



Oxford Cambridge and RSA

Cambridge National

Engineering

R101/01: Principles in Engineering and Engineering Business: Engineering principles

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for January 2023

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RMassessor3 Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to scoris and mark the **required number** of practice responses (“scripts”) and the **number of required** standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the scoris messaging system, or by email.
5. **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.
7. Award No Response (NR) if:
 - there is nothing written in the answer space

Award Zero '0' if:















- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The scoris **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the scoris messaging system, or e-mail.
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. For answers marked by levels of response: Not applicable in F501
- To determine the level** – start at the highest level and work down until you reach the level that matches the answer
 - To determine the mark within the level**, consider the following:

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

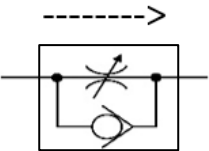
11. Annotations

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Tick: 1 Tick for each mark awarded. Do not use ticks for question 4(b)*
	Noted but no credit given, or no response for whole part-question
	Use 'Seen' and  - No Response (bottom right of screen) where there is no response for whole part-question. Typing NR also works.
	Repetition - Repeated answer or knowledge point - no additional credit/marks awarded
	Benefit of doubt given
	Knowledge - used for question 4(b)* only
	Developed knowledge point - used for question 4(b)* only
	Level 1 response (i.e. in the range of 1-2 marks) used for question 4(b)*
	Level 2 response (i.e. in the range of 3-4 marks) used for question 4(b)*
	Level 3 response (i.e. in the range of 5-6 marks) used for question 4(b)*
	Too vague, not worthy of credit/marks
	No other annotations should be used. Do not use crosses 

12. Subject Specific Marking Instructions

Question			Answer	Mark	Guidance
1	(a)	(i)	Compound (1x1)	1	
1	(a)	(ii)	Driven /driver = 32/8 (1) 4:1 (1) (2x1)	2	Award a mark for correct calculation working or award 1 mark for '4' '4 turns' etc. Award 2 marks for the correct answer as a ratio, with or without workings.
1	(a)	(iii)	Increase in output torque (1) Gear D will turn in the same direction as A (driver) (1) (1x1)	1	Allow reference to the effects of increased torque
1	(b)	(i)	Description that uses the given terms correctly. E.g.: The permanent magnet is housed/stuck around in the casing. (1) The armature rotates inside the magnetic field/ between the permanent magnets (1) The brushes run on the armature commutator (1). (3x1)	3	Accept other correct variations.
1	(b)	(ii)	The motor armature will rotate in the opposite direction. (1x1)	1	
1	(b)	(iii)	Appropriate method of holding or mount the motor to a bracket. Answers should relate to the motor shown in Fig. 2. 1 mark for reference to a method of holding/attaching the motor. 1 mark for reference to screws/nuts. (2x1).	2	Allow 'cable tie around the motor case' for 1 mark BOD total. Unclear how the motor is mounted / inappropriate method. = 0 Acceptable method, but lacks some clarity = 1 Clear and appropriate method using bracket/housing and M5 studs. = 2
				[10]	

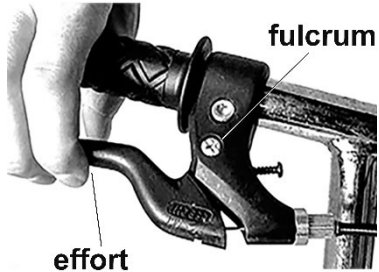
2	(a)		<table border="1"> <thead> <tr> <th>Source of power supplies</th> <th>Benefit feature</th> <th>True /False</th> </tr> </thead> <tbody> <tr> <td>AC High Tension power lines</td> <td>Voltage can be stored</td> <td>FALSE</td> </tr> <tr> <td>AC mains power supply</td> <td>Constant supply</td> <td>TRUE</td> </tr> <tr> <td>DC battery /cells</td> <td>Rechargeable and portable</td> <td>TRUE</td> </tr> <tr> <td>Petrol-driven AC generator</td> <td>Portable supply</td> <td>TRUE</td> </tr> <tr> <td>Rectified low voltage DC</td> <td>Widely used for electronics, lighting and charging</td> <td>TRUE</td> </tr> </tbody> </table> <p style="text-align: center;">(4x1)</p>	Source of power supplies	Benefit feature	True /False	AC High Tension power lines	Voltage can be stored	FALSE	AC mains power supply	Constant supply	TRUE	DC battery /cells	Rechargeable and portable	TRUE	Petrol-driven AC generator	Portable supply	TRUE	Rectified low voltage DC	Widely used for electronics, lighting and charging	TRUE	4	
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2	(b)	(i)	<p>Two correct answers i.e.:</p> <ul style="list-style-type: none"> The speed of the electric motor can be controlled (1) to be able to drive the belt faster, slower, stop/start or constant. (1) The electric motor can be controlled automatically/remotely (1) Constant power when used with AC power supply (1) <p style="text-align: center;">(2x1)</p>	2	Allow reference to reliability of power source.																		
2	(b)	(ii)	<p>Appropriate description of a system to connect and drive the conveyor belt. e.g.:</p> <p>Motor has a pulley or gear attached to the armature shaft (1) or a drive belt or gears (1) could be used to connect the motor and conveyor rollers (1). The motor can be controlled by a manual switch (1) or automatically [i.e. PLC] or using electro-pneumatics.</p> <p style="text-align: center;">(3x1)</p>	3	<p>1 mark for a method of mechanically connecting the motor to the conveyor.</p> <p>1 mark for a method of turning / rotating the conveyor.</p> <p>1 mark for controlling the motor.</p>																		
		(iii)	<p>Correct meaning of torque i.e.:</p> <p>The motor has a turning force (1) of 36Nm. (1)</p> <p>Turning force (1)</p> <p style="text-align: center;">(1x1)</p>	1																			
				[10]																			

Question			Answer	Mark	Guidance
3	(a)	(i)	No flow (1x1)	1	
3	(a)	(ii)	Flow path direction (1x1)	1	
3	(a)	(iii)	2 positions/states (1x1)	1	
3	(b)		Correct description of the operation. E.g.: When either valve A OR valve B (1) is pressed, the cylinder extends (1) and retracts when released. (1) The shuttle valve moves to the opposite position when either valve is pressed blocking the air from exhausting through the opposite valve (1) and directing air to the SAC. (3x1)	3	Award a maximum of 3 marks. There are 4 possible opportunities for marks to be awarded. Allow reference to the shuttle valve ball moving off its seat and acting as a one way valve
3	(c)	(i)	Adjustable - one way flow control valve (1x1)	1	Allow Reducing with check valve Unidirectional restrictor
3	(c)	(ii)	 (1x1)	1	Arrow pointing clockwise for the restricted part of the component.
3	(c)	(iii)	The system will provide a controlled extension of an actuator (1) but retract very quickly (1) (2x1)	2	Allow marks for valid examples of use.
				[10]	

Question			Answer	Mark	Guidance
4	(a)	(i)	Hoses (1) Cylinders (1) Pump (1) (2x1)	2	
4	(a)	(ii)	Correct description of how pressure is maintained e.g. Hydraulics use a sealed system (1) where fluid is held under pressure in the cylinder. (1) Each side of the cylinder is sealed and cannot escape (1) so that pressure levels are maintained. (1) Pressure release valves allow excess pressure to be controlled (1). (2x1)	2	Allow other valid descriptions Allow reference to 'no leaks'

Question	Guidance	Marks	Answer
4(b)*	<p>Award up to 6 marks for a discussion with examples of the benefits of using hydraulics in waste recycling and disposal.</p> <p style="text-align: center;">Level 3 (5 – 6 Marks)</p> <p>Detailed discussion showing clear understanding of the benefits of using hydraulics in waste recycling and disposal with appropriate examples.</p> <p>Specialist terms will be used appropriately and correctly. The information will be presented in a structured format. The candidate can demonstrate the accurate use of spelling, punctuation, and grammar.</p> <p style="text-align: center;">Level 2 (3 – 4 Marks)</p> <p>Adequate discussion showing an understanding of the benefits of using hydraulics in waste recycling and disposal. The response may give an appropriate example application.</p> <p>There will be some use of specialist terms, although these may not be used appropriately. The information will be presented for the most part in a structured format. There may be occasional errors in spelling, punctuation and grammar.</p> <p style="text-align: center;">Level 1 (0 – 2 Marks)</p> <p>Basic discussion showing limited understanding of the benefits of using hydraulics in waste recycling and disposal.</p> <p>There will be little or no specialist terms. Answers may well be ambiguous or disorganised. Errors of spelling, punctuation and grammar may be intrusive.</p> <p>0 = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at the end of the response.</p>		<p>Examples and relevant points could include:</p> <ul style="list-style-type: none"> • Hydraulic systems can be portable or stationary. An example of mobile hydraulic system is used in refuse waste collection on vehicles which use hydraulic power to compact the waste material into the vehicle so they can fit more material in the vehicle. • Waste materials for disposal and recycling are produced by society in enormous and increasing volumes, requiring an increase in waste management. • Hydraulics are powerful producing enough force to crush, compact and reduce high volumes of dense and heavy materials easily. • Stationary hydraulic systems are used to reduce materials such as in waste metal recycling so they can be easily transported for recycling. • Hydraulic earth moving equipment is used waste disposal such as in compacting materials, excavating, and churning materials for landfill sites.

		6	<ul style="list-style-type: none">• Hydraulic systems are robust and reliable to perform tasks for waste disposal and recycling to power to lift or compress heavy loads.• Hydraulics have an advantage over other sources of power used in engineering in that hydraulic power can be produced as a take off from another driven source. An example is hydraulic power produced by a power take-off from the vehicle engine. This and the use of a sealed system make hydraulics an efficient power source.• Pneumatics generally do not produce enough force to crush, reduce and move materials in a comparable volume to hydraulics.• One disadvantage of hydraulic systems is they are not powered by renewable sources such as electricity produced from renewable sources.
		[10]	

5	(a)	(i)	 <p style="text-align: right;">(2x1)</p>	2	
5	(a)	(ii)	Class 1 / 1st class (1) (1x1)	1	
5	(b)	(iii)	The fulcrum is in between the effort and the load [1] The fulcrum is placed between the effort and load [1]. (1x1)	1	
5	(b)		$F = m \ 1200 \times 0.5$ $F = 600 \ (1) \ N \ (1)$ (2x1)	2	No marks for the formula 1 mark for correct answer (600) 1 mark for the correct units
5	(c)		A static body is one that is stationary and held in place by gravity and friction. A force... greater ... to those holding it in place is required to move it. A dynamic ... moving .. body or load is one moving using a form of kinetic or gravitational .. potential ... energy. (4x1)	4	
				[10]	
6	(a)	(i)	DC current (1) (1x1)	1	
6	(a)	(ii)	Over time the voltage decrease (1) due to constant current draw.(1) The lower the current draw (1) the longer the cell voltage will last (1) The higher the current draw (1) the cell voltage will reduce faster.(1)	2	

			Rapid drop in voltage/battery life (1) when the battery voltage reduces to 1.1 V (1) (2x1)		
6	(a)	(iii)	The total cell capacity will increase/last longer. Battery cells will provide sufficient voltage for longer /last longer (1) (1x1)	1	Allow reference to an increase in performance.
6	(a)	(iv)	$P=IV$ $P= 1.5 \times 0.2 \text{ A}$ $P= .03 \text{ (1) W (1)}$ (2x1)	2	No marks for the formula 1 mark for correct answer (0.03) 1 mark for the correct units
6	(a)	(v)	Chemical to electrical (1) (1x1)	1	Award also: Chemical to light or heat Electrical to heat. No mark for electrical to light.
6	(b)		A crank is used (1) with reduction gears (1) connected to a generator (1) and full wave rectifier (1) which supplies a lithium cell (1) (3x1)	3	Award a maximum of 3 marks. There are 5 possible opportunities for marks to be awarded. Allow similar answers with references to a motor (instead of a generator – accept 'dynamo') generating a current when turned. Answers must include a reference to a cell /battery to store the energy, for the candidate to gain full marks.
				[10]	

Total**[60]**

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