Published

This document consists of **12** printed pages.

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 descriptors 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.

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Section A

Question	Answer	Marks	Guidance
1(a)	Lathe, milling machine, router, drill, 3D printer, laser cutter. 2 · 1 marks for suitable machines.	2	Allow any other suitable machines.
1(b)	CAM will allow machine operations to be programmed so repeatable process Flexible as item being made can quickly be changed Increased accuracy Reduced labour cost, one operator can look after many machines. 2 · 1 marks for suitable benefits.	2	Allow marks for any other valid benefits. Allow reference to speed of production
2(a)	door microswitch — process control unit — output moisture sensor — input drying completed — feedback 	3	1 mark for each correct, maximum 3 marks.
2(b)	 Connection to **C** 1 mark. Connection to **NO**, 1 mark.	2	No marks if more than two connections are made.
2(c)	To sense when the door is closed [1] ensuring that the machine cannot start with the door open. [1]	2	2 marks for a clear explanation of single point.
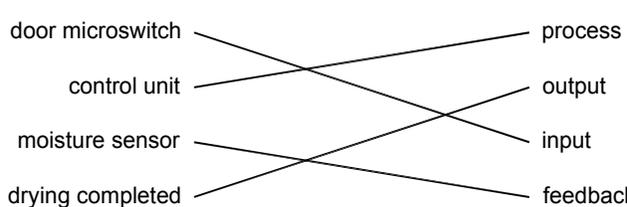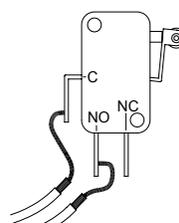
Question	Answer	Marks	Guidance
3(a)	Shell structure, 1 mark.	**1**	
3(b)	Sketches to show folds, creases or indentations to stiffen the sheet steel, 1 mark. Notes on suitable feature included, 1 mark.	**2**	No marks for constructing a box or similar

4	Reasons for using gears will include:
	    Changing direction of motion, clockwise / anticlockwise
	    Changing speed of rotation
	    Change in mechanical advantage
	    Connecting power source to a mechanism
	    Changing direction of motion, angle between two shafts
	    Do not slip like a belt and pulley.
	    Increase torque
	
	2 · 1 marks for suitable reasons.
		2	

5	Methods of locking to shaft will include:
	    Keyway
	    Splined shaft
	    Flat on shaft with grub screw
	    Interference fit.
	Clear sketch description of changes to shaft/spur gear, 1 mark
	Functional method, 1 mark.
		2	Allow welding / permanent fixing.
			
			No mark for gluing

6	**Rotary** [1] to **reciprocating** [1] **Rotary** [1] to **linear** [1]	**4**	

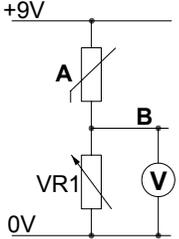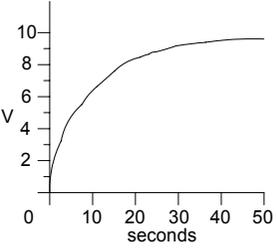| Question	Answer	Marks	Guidance

7(a)	Benefits of soldering include:
	    Fixed joint cannot work loose
	    No additional cost for other components
	    No extra space taken up on PCB.
	    Less chance of an incorrect connection.
	
	Benefits of terminal block include:
	    Easy fitting/removal of wires
	    No heat required when fitting wired
	    No chance of damage through heat.
	
	2 · 1 marks for suitable reasons
		2	

7(b)	Plastic covering on wires is for **insulation** or **identification** of the function of wire.	**1**	

Section B

Question	Answer	Marks	Guidance
8(a)(i)	 1 mark for each row correct. 3 x 1 marks	3	No marks for multiple ticks in a column.

8(a)(ii)	Defects wood will include:
	    Knots
	    Shakes
	    Splits
	    Warping
	    Rot / decay
	
	2 ∙ 1 marks for suitable defects.
		2	Allow insect / termite damage
			
			Allow mould

8(b)(i)	(a) Frame structure [1] (b) Shell structure [1] (c) Mass structure [1]	3	
8(b)(ii)	Gusset plate, 1 mark Triangulation, 1 mark Strut, 1 mark 2 ∙ 1 marks.	2	

Where the table for 8(a)(i) reads:

Property required	wood	steel	concrete	laminated wood
renewable natural resource	✓			
resists torsion and bending		✓		
long lasting and no maintenance needed			✓	
can be easily formed into curves				✓

Question	Answer	Marks	Guidance
8(c)(i)	Stationary load will not move and consists of the materials making up the structure plus and non-moving materials placed on the structure. Moving load will be any load such as a person or vehicle that moves across or on the structure. Explanation must include both types of load for two marks and a valid example for each.	**4**	
8(c)(ii)	By indicating that only one person should use the platform and that the maximum loading is 150kg the manufacturer has taken the likely load from one person and added the equipment / tools that are likely to be carried. To this figure an additional loading has been estimated and the design will have been tested to that loading. 1 mark for each valid point in explanation.	**2**	Allow 2 marks for a single point well explained..
8(c)(iii)	$(0.2 \cdot 400) + (0.5 \cdot 400) = R_2 \cdot 1$ [1] $80 + 200 = \mathbf{R_2 = 280\ N}$ [1] $R_1 = 800 - 280$ $\mathbf{R_1 = 520\ N}$ [1]	**3**	3 marks for correct answers with no working. Maximum 2 marks if reactions reversed
8(c)(iv)	Stress formula = Force [1] / Cross sectional area [1] Stress at each end is divided between the two legs. [1] $2 \cdot 1$ marks	**2**	Allow mark for reference to the given structure.
8(d)	Notes and sketches to show clearly what is meant by each force. $4 \cdot 1$ marks.	**4**	Accept arrows to indicate each force.

9(a)(i)	Advantages will include:
	    Less chance of slipping / belt coming off
	    Less tensioning required than on a flat belt
	    Can help to dampen vibration
	    More power can be transmitted
	1 mark for suitable advantage
		1	

Question	Answer	Marks	Guidance
9(a)(ii)	Spring loaded tension device or jockey wheel / idler that is in contact with the belt and can be adjusted. Valid principal used, 1 mark Clear drawing / notes, 1 mark Neither pulley has to be moved, 1 mark.	3	
9(b)(i)	Velocity ratio is **4**.	1	No mark for 1:4 or 1/4
9(b)(ii)	Frictional losses will reduce the mechanical advantage of the system. Sound / heat produced in each pulley when operated will have an effect.	2	Explanation with two points included, 2 marks. Allow 2 marks for a single point well explained.
9(b)(iii)	Addition of a named type of bearing, 1 mark Position of bearing clear from sketches / notes, 1 mark.	2	
9(c)(i)	 I mark for each correctly placed label	3	
9(c)(ii)	Joint **X** has to pivot to allow the connecting rods to move into the cylinder, 1 mark. If the joint was fixed the mechanism could not operate., 1 mark	2	
9(c)(iii)	**Reciprocating motion**, 1 mark.	1	

Question	Answer	Marks	Guidance
9(c)(iv)	 Rotation of crank described [1] Slider movement described [1] Functional mechanism [1]	**3**	
9(d)(i)	Roller follower [1]	**1**	
9(d)(ii)	The lift of the cam is **3.25mm**.	**1**	
9(d)(iii)	<table><tr><th>Angle moved by cam</th><th>Follower movement</th></tr><tr><td>90°</td><td>fall</td></tr><tr><td>180°</td><td>dwell</td></tr><tr><td>270°</td><td>dwell</td></tr><tr><td>360°</td><td>rise</td></tr></table> 1 mark for 'fall' 1 mark for both 'dwell' stages correct 1 mark for 'rise'	**3**	
9(d)(iv)	The cam follower will rotate in its guide, 1 mark Wear in the guide will be reduced, 1 mark.	**2**	
10(a)(i)	**X** is a switch **Y** is a fuse **Z** is a motor	**3**	Accept ptm switch or normally open switch.
10(a)(ii)	Indication of conventional current should include clockwise arrow(s) with flow from positive to negative.	**1**	
10(a)(iii)	Ampere	**1**	Accept 'Amp'
10(b)(i)	Change in temperature is being sensed.	**1**	Accept ' heat' , 'cold' or 'temperature'.
10(b)(ii)	Resistors in series connected across a voltage, 1 mark Dividing the voltage in the same ratio as resistor values, 1 mark.	**2**	Allow mark for understanding shown on second point

Question	Answer	Marks	Guidance
10(b)(iii)	Substitution into formula, $V_{out} = (78 / 140) \cdot 9$, 1 mark $V_{out} = 0.5571 \cdot 9$, 1 mark $V_{out} =$ **5.01 V**, 1 mark	3	Award 3 marks for correct answer with no working. Allow ecf from substitution Accept 5.0V.
10(b)(iv)	 Voltmeter symbol [1] Both connections correct [1].	2	

10(b)(v)	The following could cause reading to differ from calculated value.
	    When the voltage is checked the temperature may have
	    changed causing resistance to differ.
	    Variable resistor may not have been set precisely
	    Voltage supply may not be exactly 9V
	    Voltmeter may be inaccurate
	    Tolerance in components
	    Loading effect of the voltmeter on the potential divider.
		1	
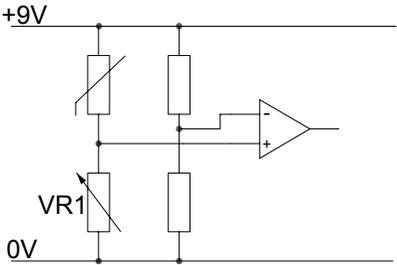
10(b)(vi)	 Resistors in correct position, 1 mark Both resistors the same value, 1 mark Centre of resistors connected to inverting terminal, 1 mark	3	Accept values 1K – 100K

Question	Answer	Marks	Guidance
10(c)(i)	Substituting into formula t = 22 000 ohms x 0.00047 [1] T = **10.34** seconds [1]	**2**	
10(c)(ii)	 Voltage starts at 0V and rises over time [1] Curved shape, starting steep and flattening out [1]	**2**	
10(c)(iii)	The voltage into the base resistor will increase, 1 mark When voltage reaches 0.6V the base emitter circuit on the transistor will allow the collector emitter circuit current to flow, 1 mark	**2**	Allow marks for understanding shown.

10(d)	Benefits of using a programmable IC will include:
	    Greater accuracy / reliability
	    Ease of changing the delay
	    Spare inputs and outputs on the IC can be used for other parts of a circuit.
	    Fewer components
	    Low current draw / power efficient
	    Low cost of IC
	    Long delays are possible.
		2	Allow other valid benefits