



DESIGN AND TECHNOLOGY

0445/41

Paper 4 Systems and Control

October/November 2018

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.

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This document consists of **13** printed pages.

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 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.

Question	Answer	Marks	Guidance
1(a)	All other keys are momentary action, push to make, or PTM	1	
1(b)	Accept any other valid use of a toggle switch in a situation where a PTM switch could not be used / would not perform function.	1	Examples include light switch, car dashboard switches, on/off switches. Must be an identified specific use

Question	Answer	Marks	Guidance
2		3	No marks for more than three lines drawn.

Question	Answer	Marks	Guidance
3	<p>Conductors crossing Conductors joined Alternating current</p>	3	Accept the alternating current symbol without terminals. Accept either conductor crossing symbol. Accept either conductor joined symbol.

Question	Answer	Marks	Guidance
4(a)	A single acting cylinder (SAC) is only air powered on the outstroke, it returns with spring pressure [1] A double acting cylinder (DAC) is air powered in both directions [1]	2	Allow marks for correct number of connections on each type SAC – 1 DAC – 2
4(b)	Reciprocating motion is produced by a pneumatic cylinder.	1	

Question	Answer	Marks	Guidance
5	A reed switch cylinder uses a magnet on the piston to operate the reed switch [1]. When the magnet is close enough to the reed switch it will close the switch [1]	2	Allow marks for understanding shown. Use of magnet must be mentioned for 2 marks.

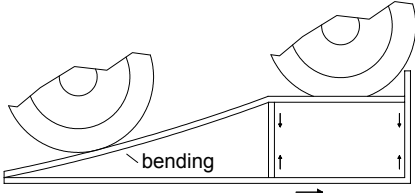
Question	Answer	Marks	Guidance
6(a)	Lever A is 1st order (first class), lever B is 3rd order (third class), lever C is 2nd order (second class), 1 mark for each correct.	3	
6(b)	The stapler , lever B , 3rd order does not give a mechanical advantage.	1	

Question	Answer	Marks	Guidance
7(a)	The joint is reinforced with a gusset plate .	1	
7(b)	Accept any functional method such as an angled tie or strut or any form of triangulation. Functional method, 1 mark. Clear drawing / notes, 1 mark.	2	Allow gusset plate if 7(a) is incorrect.

Question	Answer	Marks	Guidance
8(a)	Torsion / torque is applied to a screw that is being inserted.	1	
8(b)	1 mark each for any two of the factors below: <ul style="list-style-type: none"> • Brass is a softer / more malleable material than steel • The screw slot or pozidrive slot can easily be damaged • The body of the screw can fail / shear due to excessive torsion. 	2	Allow 'not as strong as steel'.

Question	Answer	Marks	Guidance
9(a)	Composite material	1	
9(b)	Advantages could include: <ul style="list-style-type: none"> • Not damaged by damp / wet conditions • More durable • Not damaged by insect attack • No grain structure to cause a weak point • Plastics are generally lighter than timber • Can be manufactured into different shapes. 	1	Accept any other valid advantage. Do not accept any cost related advantages.

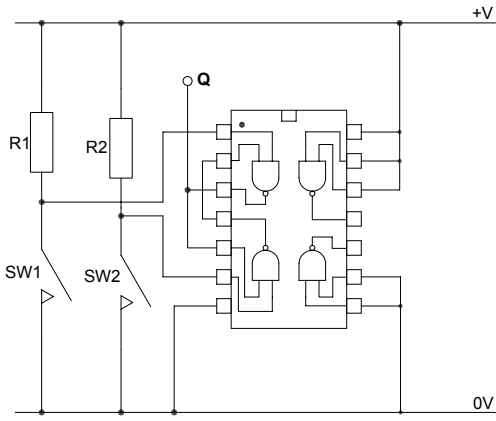
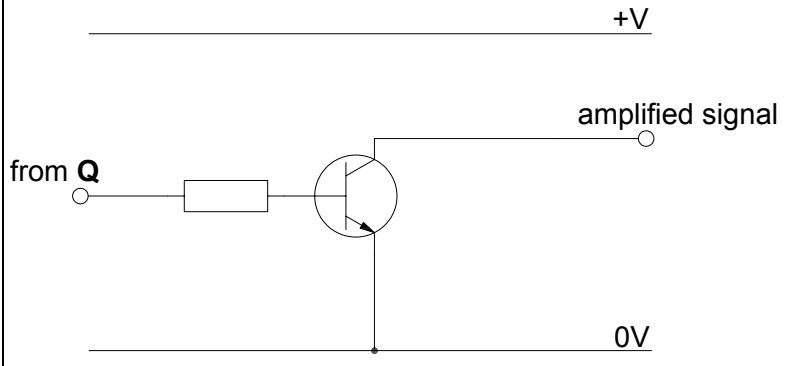
Question	Answer	Marks	Guidance
10(a)	1 mark for each type of structure. E.g. spider's web, ladder, snail shell, moulded toy.	4	Structures must be recognisable or have labels to indicate what they are.
10(b)(i)	Description to include the use of steel rod / re-bar / plastic fibres in the mix.	2	First mark for naming material, second mark for describing method.
10(b)(ii)	Concrete is naturally strong in compression	1	Allow mark for understanding shown.
10(b)(iii)	Torsion, [1] bending [1] or shear [1].	1	
10(c)	Moments at $R1 = 0 = (6 \times R2) - (2.25 \times 9)$ [1] $R2 = 20.25 / 6$, [1] $R2 = 3.375 \text{ kN}$, [1] $R1 = 9 - 3.375 = 5.625 \text{ kN}$, [1]	4	Award 4 marks for correct results with no working shown. Allow ecf for second value. Award 1 mark for correct numerical values incorrectly matched to R1 and R2.
10(d)(i)	Triangular shape of the axle stand, 1 mark.	1	Accept wedge shape on ramp.
10(d)(ii)	Shear , 1 mark	1	
10(d)(iii)	Increase diameter of pin, 1 mark Use higher tensile steel for pin, 1 mark.	2	Accept use of a stronger metal
10(d)(iv)	Angle iron is used to: <ul style="list-style-type: none"> increase resistance to torsion / bending / compression increase rigidity or stiffness Keep wheels / tyres in line with ramp 	2	Allow 2 marks for a single point well explained. 2 marks for two points in less depth. Allow 'increased strength'.

Question	Answer	Marks	Guidance
10(d)(v)	<p>The moving car will try to push the ramp forward. The material of the ramp will affect each section of the length of the ramp as the car moves up.</p> 	3	<p>2 marks for two points indicated on sketches or in notes, 1 mark for clarity of sketches / notes. Allow compression on top face, tension on bottom face as car ascends ramp.</p>
10(d)(vi)	<p>Reasons for using welding include:</p> <ul style="list-style-type: none"> • No need for disassembly • Joints are permanent • Strength of joint • Cannot work loose like nuts / bolts • Low cost as no extra components / drilling needed. 	2	<p>2 marks for any two valid reasons. Allow any other valid reason.</p>
10(d)(vii)	<p>Reasons for consideration of Factor of Safety include:</p> <ul style="list-style-type: none"> • Varying weights of vehicle • Conditions of use cannot be enforced after manufacture • Protection of manufacturer in the event of an accident • To enable a safe working load to be specified for users. 	2	<p>Allow 2 marks for a single point well explained. 2 marks for two points in less depth.</p>

Question	Answer	Marks	Guidance
11(a)(i)	Reasons for using gears will include: <ul style="list-style-type: none"> • Change direction of rotation • Increase or decrease speed • Increase mechanical advantage • Change angle of rotation / axis of motion • To drive one shaft from another / connect two shafts • Provide a positive method of drive. 	2	Allow any other valid reason.
11(a)(ii)	Velocity ratio = driver / driven = $10 / 250 = 1:25$ 0.04	1	Allow 1:25
11(a)(iii)	Input speed = output / VR = $11.5 / 0.04$ [1] = 287.5 rpm [1]	2	Award 2 marks for answer with no working. Allow output \times gear ratio, 11.5×25 .
11(a)(iv)	Required ratio is 25:1 so both parts of compound gear train must be 5:1 [1] Larger gears are $12 \times 5 =$ 60 t [1]	2	Allow ecf on ratio required.
11(a)(v)	Advantages could be more compact than simple gear arrangement, lower cost than using a very large spur gear.	1	
11(a)(vi)	Positive method of securing used, keyway / flat / hole in shaft. [1] Removable method. [1] Clear annotation / sketches to show how the method works. [1]	3	Accept any practical method.
11(a)(vii)	Factors will include: <ul style="list-style-type: none"> • Weight reduction in components • Efficient lubrication system • Design of teeth to give minimum contact area • Reduced friction in shafts. 	1	Allow any other valid factor.

Question	Answer	Marks	Guidance								
11(b)(i)	<table border="1"> <tr> <td>3</td> <td>Bell crank lever</td> </tr> <tr> <td>1</td> <td>Linkage</td> </tr> <tr> <td>4</td> <td>Crank web</td> </tr> <tr> <td>5</td> <td>Crank pin</td> </tr> </table>	3	Bell crank lever	1	Linkage	4	Crank web	5	Crank pin	3	1 mark for each correct, 3 × 1
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11(b)(ii)	A bell crank lever will change motion through an angle	1	Give mark for understanding shown.								
11(b)(iii)	Lubrication is used to: <ul style="list-style-type: none"> • Reduce friction • Cool components • Reduce wear in component surfaces • Reduce corrosion • Keep the component surfaces apart. 	2	Allow 2 marks for a single point well explained. 2 marks for two points in less depth.								
11(b)(iv)	Reciprocating to Rotary	2	1 mark for each term.								
11(c)(i)	Belt A can be fitted regardless of relative position of the pulleys Grooves help to prevent lateral / sideways movement of belt. Belt B does not allow any slipping. Pulleys are kept at exactly the same relative spacing.	2	Accept any other valid benefits.								
11(c)(ii)	Functional idea [1] Adjustable to compensate for belt stretching [1] Clear communication in the response [1]	3									

Question	Answer	Marks	Guidance																		
12(a)	<table border="1"> <thead> <tr> <th>Component</th> <th>Polarised</th> </tr> </thead> <tbody> <tr> <td>Polyester capacitor</td> <td></td> </tr> <tr> <td>Diode</td> <td>✓</td> </tr> <tr> <td>NPN transistor</td> <td>✓</td> </tr> <tr> <td>Light dependent resistor</td> <td></td> </tr> <tr> <td>Battery</td> <td>✓</td> </tr> <tr> <td>Electrolytic capacitor</td> <td>✓</td> </tr> <tr> <td>PTM switch</td> <td></td> </tr> <tr> <td>Thermistor</td> <td></td> </tr> </tbody> </table>	Component	Polarised	Polyester capacitor		Diode	✓	NPN transistor	✓	Light dependent resistor		Battery	✓	Electrolytic capacitor	✓	PTM switch		Thermistor		4	
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12(b)(i)	SW1 is a push to make (PTM) / momentary action switch SW2 is a push to break (PTB)	2																			
12(b)(ii)	Rearrange formula to $I = V / R$ [1] $I = 12 / 48$ [1] $I = 0.25 \text{ A}$ or 250 mA [1]	3	Award 3 marks for a correct answer with no working.																		
12(b)(iii)	Coil contact pins are 2 and 5	2																			
12(c)(i)	Advantages of using a logic latch could be: <ul style="list-style-type: none"> • Lower current draw from circuit • Likely to be smaller • Fast latching action • Lower cost than a relay. 1 mark for valid advantage 	1																			
12(c)(ii)	Disadvantages could be: <ul style="list-style-type: none"> • More connection to be made • An output stage will be required, relay has it already • Relay output is isolated from input. 1 mark for valid disadvantage • Very low output current. 	1																			

Question	Answer	Marks	Guidance
12(c)(iii)		2	Spare inputs can be tied either high or low. No marks if either or both spare outputs are connected.
12(c)(iv)	<p>Damage can be avoided by:</p> <ul style="list-style-type: none"> • Grounding / earthing before handling the ICs • Storing in protective sleeve / package, envelope before use • Using IC holders in a circuit • Not touching the device pins • Wearing antistatic wristband. <p style="text-align: right;">2 × 1 marks</p>	2	Allow any other valid method of avoiding damage to component. Allow 2 marks for one point well explained.
12(c)(v)		3	Current limiting resistor [1] NPN Transistor [1] All connections correct [1]

Question	Answer	Marks	Guidance
12(d)(i)	Pins 1 and 5 are common [1] anodes [1]	2	
12(d)(ii)	The two pins allow for easier track routing when designing a PCB for the display. [1] Either or both can be used. [1]	2	
12(d)(iii)	Segments a, b, c, d, g must be lit. Pin numbers are 7, 6, 4, 3, 10	1	Pin numbers can be in any order, all must be correct for the mark.