Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

DESIGN AND TECHNOLOGY **0445/41**

Paper 4 Systems and Control **October/November 2016**

MARK SCHEME

Maximum Mark: 50

Published

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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Section A

1 **(a)** Dial Gauge / dial indicator gauge / clock gauge, 1 mark. **[1]**

(b) Deflection, flexing, allow bending, 1 mark. **[1]**

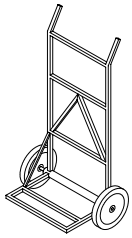
(c) The deflection will be reduced if the beam is turned through 90°, so that the narrow edge is resting on the supports or movement of supports **A** and **B** closer together,

Allow use of additional support.
Method used, 1 mark. How method reduces movement, 1 mark. **[2]**

2 **(a)** The barrow uses a **first order** or **first class** lever, 1 mark. **[1]**

(b) These areas could be reinforced:

- Back
- Base
- Base to back angle



Allow struts, webs, gusset plates.
2 × 1 marks for suitable reinforcement. **[2]**

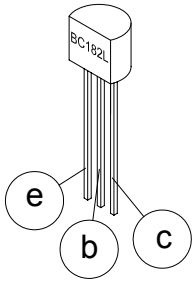
3 **(a)** Silver is the conductor. **[1]**

(b) Responses could include:

- Wood will contain varying amounts of moisture reducing its resistance
- Wood can burn if there is a fault in the circuit.

Allow other valid reasons.
1 mark. **[1]**

4 **(a)** **(i)** 1 correct, 1 mark. 2 or 3 correct 2 marks.



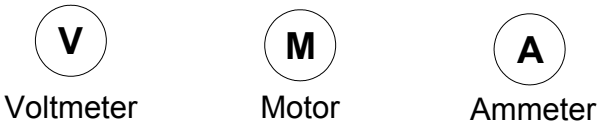
[2]

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

(b) Advantages for larger tracks and pads could be:
- Less chance of breaks in track when etching
- Less chance of drill slipping and breaking through pad
- Larger drill size can be used
- Can carry higher current
- More area to solder.

2 × 1 marks for suitable advantages. Allow other valid responses. **[2]**

5



1 mark for each correct **[3]**

6 Power sources could be:
- Compressed air
- Mains electricity
- Battery, either dry cell, rechargeable or lead acid
- Renewable sources, solar power, wind turbine, windmill, watermill
- Fossil fuels
- Clockwork / spring
- Gravity
- Manual power

3 × 1 marks for valid sources. Allow other valid responses. **[3]**

7 **(a)** **Ratchet** and **Pawl**, 1 mark for each. **[2]**

(b) Ratchet and pawl are used to prevent the drum from unwinding when there is a load on it; they allow only one way movement.
Allow mark for understanding shown. **[1]**

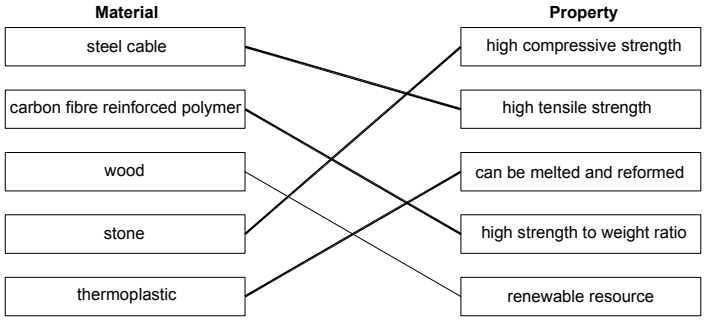
8 **Rotary** to **Linear**, allow ‘circular’ or ‘rotating’ for rotary and ‘straight line’ for linear. **[2]**

[Total: 25]

Section B

Answer **one** question from this section.

9 **(a)** 1 mark for each correct. **[4]**



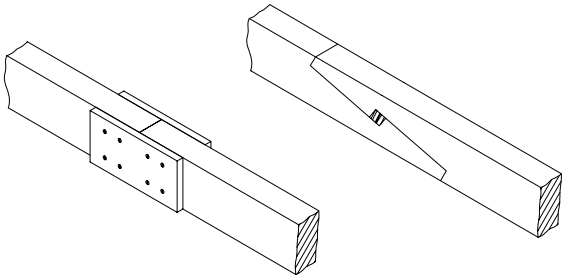
(b) **(i)** The concrete blocks are a counterweight or balancing load, (1), to help maintain equilibrium (1). Allow 'to stop the crane from falling' for 1 mark. **[2]**

(ii) **Triangulation** or the use of braces and struts. **[1]**

(iii) Turning or twisting force. **[1]**

(iv) The forces causing torsion could be from high winds acting on the jib (1) or from the jib accelerating or decelerating during the course of moving a load (1) load swinging (1), 1 mark for each force identified. **[2]**

(c) **(i)** Joint shown end to end, 1 mark
Recognised principle used, e.g. scarf joint, plates either side, 1 mark
Fixings shown, screws, bolts, wedges, 1mark
Extra components / materials listed, 1 mark.



Maximum 2 marks for impractical / non-functional method. **[4]**

(ii) Advantages of a laminated beam could be:

- Defects in timber can be avoided
- Dimensional stability, twisting, bowing does not occur
- Smaller sizes of timber are needed, sustainable timber is used
- Curves can be built into the beam
- Lighter than steel or concrete beams
- High strength / weight ratio, allow stronger than end to end joint.

1 mark for a suitable advantage. Allow other valid responses. **[1]**

(iii) Benefits of method **A** will include:
- Will resist tension on the horizontal arm.
- Vertical load on horizontal arm is transferred efficiently to the vertical piece
- No screws or nails are used.
- Does not rely on the shear strength of screws or nails
- Flush surface.

2 × 1 marks for valid benefits. Allow other valid responses. **[2]**

(iv) Benefits of method **B** will include:
- Temporary joint can be taken apart
- No cutting in vertical piece needed so strength retained
- Faster joint to produce than **A**
- Vertical position can be adjusted before joint is fixed.

2 × 1 marks for valid benefits. Allow other valid responses. **[2]**

(d) (i) **Shear**, 1 mark. **[1]**

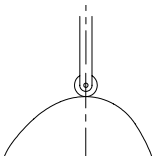
(ii) Factor of safety will take into account:
- Yield strength of the material being used
- The static load on the beam
- Expected dynamic load on the beam
- The total loading expected is then matched proportionally to the yield strength of the beam to give a safe working load. E.g. SWL could be 33% of the yield strength.

2 × 1 marks for understanding shown of above points. **[2]**

(e) Anticlockwise moment = (450 × 1.35) + (800 × 2.25) = 2407.5, 1 mark
Clockwise moment = 1.8 × F = 2407.5, 1 mark
F = 2407.5 / 1.8 = **1337.5N**, 1 mark

3 marks for correct answer with no working. **[3]**

10 (a) (i) Roller shown in correct orientation, 1 mark
Edge of roller touching the cam profile, 1 mark. **[2]**



(ii) Area **C** contains dwell. **[1]**

(iii) The cam has anti clockwise movement so segments will pass the follower in the order **ABCD**, 1 mark for correct order used.
A, the follower will **fall**
B, slight **rise**
C, **dwell**
D the follower will **rise** to its highest position.

2 × 1 marks for any two of **A**,**B** or **D** accurately described.
No mark for **C**. **[3]**

(b) (i) 1 mark for each correctly positioned, effort can be anywhere on the handle. **[3]**

(ii) Description may include:
- Fluid will be pumped from the master(small) cylinder to the slave(large) cylinder
- The jack will extend
- Fluid drawn from reservoir.

2 marks for valid points or for one point well explained. **[2]**

(iii) Description may include:
- Fluid is allowed back from the slave cylinder into the reservoir
- The jack will retract
- Speed of retraction can be cointrolled by the relief valve.

2 marks for valid points or for one point well explained. **[2]**

(iv) Reasons for not using pneumatics are:
- Air will compress further so the load on the jack will be unstable
- A ready source of air is needed so the jack would not be fully portable
- Ongoing cost of compressed air
- Difficult to control speed and precision

2 × 1 marks for valid reasons. **[2]**

(c) (i) Explanation to include: Operation of the spray can will be easier because of:
Leverage from the 1st order hand lever, 1 mark
Advantage gained from the gearing 4:1 reduction, 1 mark

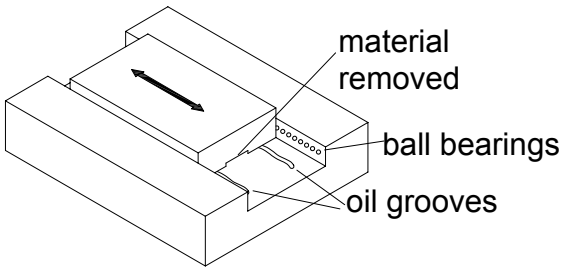
Allow 2 marks for detailed explanation of one point. **[2]**

(ii) Benefits of nylon gears are:
- No lubrication needed / self-lubricating
- Light weight
- Can be injection moulded at low cost
- Corrosion and chemical resistant
- Reduced wear on gears.

2 × 1 marks **[2]**

(d) (i) Friction, 1 mark. **[1]**

(ii) Functional mechanical method, 1 mark
Use of lubrication, oil or grease, 1 mark
Clear sketch illustrating method, 1 mark.



3 × 1 marks **[3]**

(e) Thread pitch is **X**, 1 mark.
Thread diameter is **Z**, 1 mark. **[2]**

[Total: 25]

11 (a) (i) **R1** is the **current limiting** resistor for **TR1**, allow protective resistor, 1 mark **[1]**

(ii) **R2** is a **pull up** resistor to ensure a logic level at output when transistor is not conducting, 1 mark. Allow reference to switching effect of transistor. **[1]**

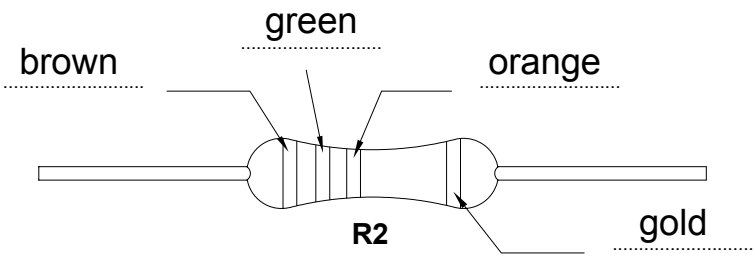
(iii) Advantages of a transistor switch include:
- No moving parts / no user input required
- Much smaller than a mechanical switch
- Fast switching rate
- No contact bounce
- No wear or arcing at contacts
- Low cost when compared to a mechanical switch.

2 × 1 marks for valid advantage. **[2]**

(iv) Disadvantages include:
- Low / restricted current carrying capacity
- Difficulty of replacement if faulty

1 mark for valid disadvantage. **[1]**

1 mark for each colour correct. **[4]**



(b) (i) 1 mark for each correct column, 3 × 1 marks.
Allow error carried forward on Column **X**. **[3]**

A	B	R	C	D	S	X
0	0	0	0	0	0	0
0	1	1	0	1	1	1
1	0	1	1	0	1	1
1	1	1	1	1	1	1

(ii) Dual in line means **two sets**, (1) of pins **parallel to** or **in line** (1) with each other. **[2]**

(iii) Benefits of IC holder will include:

- No chance of heat damage to the IC
- Easy replacement of IC
- Easy removal for recycling.

1 mark for a valid benefit. **[1]**

(c) (i) **SPST**, 1 mark. **[1]**

(ii) **4kΩ** **[1]**

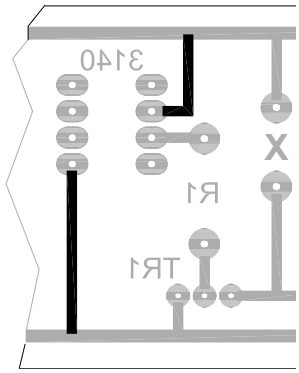
(iii) $6.1 = (R2 / R2 + R1) \times 12$, 1 mark
$6.1 \times R2 + 24.4 = 12 \times R2$
$24.4 = 5.9 \times R2$ 1 mark
$R2 = 24.4 / 5.9 =$ **4.14kΩ** 1 mark

Accept a range **4.13kΩ – 4.15kΩ**.

Correct answer with no working 3 marks. **[3]**

(iv) If the voltage at the non-inverting input is greater than the inverting input 1 mark
the output will be high, 1 mark. **[2]**

(v) Pin 4 to 0V rail, 1 mark.
Pin 7 to +12V rail, 1 mark.



[2]

(vi) **Diode**, 1 mark. Accept D1. **[1]**

[Total: 25]