

Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE  
in Engineering (6931)

Paper 01

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## 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.

Question Number	Answer	Mark															
1	<p>One mark for each correct risk (1x4 marks)            One mark for each correct precaution (1x4 marks)</p> <table border="1" data-bbox="416 427 1190 1429"> <thead> <tr> <th data-bbox="416 427 580 497">Process</th> <th data-bbox="580 427 887 497">Risk</th> <th data-bbox="887 427 1190 497">Precaution/Control measure</th> </tr> </thead> <tbody> <tr> <td data-bbox="416 497 580 678">Soft soldering</td> <td data-bbox="580 497 887 678">Fumes, skin burns,</td> <td data-bbox="887 497 1190 678">Well ventilated area, wear gloves and/or apron, place iron in holder</td> </tr> <tr> <td data-bbox="416 678 580 1032">Milling</td> <td data-bbox="580 678 887 1032">Swarf pieces flying off workpiece, workpiece flying off table, tool coming off, noisy operation could damage hearing, clothes being trapped</td> <td data-bbox="887 678 1190 1032">Machine guard and/or safety goggles, ensure workpiece tightly clamped, clamp tool securely, wear ear protection</td> </tr> <tr> <td data-bbox="416 1032 580 1214">Sand casting</td> <td data-bbox="580 1032 887 1214">Fumes, hot liquid metal, Spitting of molten metal, dropping cope &amp;/or drag on feet</td> <td data-bbox="887 1032 1190 1214">Face mask, gloves, apron, steel toe capped boots</td> </tr> <tr> <td data-bbox="416 1214 580 1429">Moving heavy loads</td> <td data-bbox="580 1214 887 1429">Load falling, crushing limbs, hoist breaking/snapping</td> <td data-bbox="887 1214 1190 1429">Wear steel cap boots, hard hat, inspect hoist regularly, lift heavy loads with a straight back</td> </tr> </tbody> </table> <p>Ensure precaution/control comments are different.            Do not award a second mark for repeat precaution /control comment.</p> <p>Accept any other appropriate response.</p>	Process	Risk	Precaution/Control measure	Soft soldering	Fumes, skin burns,	Well ventilated area, wear gloves and/or apron, place iron in holder	Milling	Swarf pieces flying off workpiece, workpiece flying off table, tool coming off, noisy operation could damage hearing, clothes being trapped	Machine guard and/or safety goggles, ensure workpiece tightly clamped, clamp tool securely, wear ear protection	Sand casting	Fumes, hot liquid metal, Spitting of molten metal, dropping cope &/or drag on feet	Face mask, gloves, apron, steel toe capped boots	Moving heavy loads	Load falling, crushing limbs, hoist breaking/snapping	Wear steel cap boots, hard hat, inspect hoist regularly, lift heavy loads with a straight back	(8)
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2	<p data-bbox="419 271 1161 376">One mark for each specific material (1x4 marks) One mark for each significant property (1x4 marks)</p> <p data-bbox="419 412 767 450"><u>Thermoplastic polymer</u></p> <table border="1" data-bbox="419 479 1161 1413"> <thead> <tr> <th data-bbox="427 479 671 551">Specific material</th> <th data-bbox="671 479 1161 551">Significant property of material</th> </tr> </thead> <tbody> <tr> <td data-bbox="427 551 671 658">Polyethylene</td> <td data-bbox="671 551 1161 658">Tough, flexible, solvent resistant, low melting point, good fluidity.</td> </tr> <tr> <td data-bbox="427 658 671 766">Polypropylene</td> <td data-bbox="671 658 1161 766">High strength, hard, high melting point, can be produced as a fibre.</td> </tr> <tr> <td data-bbox="427 766 671 873">Polyvinyl chloride (PVC)</td> <td data-bbox="671 766 1161 873">Can be tough and hard or soft and flexible, solvent resistant, age hardens.</td> </tr> <tr> <td data-bbox="427 873 671 1016">Polystyrene (PS)</td> <td data-bbox="671 873 1161 1016">Tough, hard, rigid but brittle, can be made into light cellular foam, susceptible to chemical attack.</td> </tr> <tr> <td data-bbox="427 1016 671 1160">Polytetra fluoroethylene (PTFE)</td> <td data-bbox="671 1016 1161 1160">Tough, flexible, heat resistant, highly solvent resistant, has a low coefficient of friction/non stick.</td> </tr> <tr> <td data-bbox="427 1160 671 1267">Polyamide (Nylon)</td> <td data-bbox="671 1160 1161 1267">Tough, flexible, self lubricating and very strong, good solvent resistance.</td> </tr> <tr> <td data-bbox="427 1267 671 1413">ABS</td> <td data-bbox="671 1267 1161 1413">Tough, flexible, good impact strength, good insulator, low softening temperature, good mouldability.</td> </tr> </tbody> </table> <p data-bbox="580 1420 1007 1458">Can be re-shaped with heat.</p> <p data-bbox="419 1525 772 1563"><u>Thermosetting polymer</u></p> <table border="1" data-bbox="419 1592 1161 2018"> <thead> <tr> <th data-bbox="427 1592 671 1664">Specific material</th> <th data-bbox="671 1592 1161 1664">Significant property of material</th> </tr> </thead> <tbody> <tr> <td data-bbox="427 1664 671 1807">Phenolic resins (Bakelite)</td> <td data-bbox="671 1664 1161 1807">Hard, resistant to heat and solvents, good electrical insulator, machineable, can be compression moulded.</td> </tr> <tr> <td data-bbox="427 1807 671 1951">Urea formaldehyde (UF)</td> <td data-bbox="671 1807 1161 1951">High tensile strength, low water absorbtion, nonconductive, good heat resistance.</td> </tr> <tr> <td data-bbox="427 1951 671 2018">Urea-methanol</td> <td data-bbox="671 1951 1161 2018">Hard, resistant to heat and solvents, good electrical</td> </tr> </tbody> </table>	Specific material	Significant property of material	Polyethylene	Tough, flexible, solvent resistant, low melting point, good fluidity.	Polypropylene	High strength, hard, high melting point, can be produced as a fibre.	Polyvinyl chloride (PVC)	Can be tough and hard or soft and flexible, solvent resistant, age hardens.	Polystyrene (PS)	Tough, hard, rigid but brittle, can be made into light cellular foam, susceptible to chemical attack.	Polytetra fluoroethylene (PTFE)	Tough, flexible, heat resistant, highly solvent resistant, has a low coefficient of friction/non stick.	Polyamide (Nylon)	Tough, flexible, self lubricating and very strong, good solvent resistance.	ABS	Tough, flexible, good impact strength, good insulator, low softening temperature, good mouldability.	Specific material	Significant property of material	Phenolic resins (Bakelite)	Hard, resistant to heat and solvents, good electrical insulator, machineable, can be compression moulded.	Urea formaldehyde (UF)	High tensile strength, low water absorbtion, nonconductive, good heat resistance.	Urea-methanol	Hard, resistant to heat and solvents, good electrical	
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resins (Formica)	insulator, machineable.
Methanol – melamine resins (Melamine)	Very hard, high resistance to heat and solvents, good electrical insulator, machineable, very smooth surface finish.
Epoxy resins	Tough, good chemical and thermal stability, good electrical insulator, good adhesive.
Polyester resins	Brittle, good wear resistance, high resistance to heat and water.

Cannot be reshaped with heat.

### Elastomer

Specific material	Significant property of material
Rubber (Natural, Styrene, Butyl, Silicone)	Tough, flexible, good solvent resistance, good elasticity.
Neoprene	Good resistance to UV light, performs well with oils and chemicals, very tough, high resistance to burning, high resistance to damage by bending or twisting. Stable over a range of temperatures.

### Non-ferrous metal

Specific material	Significant property of material
Aluminium	Ductile, soft, malleable, machines well, corrosion resistant.
Copper	Ductile, malleable, conducts electricity and heat.
Brass	Hard, brittle, conducts electricity.
Silver	Ductile, malleable, resists corrosion.
Lead	Soft, heavy, malleable, loses its shape under pressure.

	Zinc (Spelter)	Hard, brittle at most temperatures, malleable between 100°C – 150°C, low melting point.	<b>(8)</b>
	Tin	Malleable, ductile, anticorrosive.	
	Tungsten (Wolfram)	Extremely hard, brittle, tough.	
	<p>Do not accept strong, tough as individual statements. Must have an explanation i.e. strong in compression.</p> <p>All answers must be different.</p> <p>Accept any other appropriate response.</p>		

Question Number	Answer	Mark
<b>3 (a) (i)</b>	1 mark for identification of specific material <ul style="list-style-type: none"> <li>Stainless steel (1)</li> </ul>	<b>(1)</b>

Question Number	Answer	Mark
<b>3 (a) (ii)</b>	Up to 2 marks for explanation <ul style="list-style-type: none"> <li>Hard wearing (1) which increases longevity of product (1)</li> <li>Resistant to wear (1) which means longer working life(1)</li> <li>High corrosion resistance (1) which makes it suitable for outdoor use (1)</li> <li>Capable of handling high loads (1) which gives an extended working life (1)</li> <li>Extended service life (1) which reduces maintenance and equipment downtime (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(2)</b>

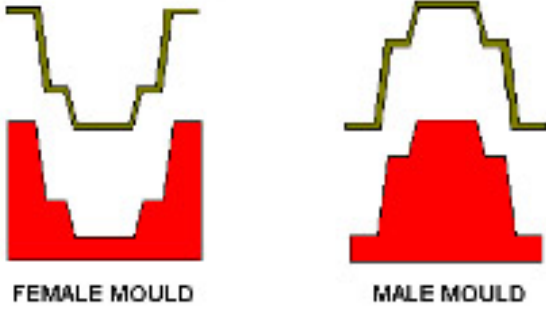
Question Number	Answer	Mark
<b>3 (b) (i)</b>	1 mark for identification of specific material <ul style="list-style-type: none"> <li>PVC (1)</li> </ul>	<b>(1)</b>

Question Number	Answer	Mark
<b>3 (b) (ii)</b>	Up to 2 marks for explanation <ul style="list-style-type: none"> <li>Can be moulded (1) so can produce complex shapes (1)</li> <li>Tough (1) so can resist impacts (1)</li> <li>Can be easily moulded (1) to include fixtures/accessories for easy assembly (1)</li> </ul>	<b>(2)</b>

Question Number	Answer	Mark
<b>3 (c) (i)</b>	1 mark for identification of specific material <ul style="list-style-type: none"> <li>Urea formaldehyde (UF) (1)</li> </ul>	<b>(1)</b>



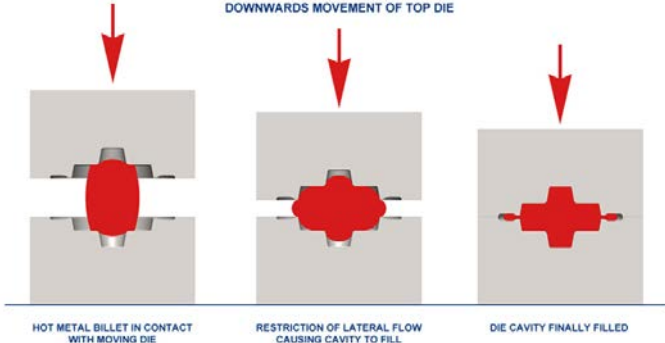
Question Number	Answer	Mark
<b>3 (c) (ii)</b>	Up to 2 marks for explanation <ul style="list-style-type: none"><li>• Good impact strength (1) therefore durable (1)</li><li>• Low cost (1) so cheap to replace (1)</li><li>• Easily moulded (1) which means you can make complex shapes (1)</li><li>• Easily coloured (1) therefore can be aesthetically pleasing (1)</li></ul>	<b>(2)</b>

Question Number	Answer	Mark
4 (a)	<p>One mark for each correctly identified female / male mould (2x1)</p> <div style="text-align: center;">  <p style="text-align: center;">FEMALE MOULD                      MALE MOULD</p> </div> <p>Accept any other appropriate response</p>	(2)

Question Number	Answer	Mark
4 (b)	<p>Up to 2 marks for correctly explaining the purpose (1x2)</p> <ul style="list-style-type: none"> <li>• Provide an outer surface that is pigmented (1) that gives an aesthetic appeal (1)</li> <li>• Maintains a weather proof outer shell (1) which prevents delamination (1)</li> <li>• To provide a hard surface (1) which makes it impact resistant (1)</li> </ul> <p>Accept any other appropriate response</p>	(2)

Question Number	Answer	Mark
<b>4 (c)</b>	<p>Up to 2 marks for each correctly explaining the purpose (1x2)</p> <ul style="list-style-type: none"> <li>• Allows fibreglass moulding to be removed from the mould (1) without damage (1)</li> </ul> <p>Only answer</p>	<b>(2)</b>

Question Number	Answer	Mark
<b>4 (d)</b>	<p>Up to 2 marks for each correctly explaining the purpose (1x2)</p> <ul style="list-style-type: none"> <li>• Provides strength and rigidity (1) to final product (1)</li> <li>• Can be moulded (1) into complex shapes (1)</li> <li>• Matting can be layed in different thicknesses (1) to enhance the strength of the product (1)</li> <li>• The multi-directional strands (1) gives strength in all directions (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(2)</b>

Question Number		Mark
5 (a)	<p>One mark for correct point from below, in appropriate order</p> <ul style="list-style-type: none"> <li>• steel cut to length (1)</li> <li>• heated to malleable state / red heat or higher (1)</li> <li>• hot metal billet placed in mould (1)</li> <li>• process can be repeated until die cavity is filled (1)</li> <li>• top die dropped on to hot billet to create basic outline (1)</li> <li>• trimming process to remove excess material (1)</li> </ul>  <p>Describing process 3 marks Sketches 3 marks</p> <p>Maximum 4 marks for describing process if no sketches</p>	(6)

Question Number		Mark
5 (b) (i)	<p>Up to 2 marks for each correctly explaining the purpose (1x2)</p> <ul style="list-style-type: none"> <li>• to make the cutting edge harder than the metal being cut (1) so that metal can be removed without damage to the chisel (1)</li> <li>• to make the cutting edge harder than the metal being cut (1) so that it retains its shape for further use (1)</li> </ul> <p>Do not accept harder without justification</p> <p>Accept any other appropriate response</p>	(2)

Question Number		Mark
<b>5 (b) (ii)</b>	Up to 2 marks for each correctly explaining the purpose (1x2) <ul style="list-style-type: none"> <li>• tempering removes some brittleness / hardness (1) so that the cutting edge will not shatter (1)</li> <li>• tempering removes some of the hardness (1) making it less brittle (1)</li> </ul> Accept any other appropriate response	<b>(2)</b>

Question Number		Mark
<b>5 (b) (iii)</b>	Up to 2 marks for each correctly explaining the reason (1x2) <ul style="list-style-type: none"> <li>• the head of the chisel needs to remain tough (1) so that it can be struck repeatedly without damage (1)</li> <li>• if both ends were made hard (1) the head would shatter when hit with a hammer (1)</li> </ul> Accept any other appropriate response	<b>(2)</b>

Question Number	Answer	Mark
<b>6 (a) (i)</b>	<p>Three marks for each correctly identified advantage and / or disadvantage (1x3)</p> <p>Answer must contain two advantages and one disadvantage to gain maximum marks</p> <p><u>Advantages</u></p> <ul style="list-style-type: none"> <li>• Durable, easy to maintain (1)</li> <li>• Add an attractive finish (1)</li> <li>• Wide variety of colours (1)</li> <li>• Corrosion Resistant (1)</li> <li>• Attractive finish (1)</li> </ul> <p><u>Disadvantages</u></p> <ul style="list-style-type: none"> <li>• Can be a long process depending on thickness required (1)</li> <li>• Cannot be touched-up if damaged (1)</li> <li>• Requires regular cleaning to maintain integrity of product (1)</li> <li>• Mainly used for aluminium (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(3)</b>

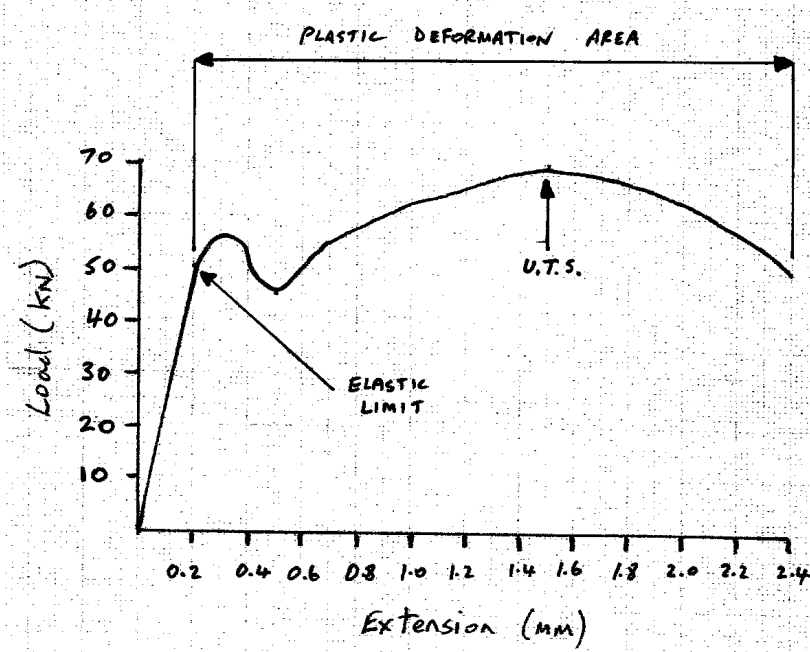
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<b>6 (a) (ii)</b>	<p>Three marks for each correctly identified advantage and / or disadvantage (1x3)</p> <p>Answer must contain two advantages and one disadvantage to gain maximum marks</p> <p><u>Advantages</u></p> <ul style="list-style-type: none"> <li>• Long lasting protective finish (1)</li> <li>• Can be painted (1)</li> <li>• Hard wearing (1)</li> <li>• Fast process (1)</li> </ul> <p><u>Disadvantages</u></p> <ul style="list-style-type: none"> <li>• Expensive set up costs (1)</li> <li>• Only suitable for mass production (1)</li> <li>• Only suitable for low carbon steel (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(3)</b>

Question Number	Answer	Mark
<b>6 (a) (iii)</b>	<p>Three marks for each correctly identified advantage and / or disadvantage (1x3)</p> <p>Answer must contain two advantages and one disadvantage to gain maximum marks</p> <p><u>Advantages</u></p> <ul style="list-style-type: none"> <li>• Long lasting protective finish (1)</li> <li>• Can be aesthetically pleasing (1)</li> <li>• Colour selection available (1)</li> <li>• Easily 'touched up' if product scratched (1)</li> <li>• Relatively cheap to buy (1)</li> </ul> <p><u>Disadvantages</u></p> <ul style="list-style-type: none"> <li>• Easily chipped/cracked/scratched (1)</li> <li>• Paint scratched can cause corrosion (1)</li> <li>• Flammable process (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(3)</b>

Question Number	Answer	Mark
<b>6 (a) (iv)</b>	<p>Three marks for each correctly identified advantage and / or disadvantage (1x3)</p> <p>Answer must contain two advantages and one disadvantage to gain maximum marks</p> <p><u>Advantages</u></p> <ul style="list-style-type: none"> <li>• Colour can be selected before process (1)</li> <li>• Corrosion resistant (1)</li> <li>• Decorative (1)</li> <li>• Non-stick (1)</li> <li>• Good heat/electrical insulator (1)</li> <li>• Relatively cheap process (1)</li> </ul> <p><u>Disadvantages</u></p> <ul style="list-style-type: none"> <li>• Cannot stand high temperatures (1)</li> <li>• Relatively high thickness to provide strength (1)</li> </ul> <p>Accept any other appropriate response</p>	<b>(3)</b>

Question Number	Answer	Mark
<b>6 (b)</b>	<p>Up to 2 marks for a correctly identified advantage with explanation (1x2)</p> <p>Less labour intensive (1) so less expense for the manufacturer (1)</p> <p>Easier to produce in mass production situation (1) because no other surface finish process required (1)</p> <p>No surface treatment required (1) saving time/money/effort (1)</p> <p>Accept any other appropriate response</p>	<b>(2)</b>



Question Number	Answer	Mark
7 (a)	<p data-bbox="384 331 746 376">Graph for this question</p>  <p data-bbox="399 448 1212 1097">A hand-drawn stress-strain graph on a grid. The vertical axis is labeled "Load (kN)" and ranges from 0 to 70 in increments of 10. The horizontal axis is labeled "Extension (mm)" and ranges from 0 to 2.4 in increments of 0.2. The curve starts at the origin, rises to a peak of approximately 55 kN at 0.25 mm extension, then drops to a local minimum of about 45 kN at 0.4 mm extension. It then rises to a higher peak of approximately 68 kN at 1.5 mm extension, before gradually decreasing to about 48 kN at 2.4 mm extension. A horizontal double-headed arrow spans from 0.25 mm to 2.4 mm, labeled "PLASTIC DEFORMATION AREA". An arrow points to the first peak at 0.25 mm, labeled "ELASTIC LIMIT". Another arrow points to the second, higher peak at 1.5 mm, labeled "U.T.S.".</p>	

Question Number	Answer	Mark
<b>7 (a) (i)</b>	Correct identification on graph of <ul style="list-style-type: none"> <li>• plastic deformation area (1)</li> </ul> (1x1 mark)	<b>(1)</b>

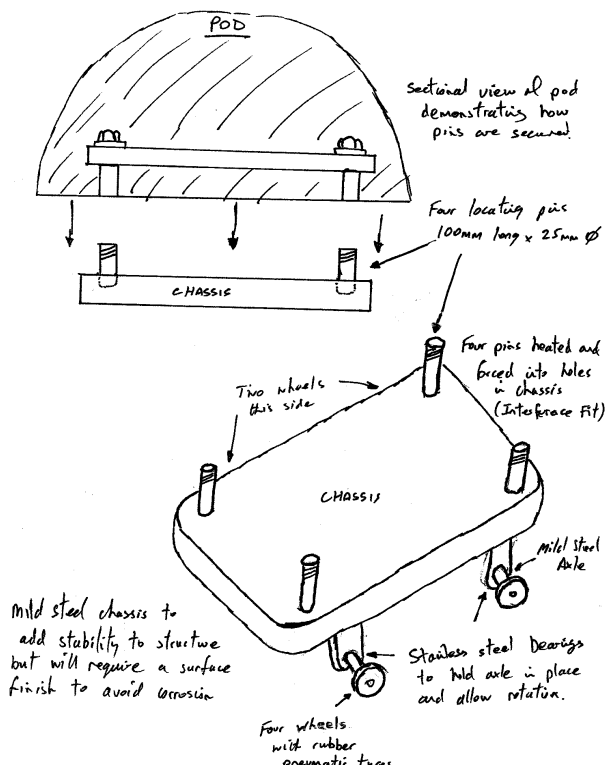
Question Number	Answer	Mark
<b>7 (a) (ii)</b>	Correct identification on graph of <ul style="list-style-type: none"> <li>• the elastic limit (1)</li> </ul> (1x1 mark)	<b>(1)</b>

Question Number	Answer	Mark
<b>7 (a) (iii)</b>	Correct identification on graph of <ul style="list-style-type: none"> <li>• UTS (1)</li> </ul> (1x1 mark)	<b>(1)</b>

Question Number	Answer	Mark
<b>7 (b) (i)</b>	$\text{Stress} = \frac{35 \text{ KN}}{70 \text{ mm}^2} \quad (1)$ $\text{Stress} = 0.5 \frac{\text{KN}}{\text{mm}^2} \quad (1)$	<b>(2)</b>

Question Number	Answer	Mark
<b>7 (b) (ii)</b>	$\text{Strain} = \frac{0.2 \text{ mm}}{80 \text{ mm}} \quad (1)$ $\text{Strain} = 0.0025 \quad (1)$	<b>(2)</b>

Question Number	Answer	Mark
<b>7 (b) (iii)</b>	$\text{Youngs Modulus} = \frac{0.5 \text{ KN/mm}^2}{0.0025} \quad (1)$ $\text{Youngs Modulus} = 200 \frac{\text{KN}}{\text{mm}^2} \quad (1)$	<b>(2)</b>

Question Number	Answer	Mark
8	<p>Up to two marks for each answer below</p> <ul style="list-style-type: none"> <li>- partial working design (1) appropriate working design of chassis (2)</li> <li>- safe or securely fastened (1) how the chassis is safely and securely fastened to the pod (2)</li> <li>- incomplete design not fully functional (1) how the axle and wheels are fastened to the chassis for forward and backward movement (2)</li> <li>- justified choice of one material (1) a justified choice of two materials (2)</li> <li>- partial working design for stopping vehicle (1) appropriate working design of stopping vehicle (2)</li> <li>-</li> </ul> 	(10)

Question Number		Indicative Content
<b>9</b>		<p>Initial correct identification of materials from both classes (2 marks)</p> <p>Ferrous material – Mild steel (1)</p> <p>Polymer material - ABS (1)</p> <p>To make the body panel from mild steel each panel must be pressed into shape (1) using large metal presses. (1). Presswork involves dies being manufactured (1) to create the shape required (1). This is an expensive process to set up (1) as individual die production takes time and skill to manufacture (1). Once in place many body panels can be produced quickly (1) reducing overall production costs (1). The process involves placing sheet metal in press (1), dies are brought together to produce shape (1), dies are opened and body panel removed (1). The body panel can be produced in less than 30 seconds (1). To complete the body part ready for practical use a finish will need to be added to the mild steel (1) to protect the body part from corrosion (1). This will usually be several layers of paint (1) increasing production time and costs (1).</p> <p>To make the body panel from ABS each body part can be vacuum formed (1). A mould will have to be produced (1) but this will not be as expensive as dies for a sheet metal press (1). Individual body parts will take longer to produce (1) as the plastic requires heating (1) before being formed into the shape of the body part(1). Even though the process of manufacturing the body panel by vacuum forming is longer than the sheet metal process (1), there will be no requirement for a finish to be applied (1), as the colour of the plastic can be chosen before the body panel is formed (1). ABS does not require a further finish to protect the body part from corrosion (1).</p>
Level	Mark	Descriptor
	<b>0</b>	No rewardable material
<b>1</b>	<b>1-4</b>	Some brief acknowledgement of the difference between the materials, performance requirements and finishing of the two materials identified.
<b>2</b>	<b>5-8</b>	Some justification of the difference between the two materials, performance requirements and finishing of the two materials identified.
<b>3</b>	<b>9-12</b>	There should a full understanding and detailed comparison of the difference between the materials, performance requirements and finishing of the two materials identified.