

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

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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) **680k Ω , 330k Ω , 390k Ω** [1] for each correct value
 No marks if more than three circles [3]

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

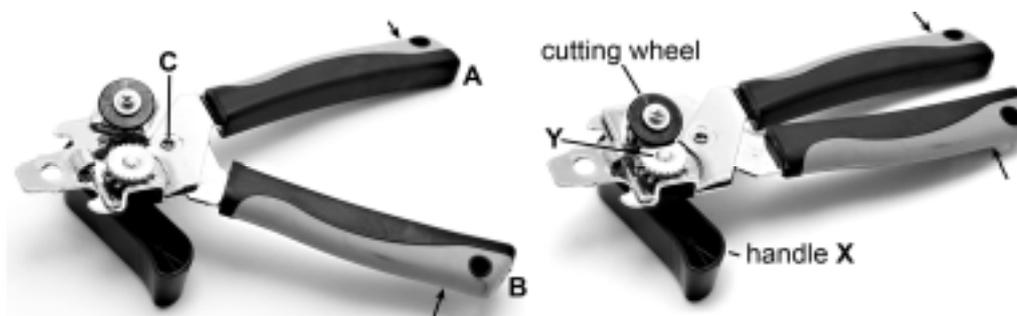


- 3 Reasons for using plastics include:
- Electrical insulator
 - Easily formed into suitable shapes
 - No finish required
 - Timber dimensions less stable, can warp / twist / shrink
- Accept any other valid reason; [1] for suitable reason [1]

- 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]

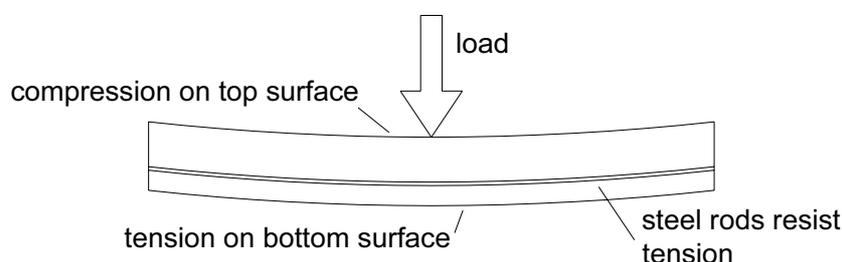


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- 5 When the handle is rotated the cutting wheel will:
- move at the same speed
 - move in reverse direction of rotation
 - have no change in input to output force / torque.
- (2 × 1) [2]

- 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]

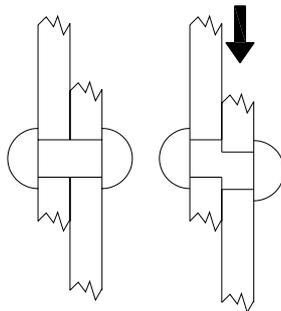
- 9 Reasons for using carbon fibre in a bicycle frame will include:
- Increased stiffness
 - durability
 - Weight reduction
 - Shock absorbing properties
 - Consistent quality
 - Frame section other than tubular is possible.
 - Will not corrode due to weather conditions
 - Allow increased strength, if qualified or compared, e.g. higher strength to weight ratio.
- (2 × 1) for valid reasons [2]

[Total: 25]

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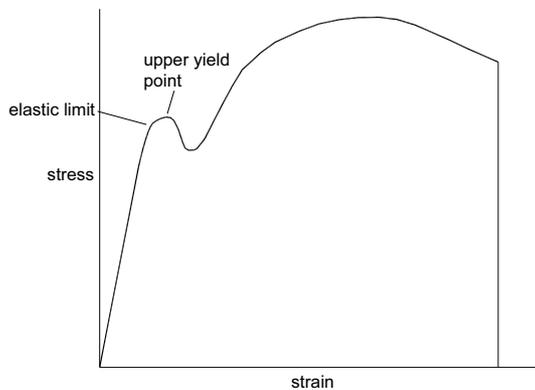
Section B

- 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 = $5390 / 50.272 = \mathbf{107.23 \text{ N/mm}^2}$ [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]
 $1.2 \times 10^{-3} / 3 = \mathbf{0.0004}$, or $\mathbf{4 \times 10^{-4}}$ [1] [2]
- (d) (i) Hole **A** should be used [1] [1]

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(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]

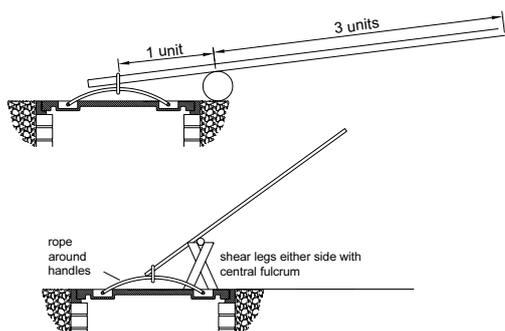
Functional method used [1]

Calculation to show that effort is 100N or less [2]

E.g. Fulcrum to lifting point $\times 300 =$ fulcrum to effort $\times 100$.

$0.5\text{m} \times 300 =$ fulcrum to effort $\times 100$

Fulcrum to effort = $150 / 100 = 1.5\text{m}$.



[5]

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- 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]

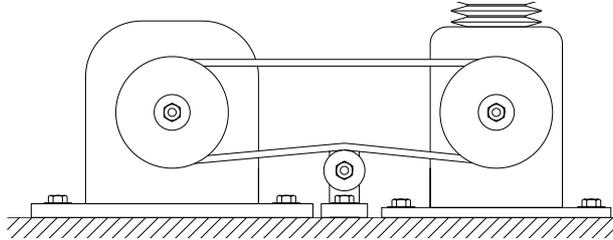
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- (iii) Gear A is 10t, gear B is 35t, reduction ratio is 3.5:1 [1].
 Speed of gear B is $462/3.5 = 132\text{rpm}$ [1]
 Allow 2 marks for answer with no working

[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]

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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.

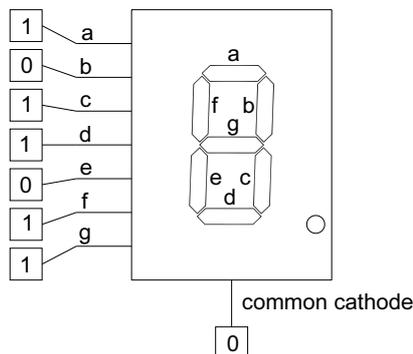
[2]

(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 $R = V / I$ $R = 7 / 0.015$ [1].

$$R = 466.6\Omega [1].$$

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]

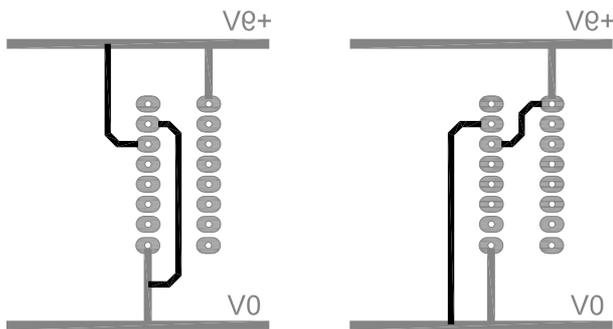
Benefit of separate resistors could be:

- 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]

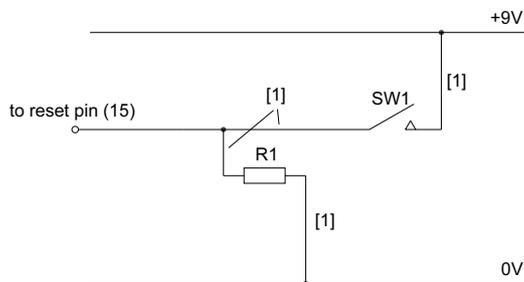
(c) 1 mark for each track correct.



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]

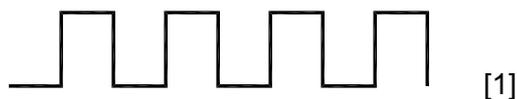


[3]

(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]



(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]