DESIGN AND TECHNOLOGY **0445/41**

Paper 4 Systems and Control **May/June 2019**

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.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Section A

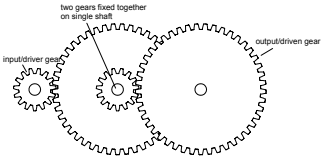| Question	Answer	Marks	Guidance
1	A – Eye protection to be worn B – Danger Electricity C – Emergency stop button 1 mark for each correct.	3	Give marks for understanding shown.

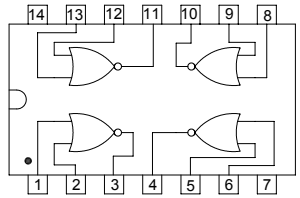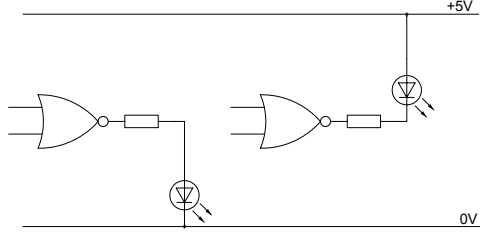| Question	Answer	Marks	Guidance
2	Renewable energy – Solar, wind, wave, tidal, geothermal, hydro-electrical, 1 mark Fossil fuel – Coal, gas, oil, 1 mark.	2	For fossil fuel allow any derivatives e.g. diesel, petrol

Question	Answer	Marks	Guidance
3(a)	Explanation to focus on: • Use of wedges • The widening of the mortise at the back • Dovetail effect when the glue has hardened • Larger surface area for adhesive. Explanation including any two valid points 2 marks.	2	
3(b)	Explanation to focus on: • Larger cross sectional area of tenon • Tenon is in one piece with the rail • Dowels may be a weaker timber than the rail • Larger cross sectional area in joint **A** Explanation including any two valid points 2 marks.	2	

Question	Answer	Marks	Guidance
4(a)	Nut and bolt, self tapping screw, 1 mark.	1	Allow any method that can be taken apart. No mark if temporary and permanent method used.
4(b)	Welding, riveting, brazing, epoxy resin adhesive, 1 mark.	1	Allow any method that does not allow taking apart. No mark if temporary and permanent method used.

Question	Answer	Marks	Guidance
5	The static load is any load on the bridge that will not move, e.g. weight of bridge components, 1 mark.	1	

Question	Answer	Marks	Guidance
6(a)	Bevel gear – Any use that requires drive to turn through 90º, can be used to change output speed. [1] Rack and pinion – steering, pillar drill operation, any use requiring rotary to linear conversion of movement. [1] Worm gear – any use requiring a large reduction in speed, winch, lift / elevator gears, change in direction of motion or increase in torque. [1]	3	Allow any other valid uses for each gear type. Allow clear description of the specific function of the gear.
6(b)	Direction can be reversed by: • Adding an idler gear [1] between the pinion and the rack [1]. • Changing the position of the rack [1] to above the pinion gear [1].	2	

Question	Answer	Marks	Guidance
7	Drawing / notes showing two gears fixed to the same shaft [1] Input and output gears shown [1]. 	2	

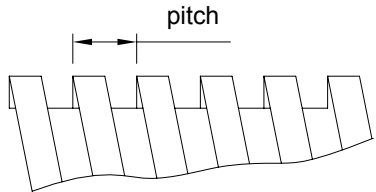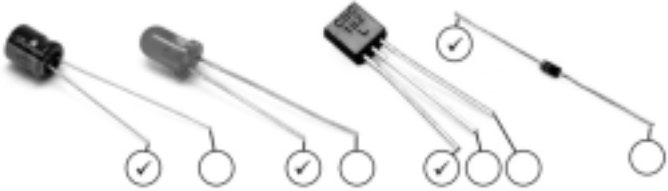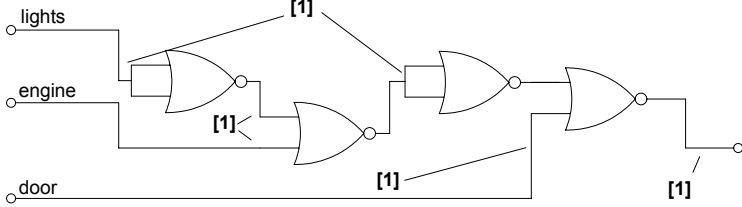| Question	Answer	Marks	Guidance
8(a)		2	Pins 1 – 7 correct, 1 mark Pins 8 – 14 correct, 1 mark
8(b)	**4001B**	1	
8(c)	 Connection to output of NOR gate, 1 mark Resistor used, 1 mark LED orientation correct and connection to either +5 V or 0 3 V, 1 mark	3	Allow either method of connection. Resistor can be either side of LED Accept LED output through a transistor driver.

Section B

Question	Answer	Marks	Guidance
9(a)	Testing should include: Placing on supports 270 mm apart, 1 mark Adding load to bridge, 1 mark Load distributed across span of bridge or point load placed in centre, 1 mark	3	Allow any other valid tests.
9(b)(i)	The bridge is a **mass** structure	1	
9(b)(ii)	Strength is gained from the large amount of material used, the weight of the structure will provide strength, e.g. brick structures, concrete structures, dams	2	1 mark for example 1 mark for understanding of where the strength comes from.
9(b)(iii)	The keystone will lock the two halves of the structure together preventing the arch from collapsing. The keystone is wedge shaped.	1	1 mark for understanding shown.
9(b)(iv)	Advantages of stone will include: • Aesthetic qualities • Strength in tension compared to concrete with no reinforcement • Durable • Weather resistant • 2 × 1 marks for suitable advantages.	2	Allow any other valid advantages.
9(b)(v)	Advantages of concrete will include: • Can be formed into different shapes • Reinforcement can be included • Texture can be cast into the concrete • Easier to transport in the raw material form than stone.	2	Allow any other valid advantages. Accept 'cheaper'.
9(c)(i)	Visible strengthening methods are: • Gusset plates • Triangulated struts • Wire ties. 2 × 1 marks	2	

Question	Answer	Marks	Guidance
9(c)(ii)	Reasons for suitability include: • Light weight • Ease of bending • Will flex to accommodate dynamic loading • Readily available • Durable	2	Explanation with two points, 2 marks Allow 2 marks for clear explanation of a single point.
9(c)(iii)	Factors to be considered include; • Natural defects in the timber, E.g. knots, splits • Insect damage • Moisture content • Strength class of the wood • Rate of growth • Stability	2	Description that includes two valid points, 2 marks. Accept other valid alternatives.
9(d)	$50 \times 1.25 = (10 \times 0.25) + 0.5 \times $ **X** [1] $62.5 - 2.5 = 0.5$**X** [1] **X = 120N** [1]	3	Award 3 marks for correct answer with no working shown.
9(e)(i)	Strain = 1.3 / 10000 [1] Strain = **0.00013** [1]	2	Award 2 marks for correct answer with no working shown.
9(e)(ii)	**Tensile strain**.	1	
9(e)(iii)	The elastic limit is the amount that the cable can be stretched [1] before permanent distortion takes place [1]. i.e. if the load is removed before the elastic limit is reached the cable will return to the original length.	2	Both points to be included for 2 marks.

Question	Answer	Marks	Guidance
10(a)(i)	Lever **A** is **second order** / class 2	1	
10(a)(ii)	Lever B is **third order** / class 3	1	
10(a)(iii)	Pushing forward on lever **A** will rotate / move the bucket [1], in a clockwise direction (oscillation) [1].	2	Allow marks for understanding shown
10(a)(iv)	Bearing used to provide rotation, 1 mark Type of bearing named / defined, 1 mark Functional method used, 1 mark Components / materials named, 1 mark.	4	Allow 1 mark for wheels used on legs for rotation.
10(b)(i)	Conversion of motion is **oscillating** [1] to **linear** [1]	2	
10(b)(ii)	Operating the release valve will allow hydraulic fluid to return to the reservoir [1], causing the jack to lower [1]. The release valve will prevent any backflow / return of fluid to the master cylinder [1]. Valve can control descent speed of the jack [1].	2	Any two points included in description, 2 marks.
10(b)(iii)	MA = distance moved by effort / distance moved by load Distance moved by effort = $2 \times \pi \times 300$, 1 mark =**1884.96** 1 mark 1884.96 / 5, = **376.99**, 1 mark	3	Award marks for correct answer with no working.
10(b)(iv)	The ratchet and pawl will allow less than a complete turn of the bar to be used [1] this is useful in restricted space [1].	2	Both points needed for two marks. Allow prevention of accidental lowering of jack.

Question	Answer	Marks	Guidance
10(b)(v)	Accept any valid use of ratchet and pawl: • Screwdriver • Wrench • Cycle freewheel • Luggage straps • Clock • Hoist 2 × 1 marks	**2**	
10(b)(vi)	The load on the jack will cause friction on the rotating parts [1] The ball bearing grace can withstand a large load [1] The bearing race will help to overcome frictional losses [1] making the jack handle easier to turn [1].	**2**	Two points in explanation, 2 marks Allow 2 marks for full explanation of a single point.
10(c)(i)	 External surface of thread indicated [1] pitch indicated [1].	**2**	
10(c)(ii)	Pitch of thread is **0.5 mm**	**1**	
10(d)	Reasons for using plain bearings include: • Lower cost than ball bearings • Not a large load on the bearing • Limited space • Ease of manufacture and assembly. 1 mark for valid reason given.	**1**	

Question	Answer	Marks	Guidance
11(a)(i)		3	1 mark for each correct.
11(a)(ii)	Component **D** may be placed in reverse bias.	1	
11(b)(i)	**VR1** will allow the voltage at the junction of the potential divider [1] to be set accurately [1] to adjust sensitivity of the circuit [1], any two points for marks.	2	Allow sensitivity / switching point of the circuit can be altered
11(b)(ii)	Resistance at 5°C is **51 kΩ** [1] Range using 15% tolerance is **43.35 kΩ** [1] to **58.65 kΩ** [1]	3	Award 3 marks if range is correct and nominal resistance not given.
11(b)(iii)	The resistance reading would decrease, 1 mark.	1	
11(b)(iv)	Dial showing milliamps, 1 mark Reading would be **0.44** mA, 1 mark	2	
11(c)(i)	Writing is mirrored so that it will appear correct when PCB is manufactured.	1	
11(c)(ii)	A mark could be placed [1] next to pin 1 [1] on the PCB layout	2	Allow other methods of correct orientation
11(c)(iii)		4	
11(d)(i)	**Double** [1] **Pole** [1] Double **Throw** [1]	3	

Question	Answer	Marks	Guidance
11(d)(ii)	Using P = V I P = 12 × 5 [1] **= 60W** [1]	**2**	Allow maximum rating should be lower than this to avoid fuse blowing Range **50–55 W**
11(d)(iii)	Order code is **20–4310**	**1**	