



Cambridge IGCSE™

DESIGN & TECHNOLOGY

0445/42

Paper 4 Systems and Control

October/November 2020

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 **12** printed pages.

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:

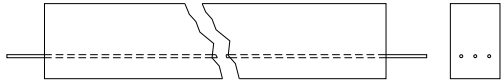
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

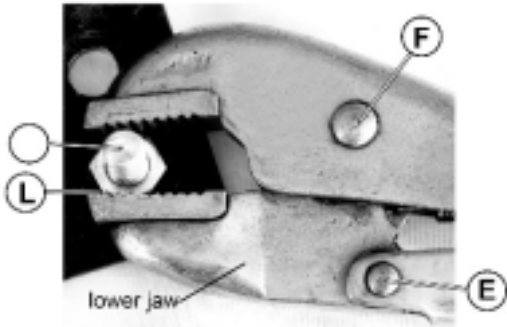
GENERIC MARKING PRINCIPLE 6:

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 | coal wind oil solar natural gas 1 mark for each correct. | 2 | No marks if more than two are circled. |

| Question | Answer | Marks | Guidance |
|----------|---|-------|---|
| 2(a) | Advantages of CAD/CAM in batch production could be: <ul style="list-style-type: none"> • Repeatability • Reduced set-up time • Accuracy • Reduced labour costs. 1 mark. | 1 | Allow any other valid alternative 'Quicker', 'easier', 'cheaper', 'reliable' must be justified for a mark. |
| 2(b) | Any CNC machine, lathe, milling machine router, laser cutter, drill, vinyl cutter, 3D printer, 1 mark. | 1 | Allow any other valid alternative. |

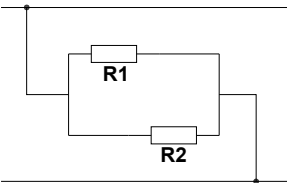
| Question | Answer | Marks | Guidance |
|----------|--|-------|---|
| 3(a) | Suitable properties of concrete will include: <ul style="list-style-type: none"> • Hard • Weather resistant • Easily moulded • Low cost material • Can be moulded on site • High compressive strength • Low maintenance material. | 2 | Do not allow 'strong' unless justified. Allow any other valid alternative. |
| 3(b)(i) |  <p>Steel reinforcement rods shown, 1 mark. Below horizontal centre line of beam, 1 mark.</p> | 2 | Accept any other recognised use of steel in reinforcement. |
| 3(b)(ii) | Tension | 1 | |

| Question | Answer | Marks | Guidance |
|----------|---|-------|---|
| 4(a) |  <p>1 mark for each correct label.</p> | 3 | No mark for the same letter being used twice. |
| 4(b) | 1st order or class 1 lever, 1 mark | 1 | |

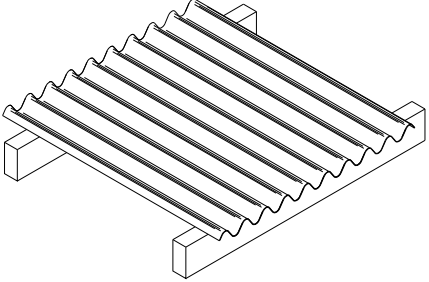
| Question | Answer | Marks | Guidance |
|----------|--|-------|----------|
| 5 | Clock pendulum – oscillating motion, 1 mark. Cutting with a saw – reciprocating motion, 1 mark. | 2 | |

| Question | Answer | Marks | Guidance |
|----------|--|-------|------------------------------------|
| 6 | Reasons for using spur gears could be: <ul style="list-style-type: none"> • To connect two shafts together • Increase or decrease speed of output shaft • Avoid any chance of slippage / positive drive • Increase torque in output shaft • Change direction of motion. 2 × 1 marks | 2 | Allow any other valid alternative. |

| Question | Answer | Marks | Guidance |
|----------|---|-------|---|
| 7 | The contacts are normally open (apart), 1 mark A magnet is used to operate the switch, 1 mark When the magnet is close the terminals are connected, 1 mark. | 3 | 3 separate points, 3 x 1 marks Allow 2 marks for a full explanation of a single point. |

| Question | Answer | Marks | Guidance |
|----------|--|-------|---|
| 8(a) | A = battery or cells. B = diode C = connecting wire / electrical connection | 3 | Do not allow LED for B. |
| 8(b) |  <p>Resistors correctly connected in parallel, 1 mark. Connections to supply shown, 1 mark.</p> | 2 | Accept drawings with no connection 'blobs' shown. |

| Question | Answer | Marks | Guidance |
|----------|--|-------|---|
| 9(a) | Recognised functional method used, could be halving, mortise and tenon, bridle, gusset plate, 2 x 1 mark. Clear description in sketch / note form, 2 x 1 mark. | 4 | No functional method mark for glued butt joint. |
| 9(b)(i) | Benefits of corrugation could include: <ul style="list-style-type: none"> • Increase stiffness / rigidity in one direction • Flexibility in the other direction • Allow watertight joints when overlap is used • Allow increased load to be supported. | 2 | Description that includes two points, 1 mark for each point included. Allow 2 marks for one fully justified benefit. |

| Question | Answer | Marks | Guidance |
|-----------|---|-------|---|
| 9(b)(ii) |  <p>Support beams across corrugations, 1 mark. At least two beams shown, 1 mark.</p> | 2 | |
| 9(c)(i) | <p>Modelling materials could be:</p> <ul style="list-style-type: none"> • Balsa / softwood / hardwood • Mild steel strip • Aluminium • Plastic strip • Laser cut plastic sheet 1 mark for suitable material. <p>Reason for choice, 1 mark.</p> | 2 | Allow other suitable alternatives. |
| 9(c)(ii) | <p>Named adhesives, epoxy resin, PVA cyanoacrylate (superglue), Tensol Solder for steel strip Rivets, screws, pins. 2 × 1 marks for suitable joining methods.</p> | 2 | <p>Joining methods must be suitable for the materials named. Allow aluminium solder. Either two methods given, or one method described in detail.</p> |
| 9(c)(iii) | <p>Testing must show:</p> <ul style="list-style-type: none"> • Load being applied, either point load or spread across deck of bridge, • Method of measuring load indicated, • Method of assessing deflection of bridge, • Determination of point(s) of failure • Measurement of distance spanned. <p>3 × 1 points included, 1 mark each.</p> | 3 | <p>Allow other suitable tests.</p> <p>Award up to 3 marks for full details of a single test.3</p> |

| Question | Answer | Marks | Guidance |
|-----------|---|----------|--|
| 9(d)(i) | Turbine A is a shell structure, turbine B is a frame structure, 2 × 1 marks. | 2 | Accept 'mass' for A . |
| 9(d)(ii) | Weight of materials in the tower, weight of the turbine blades. 1 mark for either. | 1 | |
| 9(d)(iii) | Moving loads could be: <ul style="list-style-type: none"> • Wind acting on the tower • Movement of the turbine blades • Mass of generator moving to face the wind • Ice build-up in winter • Tidal / wave forces on offshore turbines. 2 × 1 marks | 2 | Allow other valid alternatives |
| 9(d)(iv) | Points in explanation may include: <ul style="list-style-type: none"> • Reference to foundation • Secure fixing of tower to the ground. • Equal force acting on each side of the tower • Greater width at the base. | 2 | Two points included, 2 marks Allow 2 marks for one point fully explained. |
| 9(e) | Conversion of rod length / extension to same units, 1 mark Strain = $\frac{0.35}{1500}$, 1 mark Strain = 0.00023 , 1 mark | 3 | |

| Question | Answer | Marks | Guidance |
|------------|---|----------|----------|
| 10(a)(i) | Circle around 'Crank and Slider', 1 mark. | 1 | |
| 10(a)(ii) | Rotary [1] to Reciprocating , 1 mark. | 2 | |
| 10(a)(iii) | 2 | 1 | |

| Question | Answer | Marks | Guidance |
|-----------|--|-------|--|
| 10(a)(iv) | Benefits could include: <ul style="list-style-type: none"> • Self-lubricating • Low cost • Can be injection moulded / fast production • Will not get damaged easily. 2 × 1 marks | 2 | Allow other valid alternatives. |
| 10(b)(i) | Points in explanation could include: <ul style="list-style-type: none"> • The roller bearing has a greater contact area than a ball bearing • Rollers are normally larger diameter than a ball • Pitting in the surface of a roller is not so likely to affect performance • Roller is not so likely to be resisting axial loading at the same time. | 2 | Two points included, 2 marks Allow 2 marks for one point fully explained. |
| 10(b)(ii) | Bearing failure can be attributed to: <ul style="list-style-type: none"> • Lack of lubrication • Ingress of dirt / abrasive substances / water • Excessive heat causes surface of bearing to melt. | 1 | Allow other valid alternatives |
| 10(c)(i) | The 75t gear rotates anticlockwise . | 1 | |
| 10(c)(ii) | Reasons for using a worm gear will include: <ul style="list-style-type: none"> • Cannot be turned backwards / shaft is self-locking • High transfer of torque • More compact than spur gears • Large reduction in speed possible 2 × 1 marks. | 2 | |

| Question | Answer | Marks | Guidance | | | | | | | | | | |
|------------|---|-------|-------------------------------------|--------|--------|--------|----------|--------|-------|--------|--------------------------------------|---|---|
| 10(c)(iii) | <table border="1"> <thead> <tr> <th data-bbox="336 213 465 279">stage</th> <th data-bbox="465 213 815 279">velocity ratio</th> </tr> </thead> <tbody> <tr> <td data-bbox="336 279 465 344">A to B</td> <td data-bbox="465 279 815 344">60 : 1</td> </tr> <tr> <td data-bbox="336 344 465 410">B to C</td> <td data-bbox="465 344 815 410">3.33 : 1</td> </tr> <tr> <td data-bbox="336 410 465 475">C to D</td> <td data-bbox="465 410 815 475">5 : 1</td> </tr> <tr> <td data-bbox="336 475 465 542">A to D</td> <td data-bbox="465 475 815 542">$60 \times 3.33 \times 5 = 1000 : 1$</td> </tr> </tbody> </table> | stage | velocity ratio | A to B | 60 : 1 | B to C | 3.33 : 1 | C to D | 5 : 1 | A to D | $60 \times 3.33 \times 5 = 1000 : 1$ | 4 | Allow 10 : 3 for B to C . |
| stage | velocity ratio | | | | | | | | | | | | |
| A to B | 60 : 1 | | | | | | | | | | | | |
| B to C | 3.33 : 1 | | | | | | | | | | | | |
| C to D | 5 : 1 | | | | | | | | | | | | |
| A to D | $60 \times 3.33 \times 5 = 1000 : 1$ | | | | | | | | | | | | |
| 10(d)(i) | <p>Chain drive Advantage – little chance of breaking Disadvantage – can be noisy, 2 × 1 marks</p> <p>Pulley and round belt Advantage – low cost / belt easily replaced Disadvantage – belt can slip or break, 2 × 1 marks</p> <p>Pulley and toothed belt Advantage – cannot slip / relative position on pulley remains the same Disadvantage – regular replacement needed / belt can stretch, 2 × 1 marks.</p> | 6 | Allow any other valid alternatives. | | | | | | | | | | |
| 10(d)(ii) | <p>Either a tensioner pressed against the belt, sprung loaded or gravity or method of moving one of the pulleys / slotted fixing.</p> <ul style="list-style-type: none"> • Functional method, 1 mark • Details of how adjustment is carried out, 1 mark • Clear sketches / notes, 1 mark. | 3 | | | | | | | | | | | |

| Question | Answer | Marks | Guidance |
|------------|--|-------|--------------------------------|
| 11(a)(i) | Benefits for terminal block: <ul style="list-style-type: none"> • Can be disconnected easily • Wired so not have to be heated • More than one wire can be put into each connection. Benefits for plug and socket: <ul style="list-style-type: none"> • Suited to ribbon cable / multiple connections • Can only be placed in one way • Very quick to connect • No tools needed. 2 × 1 marks | 2 | Allow any other valid reasons. |
| 11(a)(ii) | Insulation stripped off, 1 mark. Wires twisted together, 1 mark. | 2 | Allow any other valid stages. |
| 11(b)(i) | 2% of 10 000 = 200 , 1 mark Upper value in range 10 000 + 200 = 10.2 kΩ , 1 mark Lower value in range 10 000 – 200 = 9.8 kΩ | 3 | |
| 11(b)(ii) | Reasons should include <ul style="list-style-type: none"> • Easier to work with than wire links • Can be used to jump over tracks • Easily manipulated by machines in commercial manufacture • Standard hole spacing (0.4") can be used on PCB. 2 × 1 marks. | 2 | Allow any other valid reasons. |
| 11(b)(iii) | Substitution in to formula P = 9 × .029 , 1 mark P = 0.261 W , 1 mark. | 2 | |
| 11(b)(iv) | Circles should be around 0.25 W and 0.125 W . | 2 | Allow ecf from (b)(iii). |
| 11(c)(i) | t = 1.1 × 15 000 × 0.001 , 1 mark t = 16.5 s , 1 mark. | 2 | |

| Question | Answer | Marks | Guidance |
|------------|---|----------|---|
| 11(c)(ii) | | 4 | Pin 2 low after 5 s, 1 mark Pin 2 returns to high after 5 s, 1 mark. Pin 3 high after 5 s. 1 mark Pin3 low after another 16.5 s, 1 mark. |
| 11(c)(iii) | | 2 | Pin 3 to buzzer correct, 1 mark Buzzer to +9 V correct, 1 mark. |
| 11(c)(iv) | The protective diode is to prevent back emf from damaging the IC. | 1 | |
| 11(d) | | 3 | One input inverted, 1 mark NOR gate or AND gate used, 1 mark Connections correct, 1 mark. |