

Mark Scheme (Results)

Summer 2010

GCE

GCE Applied Engineering
6931 Paper 01
Engineering Materials, Processes and Techniques

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General Marking Guidance

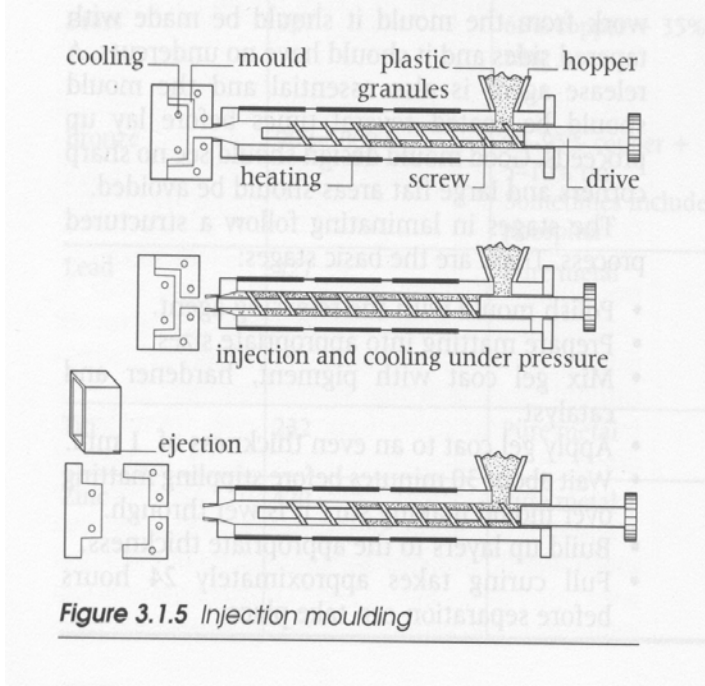
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should 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 | <table border="1"> <thead> <tr> <th>Specific material</th> <th>Class of material</th> <th>Significant property of material</th> </tr> </thead> <tbody> <tr> <td>Cast Iron</td> <td>Ferrous (1)</td> <td>Brittle / good fluidity / hard / tough (1)</td> </tr> <tr> <td>Copper</td> <td>Non-ferrous (1)</td> <td>Malleable / good conductor/ductile (1)</td> </tr> <tr> <td>Duralumin</td> <td>Alloy (1)</td> <td>Lightweight /tough/ High electrical conductivity / age hardens (1)</td> </tr> <tr> <td>ABS</td> <td>Thermoplastic (1)</td> <td>Insulator / softens at low temperature / good impact resistance (1)</td> </tr> </tbody> </table> <p><i>Do not accept 'light', 'strong', 'rust' 'plastic'</i> 1 mark for each correct material, 1 mark for each appropriate property</p> | Specific material | Class of material | Significant property of material | Cast Iron | Ferrous (1) | Brittle / good fluidity / hard / tough (1) | Copper | Non-ferrous (1) | Malleable / good conductor/ductile (1) | Duralumin | Alloy (1) | Lightweight /tough/ High electrical conductivity / age hardens (1) | ABS | Thermoplastic (1) | Insulator / softens at low temperature / good impact resistance (1) | (8) |
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| 2(a) | <table border="1"> <thead> <tr> <th>Process</th> <th>Hazard or risk</th> <th>Control measure or precaution</th> </tr> </thead> <tbody> <tr> <td>Chemical etching</td> <td>Chemical burns / splashes in eyes (1)</td> <td>Gloves /safety glasses/apron (1)</td> </tr> <tr> <td>Soft soldering</td> <td>Fumes / heat burns (1)</td> <td>Well ventilated area / wear gloves/use stand (1)</td> </tr> <tr> <td>Metal turning</td> <td>Swarf / breaking tool (1)</td> <td>Eye protection / use machine guards (1)</td> </tr> <tr> <td>MIG welding</td> <td>Arc eye / burns / fumes (1)</td> <td>Eye shield / Gloves / welding screen Ventilated room (1)</td> </tr> </tbody> </table> <p>1 mark for each correct hazard/risk, 1 mark for each different appropriate precaution</p> | Process | Hazard or risk | Control measure or precaution | Chemical etching | Chemical burns / splashes in eyes (1) | Gloves /safety glasses/apron (1) | Soft soldering | Fumes / heat burns (1) | Well ventilated area / wear gloves/use stand (1) | Metal turning | Swarf / breaking tool (1) | Eye protection / use machine guards (1) | MIG welding | Arc eye / burns / fumes (1) | Eye shield / Gloves / welding screen Ventilated room (1) | (8) |
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| Question Number | Answer | Mark |
|-----------------|--|------|
| 2(b) | <p>Any the following:</p> <ul style="list-style-type: none"> • Heat soldering iron (1) • Hold solder plus hot iron onto joint that needs to be joined (1) • Once joined remove heat and solder (1) • Allow to cool (1) <p>1 mark for each point made, maximum of 3</p> | (3) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 2(c) | <p>Any three of the following:</p> <ul style="list-style-type: none"> • Degrease / Clean (1) • Mark off areas to be etched (1) • Place in etchant (1) • Remove and wash (1) <p>The 1 mark for each element given, maximum of 3</p> | (3) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 3(a) | <p>Candidate's response can include notes and/or sketches, describing the injection moulding process.</p> <p>Annotations/notes: Good quality diagram of injection moulding process Should include the following:</p> <p>Plastic pellets poured into hopper (1) Motor / hydraulic ram (1) Heaters (1) Molten plastic forced into mould (1) Split mould parts (1) Ejector pins force work out (1) Moulding removed and waste cut off (1)</p> <p>Diagram: A well labelled, clear sketch required 1 mark for each element mentioned</p>  <p>Figure 3.1.5 Injection moulding</p> <p>(From Product Design: Graphics with Materials Technology ISBN:0-435-75771-7)</p> <p>Maximum mark of 4 only.</p> | (4) |

| Question Number | Answer | Mark |
|-----------------|---|------|
| 3(b)(i) | <p>Annealing copper</p> <p>Purpose: Soften metal / make metal more workable / relieve stresses (1)</p> <p>Method: Heat copper to 'dull red heat' (1) allow to cool down in air /quench (1) pickle in acid bath to remove oxides (1) Any 4 marks</p> | (4) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 3(b)(ii) | <p>Case hardening</p> <p>Purpose: Give hardened outer coat on mild carbon steel (1)</p> <p>Method: Heat to red heat (1) plunge into carbon rich compound (1) reheat / repeat a number of times (1) Any 4 marks</p> | (4) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 4(ai) | <p>Electrical connectors</p> <ul style="list-style-type: none"> • Copper (accept Aluminium) (1) | (1) |
| 4(aii) | <p>Any one of the following:</p> <ul style="list-style-type: none"> • Low resistivity (1) therefore good electrical conductor (1) • Ductile which means it can be stretched into thin wire (1) with relatively good tensile strength (1) • Corrosion resistant (1) which means it will have a long service life (1) | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 4(bi) | Insulation of power cables <ul style="list-style-type: none"> • PVC (1) | (1) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 4(bii) | Insulation of power cables <ul style="list-style-type: none"> • Easy to extrude (1) so can be produced in long lengths (1) • Good insulator / high resistivity(1) therefore prevents shocks (1) • Flexible (1) to allow the cable to bend (1) | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 4(ci) | Drill chuck <ul style="list-style-type: none"> • High Carbon steel / Low Carbon steel (1) | (1) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 4(cii) | Drill chuck <ul style="list-style-type: none"> • Hard (1) so that it resists wear (1) • High tensile strength (1) therefore it will be long lasting (1) • Tough / Robust (1) Long lasting (1) • Suitable for machining (1) into complex shapes (1) | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 5(a) | <p>Any two of the following:</p> <ul style="list-style-type: none"> • Easy to assemble (1) during production (1) • Easy to disassemble (1) to allow access for repairs (1) • Easier to fabricate (1) than from complex single mould (1) • Complex shape of case (1) can only be produced using injection moulding (1) <p>Maximum 2 marks</p> | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 5(b) | <p>Method of joining:</p> <ul style="list-style-type: none"> • Screws (1) • Nut and bolt(1) <p>Justification</p> <ul style="list-style-type: none"> • Easy to assemble / disassemble (1) for manufacture / maintenance(1) • Tamper proof (1) Stop unskilled getting to high voltages therefore a safety factor (1) <p>Maximum mark of 3 includes method of joining</p> | (3) |

| Question Number | Answer | Mark |
|-----------------|---|------|
| 5(c) | <p>Any of the three points stated:</p> <ul style="list-style-type: none"> • Causes discolouration (1) • Causes material to become brittle (1) • Cause structural weakness (1) • Degrades (1) • Turns material into powder (1) <p>Maximum 3 marks</p> | (3) |

| Question Number | Answer | Mark |
|-----------------|---|------|
| 6(a) | <p>Any four points of the following:</p> <ul style="list-style-type: none"> • Mild steel contains iron (1) • Iron reacts to Oxygen (1) and water (1) • This reaction causes corrosion / rust (1) • The process is electrolytic (1) <p>Maximum 4 marks</p> | (4) |

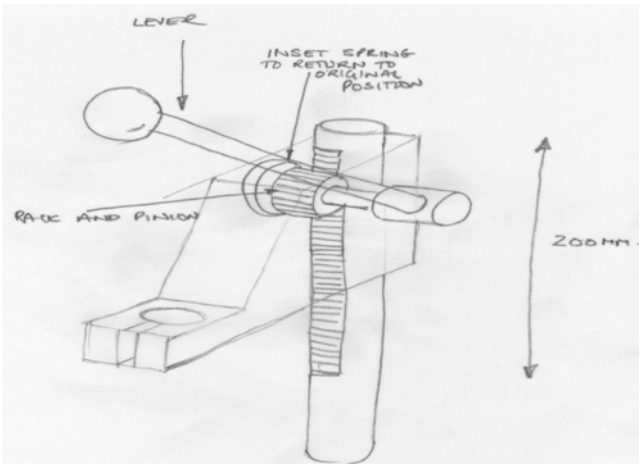
| Question Number | Answer | Mark |
|-----------------|--|------|
| 6(b) | <p>Any of the two:</p> <ul style="list-style-type: none"> • When a piezo-electric actuator is deformed, bent tapped (1) it produces a small voltage that can be used to trigger electronic circuitry (1) • Applying a voltage to a piezo-electric actuator (1) causes it to move or vibrate (if AC is applied) causing a sound to be emitted (1) | (2) |

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|-----------------|--|------|
| 6(c) | <p>Any six of the following:</p> <ul style="list-style-type: none"> • Produce the mould (1) • Release agent (1) • Gelcoat (1) • Alternate layers of resin and glass matting (1) • Allow to cure (1) • Release from mould (1) • Safety issues (1) <p>Maximum 6 marks</p> | (6) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 7(a)(i) | <p>Any four of the following:</p> <p>Anodising</p> <ul style="list-style-type: none"> • Workpiece is used as + (anode) Lead plate -ve (cathode) (1) • Immersed in electrolyte (1) • DC passed through electrolyte (1) • Oxide film thickened (1) • Workpiece boiled in water (1) • Die is added (1) • Final surface protected by lacquer (1) <p>Maximum 4 marks</p> | (4) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 7(a)(ii) | <p>Any three of the following:</p> <p>Plastic coating</p> <ul style="list-style-type: none"> • Carefully clean work to be coated (1) • Heat gently (1) • Suspend in plastic fluidizing tank (1) • Switch on blower to force nylon powder around work (1) • Switch off blower (1) • Remove work (1) • Allow to cool (1) <p>Maximum 3 marks</p> | (3) |

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|-----------------|--|------|
| 7(b) | <p>Any one of the following:</p> <ul style="list-style-type: none"> • Less labour intensive (1) so less expense for the manufacturer(1) • Easier to produce in mass production situation (1) because no other surface finish process required (1) <p>Maximum 2 marks</p> | (2) |

| Question Number | Answer | Mark |
|-----------------|--|------|
| 8 | <p>Marks will be awarded for design features relating to those below:</p> <ul style="list-style-type: none"> • A method of moving the drill vertically up and down. (1) <i>suitable system eg. Levers/rack and pin (1), and 150mm (1) rack and pinion or levers (1)</i> • A method of returning the drill back to its original position once the hole has been drilled (1)<i>spring device (1) correct range of 150mm range/workable system (1) For example: some kind of workable spring return mechanism</i> • Locking device (1) <i>fully workable (1) partially workable. Evidence working device (cam device/threaded device) (1) need to be easy to use (1) fully workable (1)</i> • Some kind of device to produce leverage to enable the drill to be moved. (1) <i>fully workable (1) partially workable Must have evidence of lever to move drill up and down</i> • Method of rotating (1) <i>fully workable (1) partially workable</i> • Appropriate dimension in relation to vertical movement. (1) • Indication of 180° rotation (1) <i>rotate freely (1) lubricated/bearing (1) 180° rotation (1)</i>  <p>Must have notes and sketches. Maximum 12 marks</p> | (12) |

| Question Number | | Answer |
|-----------------|------|---|
| 9 | | <p>Example of appropriate response is shown below:</p> <p><i>Aluminium is a lightweight (1) material that can be easily die cast (1) It is relatively more expensive than ABS (1) Aluminium is a material that will not corrode or rust (1)</i></p> <p><i>ABS is readily available (1) It can be easily injection moulded (1) and formed into complex shapes (1). Unlike aluminium ABS is an electrically safe insulator (1) therefore is very suitable for an electric drill. (1) ABS will withstand shocks if dropped (1)</i></p> <p>Maximum 6 marks including QWC*</p> |
| Level | Mark | Descriptor |
| | 0 | No rewardable material |
| 1 | 1-2 | The candidate identifies one or two advantages/disadvantages with no development. Shows limited understanding of advantages/disadvantages. The candidate uses everyday language and the responses lack clarity and organisation. Spelling, punctuation and the rules of grammar are used with limited accuracy. |
| 2 | 3-4 | The candidate identifies some advantages/disadvantages with associated developments showing some understanding of advantages/disadvantages. The candidate uses some specialist terms and the response show some focus and organisation. Spelling, punctuation and the rules of grammar are used with some accuracy. |
| 3 | 5-6 | The candidate identifies a range of advantages/disadvantages with associated developments showing a detailed understanding of advantages/disadvantages. 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. |

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