper

(i) Material

(1)

(ii) Explanation

(2)

(c) The control knobs

(i) Material

(1)

(ii) Explanation

(2)

(Total for Question 3 = 9 marks)



4 Glass Reinforced Plastic (GRP) moulding is sometimes used to manufacture components in the engineering fabrication sector.

(a) Using sketches, show the difference between a male and female mould in the GRP moulding process.

(2)

Male

Female

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(b) Explain the purpose of 'gelcoat' in the GRP process.

(2)

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(c) Explain the purpose of a 'release agent' in the GRP process.

(2)

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(d) Explain the purpose of 'glass fibre matting' in the GRP process.

(2)

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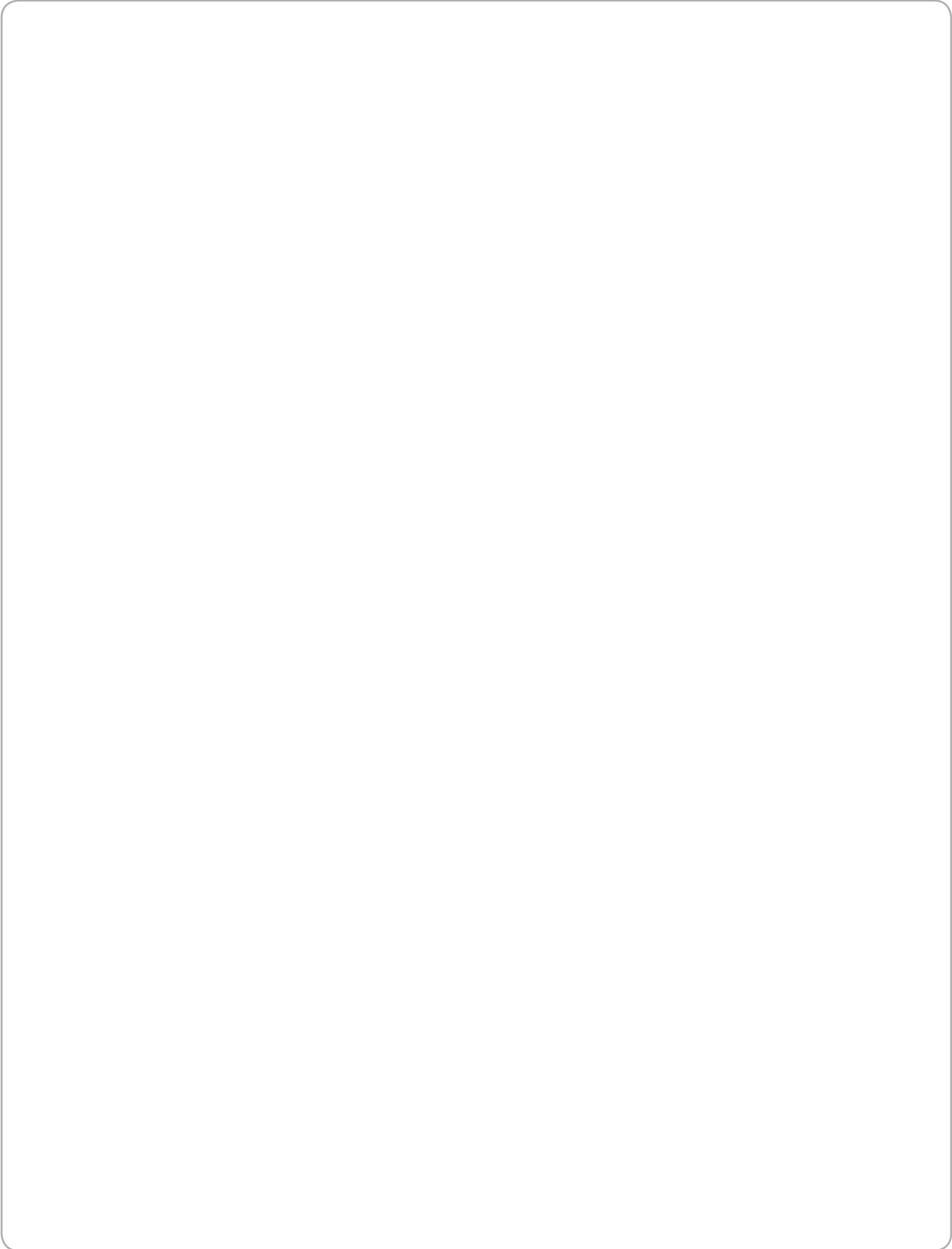
(Total for Question 4 = 8 marks)



5 A cold chisel is used in the manufacture of the pod. The cold chisel is made from high carbon steel and is drop forged.

(a) Describe, using notes and sketches, the drop forging process used to manufacture a cold chisel.

(6)



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(b) Once forged, the cold chisel is heat treated to allow it to be used as a cutting tool.
The heat treatments are:

- hardening
- tempering.

(i) Explain the purpose of hardening the cold chisel.

(2)

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(ii) Explain the purpose of tempering the cold chisel.

(2)

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(iii) Explain why only one end of the cold chisel is heat treated.

(2)

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(Total for Question 5 = 12 marks)



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6 Four surface treatments that can improve or change the properties of engineering components are anodising, galvanising, painting and plastic coating.

(a) State **two** advantages and **one** disadvantage of each of the following surface treatments when applied to metal.

(i) Anodising

(3)

Advantage 1

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Advantage 2

.....

Disadvantage

.....

(ii) Galvanising

(3)

Advantage 1

.....

Advantage 2

.....

Disadvantage

.....



(iii) Painting

(3)

Advantage 1

Advantage 2

Disadvantage

(iv) Plastic coating

(3)

Advantage 1

Advantage 2

Disadvantage

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(b) Explain **one** advantage of using self-finishing materials.

(2)

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(Total for Question 6 = 14 marks)

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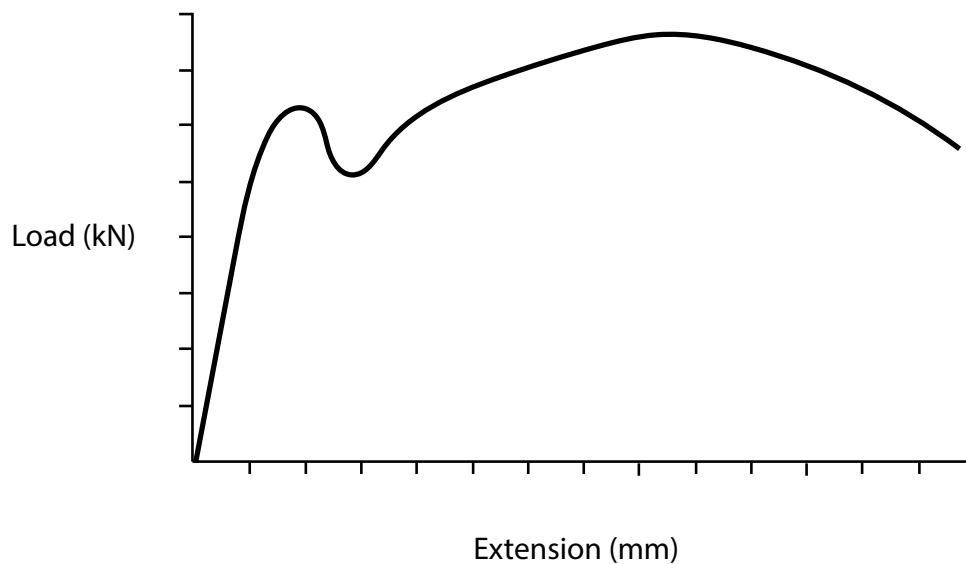
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7 When a design engineer investigates the suitability of a material for an engineering component, it is good practice to perform a tensile test to ensure the selected material will be fit for purpose.

The graph below shows a load extension graph for low carbon steel.



- (a) Show on the graph
- (i) the plastic deformation area
 - (ii) the elastic limit
 - (iii) the ultimate tensile strength

(3)



(b) The material specimen that was tested has a uniform cylindrical cross-section and its values are:

- original length = 80 mm
- cross-sectional area (csa) = 70 mm²
- load = 35kN
- extension = 0.2 mm

(i) Calculate the stress using the formula:

(2)

$$\text{Stress} = \frac{\text{load}}{\text{csa}}$$

Stress calculation

(ii) Calculate the strain using the formula:

(2)

$$\text{Strain} = \frac{\text{extension}}{\text{original length}}$$

Strain calculation



(iii) Calculate Young's Modulus using the formula:

(2)

$$\text{Young's Modulus} = \frac{\text{stress}}{\text{strain}}$$

Young's Modulus calculation

(Total for Question 7 = 9 marks)

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- *8 The PRT pod can be transported either by an overhead frame like a cable car or by wheels fastened to a chassis along a pre-determined track.

Design a chassis that can run on a track which can be attached to the pod.

Your design must include:

- a fully working chassis design
- how the chassis is fastened to the pod safely and securely
- how the axle and wheels are fastened to the chassis for forward and backward movement
- a justified choice of two materials used in the design of the chassis
- an indication of how the pod might be stopped automatically at the end of its run.

(10)

Produce your design on page 19.



Answer page for Question 8

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(Total for Question 8 = 10 marks)



*9 The body panels of the PRT pod can be pressed into shape or vacuum formed. Compare the advantages and disadvantages of these processes when producing body panels in terms of:

- materials
- performance requirements
- finishing.

(12)



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Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 9 = 12 marks)

TOTAL FOR PAPER = 90 MARKS



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