



**Cambridge National**

**Engineering Design**

**R101/01: Engineering principles**

Level 1/2 Cambridge National Certificate/Award

**Mark Scheme for June 2019**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

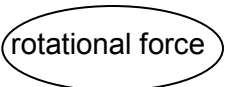
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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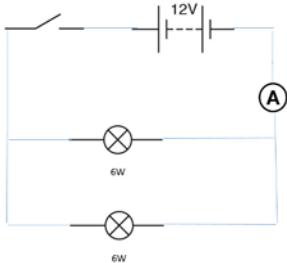
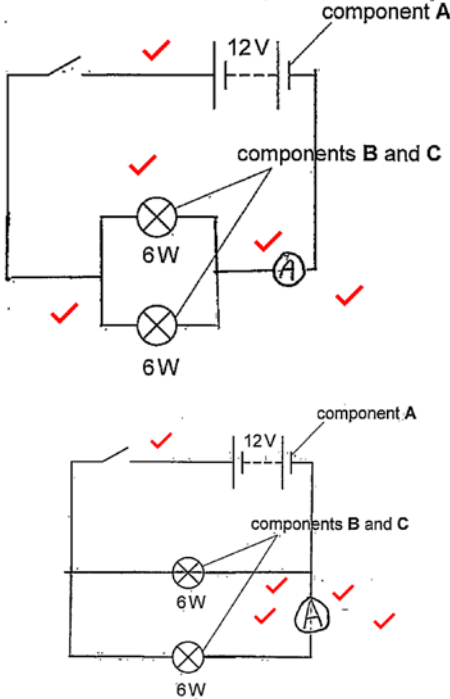
These are the annotations, (including abbreviations), including those used in scoris, which are used when Marking

Annotation	Meaning of annotation
	Blank page
	Vague
	Tick
	Noted but no credit given
	Unclear
	Repeat
	Benefit of doubt
	Cross
	Development
	Example/Reference
	Knowledge
	Level 1
	Level 2
	Level 3

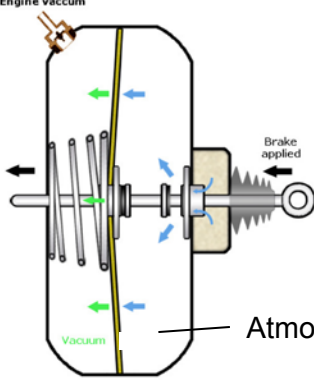
Here is the Mark scheme for this question paper.

Question		Answer/Indicative content	Mark	Guidance
1	(a)	1. Load 2. Effort  (2x1)	2	
	(b)	(i) Up to 2 marks for two features  The length of the torque wrench acts as a lever (1)  The load is at the end of the lever and the effort is applied behind the fulcrum (1)  (2x1)	2	Long handle (1) Could be operated from either side (1) Doesn't need a power supply BOD (1) Mechanical advantage BOD (1) Fulcrum close to load (1)  DO NOT ACCEPT Grip as it isn't seen in image
		(ii)  (1)  (1x1)	1	
	(c)	(i) Bevel gears (1)  (1x1)	1	Do not accept spur gear
		(ii) Allows the output to be at 90° to the input (1) Output will not slip (1) Gears /drive can rotate in both directions (1) Saves space (1)  (2x1)	2	Multiple gears can be connected (1) Compact (1) Changing speed (1) Mechanical Advantage BOD (1)
		(iii) Driven /driver = 68/18 =3.7 (1)	2	Allow 3.78  Correct answer presented as a ratio = 2 marks

			3.7:1 = (1)		
			(2x1)		
			<b>Total</b>	<b>[10]</b>	
<b>2</b>	<b>(a)</b>	<b>(i)</b>	<b>A = 3/2 Valve (1)</b> <b>B = Double acting cylinder (DAC) (1)</b>  (2x1)	<b>2</b>	B = Accept two way cylinder
		<b>(ii)</b>	The operator uses a hand lever to operate the press (1). Operating the hand lever changes the state (1) of the 3/2 valve and allows fluid under pressure to enter the DAC out stroking the piston. (1)  (3x1)	<b>3</b>	Allow similar valid descriptions Lever pulled (1) Fluid to flow into cylinder(1) Back into reservoir (1)
	<b>(b)</b>		Hydraulics can be easily controlled to operate slowly (1) Hydraulics can use and produce larger forces (1)  (1x1)	<b>1</b>	Accept fluid cannot be compressed as BoD Accept "reference to Heavy for hydraulics Accept hydraulics are stronger/powerful BOD (1)
	<b>(c)</b>	<b>(i)</b>	Pascal (1)  (1x1)	<b>1</b>	
		<b>(ii)</b>	Area of piston = $3.14 \times 30 \times 30 = 2826\text{mm}^2$ (1)  Force = $0.5 \times 2826 = 1,413\text{N/mm}^2$ (2)  (1+2)	<b>3</b>	1 mark for 2826, ignore units or rounded up to 2827  Award 3 marks for just correct Force answer i.e. 1,413 N/mm <sup>2</sup> 1 mark for answer correct, 1 mark for units correct
			<b>Total</b>	<b>[10]</b>	
<b>3</b>	<b>(a)</b>	<b>(i)</b>	Cells (1)	<b>1</b>	Accept 'battery'
		<b>(ii)</b>	Lamps (1)	<b>1</b>	Accept "bulbs" accept "lights" (BOD)

	(iii)	 <p>Both lamps connected in parallel (1)          Lamps in parallel connected to switch and cells (1)          Switch and cells connected (1)          Correct ammeter symbol (1)          Correct ammeter placement (in series with parallel lamps) (1)</p> <p style="text-align: right;">(5x1)</p>	5	<p>Also accept the following parallel arrangement:          The answer shown below would be awarded 5 marks:</p> 
(b)	(i)	<p><math>6 / 12 = 0.5 \text{ A}</math> or <math>5\text{mA}</math></p> <p style="text-align: right;">(2x1)</p>	2	<p>Award 1 mark for correct answer with no/incorrect units          Award 2 marks correct answer with correct units.          Award 2 marks for correct answer with correct units</p>
	(ii)	<p>Current draw will be reduced (1)</p> <p style="text-align: right;">(1x1)</p>	1	<p>Lamps brighter (1)</p>
		<p style="text-align: right;"><b>Total</b></p>	[10]	

4	(a)	(i)	Wind up toy (1) trampoline (1) garage door (1), Circlip pliers or similar (1) (1x1)	1	Allow other valid alternatives. Watch, Clock (BoD)
		(ii)	Potential energy (1) (1x1)	1	
	(b)	(i)	Non-return valve (1) (1x1)	1	Accept poppet, or check valve "one way valve" BOD (1)  Do not accept Shuttle valve
		(ii)	The non-return /check valves stops the flow of fluid in one direction (1), and allow free flow in the opposite direction (1) It has a ball held on a seat by a spring (1) / is normally closed at rest (1). The check valve could be used as a pressure relief valve, bypass valve or in hose ends (1) (3x1)	3	Award 2 marks for description of how the valve works. Award 1 mark for a suitable application.  Award 1 mark for reference to allows fluid travel in 1 direction
	(c)	(i)	Because the increase in pressure is the ..... <b>same</b> ..... on both sides, a small forced on the left side produces a much ... <b>greater</b> ...force on the right. (2x1)	2	Accept similar references to greater i.e. larger, bigger, more, increased. Accept 'equal' if used instead of 'same'
		(ii)	Any two correct hydraulic lifting applications e.g.  Fork lift truck (1) Digger/crane boom (1) Platform lift (1) tail lift (1) (2x1)	2	Tractor (1) Car jack (1) but do not allow car lift as repetition from the question content.  Do Not award hydraulic press as is doesn't lift
<b>Total</b>				<b>[10]</b>	

<p>5</p>	<p>(a)</p>	<p>(i)</p>	<p>Atmospheric side labelled on the opposite side to vacuum e.g.</p>  <p>(1x1)</p>	<p>1</p>	<p>Also award the mark if the candidate shows where atmospheric air actually enters the servo casing</p>
		<p>(ii)</p>	<p>When running the engine creates a vacuum on both sides of the servo (1). When the brakes are operated by the driver, atmospheric pressure (air) is allowed in (1). This pushes the diaphragm against the spring and the plunger/rod pushes a piston in a hydraulic cylinder (1)</p> <p>(3x1)</p>	<p>3</p>	<p>Award up to 3 marks for the correct sequence of actions. Award 1 mark for “diaphragm moves” Award 1 mark for pushes the cylinder piston (1) BOD For added pressure (1)</p>
		<p>(iii)</p>	<p>Vacuum cleaner (1) Vacuum lifting (1) Vacuum sealing (1) Moulding – vacuum former (1)</p> <p>(1x1)</p>	<p>1</p>	<p>Accept hoover and other branded vacuum cleaners</p>
	<p>(b)</p>	<p>(i)</p>	<p>In hydraulic systems the used fluid can return to the reservoir (1) In pneumatic systems the air is exhausted to the atmosphere once used and does not return to the reservoir (1)</p> <p>(2x1)</p>	<p>2</p>	<p>Allow hydraulics store fluid / pneumatics store air for BOD 1 mark</p>



	(ii)	A hydraulic leak could cause some loss of power (1) or slower operation (1). Loss of efficiency (1)  (2x1)	2	Brakes won't work, failure, vehicle won't stop (1)
	(c)	Mechanical advantage = load/effort  6/2 = Mechanical advantage of 3  (1x1)	1	Ignore % or units given.
		<b>Total</b>	<b>[10]</b>	

6	(a)	Candidates describe a working method of operation e.g.  The AC power supply is connected to the electric motor (1) The electric motor drives a gearbox (1) with a pulley connected to the mechanical door (1) The door can be lowered or raised by reversing the motor current (1)  (4x1)	4	Award up to 4 marks for working description. Candidates must mention reversing the motor current/direction to get the full 4 marks. (3 marks for good description but for the 4 <sup>th</sup> mark must have reversing for lowering).	
<b>Question</b>		<b>Guidance</b>		<b>Marks</b>	<b>Answer</b>
	(b)*	Award up to 6 marks for a discussion of how the choice of energy forms could be influenced by availability for a large scale manufacturing operation.  <b>Level 3 (5 – 6 Marks)</b> Detailed discussion showing clear understanding of the how the choice of energy forms could be influenced by availability for a large		6	Examples and relevant points could include: <ul style="list-style-type: none"> <li>• Energy sources need to be consistently available for large scale manufacturing. Energy is available in a variety of forms including energy produced mechanically, electrically, using chemicals, or produced by light and heat.</li> <li>• Naturally produced energy such as solar energy produces heat and light which can be used to</li> </ul>

		<p>scale manufacturing operation. Specialist terms will be used appropriately and correctly. The information will be presented in a structured format. The candidate can demonstrate the accurate use of spelling, punctuation and grammar.</p> <p><b>Level 2 (3 – 4 Marks)</b> Adequate discussion showing an understanding of the understanding of the how the choice of energy forms could be influenced by availability for a large scale manufacturing operation. There will be some use of specialist terms, although these may not be used appropriately. The information will be presented for the most part in a structured format. There may be occasional errors in spelling, punctuation and grammar.</p> <p><b>Level 1 (0 – 2 Marks)</b> Basic discussion showing limited understanding of the how the choice of energy forms could be influenced by availability for a large scale manufacturing operation. There will be little or no specialist terms. Answers may well be ambiguous or disorganised. Errors of spelling, punctuation and grammar may be intrusive.</p> <p><b>0</b> = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at the end of the response.</p>		<p>save using other energy sources and therefore money in the cost of manufacturing. Renewable sources are desirable due to the potential impact on the environment of large scale manufacturing.</p> <ul style="list-style-type: none"> <li>• Usually electrical energy is used to power electro-mechanical machinery and or pneumatic systems used in manufacturing.</li> <li>• Mechanical energy can be used to generate electrical energy but this is usually only used for stand by generators.</li> <li>• Chemical energy is usually stored in chemicals as potential energy and released when mixed with other substances or surfaces. Heat energy can be released such as with chemical etching.</li> <li>• Portable energy supplies are not usually used in manufacturing except when using electrically powered tools.</li> <li>• Heat and light energy produced naturally would have limited use as an energy source in large scale manufacturing as these sources are not likely to be available in constant and large supply to support manufacturing especially in hours of darkness. However natural light energy is useful to save the use of electrical lighting.</li> </ul>
		<b>Total</b>	<b>[10]</b>	

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