**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**Cambridge International General Certificate of Secondary Education**

# MARK SCHEME for the October/November 2014 series

# 0445 DESIGN AND TECHNOLOGY

**0445/43** Paper 43 (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)** Effects of using a pulley are:
- Mechanical advantage if more than one pulley is used in the system
- Allow 'mechanical advantage'
- The load can be lifted using less effort
- A greater length of rope passes through the hands of the user than the distance moved by the load.

2 × 1 marks for any two valid effects [2]

**(b)** **(i)** The mechanical advantage can be determined by:
- counting the lengths of rope that the load is divided between
- counting the number of pulleys
- dividing load by effort.

1 mark for suitable advantage [1]

**(ii)** The mechanical advantage is **6:1** [1]

**2** **(a)** Benefits of pneumatic tools could be:
- Compressed air can be stored easily
- It is safe to use and in use compared to electricity
- Compressed air is easily transported around a factory
- Reduced level of pollution
- It can be used in hazardous environments
- Will provide reciprocating movement easily.

2 × 1 marks for valid benefits [2]

**(b)** Tool could be bench drill, hand drill, lifting / handling equipment, impact wrench, stapler, angle grinder, metal shears

1 mark for a valid choice of tool. [1]

**3** Use of bevel gears, 1 mark
Gears of same size, 1 mark
Gears shown in correct relative positions on the shafts, 1 mark
3 × 1 marks [3]

**4** **(a)** Reason for parallel connection could be:
- LEDs do not all go out if one breaks
- Even spread of light
- Not a high enough voltage for operating in series due to voltage drop across each LED.

1 mark for suitable reason. [1]

**(b)** Cathode can be identified by:
- Flat on the casing
- Shorter cathode
- Use of a multimeter
- Trial and error in a breadboard.

2 × 1 marks for suitable methods [2]

**5** Stage of fitting should include:
- Identification of cathode / anode
- Fitting into board
- Bending legs to avoid any movement
- Heat applied to both pad and track
- Solder fed into joint
- Joint allowed to cool
- Excess leg cut off.

Any four stages described either in notes or sketches, 4 × 1 marks [4]

**6** **(a)** Adding simple or compound bends / curves will strengthen the body panels
Use of stiffened support bars at areas of high stress
Added layers, e.g. glass fibre, carbon fibre
Explanation with 2 points mentioned 2 marks
Allow 2 marks for one point fully explained [2]

**(b)** Crumple zones are there:
- to protect occupants
- to protect expensive parts of the vehicle
- to absorb energy
- to determine what happens to heavier parts such as engine in the event of an accident.

1 mark for a valid reason for using crumple zones [1]

**7** Stress in a material is calculated by force (N) 1 mark
divided by cross sectional area ($m^2$) 1 mark [2]

**8** Adjustment is carried out by:
- Twisting the body of the adjuster to alter height
- Loosening the adjuster to lower the bridge
- Tightening the adjuster to raise the bridge
- One end has left hand thread the other is a conventional right hand thread
- Loosen or tighten locknuts.

Any 3 valid points in description, 3 marks
Allow 2 marks for single point described in detail [3]

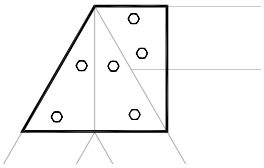
[Section A Total: 25]

## Section B

**9 (a) (i)** A moment is force [1] × distance [1], or a turning force [1], 2 × 1 marks [2]

**(ii)** RZ × 12 = (42 + 72), 1 mark
RZ = 114 / 12, 1 mark
RZ = **9.5kN**, 1 mark
RY = 22 – 9.5 = **12.5kN**, 1 mark. [4]

**(iii)** Suitable shape for gusset plate, 1 mark. All parts of joint covered 1 mark.
At least two fixing points in each timber, 1 mark. 3 × 1 marks. [3]



**(b) (i)** Advantages of concrete:
- Hardens quickly into a range of shapes
- Can be reinforced easily
- High compressive strength
- Building can be constructed faster than using brick
- Not as likely to crack as brick when reinforced
- Bed joints with brick have little tensile strength
- Reduced labour / material costs.

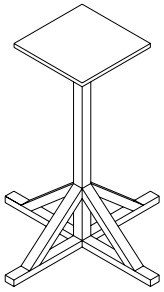
2 × 1 marks for two advantages. [2]

**(ii)** Steel reinforcing rods which are inherently strong in tension are inserted into concrete to provide tensile strength.
Reinforcement can be place under tension before concrete is poured, that is pre-stressed concrete. 2 marks for a clear explanation of reinforcement, 1 mark for use of steel rods but no mention of tensile strength. [2]

**(iii)** Reasons given could include:
- Steel box section is lighter for lifting into position
- Lighter and easier to store
- Reduced weight will reduce transport costs
- Higher tensile strength than concrete, better strength to weight ratio.

Terms such as ‘lighter’ ‘easier to use’ must be justified for a mark.
1 mark for each valid reason given. [2]

**(c) (i)** Stable in two directions, 2 × 1 marks. Functional design, 1 mark.
Details of joints / fixings, 1 mark. [4]



**(ii)** Equilibrium means that forces acting on a structure are balanced; clockwise moments are equal to anti-clockwise moments. 2 × 1 marks for two valid points mentioned. [2]

**(d) (i)** Explanation should include:
- Traditional joints will take longer to cut and increase the price of the furniture
- Composite materials are often used which do not benefit from the use of joints like the dovetail
- Composite boards are more stable so do not need the resistance to bending or warping given by traditional joints
- Plastics sections can be extruded or injection moulded giving consistent quality.

Explanation that includes two points, 2 marks
Allow 2 marks for a single well explained point. [2]

**(ii)** Benefits of manufactured board will include:
- Larger sizes of board available
- Consistent quality
- Decorative finishes can be applied to the complete board
- Generally more stable than wide pieces of hardwood
- Shapes are possible using laminating techniques that would not be possible with a single board.

Any points relating to cost must be justified to gain a mark.
2 × 1 marks for valid benefits [2]

[Total: 25]

**10 (a) (i)** Reasons for using a ratchet and pawl mechanism could include:
- 360° movement not possible due to restricted access
- Hand does not need to be taken off the tool.

1 mark for a suitable reason. [1]

**(ii)** Oscillating movement, [1] is converted to rotary movement, [1]. [2]

**(iii)** Explanation will include:
- Screwdriver will need to be used to remove screw
- Socket wrench will need to unscrew nut or bolt
- On the woodwork brace it is sometimes necessary to unscrew the drill / bit when the full depth has been reached.

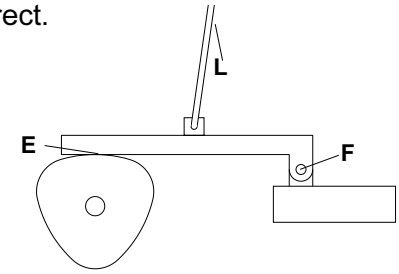
2 points included for 2 marks or 1 point well explained. [2]

**(iv)** The **screwdriver** gives the least mechanical advantage, 1 mark. [1]

**(b) (i)** The follower will rise and fall, 1 mark, three times, 1 mark.
In an oscillating movement, 1 mark.
2 marks for any two correct statements. [2]

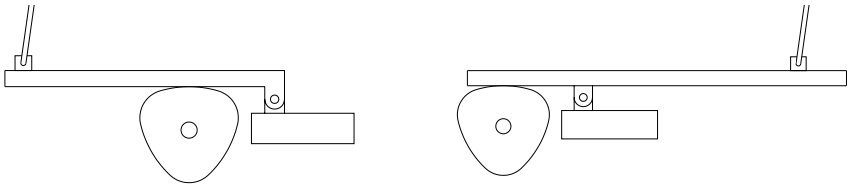
**(ii)** The lever is second order / second class, 1 mark. [1]

**(iii)** 1 mark for each correct.




[3]

**(iv)** Position of follower relative to cam changed, [1]
Length of follower increased, [1]
Lever changed to a third order lever.
Allow first class lever though rise and fall will be reversed, [1]. [3]



**(c) (i)** Belt drawn in top position, largest pulley on motor end, 1 mark. [1]

**(ii)** 1 mark for each correct, 3 × 1 marks. [3]

| | bearing type |
|---|---|
| main shaft | **ball bearings** |
| motor shaft | **bronze plain bearing** |
| pinion shaft | **steel plain bearing** |

**(iii)** Lubrication is necessary to:
- Reduce friction between mating surfaces;
- To provide cooling effect;
- To prolong the life of the bearing
- Prevent corrosion.

2 × 1 marks for valid reasons. [2]

**(iv)** **Nylon** does not need lubrication, 1 mark.
Allow mark for phosphor bronze soaked in oil or vacuum / pressure loaded with oil [1]

**(d)** For prevention of rotation allow either a spline or a keyway, 1 mark
To prevent nut form coming loose allow spring washer, nyloc nut, castle nut and split pin or any other functional method, 1 mark
Allow the use of adhesive on the thread.
Clear communication either in notes or drawing, 1 mark. [3]

[Total: 25]

**11 (a) (i)** The light level of natural light cannot be guaranteed, 1 mark, so a steady light source will increase reliability, 1 mark. [2]

**(ii)** Switching voltage for TR1 will be approximately 0.6V; allow 0.5V – 0.9V [1]

**(iii)** The LDR is exposed to the white LED light source, 1 mark.
The 1MΩ potentiometer will be adjusted so that the transistor / relay is just off, 1 mark.
The switch should then be tested by placing a finger between the LED light source and the LDR, 1 mark. [3]

**(iv)** Casing to hold the LED and LDR in fixed position, 1 mark.
Sufficient room for finger to be placed between the two components, 1 mark
Functional design, 1 mark.
Details of fixing to wall or surface, 1 mark. [4]

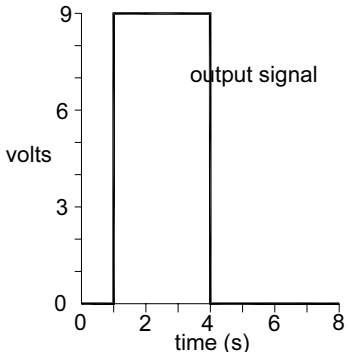
**(b) (i)** The two voltages are isolated by the relay, 1 mark. The relay coil and 9V circuit have no physical connection to the 18V relay contacts circuit, 1 mark. [2]

**(ii)** The solenoid has a reciprocating action, 1 mark. [1]

**(iii)** Use of 38Ω from the multimeter, 1 mark.
I = 18 / 38, 1 mark. I = 0.47A or 474mA, 1 mark. [3]

**(c) (i)** The IC can be orientated by using either the semicircle cut out or the dot, 1 mark.
Pin 1 is the top left hand pin when the IC is held with semicircle or dot to the top, 1 mark. [2]

**(ii)** Amplitude 9V, 1 mark. Switch on at 1s and off at 4s 1 mark. [2]




**(iii)** If the trigger pin remains low the output will re-trigger, 1 mark and will appear to be on permanently, 1 mark. [2]

**(d)** The rotary switch has a number of poles available at terminals on end of switch, 1 mark.
There is one common terminal, 1 mark which is connected to each of the poles in turn, 1 mark. Allow marks for understanding shown. [3]

[Total: 25]