CAMBRIDGE
International Education

Cambridge IGCSE™

DESIGN & TECHNOLOGY **0445/43**

Paper 4 Systems and Control **October/November 2024**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Section A

Question	Answer	Marks	Guidance
1(a)	Joints at each end of part **A** are temporary, they are made using **nails**. Part **A** uses **triangulation** to ensure that the frame is **rigid** 1 mark for each word correctly inserted.	**3**	
1(b)	**Compression**	**1**	Do not allow bending

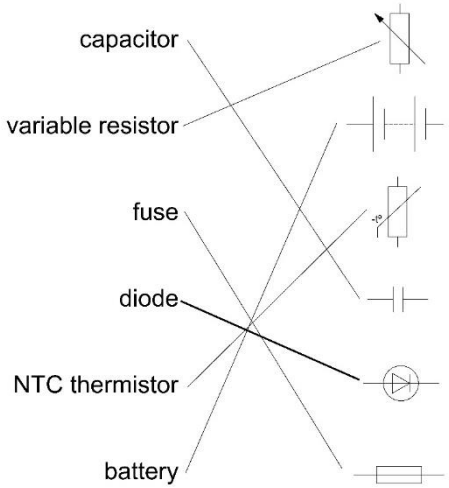
Question	Answer	Marks	Guidance
2(a)	1 mark for a suitable example; concrete, GRP, carbon fibre, CFRP, fibreglass.	**1**	Allow kevlar Allow any other valid composite.
2(b)	Benefits will include: properties of constituent materials can be combined, weakness of individual materials can be avoided, increased strength, reduced weight, increased corrosion resistance, increased durability, complex shapes can be achieved [2 × 1]	**2**	Allow other valid benefits 1 mark for each benefit stated up to 2 marks.

Question	Answer	Marks	Guidance
3	Reasons for disassembly will include: access for repair, ease of recycling, more chance to reuse components, reduced cost of disposal, to take up less space [2 × 1]	**2**	Allow any other valid reasons.

Question	Answer	Marks	Guidance
4(a)	Friction can be reduced by: use of good bearing materials, lubricating moving parts with oil or grease, reduction of areas in contact [2 × 1]	**2**	1 mark for each point mentioned. Allow reference to specified bearing types. Allow 2 marks for a single point fully described.

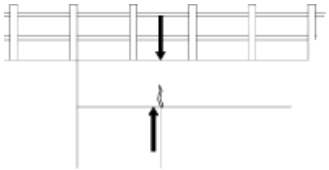
Question	Answer	Marks	Guidance
4(b)	The fulcrum (pivot at point **X**) is between the effort and load	**1**	
4(c)	**Linear** motion [1] **Rotary** motion [1]	**2**	
5	Reasons for choosing spur gears will include: they are positive method of connecting shafts, no slipping is possible, efficient method, reduction or increase in output speed is possible, direction of motion can be changed easily, increased torque if a reduction ratio is used [2 × 1]	**2**	AOVR Reference to 'high loads' = BOD mark. No mark for 'ease of availability' or 'cost'

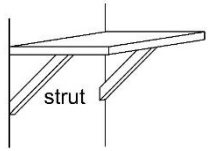
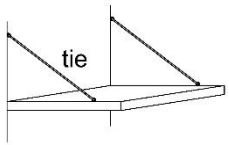
Question	Answer	Marks	Guidance
6	The driven gear will be rotating faster than the drive gear [1] The direction of rotation will be changed [1] Torque will be reduced [1] [2 × 1]	**2**	Do not award no more than 2 marks

Question	Answer	Marks	Guidance
7		**4**	1 correct – 1 mark 2 correct – 2 marks 3 correct – 3 marks 4 or 5 correct 4 marks.

Question	Answer	Marks	Guidance
8	**C** – Common [1] **NC** – Normally closed [1] **NO** – Normally open [1]	**3**	

Section B

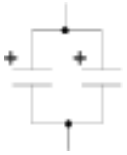
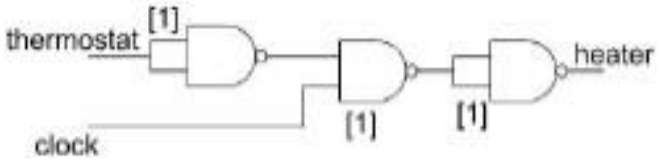
Question	Answer	Marks	Guidance
9(a)(i)	Frame structure – ladder or scaffolding [1] Mass structure – building / house [1] Shell structure – car body or scaffold poles [1]	**3**	Allow other valid alternatives. E.g. windows, door frames. Do not allow 'car' without 'body'.
9(a)(ii)	Description to include: triangulation formed by diagonal poles at front and sides, securely held by extending over ridge of roof. short length of poles, poles held firmly by strong rigid joints, some loading transferred to the roof, square plates at base of verticals	**2**	1 mark for each valid point up to maximum 2. Allow 2 marks for a single point fully justified.
9(a)(iii)	Boards marked **A** will spread the vertical load across a wider area, protecting the roof tiles. A flat / level surface is available for scaffold to rest on	**1**	Award mark for understanding shown.
9(a)(iv)	Safety features include: boards on edge to stop items falling, boards provide a solid base, gates at the two horizontal platform entrances, ladders secured in position, horizontal poles on walkways	**2**	Allow 2 marks for a single point fully described.
9(b)(i)	**Shear**	**1**	
9(b)(ii)		**1**	Arrows almost in vertical alignment [1]
9(b)(iii)	Small cracks will allow water to get in, leading to expansion of cracks [1] When the water freezes in winter it will cause the exposed reinforcement to expand, causing further cracking [1] Pieces of the outer skin of concrete will drop off. [1] Structure can eventually collapse [1]	**3**	Award marks for understanding shown 1 mark for each valid point up to maximum 3. Allow 2 marks for a single point fully justified.
9(b)(iv)	Load from each beam = 100 kg acting on central support Total load on centre support = 200 kg × 9.81 = **1962 N** [1] Area of centre support = 0.3 × 0.2 = **0.06 m^2** [1] Stress = 1962 / 0.06 = **32 700** [1] **Nm^2** [1]	**4**	Award 3 marks for a correct numerical answer with no working. Units must be there for 4th mark.

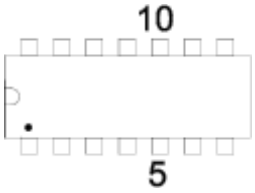
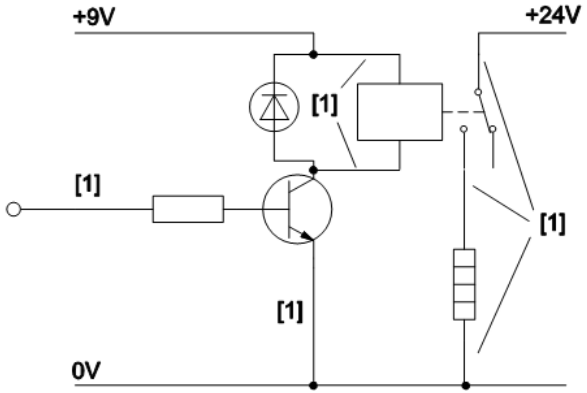
Question	Answer	Marks	Guidance
9(c)(i)	 Strut correctly drawn at each end [1] Suitable proportions [1]	**2**	
9(c)(ii)	 Tie correctly drawn at each end [1] Suitable proportions [1]	**2**	
9(c)(iii)	Section **B** chosen for supporting material [1] Section **B** piece fixed on edge [1] Suitable position for support [1] Method of fixing indicated [1]	**4**	

Question	Answer	Marks	Guidance
10(a)(i)	**X** is a **ratchet** [1] **Y** is a **pawl** [1]	**2**	Do not allow reverse answers.
10(a)(ii)	Description to include: shaft can only rotate in one direction, ratchet rotates with the shaft, pawl is free to oscillate, engages with ratchet using gravity to drop, shaft is prevented from turning backwards by pawl.	**3**	1 mark for each valid point up to maximum 3. Allow 2 marks for a single point fully justified.
10(a)(iii)	Benefits of tapered shaft include: can always fit tightly onto shaft, no method of locking in place is required, can be easily removed from the shaft, square on shaft gives is a positive method that does not allow any slipping	**1**	Allow other valid reasons
10(a)(iv)	Mechanical advantage is a measure of advantage gained [1] by using a mechanism to transmit force [1]	**2**	Award marks for understanding shown.
10(a)(v)	Sketch or notes showing an increase in distance between centre of shaft and centre of handle [1] Notes showing understanding of how advantage is increased [1] Method of reducing friction between the hand grip and hand of the user [1]	**3**	
10(b)(i)	Reasons could include: four holes provide a stable method of mounting, the load is spread over a greater surface area than if using only two holes, slots allow for positioning and tensioning of the motor [2 × 1]	**2**	Allow other valid reasons
10(b)(ii)	Methods used could include: a lever to force the motor back, tensioning the belt, bolts tightened gradually while motor is held in position, check made on tension of belt before fully tightening the bolts, a spring operated idler pulley Valid principle used [1] clear notes / sketches [1]	**2**	1 mark for each valid point included in sketches or notes.
10(b)(iii)	Motor pulley / saw blade pulley = 64 / 46 = 1.391 [1] 1.391 × motor speed 2850 rpm [1] = **3965** rpm [1]	**3**	Correct answer with no working = 3 marks Allow rounding differences.

Question	Answer	Marks	Guidance
10(b)(iv)	Explanation to include: frictional losses, heat and sound produced when cutting, size and weight of blade, pressure of wood on blade, poor / inadequate lubrication, slipping belt on pulley [2 ×1]	**2**	1 mark for each valid point, maximum 2. Allow 2 marks for a single point fully explained.
10(b)(v)	The covers will prevent dust, sawdust etc from entering the lubrication hole and being drawn into the bearings	**1**	
10(c)(i)	A plain bearing is a simple bearing with no moving parts. It will normally be made of a material that has friction reducing properties. Material will be softer than the shaft that is running in it.	**1**	
10(c)(ii)	Using tapered roller bearings in pairs allows: adjustment of the bearings, both radial and axial/thrust loading can be controlled, heavy loads to be supported, support over an increased axle distance, easy lubrication with grease	**3**	AOVR 1 mark for each point included up to three. Allow 2 marks for a single point described in depth.

Question	Answer	Marks	Guidance
11(a)(i)	Reasons could include: thicker tracks in **A**, less chance of a break/conducts higher current, square pads in **B** are too small and fragile, round pads in **A** give more soldering area	**1**	
11(a)(ii)	Hazards could be: • UV light • Developer chemicals • Ferric chloride • Tinning salts Health and safety measures will include: • Protective screen / glasses for UV light • Use of PPE for chemicals • Spill kits to be available • Washing hands after using chemicals	**2**	Allow other valid hazards and measures

Question	Answer	Marks	Guidance
11(b)(i)	**astable bistable amplifier monostable switch**	**1**	
11(b)(ii)	The signal goes from high to low after 2 seconds [1] Returns to high after a further 5 seconds. [1]	**2**	Allow marks for understanding shown
11(b)(iii)	3 = 1.1 × R × 100 μF [1] R = 3 / 1.1 × 100 μF [1] R = **27 272.72 Ω** or **27.27 kΩ** [1]	**3**	Award 3 marks for a correct response with no working.
11(b)(iv)	When the first output pulse finished the trigger was still low (0V) [1] This caused a second delay to start [1] ending when the trigger returned to 0V [1] 1 mark for each valid point.	**2**	Allow marks for understanding shown
11(b)(v)	Correct electrolytic symbols [1] Correct polarity at connections [1] 	**2**	Allow American electrolytic symbol Maximum 1 mark if there are any other connections that would prevent the circuit from working.
11(b)(vi)	Capacitors have a high tolerance [1] The total capacitance is likely to be within the tolerance range for that value [1]	**2**	
11(c)(i)	 1 mark for each gate correctly configured and connected.	**3**	No mark if there are any connections that would prevent a gate from operating correctly.
11(c)(ii)	NAND and NOR are known as universal gates because all other gates can be made using them.	**1**	

Question	Answer	Marks	Guidance
11(c)(iii)	 1 mark for each correct	**2**	
11(c)(iv)	1 mark for each group of connections [4 × 1] 	**4**	Do not award mark if an incorrect connection would prevent that feature from working correctly.