CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the May/June 2013 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.
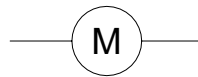
Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.
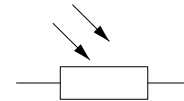
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Section A

1 (a) 1 mark for each correct symbol, 2×1.

motor [1]   LDR [1]

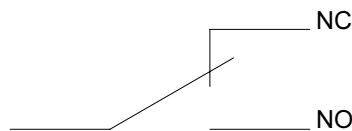**2** 10kΩ resistors connected in parallel [1], correct connections to **A** and **B**. [1]   **[2]**

10kΩ

A   B

10kΩ
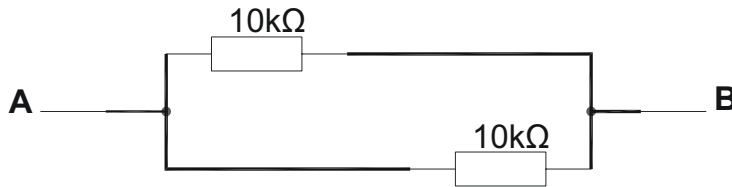
3 (a) Switch arrangement is **single pole double throw / SPDT**, 1 mark.   **[1]**

(b) Correct labels [1].   **[2]**

NC

NO

4 Examples could include: Bones in skeleton, tree branches, spiders web or any other that will resist tension, 2×1 marks.   **[2]**

5 One mark for each correct, 3×1 marks.   **[3]**

materials	tension	compression	bending
concrete		✓	
steel cable	✓		
laminated wooden beam			✓

6 Strengthening should be in the form of triangulation, struts, ties, gusset plates.
One mark for two different methods or one mark each for the same method resisting
loads in different directions 2×1 marks.   **[2]**

7 Advantages of roller bearings could be:
- reduced friction between surfaces
- can carry higher load
- lower cost in replacement
- more durable at high speed
- Can be sealed for life, requiring less lubrication

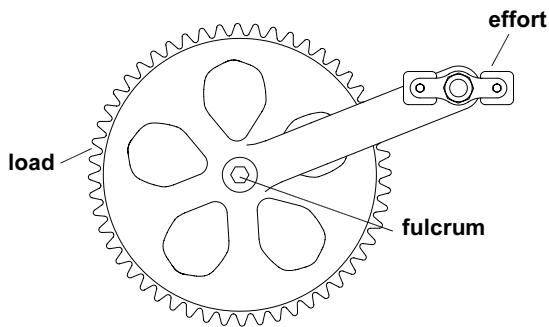Allow any other valid benefit 2×1 marks.   **[2]**

8 **(a)** Indication on the lower half of cam profile 1 mark.

(b) **Rotary** to **reciprocating** one mark for each correct term.

9 One mark for each correct label 3 × 1. **[3]**

10 **(a)** The wheelbarrow is a **class 2** lever, 1 mark. **[1]**

(b) The load is moved closer to the fulcrum. [1]
This will increase the efficiency / mechanical advantage of the lever. [1]
The load is more stable against the front of the barrow. [1]
Give marks for any **two** correct points in description.
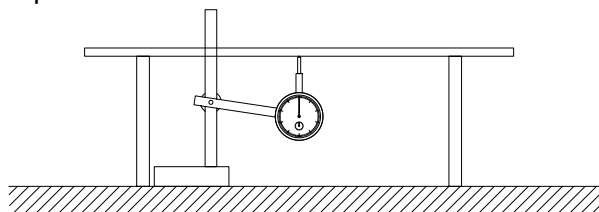Accept reasons for not choosing method **Y**. **[2]**

[Total: 25]

Section B

11 **(a)** Dial gauge shown or described. [1]
Probe of dial gauge placed centrally under beam. [1]
Dial gauge supported in a suitable way. [1]
Dial gauge adjusted to read zero before test. [1]
Description of gauge movement as beam deflects. [1]
Any four of above 4 × 1 marks.
Allow other valid points. No marks for use of a ruler. **[4]**

(b) (i) The following points may be included:
- Factor of safety is the structural capacity beyond the expected load
- How much stronger is the structure than the expected load
- Ratio of maximum strength to the intended design load

Explanation that includes two justified relevant points 3 marks.
Only one justified point mentioned 2 marks.
Some understanding shown 1 mark. **[3]**

(ii) The following features of a road bridge could be considered:
- Maximum amount of vehicles on bridge at any one time
- Dynamic loads caused by weather conditions
- Potential movement of ground supporting the structure
- Increase in weight of HGVs in the future
- Choice of materials used

Allow any other valid feature, 3 × 1 marks. **[3]**

(c) Take moments about A
$(65 \times 10) + (100 \times 13) - R_D \times 23 = 0$ [1]
$R_D = (650 + 1300) / 23 =$ **84.78kN** [1]
$R^A + R^D = 165$kN [1]
$R^A = 165 - 84.78 =$ **80.22kN** [1]
Allow 4 marks if correct answer with no working. **[4]**

(d) Nut and bolt, no heat involved, can be removed if necessary, [1]
Rivet, permanent method can be either hot or cold process, [1]
Welded joint, permanent method, strong, flush surface, [1]
Allow any other valid reasons. **[3]**

(e) (i) Reasons could include:

- Renewable resource can come from a managed forest
- Durable, particularly when protected
- Strong in tension and compression ('strong' must be qualified)
- Will allow movement in foundations without losing strength
- Easily worked and can be prepared off site in controlled conditions

2 × 1 marks for any suitable reasons. **[2]**

(ii) Increased width compared to thickness will resist bending better. [1]
Fewer supports will be needed, saving on timber. [1]
The beam can span a greater distance safely. [1]
[2]

(iii) Defects could include, splits, shakes, knots, warping, insect damage or any other valid defect, 2 × 1 marks. **[2]**

(f) A strut will resist compression. [1]
A tie will resist tension. [1]
[2]

Allow marks for understanding shown.

[Total: 25]

12 (a) (i) One mark for each pivot point correct, 3×1.
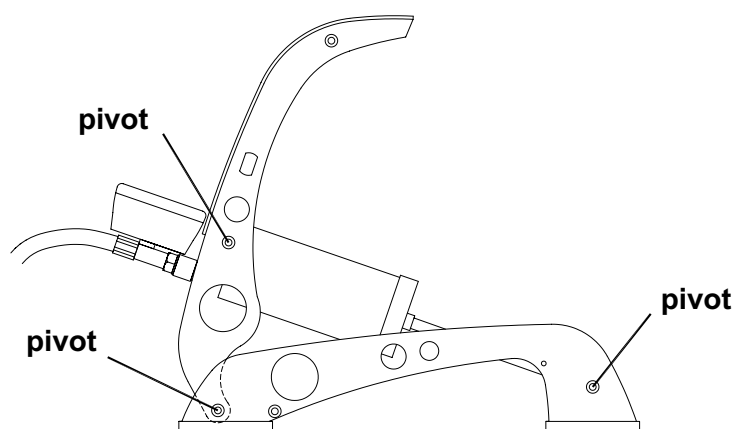
pivot

pivot

pivot

(ii) Grease will not run off the pivot points as quickly as oil.
Foot pump may be used infrequently so lubrication with grease will
last longer, 1 mark for suitable response.
Allow any other valid reasons. **[1]**

(iii) **Oscillating** motion is converted to **reciprocating** motion. 2×1 marks. **[2]**

(iv) Explanation to mention frictional losses at pivot points in both axial and thrust.
Losses in the piston rod movement and in air moving out of pump.
Air tube and cylinder will heat in use; some energy is converted to heat.
2 marks for justified explanation. **[2]**

(b) (i) Reasons for using a chain drive include:
- Only a small amount of stretching takes place in the chain
- Positive drive will not slip
- Long lasting and works well in adverse weather conditions

Allow any other valid reasons. **[2]**

(ii) **24** gear ratios available. **[1]**

(iii) Velocity ratio = 52 / 18, 1 mark = **2.89:1**, (accept 2.88, 2.9) 1 mark.
Allow 2 marks for answer with no working. **[2]**

(iv) Reasons for ball bearing use will include:
- Ball bearings will reduce the contact area between axle and bearing race
  (reduce friction)
- Easily replaceable for maintenance
- Ball bearings will also deal with thrust where a roller bearing will not

Two factors mentioned and justified, 2 marks.
Allow 2 marks for one factor fully explained. **[2]**

(v) Moving the chain across the sprockets to change gear. [1]
Tensioning the chain. [1] **[2]**

(c) (i) Power sources will include:
- Mains electricity
- Battery power
- Chemical
- Pneumatics (air)
- Hydraulics (oil)
- Water, wind, and other renewable sources
- Human power

Accept other valid answers.

1 mark for each correct, 3 × 1. **[3]**

(ii) Improvements to a mechanism could include:
- Reducing weight, this will reduce friction in moving parts
- Using appropriate materials modern, lightweight, e.g. carbon fibre
- Reducing the number of parts
- Improved bearings on moving parts

Two relevant points with justified explanation for 3 marks.
One point with clear explanation, 2 marks.
One / two relevant points with no further explanation, 1 mark. **[3]**

(d) 1 mark for ratchet and pawl mechanism shown or described.
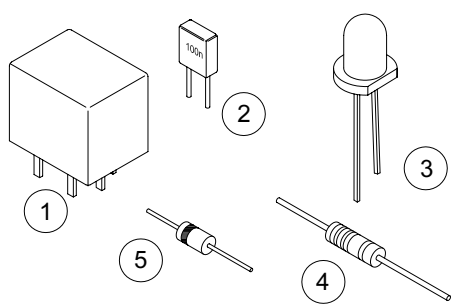1 mark for a valid use, which could be:
- Mechanical clock / watch winder
- Ratchet screwdriver
- Socket set wrench
- Cable clamps
- Handcuffs
- Electrical ties (zip ties)

2 × 1 marks. **[2]**

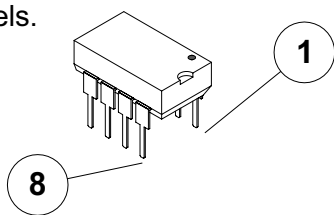**13 (a) (i)** 4 × 1 marks.

[2]

    (ii) Capacitor **470µF**, 1 mark Resistor **2MΩ**, 1 mark. **[2]**

    (iii) 2 × 1 marks for correct pin labels. **[2]**

(b) (i) **VRI** is to adjust the sensitivity of the trigger / form a potential divider with the thermistor / alter the trigger point of the IC.
Allow mark for understanding shown. **[1]**

    (ii) Substitution into formula
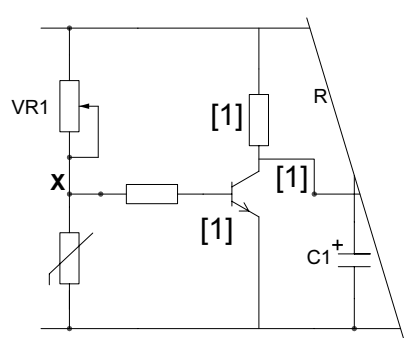V_{out} = (3K / (3K + 40K) × 9   [1]

V_{out} = (3 / 43) × 9 = **0.628V**   [1]

Allow 2 marks for correct answer with no working. **[2]**

    (iii) Symbol(s) correct [1] allow direct connection of base to X.
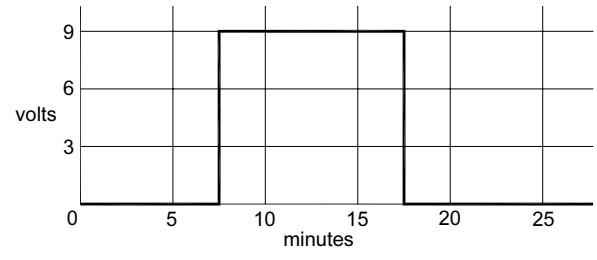Pull up resistor used [1]
Connection to pin 2 [1]

[3]

(c) (i) Correct shape going from 0V to +9V and returning to 0V. [1]
Pulse to start at 7.5m and continue for 10m. [1]

(ii) Tolerance on value of capacitor or resistor. [1]
This will affect the total time delay produced. [1]
Explanation must include reference to the component tolerance for marks. **[2]**

(d) Dial setting **mA**, [1] Battery negative to circuit 0V, [1] positive through meter. [1]
Multimeter may be inserted into the negative line. **[3]**
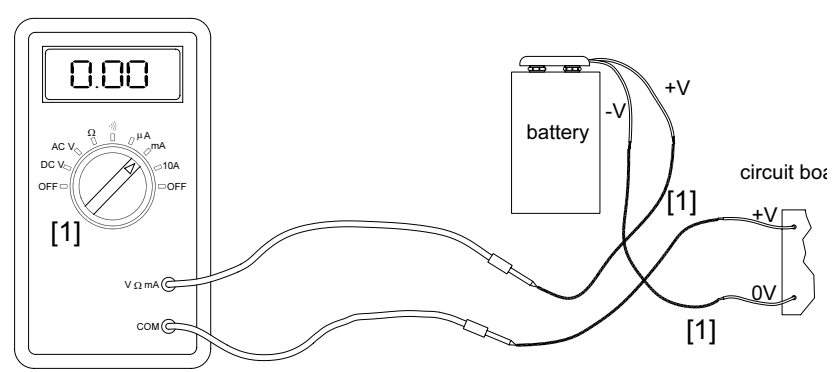
(e) (i) The logic used is NOR, 1 mark. **[1]**

(ii) Truth table output correct, 1 mark. **[1]**

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

(iii) Joining the inputs forces the same logic level on both input gates. [1]
The result is that the output for the gates is opposite to the input. [1]
This gives a NOT gate or inverter. [1]
2 × 1 marks for any two of above statements included in desciption. **[2]**