1145-530 Level 3 Technical Certificate in Engineering

1145-530 Level 3 Advanced Technical Diploma in Engineering

1145-530 Level 3 Advanced Extended Technical Diploma in Engineering

Level 3 Engineering – Theory test (1) March 2018

Marking scheme

Q	Acceptable answer(s)	Guidance	Max mks	Ref
1a)	Elasticity		**1**	**301** **1.1** **AO1**
1b)	Creep		**1**	**301** **1.1** **AO1**
2a)	Award **one** mark for any of the following points, up to **four** marks in total: • Heat the metal until cherry red • Add carbon either through a modified atmosphere or surface coating/powder/carburising compound • Allow soak time so that the carbon can be adsorbed into the surface • Cool quickly/quench.		**4**	**301** **2.1** **AO1**
2b)	Award **one** mark for any of the following points, up to **four** marks in total: • Normally the movement of dislocations within the lattice facilitates plastic deformation • In precipitation hardening, an impurity phase is taken into solution • Heat treatment is used to allow the impurity phase to precipitate (1) typically in areas where there are dislocations in the lattice (1) • The precipitated particles impede the movement of dislocations		**4**	**301** **2.2** **AO2**

	• This increases strength and hardness (1) and reduces plasticity (1).			
3	Award **one** mark for any of the following points, up to **four** marks in total: E.g. for Vickers hardness: a diamond shaped tool (1) is pushed into the surface of the material (1) using a set load (1). After this is removed, the dimensions of the indentation are measured (1) and these are related to the hardness using a table (1) Any other appropriate response (including descriptions of other hardness testing methods)		**4**	**301** **3.2** **AO1**
4a)	Defects could include: voids, disbands, delamination and porosity.	4a) and 4b) **One** mark for each cell completed with accurate information, up to **four** marks in total	**2**	**301** **4.4** **AO1**
4b)	Test methods could include: tap testing, thermography, x-ray, shearography, ultrasonic.		**2**	**301** **4.4** **AO1**
5	Award **one** mark for any of the following points, up to **five** marks in total: • Typically have four electrons in their outer shell (1), which form perfect covalent bonds with their neighbouring atoms resulting in poor ability to conduct electricity (1) • A small amount of impurity is added to the material (doping) • In n-type materials, this adds an extra electron which is free to move around • Typical n-type dopants include phosphorous or arsenic • In p-type materials, this takes away an electron, leaving a 'hole' which allows electrons from neighbouring atoms to move into the space/hole movement		**5**	**301** **5.3** **AO2**

	• Typical p-type dopants include boron or gallium			
6a)	Award **one** mark for any one of the following, up to **two** marks in total: • Gas welding/oxyacetylene • Manual metal arc/'stick' welding • Metal Inert Gas (MIG) / Metal Active Gas (MAG) • Tungsten Inert Gas (TIG) • Friction • Resistance (spot and seam).		**2**	**304** **1.1** **AO1**
6b)	Award **one** mark for any one of the following, up to **four** marks in total: • Quality Control (QC) is carried out after products are made • QC involves measurement of products • QC detects faulty products, so that they can be sent back for rework or scrapped • Quality assurance (QA) affects products before they are made • QA involves putting in place systems to ensure that products are made to the required standard • Any other suitable point.		**4**	**304** **2.2** **AO2**
6c)	Award **one** mark for any one of the following, up to **two** marks in total: • Coatings • Shrink wrap • Packaging.		**2**	**304** **2.5** **AO1**
6d)	Award **one** mark for each advantage and a mark for a reason associated with it, up to four marks in total.		**4**	**304** **5.2** **AO2**

	For example: less work in progress (1) means that less defects are produced before a fault is detected (1); that less money is tied up in stock (1) and less storage space is required for work in progress (1), both of which result in greater profitability for the company (1). Any other appropriate response.			
6e)	Award up to four marks in total, as indicated: Award **one** mark for naming a suitable material and one mark for a suitable reason: for example, a thermoplastic (1) as it is easy to clean (1), or aluminium (1) as it can be recycled (1). Award one mark each for up to two manufacturing processes and one mark for a reason: for example, injection moulding (1) or pressure die casting (1) as the quantity means that it is cost effective to make a reusable mould (1). Any other appropriate response. Marks for the manufacturing process can be awarded even if the material recommended was not appropriate.		**4**	**AO4**
7a)	Award **one** mark each for two of the following: • aesthetic requirements • cost • environmental issues • size • safety considerations • function • materials • limitations affecting the choice of manufacturing methods • maintenance requirements.		**2**	**305** **1.2** **AO1**
7b)	Award **one** mark each for up to three of the following:		**5**	**305** **2.2** **AO2**

	• Design constraints are needs that must be met for the product to function or meet its critical requirements • Design constraints limit what you can make • Design wants represent features that are desirable but not essential for the product to be effective • Any other suitable point. **One** mark **each,** for suitable example of a design constraint and a design want.			
8a)	Award **one** mark for each drawing type up to a total of **three** marks: • Sketches to show design ideas • Orthographic (working) drawings • General arrangement drawings • Exploded views • Circuit diagrams • Flow charts • Any other suitable drawing type		**3**	**305** **3.3** **AO1**
8b)	Award **one** mark for each advantage or disadvantage and a mark for a reason associated with it, up to six marks in total. For example: advantage: physical components are not needed (1) so it is cost effective (1); components can be changed easily (1) reducing the time needed to test different ideas (1). Disadvantage: not using the actual components (1), so the circuit may not be operate as exactly as modelled (1) Any other appropriate response.		**6**	**305** **3.4** **AO2**
9	**Band descriptors** Award marks as follows:	**Indicative content** Examples of points that may be included in the answer are:	**9**	**AO4**

	No answer worthy of credit – e.g. insufficient work submitted, answer not relevant to the question, answer is factually incorrect. **(0 marks)** **Band 1 – basic** – largely descriptive response based on recall of knowledge. A few influences, either mainly social or mainly economic, are stated but their implications are not explained. Candidates at the top of this level may be characterised by describing some influences more in detail, but showing understanding of the implications of just one contribution **(1-3 marks)** **Band 2 – clear** – more detailed response, including statements of influences that show understanding of most of their direct implications. Both social and economic influences discussed with some evaluation. Candidates at the top of this level may be characterised by stating and explaining a variety of influences or causal links contributing to or resulting from influences; they may evaluate the broader implications beyond manufacturing of a few of these influences. **(4-6 marks)** **Band 3 – detailed** – fully detailed response including statements of influences that show understanding of both their direct and secondary implications. Both social and economic influences discussed, with linking and conclusions drawn. Candidates at the top of this level may be characterised by evaluating and substantiating how a broad range of influences or causal links have affected society both directly and through secondary effects. **(7-9 marks)**	• Facilitating the production of high volume items for consumer consumption • Improved consistency of products/'standardised' quality, giving improved customer confidence in product performance • Reduction in 'customisation' of goods – 'one size fits all' approach • Development of increased production capacity, providing faster access to goods and high volume goods at lower prices • Development of large factories, providing centralised employment opportunities and increased jobs in transportation • Reduction in overall number of employment opportunities, but increase in specialist roles such as programming or maintenance • Reduction of the need for human workers to do repetitive work or work in hazardous environments ***For no awardable content, award 0 marks.***		
10a)	n log 12 = log 8 Therefore n = log 8 / log 12 = 0.837		**3**	**306** **1.3** **AO2**

	Award one mark for taking logs, one mark for rearranging and one mark for the correct answer.			
10b)	x = $(-b+/-(b^2-4ac)^{1/2})/2a$ = $(-8+/-(8^2-4x1x7)^{1/2})/2x1$ = + 7 and + 4 Award **one** mark for the formula, **one** mark for inserting correct values and **one** mark for **each** of the two roots.		**4**	**306** **1.4** **AO2**
10c)	a) x = r cos θ = 450 cos 70° = 153.9 y = r sin θ = 450 sin 70° = 422.9 Award one mark each for the method and one mark for each correct answer.		**4**	**306** **4.4** **AO2**
11a)	As the maximum value of sin (5t) = 1, therefore the amplitude is 50 mm.		**1**	**306** **2.3** **A02**
11b)	As θ = ω t = 5t, the angular frequency = 5 rad s^{-1}		**1**	**306** **2.3** **A02**
11c)	The frequency f = ω / 2π = 5 / 2π = 0.796 Hz **(1 mark for formula, 1 mark for answer)**		**2**	**306** **2.3** **A02**
11d)	The time of one cycle T = 1/f = 1 / 0.796 = 1.257 seconds **(1 mark for formula, 1 mark for answer)**		**2**	**306** **2.3** **A02**
11e)	The time for the mass to travel from zero to maximum movement = 0.25 T = 0.314 seconds **(1 mark)** Allow for follow through for d) and e).		**1**	**306** **2.3** **A02**
12	du/dx = 2x $\Rightarrow$ xdx = ½ du $\Rightarrow \int 4e^u$ ½ du		**6**	**306** **3.2** **AO2**

	So $\Rightarrow \quad 2\int e^{u}\ du$ $\Rightarrow \quad 2e^{u} + c$ Hence the area under the curve is $2e^{(x^2-1)} + c$ Award one mark for each step, including the answer.			
13	**Band descriptors** Award marks as follows: No answer worthy of credit – e.g. insufficient work submitted, answer not relevant to the question, answer is factually incorrect. **(0 marks)** **Band 1 – basic** – largely descriptive response based on recall of knowledge, relating only to manufacturing processes or use of automation. May describe one or two considerations for specific activities in relation to production volume. Candidates at the top of this level may be characterised by showing understanding of the reasons for a few decisions related to scale of manufacture. **(1-4 marks)** **Band 2 – clear** – more detailed response, showing recall of knowledge and understanding of the implications of the production volume on the manufacturing processes and supporting activities. Different options for manufacturing processes and systems are considered and analysed, with reasoning as to why these would be used or not used for different scales of manufacture. Candidates at the top of this level may be characterised by evidence that they have considered how product quality and cost are influenced by the decisions made. **(5-8 marks)** **Band 3 – detailed** – fully detailed response, showing understanding of how the production volume affects the whole manufacturing system. A range of different manufacturing approaches are evaluated, with substantiation of which approaches are deemed more	**Indicative content** Examples of points that may be included in the answer are: • One-off, batch, mass and continuous (flow-line) production • Use of jigs, fixtures, templates and moulds • Use of CAD/CAM • Use of automation for processes and materials handling • Assembly methods: from hand built to cradles, conveyor belts and automated assembly. • Materials and process selection • Consideration of process capabilities and manufacturing tolerances • Design for Manufacture • Measurement and testing, including equipment used • Raw materials and stock requirements • Consistency, repeatability and production rates	**12**	**AO4**

	effective at different scales of production, making recommendations and producing supporting conclusions. Candidates at the top of this level may be characterised by analysing and evaluating how the approaches used at different scales of production are affected by product-related factors such as repeatability, cost, consistency and customer preference. **(9-12 marks)**	• Impact of quality on the customer		