CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the May/June 2015 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 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

CAMBRIDGE
International Examinations

Section A

1 (a) Component **A** is an LDR / light dependent resistor [1] **[1]**
Do not accept light sensor
Component **B** is a thermistor [1] **[1]**
Do not accept heat sensor

(b) The resistance change is caused by:
A change in light intensity / the light level has increased [1]
Resulting in a decrease in resistance [1] **[2]**

2 (a) **680kΩ**, **330kΩ**, **390kΩ** [1] for each correct value
No marks if more than three circles **[3]**

(b) Two resistors in **series** [1] **[1]**

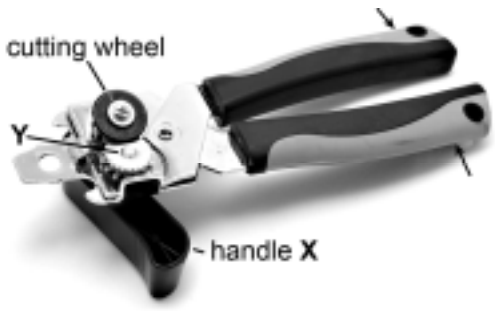
3 Reasons for using plastics include:
- Electrical insulator
- Easily formed into suitable shapes
- No finish required
- Timber dimensions less stable, can warp / twist / shrink

Accept any other valid reason; [1] for suitable reason **[1]**

4 (a) First order / first class lever [1] **[1]**

(b) **Rotary** motion [1]; allow oscillation **[1]**

(c) Arrows shown pointing inward toward the end of each grip
Arrows can be on either view; [1] each
Arrows pointing inward but not at end of grip [1] **[2]**



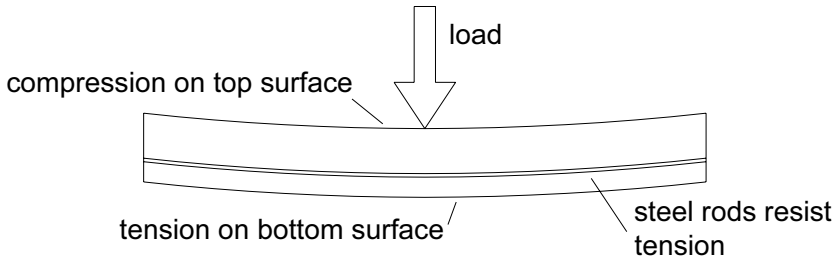
5 When the handle is rotated the cutting wheel will:

- move at the same speed
- move in reverse direction of rotation
- have no change in input to output force / torque.

(2 × 1) **[2]**

6 Stored energy examples are battery, compressed air, chemical energy, gravitational potential energy (GPE) and potential energy in a spring or pendulum
Allow any other form of stored energy, (2 × 1) **[2]**

7 The reinforcement in the concrete will be toward the bottom of the beam to resist tension [1]
The top surface has to resist compression which the concrete will do [1]
Clear sketch to illustrate a loaded beam [1]



[3]

8 Force acting at **A** is **tension** [1]
Force acting at **B** is **compression** [1]
Force acting at **C** is **bending** [1] **[3]**

9 Reasons for using carbon fibre in a bicycle frame will include:

- Increased stiffness
- durability
- Weight reduction
- Shock absorbing properties
- Consistent quality
- Frame section other than tubular is possible.
- Will not corrode due to weather conditions
- Allow increased strength, if qualified or compared,
  e.g. higher strength to weight ratio.

(2 × 1) for valid reasons **[2]**

[Total: 25]

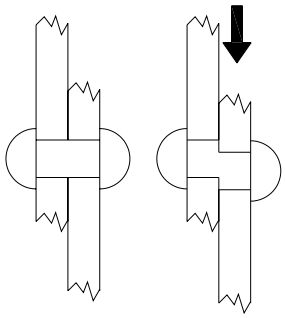
Section B

10 (a) (i) Frame structure [1] **[1]**

(ii) Triangulation [1] **[1]**

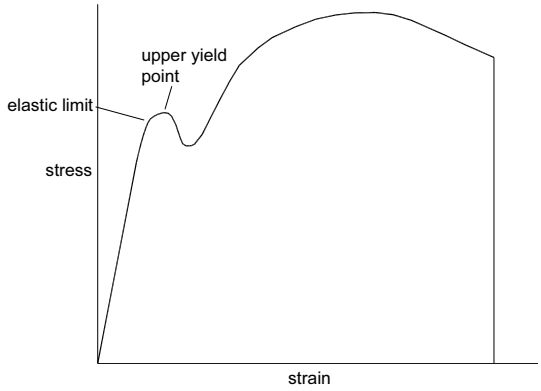
(iii) **A** is a tie, allow brace [1] **[1]**
B is a, strut [1] **[1]**
C is a gusset plate [1] **[1]**

(iv) Drawing / description of a rivet, joining two plates together [1]
Indication of force parallel and close to plate [1]
Indication of method of failure [1]



[3]

(b) Correct shape curve [1]
Elastic limit indicated [1]
Upper yield point indicated [1]



[3]

(c) (i) Stress in the cable = force / cross sectional area
550 kg = **550 x 9.8N** or **5390N** [1]
Area of cable = $3.142 \times 4^2 = 50.272$ [1].
Stress = 5390 / 50.272 = **107.23 N/mm^2** [1]
Allow small variation in value of pi used for stages two and three.
Allow 107230kPa or 107230000P **[3]**

(ii) Change in length = 1.2mm = 1.2×10^{-3} [1]
$1.2 \times 10^{-3} / 3$ = **0.0004**, or **4** $\times$ **10^{-4}** [1] **[2]**

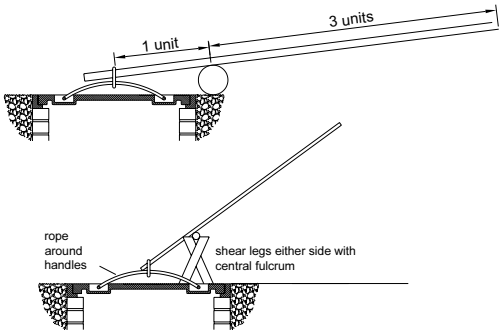
(d) (i) Hole **A** should be used [1] **[1]**

(ii) Explanation could include the following points:

- When the beam is loaded the top face will be in compression and the bottom face in tension,
- The notch will leave a weakness at the bottom face as wood at corners of notch tends to split.
- Hole **B** will leave a small area of wood subject to tension and this is likely to fail.
- Hole **A** will have the thin area at top of hole in compression and this is less likely to fail.

Three valid points included = [3]
Two points with one point well explained = [2]
Two valid points = [2]
One valid point = [1] **[3]**

(e) Sketch to show method of providing a fulcrum, e.g. shear legs [1]
Lever shown in suitable position [1]
Functional method used [1]
Calculation to show that effort is 100N or less [2]
E.g. Fulcrum to lifting point × 300 = fulcrum to effort × 100.
0.5m × 300 = fulcrum to effort × 100
Fulcrum to effort = 150 / 100 = 1.5m.



[5]

[Total: 25]

11 (a) (i) The adjusting handle is turned, [1]. Lever **A** then moves to adjust the base, [1]
the gear transmits motion from lever **A** to the link arm, [1]
Two points included in description [2] **[2]**

(ii) Any of the four moving pivot points or the threaded rod (2 × 1) **[2]**

(iii) Lubricating oil, allow 'oil' or 'grease' [1] **[1]**

(iv) To avoid wear on the parts in contact, [1]; to reduce friction, [1]; cooling, [1].
Allow reference to removing squeaks or to make movement smooth. **[2]**

(b) (i) The description will include:

- The cylinder outstrokes when air enters the cylinder
- Only one operating valve is needed
- The piston will instroke as soon as the air supply is cut off
- There is a compression spring to instroke the piston.
- Speed of outstroke can be controlled

(2 × 1) **[2]**

(ii) A double acting cylinder requires an air supply at each end

- It will require two operating valves
- Speed of outstroke and instroke can be controlled
- Cylinder remains outstroked when air is cut off
- The cylinder can be cushioned to control the last part of movement
- A reed switch version can be used to provide positional feedback.

(2 × 1) **[2]**

(c) (i) **Eccentric** cam [1]. **Pear shaped** cam allow **egg shaped** [1]
Snail cam [1] E try to be there for about 12:00 **[3]**

(ii) Circle around snail cam [1]. **[1]**

(d) (i) Advantages of a ball bearing race will include:

- Reduced friction compared to a plain bearing
- Longer life
- Easy replacement if necessary
- Will support both axial and radial loads / thrust bearing
- Can be sealed for life meaning no lubrication necessary

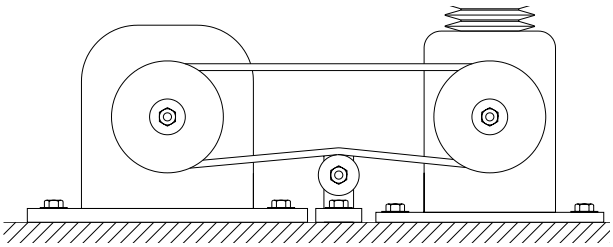
(2 × 1) **[2]**

(ii) A compound gear train will have two gears fixed in position on a single body [1].
At least one of these is required in a compound train [1]. This allows the gear train to be fitted into a smaller space for larger reduction ratios [1].
Gear ratios of each stage are multiplied to give final ratio [1].
Any three points included in description = [3]
One point described in depth can be worth 2 marks. **[3]**

(iii) Gear A is 10t, gear B is 35t, reduction ratio is 3.5:1 [1].
Speed of gear B is 462/3.5 = **132rpm** [1]
Allow 2 marks for answer with no working **[2]**

(e) Method of adjustment could be:

- Adjustable idler pulley against belt in fixed position



- Spring loaded idler pulley held against belt
- Slots in the base of motor or compressor to allow them to be moved apart
- Functional method [1], quality of sketches [1].

Clear description of adjustment method [1] **[3]**

[Total: 25]

12 (a) (i) Reason should relate to toxic nature of lead or regulations controlling use of leaded solder [1]. **[1]**

(ii) Flux will:
- Protect against oxide formation
- Help to break down surface tension of solder / make the solder flow better
- Active fluxes will clean the joint.

(2 × 1) **[2]**

(iii) Risks could include:
- Burns from soldering iron
- Fumes from flux
- Fumes from solder
- Solder / flux spitting into eyes
- Electrical faults in soldering iron
- Burned or melted insulation on cable of soldering iron

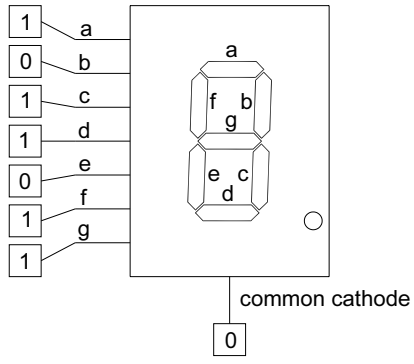
(2 × 1) **[2]**

(iv) Precaution need not relate to the dangers identified in (iii) and could include:
- Keeping hands away from soldering tip and other hot parts of the iron
- Use of extraction equipment for flux / solder fumes
- Regular checks on plug connections / insulation for damage
- Checking cable for burns / melted areas.
- Wearing goggles

1 mark for simple description of precaution, 2 marks for detailed description. **[2]**

(b) (i) Common cathode means that all of the negative or cathode connections from the LEDs are internally connected [1]. **[1]**

(ii) Segments **a,f,g,c,d** will be lit [1].
Lit segments logic 1 [1]. Unlit segments logic 0 [1].
Common cathode logic 0 [1].



[4]

(iii) Use of voltage drop, 9V – 2V = 7V, [1].
Correct formula used and substitution made R = V / 1 R = 7 / 0.015 [1].
R = **466.6**Ω [1].
Allow **466** Ω or **467** Ω
Correct answer with no working, 3 marks. **[3]**

(iv) Benefit of DIL package could be:

- Smaller footprint than separate resistors
- Faster manufacture / no legs to bend or wires to be cut

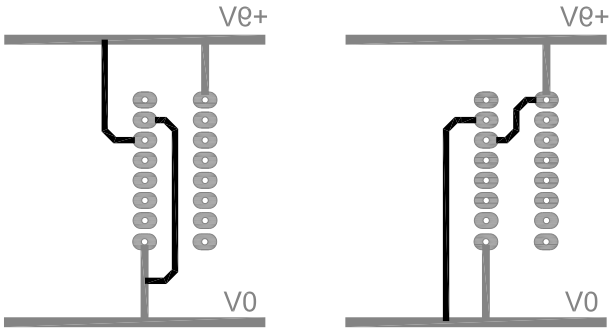
Allow any other valid benefits, no marks for cost related. **[1]**

Benefit of separate resistors could be:

- Will make for easier routing of PCB can be used to bridge tracks
- Likely to be standard resistors kept in stock

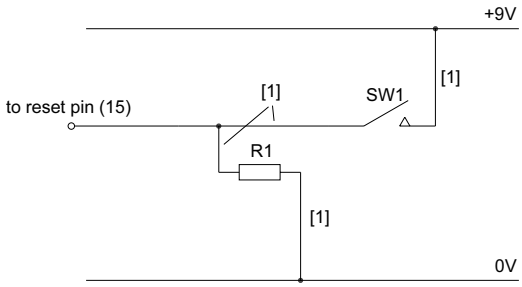
Allow any other valid benefits, no marks for cost related. **[1]**

(c) 1 mark for each track correct.



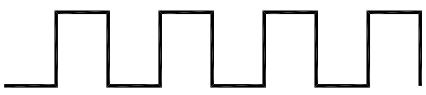
Other solutions are possible, allow the use of a bridge. **[2]**

(d) SW1 to +9V [1]. R1 to 0V [1]. SW1 and R1 to reset [1]



[3]

(e) **(i)** An astable signal is a regular on / off pulse, [1]
The signal does not have a stable state in either on or off position, [1]
Amplitude is constant and frequency is regular but can be varied, normally by changing resistor / capacitor values, [1]



[1]

(2 × 1) for any two written or sketched points. **[2]**

(ii) IC named could be 555, 4001, 4011 or PIC IC
1 mark for valid number or description of IC. **[1]**

[Total: 25]