CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the October/November 2013 series

0445 DESIGN AND TECHNOLOGY

0445/41 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.

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Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

CAMBRIDGE
International Examinations

Section A

1 (a) Torsion/Torque [1]

(b) Shear [1]

(c) Factor of safety could be increased by:
- using larger gauge screws
- quality of wall plugs
- using hardened screws
- using more screws spread across the frame.
- using washers under screw heads

Description including two of above points, 2 marks.
Allow 2 marks if one point well described/justified. [2]

2 Natural shell structure – nut shells, eggs, honeycomb, shells of seafood. [1]
Manufactured shell structure – drinks cartons/cans, car bodies. [1]

3 Any third order lever, effort between load and pivot [1], label [1]. [2]

4 Card shown folded or fold lines marked [1], capable of supporting a load [1]. [2]

5 Label on top of hook [1]
Label on the guy rope for tension [1]
Label on shear legs for compression [1]
Allow tension in the rope holding the load. [2]

6 (a) **A** – spur gear [1], allow 'gear' or similar. **B** – Worm gear, [1]. [2]

(b) Reduction ratio is **48:1**. No mark for 1:48. [1]

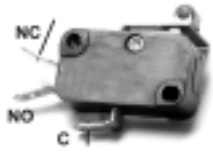
7 (a) A crankshaft converts **rotary** motion to **reciprocating** motion or
A crankshaft converts **reciprocating** motion to **rotary** motion. [2]

(b) A **cam** will convert rotary motion to reciprocating motion. [1]

8 (a) Colour codes are used because:
- components are physically very small; it would be difficult to read print
- they can be read regardless of the orientation of the component on a PCB

Allow any other valid response. [1]

(b) 560 K colour code is **green** – blue – **yellow**. 2 × 1 marks [2]

9 Connections to **NC** [1] and **C** [1] 

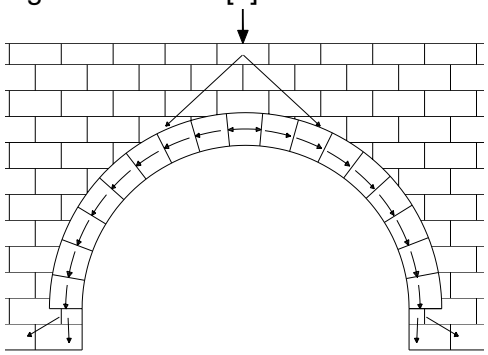
[2]

10 **0.1 µF 100 nF,** 2 marks, no marks for any other combination. [2]

[Total: 25]

Section B

11 (a) Force through bricks distributed [1]
Force through arch shown [1] [2]



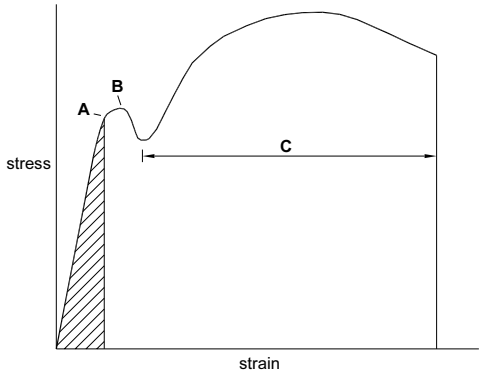
(b) (i) Strain gauge 1 will measure tension [1]
Strain gauge 2 will measure compression [1] [2]

(ii) The markings are to allow accurate alignment of the strain gauge. [1]

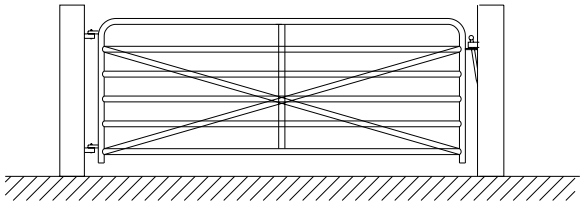
(c) (i) Point **A** is **elastic limit** [1] allow mark for understanding shown.
Point **B** is **upper yield point**, allow yield point [1]
Allow marks for understanding shown. [2]

(ii) Section indicated by **C** is area of plastic deformation. [1]

(iii) Single point on graph indicated [1].
Clear indication of area showed [1]. [2]

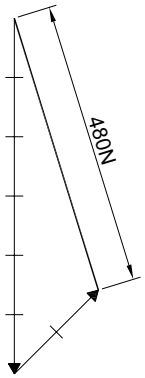


(d) (i) Triangulation used [1], Central support(s) to stop bending of horizontals [1] [2]



(ii) Indication of welding/bolts/rivets [1] [1]

(e) Resultant force **479.89 N**. Allow either calculation/triangle/parallelogram method.
Suitable method chosen [1], accurate drawing/scale used [1] correct result [1]. [3]



(f) Suitable joining method plates / scarf joint [1]
Method of fixing shown screws / bolts / glue / wedges [1]
Will keep two pieces in horizontal alignment [1]
Will keep two pieces in vertical alignment [1]. 4 × 1 marks. [4]

(g) **(i)** A moment is **force** × **distance** [1]. [1]

(ii) Moments about **A**: Reaction at **B** x 9 = (3 x 900) + (7 x 500) [1]
Reaction at **B** = (2700 + 3500) / 9
= **688.89 N** [1]
Reaction at **A** = 1400 – 688.89 = **711.11 N** [1] [4]

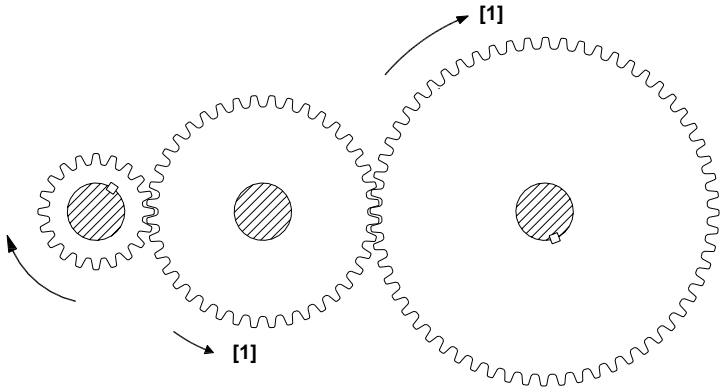
[Total: 25]

12 **(a)** Examples of energy loss could include:
- Heat – transformer, charging battery, motor, gears
- Sound – motor, reduction gears, output shaft
- Friction – motor, reduction gears, output shaft

3 × 1 marks for any three points included.
Type of energy involved must be given to gain each mark. [3]

(b) Benefit of operating from batteries – Can be operated remotely, safer than mains power, no cables to get tangled, cause trip hazard.
1 mark for any suitable benefit, reduced cost must be justified. [1]
Drawback – constant level of output from the transformer, battery output will decrease as charge drops or will fail suddenly. Battery output may be too low to operate the system. 1 mark for any suitable drawback. [1]

(c) (i) 1 mark for each correct direction arrow. [2]



(ii) Gear ratio is 3:1, gear **C** rotates at **20 rpm**. [1]

(iii) Gear **B**, the idler gear can rotate freely [1], as it is not being driven by its shaft or transferring drive to its shaft [1], 2 marks for clear explanation.
1 mark for reference to free rotation being possible. [2]

(d) (i) **Ratchet** and **pawl**. [1]

(ii) Jack has to open a distance of 350 – 180 = 170 mm [1]
Pitch of screw is 5 mm, therefore 34 turns needed [1]. [2]

(iii) Effort could be reduced by:
Ensuring all parts are oiled/greased and move freely
Smaller pitch on the thread will reduce effort but require more turns
Extending the lever used to operate the jack
2 × 1 marks. [2]

(e) (i) Benefit of:
Ball race – reduced contact area, can resist thrust, easily replaced.
Roller race – reduced contact area, will take greater radial load than ball bearing.
Plain bearing – low cost, can be pre oiled, can resist thrust.
3 × 1 marks, allow other valid benefits. [3]

(ii) A nylon bearing will be self lubricating, lower cost, easy to produce in bulk. [1]

(iii) Nylon has a relatively low melting point [1] and high speed rotation could melt the bearing [1]. [2]

(f) (i) A bell crank lever will transfer motion through an angle, normally 90º [1].
Operated by wire for pulling action or rod for pushing action [1], 2 × 1 marks. [2]

(ii) Mechanical advantage will be gained by moving linkage to position B [1].
More movement of input link will be needed to move the output link the same distance as previously [1] [2]

[Total: 25]

13 (a) (i) **Silver** [1] **Brass** [1] **Tin** [1], 3 × 1 marks. [3]

(ii) Component containing a semiconductor could be **transistor/diode/IC**. [1]

(iii) Explanation should mention no moving mechanical parts, ease of assembly as all switches are on one part, tactile action, lower cost than mechanical switches, and no problem with arcing/oxidising of contacts.
Response with two points mentioned 2 marks.
Allow 2 marks for a clear explanation of one point. [2]

(b) (i) NC and NO contacts are joined each junction going to a power rail [1].
Motor contacts are connected to common terminals of each switch [1].
When switch is operated the motor connections to power are reversed [1].
Allow marks for understanding shown. 2 × 1 marks for any two relevant points. [2]

(ii) Advantages of relay circuit could be:
- Connecting through a relay allows driver circuit voltage and motor circuit voltage to be different.
- Motor circuit will run at higher current.
- Driver circuit and motor circuit are isolated so no interference from motor circuit to affect the driver circuit.
- Two switches can be operated electronically by a single switch.

1 mark for valid advantage. [1]

(c) (i) LEDs can differ in size, shape, intensity, angle of light output, frequency of light emitted (IR). Allow any other valid difference, 2 × 1 marks. [2]

(ii) 6V – 1.8 V = **4.2 V** [1] Substitution into formula R = V/I R = **4.2 / .015** [1]
R = **280 Ω** [1] Correct answer with no working [3]. [3]

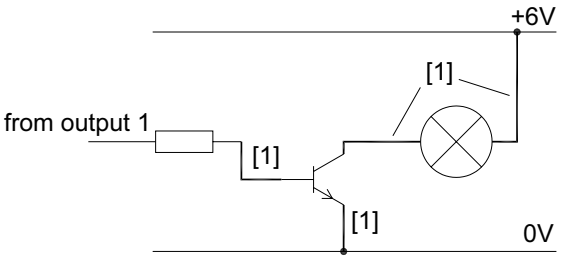
(d) (i) **Resistance** in the strain gauge will change. [1]

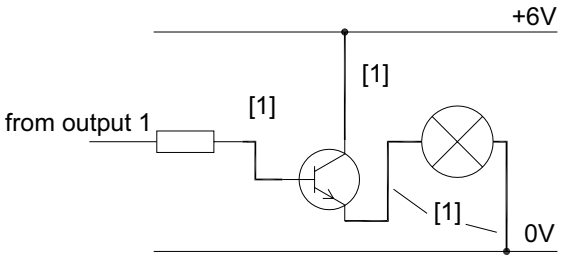
(ii) RA / RC and RB / strain gauge are potential dividers [1]
Voltage across the centre of each will change from 0 V when resistance in the strain gauge changes [1]. Voltmeter will measure change in voltage [1]. [3]

(e) (i) **AND** gates [1], **NOT** gates or **inverters** [1]. [2]

(ii) When switch 1 is pressed a logic 1 signal goes to AND gate **A** the other input is from NOT gate **D** which is a logic 1 signal, this makes the output of gate **A** logic 1 [1]
As soon as gate **A** output has changed NOT gate **C** will send a logic 0 signal to an input of AND gate **B** preventing the gate from giving a logic 1 output [1].
Allow marks for understanding of each stage, 2 × 1 marks. [2]

(iii) Resistor to transistor base [1], emitter to 0 V [1], two lamp connections [1].
3 × 1 marks for correct answer, any incorrect connections maximum of 2 marks. Emitter follower circuit can be used. [3]





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