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Mark Scheme (Results)

Summer 2013

GCE
Engineering (6931/01)

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Question Number	Answer	Mark
1	One mark for each correct risk (1x5 marks) One mark for each correct precaution (1x5 marks)	**(10)**

Process	Risk	Precaution
Handling sheet metal	Cuts/abrasions to hands/body	Wear protective gloves/overalls
	Manual lifting	Clear work area of people/Use lifting equipment
Punching	Limbs trapped in machinery	Guards to protect operator
	Loose metal in eye	Wear safety glasses
	Noisy operation that could damage hearing	Wear ear protection for operator
Painting	Fumes	Wear protective mask Use a well ventilated room
	Paint in eyes	Wear protective glasses
	Paint on skin	Wear protective clothing
Electric arc welding	Arc eye	Wear eye protection
	Electrocution	Handling mains lead
Drilling	Drill breaks	Wear safety glasses
	Drill snags in workpiece	Clamp workpiece to table
	Swarf flying from drill	Wear eye protection

			Loose clothing caught/trapped	Remove ties or other clothing
	Ensure precaution comments are different. Do not award a second mark for repeat precaution comment.			

Question Number	Answer	Mark
2	One mark for each specific material (1x5 marks) One mark for each significant property (1x5 marks) **Ferrous metal** Mild steel — Tough, ductile, high tensile strength, rusts easily. Carbon Steel — Tough, can be hardened and tempered. Stainless steel — Tough, resistant to rust and stains. Cast iron — Strong in compression, brittle, compressive strength very high. Wrought Iron — Fibrous, tough, ductile, resistant to rusting. **Non-ferrous metal** Aluminium — Ductile, soft, malleable, machines well, very light, 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^{o} – 150^{o} C, low melting point. Tin — Malleable, ductile, anti-corrosive. Tungsten (Wolfram) — Extremely hard, brittle, tough. **Thermoplastic polymer** Polyethene — Tough, flexible, solvent resistant, low melting point, good fluidity. Polypropylene — High strength, hard, high melting point, can be produced as a fibre. Poly vinyl chloride (PVC) — Can be made 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	**(10)**

	chemical attack.
Acrylic (PMMA)	Brittle, rigid, easily scratched, softens under heat and can be moulded, susceptible to chemical attack.
Polytetra fluoroethylene (PTFE)	Tough, flexible, heat resistant, highly solvent resistant, has a low coefficient of friction.
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

Thermosetting polymer

Phenolic resins (Bakelite)	Hard, resistant to heat and solvents, good electrical insulator, machineable, can be moulded.
Urea formaldehyde (UF)	High tensile strength, low water absorbtion, non-conductive, good heat resistance.
Urea- methanol resins (Formica)	Hard, resistant to heat and solvents, good electrical insulator, machineable.
Methanal – 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.

Elastomers

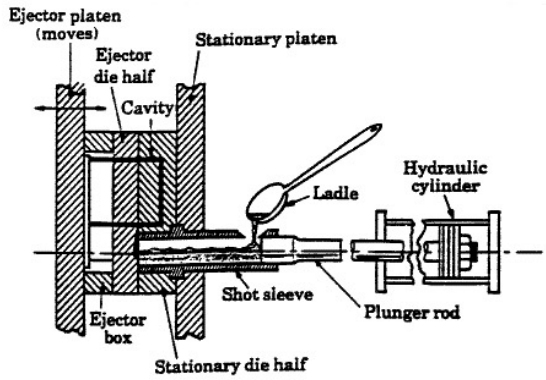
Rubber (Natural, Styrene, Butyl, Silicone)	Tough, flexible, good solvent resistance, good elasticity.
Neoprene	Good resistance to UV light, performs well with oils and chemicals, very tough, high resistance to burning, high resistance to damage by bending or twisting. Stable

		over a range of temperatures.	

Accept any appropriate thermo or thermosetting polymer

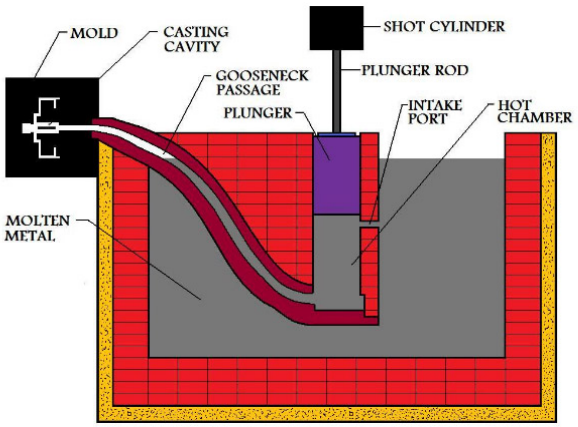
Question Number	Answer	Mark
3(a)	1 x 2 marks for advantage and 1 x 2 marks for disadvantage (max 4 marks) **Advantages** • Can produce intricate shapes (1) • Can produce accurate shapes (1) • Less waste material produced (1) • Low cost production after initial set-up costs (1) • Fast production process (1) • Die cast moulds can be used repeatedly (1) • Good surface finish (1) **Disadvantages** • Expensive machine set-up costs (1) • Expensive tooling costs (1) • Only certain materials can be used (1) • Cannot be used for large castings as capacity is limited (1) • Die casting is only suitable for lower melting point materials (1) Accept any other appropriate response	**(4)**

Question Number	Answer	Mark
3(b)	Accept either cold or hot chamber process (max 6 marks) **Cold Chamber** • Two halves of die brought together (1) • Metal placed in shot sleeve (1) • Hydraulic cylinder forces plunger rod to push metal into cavity (1) • Shape forms in mould (1) • Half of mould opens (1) • Ejector pins release product (1)	**(6)**



Hot Chamber

- Two halves of die brought together (1)
- The supply of molten metal is attached to the die casting machine (1)
- Shot cylinder provides the power for the injection stroke (1)
- Plunger rod goes from shot cylinder down the plunger (1) which is in contact with the molten metal (1)
- Intake ports allow chamber to fill with liquid metal (1)
- Plunger travels past intake ports (1) cutting off flow of molten liquid to hot chamber (1)
- Correct amount of molten material in the chamber (1) for the 'shot' that will be used to fill the mould (1)
- Shape forms in mould (1)
- Mould opens and releases shaped product (1)



One mark each for process description (max 6 marks)

Question Number	Answer	Mark
4(a)(i)	One mark for each correct property The ductility of a material is a measure of the amount by which it can be drawn out in tension before it fractures (1) drawn into wire (1).	**(1)**

Question Number	Answer	Mark
4(a)(ii)	One mark for each correct property The elasticity of a material is a measure of its ability to withstand elastic deformation (1).	**(1)**

Question Number	Answer	Mark
4(a)(iii)	One mark for each correct property Ability to be bent (deformed) and worked into shape (1).	**(1)**

Question Number	Answer	Mark
4(a)(iv)	One mark for each correct property Hardness is the ability to withstand wear, scratching or abrasion (1).	**(1)**

Question Number	Answer	Mark
4(a)(v)	One mark for each correct property Ability to withstand impact without fracturing (1).	**(1)**

Question Number	Answer	Mark
4(b)(i)	The test piece returns to its original length (1)	**(1)**

Question Number	Answer	Mark
4(b)(ii)	One mark for each correct letter: B to E	**(2)**

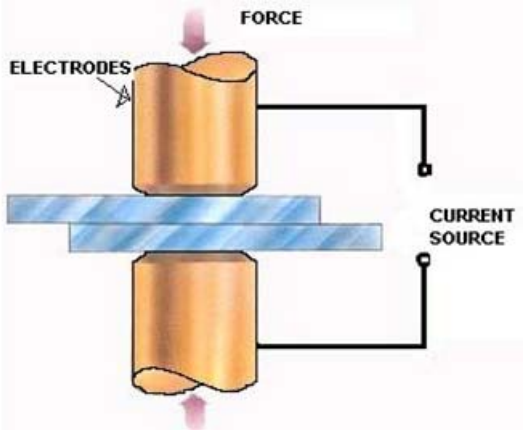
Question Number	Answer	Mark
4(b)(iii)	The test piece fractures (1)	**(1)**

Question Number	Answer	Mark
4(b)(iv)	The ultimate tensile strength (1)	**(1)**

Question Number	Answer	Mark
5(a)(i) / (ii)	One mark for purpose and up to three marks for description of process (max 4). Normalising carbon steel (i) Purpose • Relieve internal stress (1) (ii) Process • Heated to cherry red temperature (800^0 – 900^0 C) (1) • Allow to cool (1) • At room temperature/air (1) Accept any other appropriate response.	**(4)**

Question Number	Answer	Mark
5(b)(i) / (ii)	One mark for purpose and up to three marks for description of process (max 4). Case hardening low carbon steel (mild steel) (i) Purpose • Harden the outer layer or skin (1) (ii) Process • Heated to cherry red temperature (1) • Plunged into case hardening compound (1) • Steel heated again to cherry red (1) • Plunged in cold clean water or brine (1) Accept any other appropriate response.	**(4)**

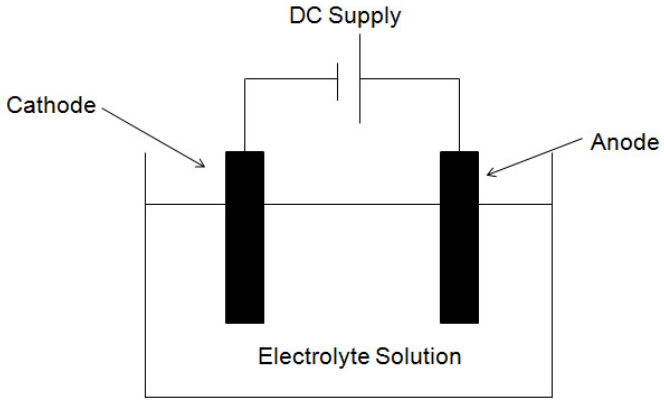
Question Number	Answer	Mark
6(a)(i)	One mark for each correct application of spot welding (max 2 marks). • Car industry (1) • Welding toolbox panels (1) • Sheet metal garage doors (1) • Frame of gas cooker (1) • Wheelbarrow (1) • Metal gates (1) • Filing cabinets (1) • Shopping trolleys (1) • Gas barbecues (1) Accept any other appropriate response.	**(2)**

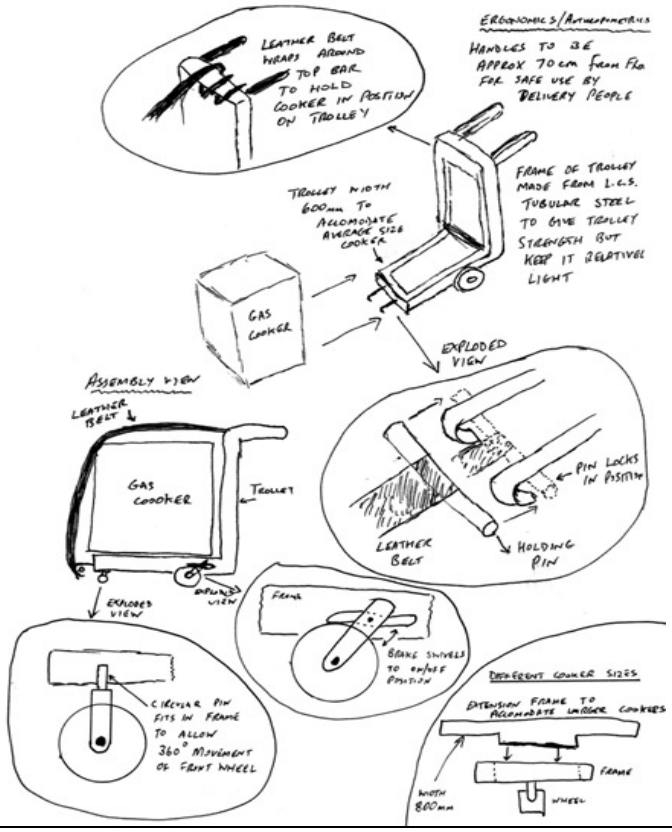
Question Number	Answer	Mark
6(a)(ii)	One mark each for process description (max 4 marks) • Copper electrodes come together (1) to clamp material in place (1) • Circuit completed (1) electricity flows (1) • Heat generated (1) to fuse materials together (1) • Electrodes removed (1) and 'nugget' of molten material solidifies forming the joint (1)  Max 4 marks without diagram	**(6)**

Question Number	Answer	Mark
6 (b)	One mark each for item description (max 3 marks) Two pieces of sheet steel can be fastened with a screw/bolt (1) through each piece of steel with a spring washer (1) and nylock nut (1) for secure fastening to avoid vibration Accept any other appropriate response.	**(3)**

Question Number	Answer	Mark
7 (a)(i)	One mark for correct response (max 2 mark) • Tin • Zinc • Nickel • Silver • Gold • Chromium Accept any other appropriate response.	**(2)**

Question Number	Answer	Mark
7(a)(ii)	• To prevent rusting or corrosion (1) to make the product last longer (1) • To provide a decorative finish (1) to improve the aesthetics of the product (1)	**(2)**

Question Number	Answer	Mark
7(b)	One mark each for process description (max 5 marks) Up to 3 marks for labelled diagram (max 3 marks) • Component chemically cleaned (1) • Part to be plated is cathode (1) • Anode to be made of metal to be plated (1) • Electrolyte solution that permits flow of electricity (1) • DC power supply required (1) • DC power supply oxidises metal atoms from anode (1) • Dissolved metal ions in electrolyte solution attract to cathode (1) Accept any other appropriate response.  	**(6)**

Question Number	Answer	Mark
8	One mark each for written point relevant to design task and marks to be awarded for a labelled diagram (max 12 marks) • Ability to steer, appropriate design (1), fully workable (1) • Suitable materials (1), justification (1) • Fastening device, appropriate design (1), fully workable (1) • Locking device, appropriate design (1), fully workable (1) • Accommodate sizes of cooker, appropriate design (1), fully workable (1) • Quality of communication (2) 	**(12)**

Question Number		Indicative Content
9		When looking at the two materials mild steel has a dull finish (1) and stainless steel has a shiny finish (1). Aesthetically, stainless steel would look better on the eye (1) in a domestic household kitchen, were as mild steel would be used in an industrial kitchen, where looks are not important (1). Mild steel is a low carbon steel with less than 0.3 % carbon content (1). This makes the steel cheaper (1) to buy and easy to work with (1) due to the steel being malleable (1). In contrast stainless steel contains more than 0.3 % carbon (1) which makes the material more expensive to purchase (1). With the increased carbon content stainless steel is a tougher (1) material and harder to work with (1). Mild steel is easier to manufacture (1) than stainless steel. To manufacture stainless steel specialised tooling is required (1) due to its toughness (1), with no specialised tooling required for the manufacture of mild steel (1). Another problem when manufacturing stainless steel is that the material has to be protected (1) during the production process. The manufacturer cannot allow scratches (1) or other abrasions (1) to damage the surface of the material as the product would have to be scrapped (1) causing financial implications (1). Any slight abrasions on mild steel are not as important (1) as further production processes can hide any imperfections, i.e. spray painting (1). Usually after manufacture mild steel will have a protective coating coated on its outer shell (1). This can be spray painted on to the cookers frame to look good (1) and allow for customer requests i.e. a particular coloured cooker (1). Once produced, stainless steel parts are ready for installation (1) and require no further production processes (1). Each material has its own advantages and disadvantages which are dependent on a number of factors including cost (a mild steel cooker is less expensive (1) than a stainless steel cooker (1)). Mild steel is easier to manufacture (1) but stainless steel has aesthetic properties (1) which may be important to the customer (1).
Level	**Mark**	**Descriptor**
	0	No rewardable material
1	**1-3**	Some benefits and limitations of materials listed.
2	**4-6**	Most benefits and limitations in well constructed sentences.
3	**7-9**	As level 2 with a balanced comparison and a conclusion.

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