



**General Certificate of Education (A-level)  
June 2012**

**Design and Technology:  
Product Design**

**PROD1**

**(Specification 2550)**

**Unit 1: Materials, Components and Application**

**Final**

***Mark Scheme***

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Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	a		E.g. A composite is a mixture of two or more materials combined to produce a material with enhanced properties.	2	“A mixture of two or more materials” = 1 mark
1	b		<p><b>Suitable products:</b></p> <p>Boats, trains, cars, theme park ride diorama, outdoor sculpture.</p> <p><b>Reasons for use:</b></p> <p>e.g. GRP can be laminated over a former to make complex shapes such as the curves of a car body panel. GRP is coloured using a pigment added to the resin. This means it doesn't wear off like an applied finish can.</p>	1  2	<p>1 mark for a suitable product</p> <p>2 marks for explanation linking relevant property(s) of GRP to chosen product.</p> <p><b>If product is not suitable for GRP award no marks.</b></p> <p>If simply a product and then bullet point / single word explanation = 2 marks.</p>
2			<p><b>Suitable applications:</b></p> <p>Laminating formers, modelling, buoyancy, insulation, sound proofing, food packaging, general packaging, filler for doors, crash/cycle helmets, take-away food packaging.</p> <p><b>Reasons for use:</b></p> <p>Styrofoam is soft and can be cut to shape easily with handtools (such as a coping saw) or hot wire cutter, CNC, and sanded with abrasives to give a smooth finish needed for modelling. Styrofoam is available in large, thick sheets so a former can be made more quickly and economically than joining lots of small pieces of timber. Good for absorbing impact, thermal insulation – can be moulded into a shape, e.g. helmet.</p>	1  2	<p>1 mark for a suitable product</p> <p>2 marks for explanation linking relevant property(s) of Styrofoam to chosen product.</p> <p><b>If product is not suitable for styrofoam award no marks.</b></p>
3			<p><input type="checkbox"/> B Joining pieces of acrylic sheet together</p> <p><input type="checkbox"/> C Joining a melamine formaldehyde laminate to MDF sheet</p> <p><input type="checkbox"/> A Joining 50mm x 50mm x 5mm pieces of HDPE to a mild steel sheet</p> <p><input type="checkbox"/> D Gluing a mortice and tenon made from oak</p>	4	1 mark for each correct letter

4	a		E.g. Plastic sauce bottles, sandwich box, carrier bags, detergent bottles, cling film, bubblewrap, plastic milk bottle, food packaging.	1	1 mark for suitable product  <b>Do not accept Drinks bottle, water bottle, plastic bottle.</b>
4	b		E.g. Recycling symbol for low density polyethylene. It would be moulded into products made from LDPE such and is used to help recycling authorities identify and sort different types of plastics.  Must have reference to aiding sorting for 3 marks.  Reference to encourage consumer to recycle to save/protect the environment = 2 marks	3	1 mark for simple statement "recycling" symbol or logo or SPI code.  2 marks for explanation that it is a recycling symbol used on plastic products  3 marks for explanation that it is used on polymer products used to show the product is recyclable and to aid in sorting
5	a	i	E.g. Oxo – degradable polymers are plastics that have an additive that makes the plastic break down with exposure to oxygen.	1	
5	a	ii	<b>Suitable products:</b>  Accept any type of short life cycle polymer product.  <b>Reasons for use:</b>  e.g. Plastic packaging has a short life cycle. It is not usually kept by the consumer and quickly enters the waste stream. If the product goes to landfill it would not degrade unless a bio-batch additive was mixed with the plastic.  Accept simple statements like "they will degrade quickly when they are disposed of".  Accept reference to degrading in landfill.	2	1 mark for correct type of product  1 mark for correct reason.  <b>If product unsuitable – no marks.</b>
5	b		E.g. Products made with oxo-degradable polymers will have a 'shelf-life' and begin to breakdown from between 6 months and 2 years. They are unsuitable for products that might be needed to be used for longer.  <ul style="list-style-type: none"> <li>• It's more expensive</li> <li>• Difficult to recycle</li> </ul>	1	Alternatives  They can contaminate other plastics destined for recycling which would cause defects in new products made with the contaminated plastics.  Putting bio-batch additives into a polymer resin will increase production costs.

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			Accept - cannot be recycled - don't fully degrade		Making biodegradable plastics encourage consumers to throw items away rather than recycle them.
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Question	Part	Sub Part	Marking Guidance	Mark	Comments
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6	a	i	<p>Mild steel is a malleable material which means it can be press formed into the shape required and retain the shape.</p> <p>Mild steel is a ductile material which means it can stretch over the forming die without tearing or splitting.</p> <p>Mild steel can be spot welded easily because it has good fusibility properties. Spot welding is one of the main ways of fabricating the body panels.</p> <p>Mild steel will take a variety of finishes such as zinc based coatings, acrylic and cellulose based paints for a high quality finish required to produce desirable aesthetic qualities.</p> <p>Mild steel sheet is soft enough to function in crumple zone structure.</p> <p>Can be painted for improve aesthetics = 1 mark Can be painted to prevent corrosion = 1 mark Can be recycled = 1 mark</p>	6	1 – 2 marks per relevant point. Award second mark for explanation of point.
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6	a	ii	<p>Carton board has a slightly smoother side which makes it better to print logos and handling instructions on, compared to the rougher side which is used on the inside of the box.</p> <p>Carton board is biodegradable and because packaging is disposed of quickly, if it does go to landfill, it's effect on the environment is reduced.</p> <p>Carton board in constructed with a corrugated core which helps to give the board some solidity and resist minor impacts.</p> <p>Carton board has good insulative properties, e.g. for applications such as pizza boxes.</p> <p>Carton board can be scored, cut and glued easily in order to make the required box structure.</p> <p>Carton board does not need to have a high quality surface finish as it is not going to be printed with presentation graphics.</p> <p>Good impact strength to protect contents</p>	6	1 – 2 marks per relevant point. Award second mark for explanation of point.
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		<p>Non toxic – will not contaminate food items Can be recycled References to printing must include the specific printing process, e.g. flexography / off-set lithography / screen printing, etc to gain full credit: e.g Can be printed on via flexography process to add text for consumer information = 2 marks.</p> <p>Accept reference to lightweight.</p> <p>Accept reference to die cut.</p> <p><b>Do not accept reference to plastic lamination</b></p>		
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6	a	iii	<p>Kevlar is woven into a matting which can be laminated over a mould to take the shape of the motorcycle helmet</p> <p>Kevlar is very lightweight which means the helmet can be kept as light as possible, making it comfortable to wear.</p> <p>Kevlar would add impact resistance to the helmet and would help to stop the helmet from breaking in the event of accident at low to moderate speeds.</p> <p>Gel coats and pigments are added in the manufacture of the helmet which will give a high aesthetic appeal.</p> <p>Kevlar can be finished with acrylic / water-based finishes to give improved aesthetics.</p> <p>Kevlar can be combined with other composites, e.g. CFRP/GRP to further enhance product properties.</p> <p>Can be painted for aesthetics = 1 mark</p>	6	<p>1 – 2 marks per relevant point.</p> <p>Award second mark for explanation of point.</p>
6	b		<p><b>Suitable materials:</b></p> <p>Aluminium, GRP Glass Reinforced Plastic, Carbon Fibre Reinforced Plastic CFRP, Kevlar and carbon fibre (htbrid textile) reinforced polymer, stainless steel, or suitable thermoplastics (not acrylic, UF/MF).</p> <p><b>Reason:</b></p> <p>Aluminium is a lightweight metal which helps to reduce fuel consumption.</p> <p>Aluminium is a malleable, ductile material that can be easily press formed.</p> <p>Thermoplastics used to make interchangeable panels, e.g. Smart car.</p>	2	<p>If material incorrect = zero marks.</p>

7	a	<p>E.g.</p> <p>MDF is available in long- wide boards which means that a large surface like the table top can be made more easily than joining lots of planks together.</p> <p>MDF can be machined to take Knock-Down fittings typically used to assemble such products.</p> <p>The laminate finish used on the MDF protects the table from hot drinks, plates, etc and is hard so would withstand wear and tear through daily use.</p> <p>The laminate gives the product a suitable finish that has an aesthetically pleasing colour and wood grain effect.</p> <p>MDF is a widely available material which helps to keep the costs of production to a minimum</p> <p>MDF is a very stable material, that does not warp or twist like natural timber can. This is perfect for the application of a laminate where a totally flat surface would be needed.</p> <p><b>If “cheap” or “inexpensive” must be compared to solid wood for mark.</b></p>	6	1 – 2 marks per point. Award second mark where point is explained.
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7	b	<p>Expect reference to:</p> <p>Use of circular saws/dimension saws to cut pieces to size- cutting all pieces of same dimension at the same time to avoid wasting time adjusting machine.</p> <p>Use of ‘stops’ and guides to ensure parts are cut to size quickly and square..</p> <p>CNC machining e.g. CNC router to machine slots, holes etc for the various KD fittings.</p> <p>Alternatively use of templates/jigs for use with a manual router and drills</p> <p>Use of morticer (if traditional joining methods described)- cutting all mortice holes at the same time and using depth stops on the machine.</p> <p>Cutting all tenons at the same time on band saw or using a router with template.</p> <p>Use of marking gauges set to correct dimension. Use of go/no-go gauges to check dimensional accuracy.</p> <p>Possible use of bench fixtures/clamps if candidates describe gluing</p>	10	<p>Mark breakdown:</p> <ul style="list-style-type: none"> <li>• Very simple diagram(s) with inaccurate and basic description e.g. hand cutting with ‘saw’. Some generic fixings stated e.g. ‘screw’. Little or no reference to batch production. (0 – 4 marks)</li> <li>• Better diagram(s) showing some further detail e.g. circular saws, routers. Possibly reference to Jigs or fixtures. May be some confusion between several different methods or terminology not quite accurate. (5 – 6 marks)</li> <li>• A detailed answer with ref to cutting stops, jigs/fixtures, CNC router/circular saws, clear ref to batch production</li> </ul>
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			framework.		methods. (7 – 10 marks)
<b>7</b>	<b>c</b>		<p>E.g.</p> <p>Provision of personal protective equipment such as goggles, dust mask and overalls to protect employees from dust being inhaled or going into eyes.</p> <p>Use of dust extraction with all machines to prevent inhalation of hazardous dust.</p> <p>Training in manual handling to avoid injury from lifting heavy loads.</p> <p>Risk assessments to assess the nature of hazards and reduce the risk of injury.</p> <p>Guarding of machines such as CNC routers, circular saws, etc to prevent employees getting injured.</p> <p>Specific training on the safe use of each machine to prevent accidents from unauthorised use.</p> <p>Provision of fire training / fire exits / extinguisher</p> <p>Provision of first aid</p> <p>Provision of safety signage</p> <p>Emergency stops on machines, etc.</p>	<b>4</b>	<p>1 – 2 marks per point. Award second mark for explanation of point.</p> <p>Award only 1 mark for a list of PPE e.g. goggles, masks, overalls, safety boots, etc.</p>

Question	Part	Sub Part	Marking Guidance	Mark	Comments
<b>8</b>	<b>a</b>	<b>i</b>	<p>Polypropylene is a thermoplastic which makes it suitable for injection moulding. Thermosets are generally not used in injection moulding because of the long 'curing' time involved.</p> <p>Polypropylene like all polymers can be coloured with a pigment to improve the aesthetic qualities of the product.</p> <p>Polypropylene is a relatively flexible polymer so it will give when people stretch and lean back on the chair.</p> <p>PP is a tough polymer that will withstand a good amount of wear and tear through use and should not break if the chair is tipped over.</p> <p>Chemical / water resistance making it easier to clean.</p> <p>Accept reference to recycling the polymer parts of the chair.</p>	<b>6</b>	<p>1-2 marks per relevant point. Award second mark where point is explained.</p>

<p>8</p>	<p>a</p>	<p>ii</p>	<div data-bbox="528 271 1145 701" data-label="Diagram"> </div> <p><b>E.g,</b></p> <ul style="list-style-type: none"> <li>- Polymer granules are loaded into the hopper</li> <li>- The Archimedean screw moves the granules past the heaters which melts the polymer</li> <li>- As the polymer melts, the Archimedean screw moves back.</li> <li>- When sufficient polymer has melted, the hydraulic ram moves the Archimedean screw forwards which injects the polymer into the mould.</li> <li>- The product is cooled in the water cooler mould</li> <li>- The mould opens and ejector pins push the completed moulding out,</li> <li>- Sprue pins and flash would be removed.</li> </ul> <p>For full marks expect reference to mould to reflect the product shape</p>	<p>10</p> <p>Mark breakdown:</p> <ul style="list-style-type: none"> <li>• Simple description with little detail. Diagrams are basic with incorrect labels or incomplete parts. (0 – 4 marks)</li> <li>• Better description using correct terminology. Diagram mostly complete and correct. (5 – 7 marks)</li> <li>• Full description. Correct / complete diagram. Detail includes terminology (8 – 10 marks)</li> </ul> <p><b>If no diagram max 5 marks.</b></p> <p><b>If no description max 5 marks.</b></p>
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Question	Part	Sub Part	Marking Guidance	Mark	Comments
8	b		<p>Possible answers may include:</p> <ul style="list-style-type: none"> <li>- Making the back solid rather than have slots in the backrest</li> <li>- Making the back thicker and so giving it more mechanical strength/rigid</li> <li>- Using alternatives such as plywood</li> <li>- Using a pressed/punched metal e.g. aluminium rather than a polymer for the backrest to increase strength</li> <li>- Adjusting the resin/filler ratio in the moulding to make it more flexible or to make it stiffer and stop the effects of fatigue through continual flexing.</li> <li>- The use of reinforcing 'webs' or similar to stiffen the back rest.</li> <li>- Adding padding to the backrest to improve comfort</li> <li>- Adding arm rests to improve comfort.</li> <li>- Possibly incorporating adjustable backrest height or backrest angle adjustment. (credit comments about increasing complexity/cost of manufacture)</li> <li>- Using longer screws or bolts connecting pad to frame</li> <li>- Using an adhesive to attach the pad to frame</li> <li>- Using some form of clamping arrangements</li> </ul> <p><b>If answer does not address the splitting and detachment – max of half marks.</b></p>	12	<p>Mark breakdown:</p> <ul style="list-style-type: none"> <li>• Basic drawings with limited detail but feasible solution (0 – 4 marks)</li> <li>• Better drawings with good annotation. Solution would work but not the best/most suitable. (5 – 8 marks)</li> <li>• Very clear drawings with full annotation. Solution is feasible and takes account of all of the criteria. (9 – 12 marks)</li> </ul>
8	c	i	<p>E.g.</p> <p>Mild steel is a malleable material which can be bent into the shape of the legs and frame.</p> <p>Mild steel is a widely available material which helps to keep production costs down to facilitate economic batch production.</p> <p>Mild steel has good fusibility so it can be welded relatively easily</p> <p>Mild steel has good tensile and compressive strength so it suitable to make something that will have to withstand weight.</p> <p>Reference to appropriate applied finishes.</p> <p>Where candidate state <i>strong</i> enough to support weight of people sitting down = 1 mark.</p>	6	<p>1-2 marks per relevant point. Award second mark for explanation of the point.</p>

8	c	ii	<p>Answer may include:</p> <p>Cleaning of frame/legs using a chemical wash or sand blasting to remove grease, dirt and provide a 'key' for the paint.</p> <p>Use of electrical charge on work piece &amp; electrical charge in paint particles to ensure even coverage.</p> <p>Powder blown through compressed air gun.</p> <p>Low temperature 'bake' to cure the paint.</p> <p>Do not accept reference to plastic dip coating.</p>	6	<p>Mark breakdown:</p> <ul style="list-style-type: none"> <li>• Basic diagram(s) with limited detail. Possibly confusion with dip coating or other finishing processes. (0 – 3 marks)</li> <li>• Clear diagrams with correct powder coating process. (4 – 6 marks)</li> </ul>
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