MARK SCHEME for the May/June 2014 series

0445 DESIGN AND TECHNOLOGY

0445/42   Paper 4 (Systems and Control), maximum raw mark 50

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Section A

1   Examples include skeleton, leaf structure, spider's web, tree, 2 x 1 marks.   **[2]**
Do not allow 'human body'.

2   **Cantilever**, 1 mark.   **[1]**

3   **(a)**   Force at **X** can be **bending**, **compression** or **torsion**, 1 mark.   **[1]**
Force at **Y** is **shear**, 1 mark.   **[1]**
Force at **Z** is **tension**, 1 mark. Allow 'compression and tension'.   **[1]**

(b)   The most suitable non-ferrous metal for the frame is aluminium, accept duralumin or other named aluminium alloys.   **[1]**

(c)   Suitable plastics will include polystyrene, ABS, polypropylene, 1 mark.
Accept other suitable plastics; do not accept acrylic.   **[1]**

4   **(a)**   1 mark for each correct line, 3 × 1 marks.   **[3]**
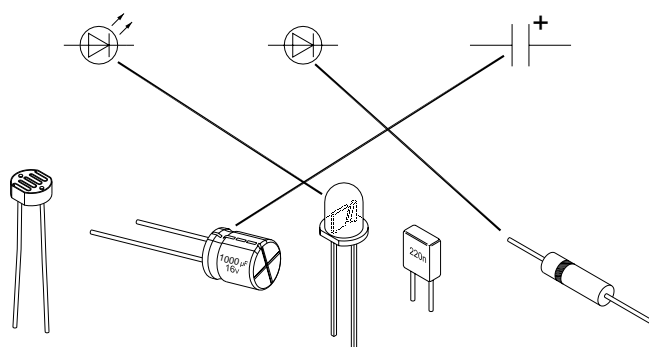

(b)   A polarised component is one that must be connected a particular way around in a circuit. **[1]**

5   **(a)**   When the relay coil is energised it generates an **electromagnetic field**, 1 mark and the core of the electromagnet attracts the moving contact, causing the output **contacts** to **'change over'**, 1 mark.
Allow 2 marks for a clear description of one effect.   **[2]**

(b)   Other components could be solenoid, electric motor, induction coil, transformer, rheostat (allow VR). Do not allow 'resistor'. 1 mark for suitable example.   **[1]**

6 (a) 1 mark for each, 3 × 1 marks.
Load and effort can be indicated on either side. **[3]**
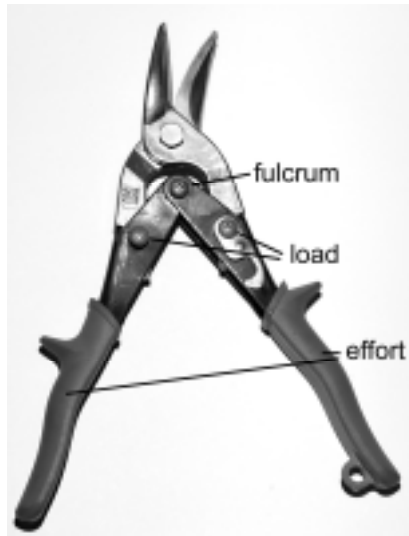
(b) Lever **B** is a pair of **first class** levers, allow '**first order**' levers, 1 mark. **[1]**

7 Compound levers are used to increase output force, 1 mark.
Increase mechanical advantage, 1 mark
Reduces the space needed to achieve a particular output force, 1 mark.
Allow reference to greater efficiency or improved precision of 2nd lever. **[2]**

8 (a) Part **X** is the **Connecting rod**, 1 mark. **[2]**
Part **Y** is the **Crankshaft**, 1 mark. Allow crank or crankpin.

(b) **Cam** and **follower**, 2 x 1 marks.
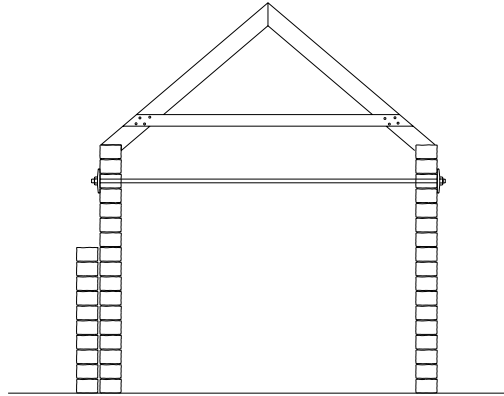**Pin** and **slot,** 2 x 1 marks. **[2]**

[Total: 25]

Section B

9 **(a) (i)** Extra timber in suitable position, 1 mark.
Method of fixing shown, e.g. screw or bolt heads or evidence of joint 1 mark. **[2]**

(ii) Use of a buttress or tie rod, 1 mark.
Suitable height for buttress/method of holding tie rod in place, 1 mark. **[2]**

(b) (i) Examples of composite materials are: MDF, carbon fibre, GRP, concrete, aluminium/fibreglass (GLARE), 1 mark for each suitable example, 2 x 1 marks. **[2]**

(ii) Reasons given in explanation could include:
- Improve the working qualities of material, less likely to twist or expand
- Avoid natural defects or faults in materials
- Provide consistent quality
- Increase the size of material available.

1 mark each for two points included, allow 2 marks for one point well explained. **[2]**

(c) (i) 1 mark each for correctly identified strut and tie, 2 × 1 marks

[2]

(ii) Compression, 1 mark. **[1]**

(iii) Tension, 1 mark. **[1]**

(iv) Frame structure, 1 mark. **[1]**

(d) **(i)** Use of maximum span **3.41 m** 1 mark.
Size of joist **195 x 47**, spacing **600** mm, 2 marks   **[3]**

    (ii) Support strip shown under each shelf/use of back sheet,1 mark.
Details of fixings shown, 1 mark.
Clarity of communication, 1 mark.   **[3]**

(e) Sleeve used, 1 mark, suitable size for sleeve, 1 mark.
Suitable method of fixing each tube to sleeve indicated, 1 mark.   **[3]**

(f) Safe working load is the **recommended maximum load** that can be safely lifted.
SWL includes a **safety factor** applied to the weakest part of the device.
It is much **less than the breaking load** that would cause the device to fail.
Clear explanation including two points, 3 marks.
One point clearly explained, 2 marks.
One or two points mentioned but not explained, 1 mark.   **[3]**

                                                             [Total: 25]

10 **(a)** **(i)** **1.0 mm**, 1 mark.   **[1]**

    (ii) 16 turns to close from 25 mm to 17 mm, 1 mark.   **[1]**

    (iii) Ratchet must clearly show single direction of rotation is possible, 1 mark.
Pawl shown held against ratchet by spring pressure, 1 mark.
Direction of operation shown on drawing or in notes, 1 mark.   **[3]**

    (iv) Second class lever, 1 mark.   **[1]**

  (b) **(i)** **Rack**, 1 mark and **pinion**, 1 mark.   **[2]**

    (ii) **Rotary** motion is converted to **linear** motion, 2 × 1 marks.   **[2]**

    (iii) Benefits of ball bearings will include;
- Less friction
- Smaller contact area
- Allows faster operating speed
- Less wear/longer life
- Supports against axial and radial loads.

2 × 1 marks for suitable benefits.   **[2]**

    (iv) Reasons for specifying sealed for life bearings will include:
- No maintenance necessary
- Bearing life extended
- Sawdust would soak up any non sealed lubrication

2 × 1 marks for suitable benefits.   **[2]**

(c) (i) Explanation should include:
- Belt is held in a fixed position on the pulleys
- Less chance of belt coming off pulleys
- More surface area in contact with the pulley
- Less chance of belt slipping

Explanation that includes two points, 2 marks
Allow 2 marks for one point fully explained. **[2]**

(ii) Different sized pulleys will alter the speed, 1 mark.
Allows lower speed higher torque, 1 mark. **[2]**

(iii) Driven pulley speed is 840 rpm
Pulley ratio is 5:3, 1 mark
Motor speed = 840 × 5/3, 1 mark
Motor speed = 1400 rpm, 1 mark
Correct answer with no working 3 marks. **[3]**

(iv) Sketches and notes to show:
- Sprocket and chain drive
- Direct drive through spur gears
- Friction drive from motor to final output

2 × 1 marks for each named system, clearly illustrated. **[4]**

[Total: 25]

11 (a) 1 mark for each correct.

	small		large
resistance	Ω	kΩ	MΩ
capacitance	pF	µF	F

[4]

(b) (i) Switch **C**, 1 mark. **[1]**

(ii) A toggle switch remains in place once switched, 1 mark
A push to make switch is a momentary action which is reversed when switch is released, 1 mark **[2]**

(c) (i) Curve to show rise in voltage, 1 mark
Maximum voltage 9 V, 1 mark
Slow loss of charge after 5 seconds, 1 mark **[3]**
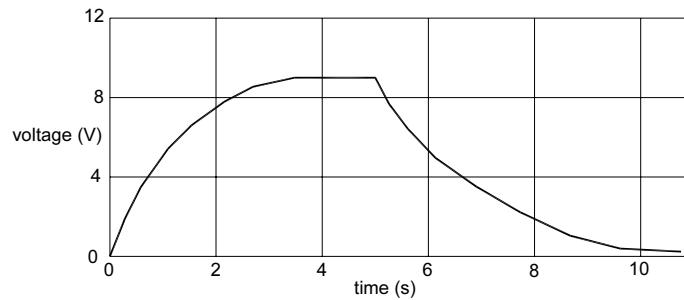
(ii) Delay can be increased by:
Increasing the value of C1, 1 mark
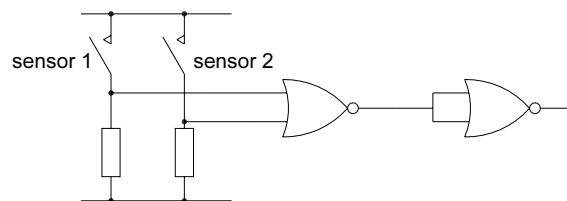Increasing the value of R1, 1 mark **[2]**

(iii) LED will switch off when voltage at the base of TR1 drops to approximately 0.6 V. **[1]**

(d) (i) **OR** gate. **[1]**

(ii) 0,0 giving 0, 1 mark. All other combinations at 1, 1 mark. **[2]**

in1	in 2	out
0	0	0
0	1	1
1	0	1
1	1	1

(iii) Gate 1 connected to sensors, 1 mark.
Gate 2 connected as NOT gate, 1 mark.

[2]

(e) (i) The latched signal will remain on when the cause of either sensor being activated has been removed, most sensors are momentary action so either a delay or latching is needed. Clear explanation with two points mentioned 2 marks. Allow 2 marks for one point clearly explained with example given. **[2]**

(ii) The following points may be included in the explanation:
- The transistor base receives a voltage from the sensors via the OR gate, this switches the transistor on and provides a 0V signal for the coil of RLA1
- When the coil is activated the contacts on the SPDT change there is a 9V signal to the base of the transistor
- because the OR gate has a 1 at input from the relay connection
- The relay remains latched until both sensor signal and signal from relay contact are at 0V or disconnected

2 x 1 marks for clear description. **[2]**

(iii) D1 is to **protect the transistor from back emf** when the coil is switched off. **[1]**

(iv) Current = **9/100**, 1 mark
Current = **90 mA** or **0.09A**, 1 mark **[2]**

[Total: 25]