NCFE Level 1/2 Technical Award in Engineering (603/2963/4)

Paper number: L12_TA_Eng_03

Unit 01 Understanding the engineering world

Mark Scheme

This mark scheme has been written by the Assessment Writer and refined, alongside the relevant questions, by a panel of subject experts through the external assessment writing process and at standardisation meetings.

The purpose of this mark scheme is to give you:

- examples and criteria of the types of response expected from a learner
- information on how individual marks are to be awarded
- the allocated assessment objective(s) and total mark for each question.

Marking guidelines

General guidelines

You must apply the following marking guidelines to all marking undertaken throughout the marking period. This is to ensure fairness to all learners, who must receive the same treatment. You must mark the first learner in exactly the same way as you mark the last.

- The mark scheme must be referred to throughout the marking period and applied consistently. Do not change your approach to marking once you have been standardised.
- Reward learners positively giving credit for what they have shown, rather than penalising them for what they might have omitted.
- Utilise the whole mark range and always award full marks when the response merits them.
- Be prepared to award zero marks if the learner's response has no creditworthy material.
- Do not credit irrelevant material that does not answer the question, no matter how impressive the response might be.
- The marks awarded for each response should be clearly and legibly recorded in the grid on the front of the question paper.
- If you are in any doubt about the application of the mark scheme, you must consult with your Team Leader or the Chief Examiner.

Guidelines for using extended response marking grids

Extended response marking grids have been designed to award a learner's response holistically and should follow a best-fit approach. The grids are broken down into levels, with each level having an associated descriptor indicating the performance at that level. You should determine the level before determining the mark.

When determining a level, you should use a bottom-up approach. If the response meets all the descriptors in the lowest level, you should move to the next one, and so on, until the response matches the level descriptor. Remember to look at the overall quality of the response and reward learners positively, rather than focussing on small omissions. If the response covers aspects at different levels, you should use a best-fit approach at this stage, and use the available marks within the level to credit the response appropriately.

When determining a mark, your decision should be based on the quality of the response in relation to the descriptors. You must also consider the relative weightings of the assessment objectives, so as not to over/under credit a response. Standardisation materials, marked by the Chief Examiner, will help you with determining a mark. You will be able to use exemplar learner responses to compare to live responses, to decide if it is the same, better or worse.

You are reminded that the indicative content provided under the marking grid is there as a guide, and therefore you must credit any other suitable responses a learner may produce. It is not a requirement either, that learners must cover all of the indicative content to be awarded full marks.

Assessment objectives

This unit requires learners to:

AO1	Recall knowledge and show understanding.
AO2	Apply knowledge and understanding.
AO3	Analyse and evaluate knowledge and understanding.

The weightings of each assessment objective can be found in the qualification specification.

Qn	Mark scheme	Total marks
		Total: 80 marks
1	Figure 1 **shows a mechanical system.** **Identify the mechanical system shown in** Figure 1**.** Answer: C Pulleys	**1** **AO1=1**
2	**Which engineering discipline includes radiotherapy?** Answer: A Biomedical	**1** **AO1=1**
3	**The Health and Safety at Work Act (HASAWA) makes employers responsible for their employees' safety.** **Identify** one other **group of people that the HASAWA makes employers responsible for.** Award one mark for any of the following: • delivery driver (1) • clients visiting a site (1) • members of the public (1) • sales representatives (1) • building inspector (1) • health and safety managers (1) • a person who may be affected by the employer's business activities (1). Accept any other suitable response.	**1** **AO2=1**
4 (a)	**Which** one **of the following activities should an employee wear a bump cap for?** Answer: C Working in a confined space	**1** **AO1=1**

4 (b)	**It is important to choose the most appropriate personal protective equipment (PPE) for each job.** **Give** two **reasons for choosing disposable overalls.** Award one mark for each reason, to a maximum of two marks: • has a hood and covers the whole body apart from hands and feet (1) • suitable for dirty/contaminated situations (1) • easy to wrap/bundle up and dispose of safely (1) • no need to wash (1) • cheap/inexpensive (1). Accept any other suitable response.	**2** **AO2=2**

4 (c)	**Welding is hazardous for the welder.** **State** two **types of PPE that would protect the hands and arms of a welder.** **Justify why** each **type of PPE should be worn.** Award one mark (AO1) for each correct type of PPE and one mark (AO3) for a linked justification, to a maximum of four marks. • Gloves (1) to protect the hands from burns (1). • Leather armlets/gauntlets (1) to protect from UV radiation/sun burn (1). • Overalls (1) protect the arms from welding sparks (1). Accept any other suitable response.	**4** **AO1=2** **AO3=2**

5 (a)	**Which** one **of the following does a milliamp measure?** Answer: B Current	**1** **AO1=1**

5 (b)	**Which** one **of the following is a kiloamp?** Answer: D 1000 amps	**1** **AO1=1**

5 (c)	**Which** one **of the following is equal to 1 000 000 microcandelas?** Answer: C 1 candela	**1** **AO1=1**

5 (d)	**Which** one **of the following does a kilogram measure?** Answer: C Mass	**1** **AO1=1**

6	Figure 2 **shows Pascal's principle of a liquid in a closed container. Each cylinder is 100 mm in diameter.** **Describe what would happen if a downward pressure was applied to the plunger at point** A **in** Figure 2**.** Award one mark for a description and one mark for an expansion, to a maximum of two marks. • A pressure change at point A is transmitted (1) without loss to all other parts, pushing the plunger up at point B (1). • Pressure is transmitted from point A (1) throughout the liquid/fluid and to the walls of the container (1). • The liquid level will rise at other end/side of the container (point B) (1), which will be equal to the downward movement at point A (1). • The upward force will be equal to downward force (1) because the two cylinders are equal in diameter/dimensions (1). Accept any other suitable response.	**2** **AO2=2**

7 (a)	**An engineer is tightening a bolt on the front wheel of an electric motorcycle. The engineer applies 45 N of force at a distance of 400 mm from the bolt.** Figure 3 **shows the spanner tightening the bolt.** **Calculate the moment of force being applied on the bolt in** Figure 3. **Use the equations on pages 2 and 3.** **Show your working.** moment = force x perpendicular distance from pivot (m = F x d) 400 mm divided by 1000 = 0.4 m (conversion to metres) **(1 mark)** 45 N x 0.4 m = 18 Nm (accept 18) **(1 mark)**	**2** **AO2=2**

7 (b)	**Engineers are testing the motorcycle. It produces 372 W of usable power for every 400 W of input during the charging process.** **Calculate the motorcycle's efficiency.** **Use the equations on pages 2 and 3.** **Show your working.** efficiency (%) = (useful energy out ÷ total energy in) x 100 372 ÷ 400 = 0.93 **(1 mark)** 0.93 x 100 = 93% **(1 mark)** or 372 ÷ 400 x 100 **(1 mark)**	**2** **AO2=2**

7 (c)	**The motorcycle and rider require a force of 350 N to move.** **Calculate the work done to move them 0.6 km.** **Use the equations on pages 2 and 3.** **Show your working.** work done = force x distance (W = F x d) 0.6 km = 600 m **(1 mark)** 350 N x 600 m = 210 000 J or 210 KJ **(1 mark)** Award correct answer without units also	**2** **AO2=2**

8	**Electricity and magnetism are often combined in everyday products, such as a washing machine or a vehicle.** **Evaluate the importance of magnetism in everyday products.**	**9** **AO1=3** **AO2=3** **AO3=3**

Level	Marks	Description
3	7–9	A wide range of relevant knowledge and understanding is shown, which is accurate and detailed. Subject-specific terminology is used consistently throughout. Application of knowledge and understanding is appropriate, with clear relevance to the context. Analysis and evaluation are present and very effective.

		The conclusions drawn are fully supported by judgements.
2	4–6	A range of relevant knowledge and understanding is shown, but may be lacking in sufficient detail, with a few errors. Subject-specific terminology is used, but not always consistently. Application of knowledge and understanding is mostly appropriate, but sometimes lacks clarity, and there may be a few errors. Analysis and evaluation are present and effective but may be lacking appropriate development. There are attempts to draw conclusions, which are supported by judgements, but it is likely that some will be irrelevant.
1	1–3	A limited range of relevant knowledge and understanding is shown, but is often fragmented. Subject-specific terminology, if used, is often inappropriate and a lack of understanding is evident. Application of knowledge and understanding is inappropriate, with any attempt showing fundamental errors. Analysis and evaluation, if present, is of limited effectiveness. Attempts to draw conclusions are seldom successful and likely to be irrelevant.
	0	No creditworthy material.

Indicative content:

Subject-specific content:

- lifting cranes: electro-magnet that can be switched on/off and is capable of lifting heavy loads
- loudspeakers and earphones: enable audio communication, music etc
- electric motors in electric cars: environmentally friendly
- metal recycling: differentiating metals (eg ferrous and non-ferrous)
- motors in washing machines, vacuum cleaners: cleaner, more hygienic
- generators: allow power off grid, camping etc
- transformers to reduce power: mobile phone chargers etc
- solenoids: used to create motion, locks, switches etc.

Advantages:

- engineers can produce efficient electric motors that drive modern cars. This will use fewer natural resources and produce less global pollution
- reliability is improved as there are fewer moving components to fail in an electric car
- magnetism allows the conversion of electrical energy into mechanical energy.

Disadvantages:

- electric cars, which use magnetism, have limited driving range, requiring frequent recharge of the battery. They are expensive compared to non-electric cars
- requires a supply of electricity
- magnetism can degrade over time depending on the magnet used.

3: Justification or evaluative statements to include the following:

- clear understanding of magnets being used with a range of products
- processes explained
- a range of examples described in detail
- coherent descriptions
- detailed explanation of benefits.

2: Reasoned statements with some justification to include the following:

- demonstrates some understanding of magnets being used within other products
- some applied examples of magnetism (eg used in steel recycling, electric motors in cars to reduce pollution)
- some clear descriptions
- some linked explanation of benefits.

1: Brief statements with no justification:

- limited understanding of magnets being used within other products
- basic understanding of magnetism (eg to attract mild steel) is evidenced
- importance is indicated without explanation
- no example is given
- no explanation on why magnetism is used.

	0. No written material that has any reference to the context of conductivity. Accept any other suitable response.	

9	**An electrical wire can become hot when a current is passed through it.** **Give** one **reason why the wire might become hot** and **identify a risk if the wire heats up.** Award one mark (AO2) for a valid reason: • electrical resistance causes heat (1) • resistance (1) • electrons colliding with the ions in the metal. (1) Accept any other suitable response. Award one mark (AO3) for identifying a risk caused because of resistance: • could result in a fire (1) • insulating material could melt, resulting in toxic fumes (1) • a coiled extension cable could increase heat leading to risk of fire (1). Accept any other suitable response.	**2** **AO2=1** **AO3=1**

10 (a)	**It is important that engineering components can withstand regular use over a long period of time.** **Which** one **of the following properties identifies this characteristic?** Answer: B Durability	**1** **AO1=1**

10 (b)	**Which** one **of the following statements describes the ductility of a material?** Answer: A The ability to be drawn, reducing its cross-section	**1** **AO1=1**

10 (c)	**Which** one **of the following properties identifies a metal's ability to be shaped by hammering or pressing without fracture?** Answer: B Malleability	**1** **AO1=1**

11	**Identify** two **properties of a brick that make it suitable for civil engineering applications.** Award one mark for each correct property, to a maximum of two marks. • Hardness (1). • Strength (1). • Durable (1). • Fire resistant (1). • Uniform size//shape (1). • Low weight per brick (1). • Strong (1). Accept any other suitable response.	**2** **AO1=2**

12	Figure 4 **shows carbon fibre baseball bats.** **Carbon fibre reinforced polymer (CFRP) is now commonly used in sporting equipment such as baseball bats.** **Discuss the advantages** and **disadvantages of using composite materials such as CFRP in sporting equipment.**	**9** **AO1=3** **AO2=3** **AO3=3**

Level	Marks	Description
3	7–9	A coherent explanation with reference to composite materials in a sports context. A wide range of relevant knowledge and understanding is shown, which is accurate and detailed. Subject-specific terminology is used consistently throughout. Application of knowledge and understanding is appropriate, with clear relevance to the context. Analysis and evaluation are present and very effective. The conclusions drawn are fully supported by judgements.
2	4–6	A clear explanation with some reference to composite materials in a sports context. A range of relevant knowledge and understanding is shown, but may be lacking in sufficient detail, with a few errors. Subject-

			specific terminology is used, but not always consistently. Application of knowledge and understanding is mostly appropriate, but sometimes lacks clarity, and there may be a few errors. Analysis and evaluation are present and effective but may be lacking appropriate development. There are attempts to draw conclusions, which are supported by judgements, but it is likely that some will be irrelevant.
	1	1–3	A basic explanation which may not be fully accurate and does not mention composite materials in a sports context at all. A limited range of relevant knowledge and understanding is shown but is often fragmented. Subject-specific terminology, if used, is often inappropriate and a lack of understanding is evident. Application of knowledge and understanding is inappropriate, with any attempt showing fundamental errors. Analysis and evaluation, if present, are of limited effectiveness. Attempts to draw conclusions are seldom successful and likely to be irrelevant.
		0	No creditworthy material.

Indicative content:

Examples of suitable sporting equipment:

- bicycle frames
- bicycle wheels
- football boots
- helmets
- tennis//squash//badminton rackets etc
- hockey sticks
- Formula One cars//equipment.

Advantages:

- strength: carbon materials are tough and strong, they last longer
- weight: despite its strength, carbon fibre is very light, therefore the user can perform longer before tiring

	• increased stiffness: more force transferred from bat to ball, which improves efficiency • increased reaction speed: due to reduced weight therefore advantageous performance • stress resistance: parts made from carbon fibre are less prone to wear and tear, therefore longer lasting • corrosion resistance: carbon fibre is durable in corrosive environments • helmets: more comfortable due to decreased weight on neck. Disadvantages: • expensive • slow production process//labour intensive • specialist knowledge of the process needed • pre-impregnated carbon fibre (with epoxy resin): needs to be stored below freezing point to prevent curing before use • specialist equipment needed such as an autoclave. 3: Justification or evaluative statements to include the following: • a range of justification statements given on CFRP/composite materials used in sporting equipment • a range of advantages/disadvantages explained on the use of CFRP/composite materials used in sporting equipment • application to sports technology explained in detail • detailed/real-life examples of CFRP in sports equipment. 2: Reasoned statements with some justification to include the following: • brief justification statements given on CFRP/composite materials used in sporting equipment • some advantages/disadvantages explained on the use of CFRP/composite materials in sporting equipment • application to sports technology explained in some detail • some real-life examples of CFRP/composite materials used in sporting equipment. 1: Brief statements with no justification: • limited justification for use of CFRP/composite materials in sporting equipment • limited explanation of advantages or disadvantages (not both) on the use of CFRP/composite materials in sporting equipment • some basic examples cited on composite applications • limited explanation on properties of CFRP/composite materials used in sporting equipment. 0: No written material that has any reference to the context of CFRP/composite materials used in sporting equipment.	

	Accept any other suitable response.	

13 (a)	**Name** two **tools used when marking out a rectangle on sheet steel** and **justify why** each **tool is used.** Award one mark (AO1) for identifying each suitable marking out tool and one mark (AO3) for a linked justification of use, to a maximum of four marks: • steel rule (1) provides a straight edge for accuracy (1) • engineer's square (1) to ensure right angles/90° corners (1) • scriber (1) so you can see the mark in the metal clearly (1) • Caliper or odd leg caliper (1) • marker pen or engineer's blue (1)	**4** **AO1=2** **AO3=2**

13 (b)	**An engineer cuts four rectangles from a 2 mm thick mild steel sheet. Each rectangle measures 95 mm by 75 mm.** **Identify** two different **tools the engineer could use to cut out the rectangles.** **Briefly justify which of these tools would be the most suitable for this task.** Award one mark (AO1) for each identification, to a maximum of two marks: • jigsaw (1) • computer-aided manufacture laser cutter (1) • hacksaw (accept junior hacksaw) (1). • Dremmel (1) • Guillotine (1) • Angle grinder (1) Accept any other suitable response (for example guillotine, water jet or plasma cutter). Award one mark (AO3) for a valid justification. • Computer-aided manufacture laser cutter – because it is fast/requires no physical labour (1). • Hacksaw – because it is readily available/requires limited skill (1). • Jigsaw – because it is less labour intensive/fast cutting action (1). • Cut efficiently Accept any other suitable response.	**3** **AO1=2** **AO3=1**

14 (a)	Figure 5 **shows a Torx screwdriver.** **Explain** one **benefit of using the Torx screwdriver shown in** Figure 5**.** Award one mark (AO2) for an explanation and one mark (AO3) for an expansion. • Improved security as Torx screws/bolts are more difficult to remove using a common screwdriver/tools (1) and require the use of a Torx screwdriver (1). • Torx screwdriver is less common, improving safety and security, (1) as it is more difficult to remove Torx bolts/screws without a Torx screwdriver (1). • Additional security because only a Torx screwdriver will fit the star-shaped pattern in Torx bolts/screws, (1) whereas common screwdrivers won't fit (1). • Increased safety (eg from electrocution) in products requiring the use of a Torx screwdriver (1) to stop people trying to tamper/repair items themselves as they will be less likely to have a Torx screwdriver (1). • Less likely to come loose while being used (1). Accept any other suitable response.	**2** **AO2=1** **AO3=1**

14 (b)	Figure 6 **shows a nail gun.** **Explain what PPE should be worn when using the nail gun in** Figure 6**.** Award one mark for an explanation and one mark for an expansion. • Wear goggles or a visor (1) to protect the eyes from splinters (1). • Wear ear defenders (1) to protect the ears as the gun fires (1). • Wear a hard hat (1), which is required on a construction site where nail guns are commonly used (1). • Safety shoes/steel toe caps (1) reduce accidental injury (firing a nail when carrying) (1). Accept any other suitable response. Do not accept gloves	**2** **AO2=2**

15 (a)	**Complete** Table 1 **below by identifying the** two **ceramics that are described.** Award one mark for each correctly identified ceramic, to a maximum of two marks. Table 1 | Name of ceramic	Description | |---|---| | Diamond (1) | **Very hard, brittle and used on tool tips for improved cutting.** | | Pottery (1) | **Fired clay, often used in decorative or functional containers.** |	**2** **AO1=2**

15 (b)	**Complete** Table 2 **below by identifying the** two **mechanical properties that are described.** Award one mark for each correctly identified property, to a maximum of two marks. Table 2 | Name of property	Description | |---|---| | Elasticity (1) | **Ability of a material to return to its original shape and size after force is no longer applied.** | | Plasticity (1) | **Ability of a material to be easily shaped or moulded** |	**2** **AO1=2**

16	**What is the name of the regulation relating to hazardous lifting tasks?** **State** two **of the three rules for reducing risk when moving a heavy item.** Award one mark (AO1) for correct name of regulation: • Manual Handling Operations Regulations (1). Accept Manual Handling Operations or MHOR. Award one mark (AO2) for each rule/measure, to a maximum of two marks.	**3** **AO1=1** **AO2=2**

	• Avoid hazardous manual handling operations so far as is reasonably practicable (1). • Assess any hazardous manual handling operations that cannot be avoided (1). • Reduce the risk of injury so far as is reasonably practicable (e.g., 2 persons lifting, use of lifting equipment) (1). Accept any other suitable response.	

17	Figure 7 **shows a technical drawing of a component.** **Identify the type of line shown as** A **in** Figure 7**.** Award one mark for the correct answer: • visible line (1). Accept 'visible' for one mark.	**1** **AO1=1**

18	**Name the engineering discipline responsible for computer programming.** Award one mark for the correct answer: • software engineering (1). Accept 'software'.	**1** **AO1=1**

19	**The Control of Substances Hazardous to Health Regulations (COSHH) protect the safety of employees.** **State** two **types of hazardous substance that the COSHH Regulations cover.** Award one mark for each correct answer, to a maximum of two marks: • chemicals (1) • dust (1) • fumes (1).	**2** **AO1=2**

20	Figure 8 **shows a box with a base measuring 500 mm by 500 mm on a shelf. The box applies a force of 175 N over its base.** **Calculate the pressure applied to the shelf shown in** Figure 8**.** **Use the equations on pages 2 and 3.** **Show your working.** pressure = force ÷ area (p = F ÷A) 0.5 m x 0.5 m = 0.25 m^2 or 500 mm x 500 mm = 250 000 mm^2 = 0.25 m^2 **(1 mark)** 175 N ÷ 0.25 m = 700 N/m^2 **(1 mark)**	**2** **AO2=2**

21	**Discuss the importance of workshop training for all new employees in an engineering factory.**	**9** **AO1=3** **AO2=3** **AO3=3**

Level	Marks	Description
3	7–9	A coherent explanation with reference to new employee training in an engineering context. A wide range of relevant knowledge and understanding is shown, which is accurate and detailed. Subject-specific terminology is used consistently throughout. Application of knowledge and understanding is appropriate, with clear relevance to the context. Analysis and evaluation are present and very effective. The conclusions drawn are fully supported by judgements.
2	4–6	A clear explanation with some reference to new employee training and its application in context. A range of relevant knowledge and understanding is shown, but may be lacking in sufficient detail, with a few errors. Subject-specific terminology is used, but not always consistently. Application of knowledge and understanding is mostly appropriate, but sometimes lacks clarity, and there may be a few errors. Analysis and evaluation are present and effective but may be lacking appropriate

		development. There are attempts to draw conclusions, which are supported by judgements, but it is likely that some will be irrelevant.
1	1–3	A basic explanation of employee training and its application. A limited range of relevant knowledge and understanding is shown, but is often fragmented. Subject-specific terminology, if used, is often inappropriate and a lack of understanding is evident. Application of knowledge and understanding may be inappropriate, and may show fundamental errors. Analysis and evaluation, if present, are of limited effectiveness. Attempts to draw conclusions are seldom successful and likely to be irrelevant.
	0	No creditworthy material

Indicative content:

Reference is made to relevant training, such as:

- Control of Substances Hazardous to Health Regulations (COSHH)
- The Health and Safety at Work Act 1974 (HASAWA)
- Manual Handling Operations Regulations 1992 (MHOR)
- specific training relating to noise, abrasive wheels, risk assessments, dust control, welding safety etc.
- mandatory training for new employees
- training to meet legislation
- Highlighted benefits for the employer and the company

Relevant training examples:

- Health and Safety at Work Act: responsibilities of employers to keep employees safe
- training in case employees have never used the machinery before
- training to improve user understanding/competence/confidence
- duty of care (eg many serious accidents at work are attributed to recently employed recruits, lacking experience)
- training to prevent unnecessary accidents
- training to ensure employees understand which PPE to wear and to help employees understand why PPE is necessary (eg so that employees wear goggles to protect their eyes when using equipment such as an angle grinder)

	• Manual Handling Operations Regulations: so that employees do not try to lift heavy things and damage their backs (back injuries account for most time off in industry) • Control of Substances Hazardous to Health (COSHH): not understanding COSHH Regulations could lead to flammable chemicals being stored incorrectly, resulting in fire. 3: Justification or evaluative statements to include the following: • strong identification of risks associated with each piece of equipment and why training is required • strong links between type of training and equipment used • a range of links to health and safety legislation given • wide range of explanations on types of training specific to the presented scenario. 2: Reasoned statements with some justification to include the following: • some identification of risks associated with each piece of equipment • some links between type of training and equipment used • developed links to some health and safety legislation given • some explanation on types of training specific to the presented scenario. 1: Brief statements with no justification: • limited identification of risks associated with one or two pieces of equipment • basic understanding of the link between type of training and equipment used • limited links to health and safety legislation given • very basic understanding of the types of training specific to the presented scenario. 0: No written material that has any reference to the context of communication. Accept any other suitable response.	

Assessment Objective Grid

Question	AO1	AO2	AO3	Total
1	1			1
2	1			1
3		1		1
4 (a)	1			1
4 (b)		2		2
4 (c)	2		2	4
5 (a)	1			1
5 (b)	1			1
5 (c)	1			1
5 (d)	1			1
6		2		2
7 (a)		2		2
7 (b)		2		2
7 (c)		2		2
8	3	3	3	9
9		1	1	2
10 (a)	1			1
10 (b)	1			1
10 (c)	1			1
11	2			2
12	3	3	3	9
13 (a)	2		2	4
13 (b)	2		1	3
14 (a)		1	1	2
14 (b)		2		2
15 (a)	2			2
15 (b)	2			2
16	1	2		3
17	1			1
18	1			1
19	2			2
20		2		2
21	3	3	3	9
Total	**36**	**28**	**16**	**80**