MARK SCHEME for the October/November 2015 series

0445 DESIGN AND TECHNOLOGY

0445/43	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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Section A

1 **(a)** Reinforcement is added to improve the **tensile** strength of the material and the **resistance to bending**. Allow other valid benefits. [1]

    (b) Plastic based reinforcement will not corrode on exposure to air, unlike steel.
The reinforcement can be added during the mixing of the concrete so saves time. [1]

2 **(a)** The crack is caused by shear force (1).
Allow reference to the weight of the wall or to gravity. [1]

    (b) Reason could be movement in the ground / foundation not strong enough,
earthquake damage. 1 mark for suitable reason. [1]

3 A strut will resist compression (1) and a tie will resist tension (1).
Suitable example / drawing used, 1 mark for each. (2 × 1)
Allow force arrows on diagrams to illustrate the forces resisted. [4]

4 **(a)** **Heat** and **sound** will result from unwanted friction in a mechanism. (2 × 1) [2]

    (b) Examples include:
Tripod / shear legs on the ground, vee belt and pulley, screw threads.
Allow braking devices on vehicles / machines, ratchet and pawl.
(2 × 1) marks for valid examples. [2]

5 **(a)** The mechanism is a **crank**. [1]

    (b) Driver gear is **40 teeth**. Driven gear is **8 teeth**. 1 mark each for correct gears,
1 mark for driver / driven correctly matched to gears. (3 × 1) [3]

6 Symbol A – **LDR** / Light Dependent Resistor (1)
Symbol B – **Thermistor** (1)
Symbol C – **Variable resistor** (1). Accept potentiometer or rheostat. [3]

7 The negative / cathode leg must be identified (1).
The negative leg is normally shorter or has a marking on the casing (1).
The capacitor is inserted into the PCB with negative leg matching negative symbol on the board (1).
(2 × 1) marks. Allow marks for understanding shown. [2]

8 **(a)** **(i)** Calculation to be shown:
Use of voltage drop (1). Correct calculation of power (1).
P = (9 – 2) × 0.05 A = 0.35 W
Allow 1 mark for 0.1 W or 0.45 W [2]

(ii) **0.4 W** (1). Allow error carried forward from (i) if 0.1 W or 0.45 W are used. [1]

(b) A resistor rated at below 0.4 W would:
Overheat and could burn out, damaging the circuit board (1).
Accept any form of destruction of resistor. Allow destruction of LED. [1]

[Total: 25]

Section B

9 (a) (i) Advantages of aluminium over timber could be:
- light weight
- will not rot
- no natural defects / no termite or insect damage
- non-flammable
- rigid
- easier to manufacture
- extruded rungs can have grip on.

(2 × 1) Allow other suitable advantages. [2]

(ii) Force acting at A is **compression** (1), allow bending.
Force acting at B is **tension** (1). [2]

(iii) R2 × 370 = 250 × 750 (1)
R2 = 187500 / 370 = **506.76 N** (1)
R1 = 750 – 506.76 = **243.24 N** (1)
Correct result with no working (3). [3]

(iv) Indication of dial gauge either notes or drawing (1)
Suitable position for gauge (1)
Method of supporting the gauge in position (1)
Allow other valid methods of measurement to be used.
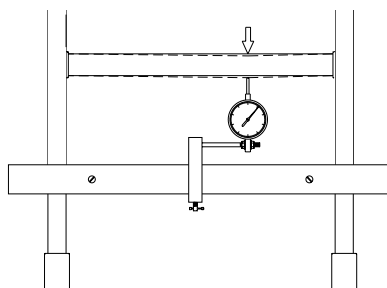
[3]

(v) Explanation could include:
- weight of user
- weight of items being carried
- amount of extension overlap
- weather conditions whilst in use
- slipping on ground

Points should be related to conditions of normal use, extremes of the above points will be built into factor of safety, 2 marks for two points mentioned, 2 marks for one point well explained. [2]

(vi) Safety instructions will be with the ladder when it is new.
Printed instructions / pictograms / SWL warnings should also be attached permanently to the ladder. 1 mark for each point in the description, 2 marks for clear description of one point. [2]

(b) (i) Advantages of mortise and tenon joint:
- mechanical strength
- does not totally rely on adhesive
- load is spread through width of verticals
- can be produced using machinery
- nails / screws can corrode
- will resist shear force better.
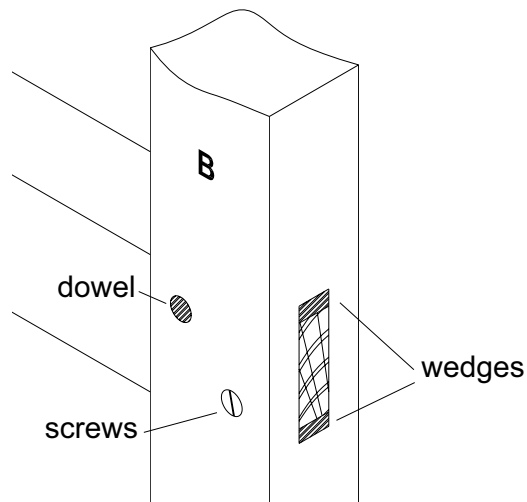
(2 × 1) marks for suitable benefits [2]

(ii) Use of wedges / dowels / screws / nails / gusset plate (1)
Functional position for the above (1)
Clear drawing (1) (3 × 1) [3]

(iii) Temporary method could be screws, nails, G cramp, coach bolt.
Allow other valid methods. (2 × 1) [2]

(c) Explanation could include:
- longer spans are possible
- lighter than steel beams
- complex shapes / compound curves can be created
- fewer vertical supports needed so larger unimpeded floor area
- more aesthetically pleasing than other support methods
- can be any length timber used in construction
- greater torsional strength
- each beam will be of similar strength / fewer natural defects
- greater dimensional stability than solid timber
- not subject to corrosion.

2 marks each for two points well explained, maximum 3 for a list of points with no explanation. No marks for 'cheaper'. [4]

[Total: 25]

10 (a) (i) Drive systems are:
- toothed belt and pulley
- vee belt and pulley
- chain and sprocket. (3 × 1) [3]

(ii) Explanation to include the fact that the vee belt will allow for a certain amount of slipping, the other two methods are very positive and if the mechanism is stopped it will cause damage to either, chain, toothed belt or motor.
2 marks for two points mentioned, 2 marks for one point well explained.
Allow other valid reasons. [2]

(b) Motor shaft to intermediate shaft has a ratio **5:1**, (given).
Intermediate shaft to blade axle has a ratio of 85/34:1 = **2.5:1** (1)
Total reduction = (5 × 2.5) : 1 = **12.5 : 1** (1)
Final speed is 4000/12.5 = **320 rpm** (1)
Allow 3 marks for correct answer with no working. [3]

(c) (i) **First** order lever (1) [1]

**(ii)** 1 mark each for L, F, E correctly positioned.
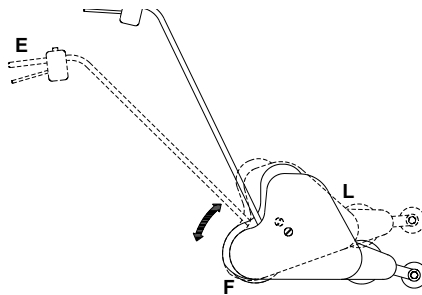
[3]

(d) Conversion of motion is **rotary** to **linear**. (2 × 1) [2]

(e) (i) Beneficial points of a worm gear will include:
- large reduction in speed and increase in torque at the worm wheel
- a worm gear system is compact
- the lift car plus occupants can be very heavy so increased torque is needed
- a worm drive can only operate in one direction so the lift car cannot slip back
- a worm wheel can be effectively lubricated to reduce wear
- will turn drive through 90º.

1 mark for each point in the explanation, (3 × 1).
2 marks for a single point explained in depth. [3]

(ii) Reasons will include:
- to spread the load over more than one cable
- if one cable breaks the others can take the extra strain
- increased surface area of cable in contact with the pulley to prevent slipping.

(2 × 1) marks for suitable reasons. [2]

(iii) Description to include:
- power transferred using a liquid
- liquid used is under pressure
- pressurised liquid is passed through a pipe from one cylinder to another
- cylinders are normally different sizes so that mechanical advantage can be gained.

2 points in the description 1 mark each, or 2 marks for one clearly described point. [2]

(f) Roller visible on cam 1 (1)
Flat area of follower visible, can be offset to one side slightly (1)
Extended edge follower (1), follower or linkage attached (1)

(4 × 1)
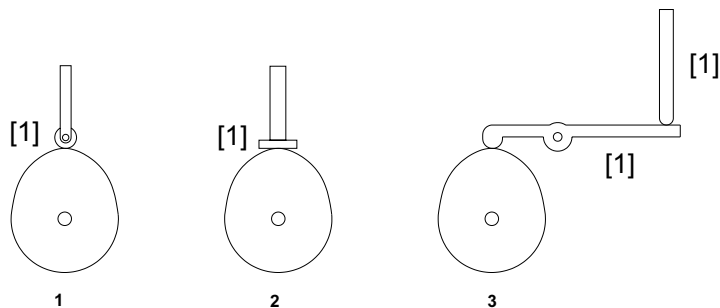
[4]

[Total: 25]

11 (a) A = conductors crossing but not connected (1)
B = junction, two conductors connected (1)
C = Voltmeter (1). Allow multimeter. [3]

(b) (i) Substitution into formula V_{out} = $\dfrac{650\,000 \times 6}{1\,200\,000 + 650\,000}$ (1)
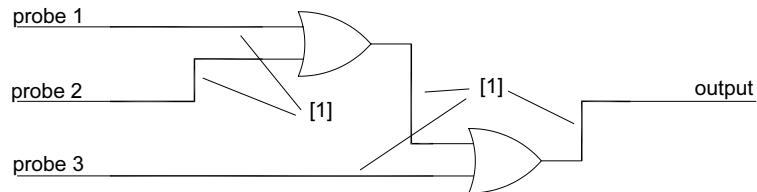
$= \dfrac{65 \times 6}{185}$ (1)

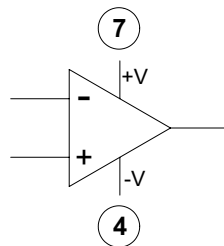= **2.11 V** (1)
3 marks for correct answer with no working. [3]

(ii) Value for variable resistor to allow plus / minus variation on 650 kΩ.
1 MΩ would be suitable. [1]

(iii) Inputs connected to gate 1 (1) all connections to gate 2 and output (1).

[2]

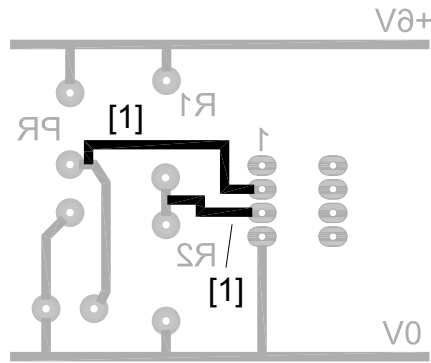**(c) (i)** Power connections 4 & 7 correct.

(2 × 1) [2]

(ii) Inverting input > non-inverting input: output is around 0 V (1)

Non-inverting input > inverting input: output is above 5.0 V (1) [2]
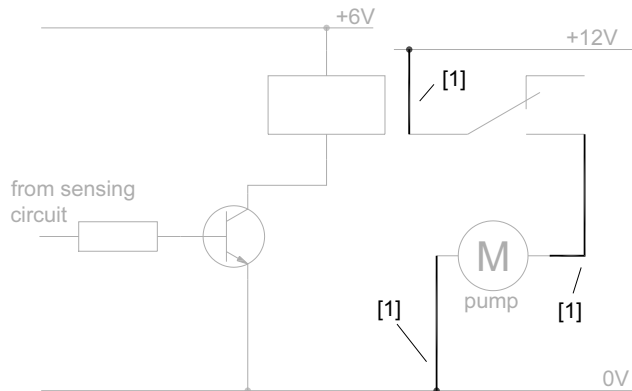
(iii) 1 mark for each correct track.

[2]

(iv) Information is reversed as it is viewed from the top / above the board, when the PCB is produced it will be the correct way around on the copper.
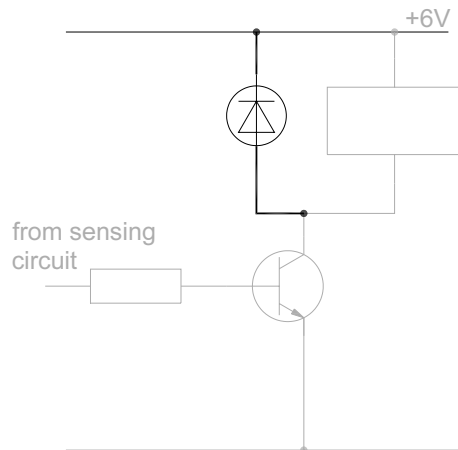Allow mark for understanding shown. [1]

(d) (i) Pump motor connected to NO (1)
Pump motor to 0 V (1)
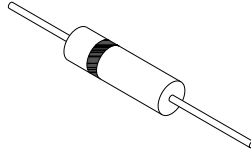12 V connection to C (1)

[3]

(ii) Diode in series with relay coil (1); in reverse bias (1)

[2]

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(iii) Diode shown with a stripe (1)
The negative / cathode end clearly marked (1)

[2]

(e) Benefits of using a PIC for a time delay could include:
- delay can be edited easily
- precise delay
- delay not affected by tolerance of components
- reduced size of PCB layout
- easier to interface with other inputs / outputs.

(2 × 1) marks for valid benefits. [2]

[Total: 25]