

Cambridge National

Engineering

R101/01: Principles in Engineering and Engineering Business: Engineering principles, written

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for January 2022

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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.

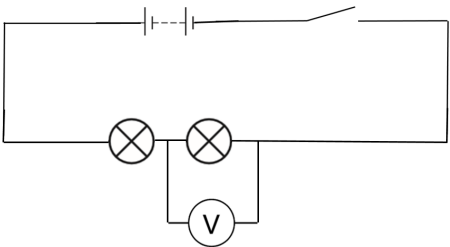
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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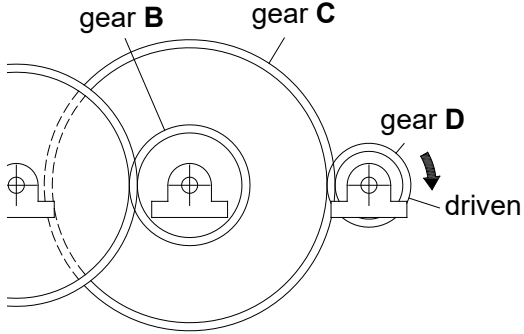
1. Annotations

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
	Error carried forward

2. Subject specific instructions

Question			Answer/Indicative content	Mark	Guidance
1		(i)	 <p>The diagram shows a rectangular circuit loop. At the top, there is a battery symbol (two cells) and an open switch. The bottom wire of the loop contains two lamps, represented by circles with an 'X' inside, connected in series. A voltmeter, represented by a circle with a 'V' inside, is connected in parallel across the second lamp. Its terminals are connected to the junction between the two lamps and the junction after the second lamp.</p>	2	

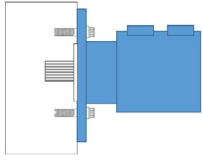


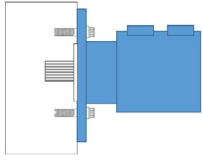


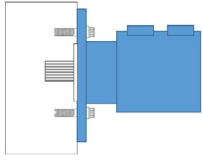


Question			Answer/Indicative content	Mark	Guidance
			Two lamps in series (1). Cells / Battery in correct placement /orientation (1) . (2x1)		
		(ii)	Correct symbol for Voltmeter (1). Correct placement in circuit (across one lamp) (1).	2	
		(iii)	3V (1) or 3 (1) (1x1)	1	
		(iv)	$I = P/V$ $1.2 + 1.2 = 2.4 / 6 = 0.4A$ or 400 mA (2x1)	2	Allow ECF if parallel circuit or incorrect voltage is used in 1(a)(i) or 1(a)(iii) One mark for correct answer. One mark for correct units to match a feasible numerical answer.
		(v)	Lamps would be brighter (1) Higher power consumption (1) Higher current flow in circuit (1) Charge in cells would not last as long (1) (2x1)	2	
		(vi)	If one lamp filament fails, the other will fail to light/ there will be an open circuit. (1)	1	Do not allow 'lights will be dimmer'.
			Total	[10]	
2	(a)	(i)	MIG Welding - Electrical or Heat Using a hand-powered drill – Mechanical Photo-etching delicate components - Light Grinding – Electrical or Heat	4	

Question	Answer/Indicative content	Mark	Guidance
	(4x1)		
	(ii) Solar powered calculator, PV /Photovoltaic panels (solar panels) (1) Laser cutting (1) (1x1)	1	Accept other examples
(b) (i)	 <p>Clockwise arrow drawn on gear D</p>	1	
	(ii) Compound gear train (1) (1x1)	1	Allow 'Compound'
	(iii) $\frac{\text{Driver}}{\text{Driven}} = 280/140$ or $280:140$ (1) = 2:1 (1) (2x1)	2	Allow 1:0.5 or other correct version of ratio Award 2 marks if correct answer only is given as a ratio without workings.
	(iv) To allow the output gear to rotate in the same direction as the input gear. Allows greater reduction as it is a compound gear. (1x1)	1	

Question		Answer/Indicative content	Mark	Guidance
		Total	[10]	
3	(i)	1 mark for each correct labelled part of the relay A – Iron Core (1) B - Contacts (1) (2x1)	2	Allow 'metal rod', 'solenoid' or 'electromagnet' for A
	(ii)	When the switch is closed, the current is passed through the coil (1). The soft iron core and coil create a magnetic field (1) which draws the contacts together (1). The contacts connect the power supply to the load (1) (3x1)	3	Allow similar explanation.
	(iii)	The relay could be used to switch on any high wattage / high current device1. The relay reduces arcing/load on the switch contacts. (1) (2x1)	2	Allow any valid application. e.g. lamp, start car, open door Award 1 mark for the application Award 1 mark for the reason for using a relay.
	(iv)	Normally open contacts close when the relay is energized (1) acting as a switch or latch. Normally closed contacts open when the relay is energised (1) which can be used to isolate parts of the circuit (1). (3x1)	3	Allow similar answers For NC contacts allow 'current passed to load when no current in coil.'
		Total	[10]	
4	(i)	The available operating pressure will be reduced (1) The actuator may operate slowly or fail to operate fully (1) (1x1)	1	
	(ii)	Pressure gauge (1) (1x1)	1	Do not allow 'pressure regulator' or 'pressure valve'
	(iii)	Two valid points made to describe why the pressure gauge is used. E.g. The pressure of the air to the clamp can be monitored.(1)	2	"To assure the correct pressure placed on what the clamp is required to hold" One mark for monitoring pressure.

Question	Answer/Indicative content	Mark	Guidance
	<p>A regulator is used to reduce the supply pressure from the receiver (1) to the clamp. The pressure is reduced to avoid damaging the work piece when it is clamped (1) only light pressure is used to clamp the work piece/ so too much pressure is not used (1) (2x1)</p>		<p>One mark is for why the pressure needs to be monitored.</p>
(iv)	<p>Double acting cylinder / actuator (1) (1x1)</p>	1	<p>Allow 'Double acting cylinder' or 'DAC' Accept 'two way cylinder'</p>
(v)	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> <p>Sequence</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> </div> <div style="width: 85%;"> <p>Stage</p> <p>Cylinder E outstrokes, operating clamp to hold workpiece</p> <p>Operator presses button on valve F</p> <p>Operator presses button on valve B to operate press</p> <p>Valve F changes state, outstroking the clamp cylinder E</p> <p>Cylinder C is supplied with air through port X</p> <p>Cylinder E exhausts through port Y</p> </div> </div> <p>1 mark for each correct stage in the correct order of sequence.</p> <p>(4x1)</p>	4	<p>1 stage correct, 1 mark 2 stages correct, 2 marks 3 stages correct, 3 marks 4 or 5 stages correct, 4 marks</p> <p>Maximum of 4 ticks</p>
(vi)	<p>A device that uses an electrical input/current to control a pneumatic action/output (1)</p>	1	<p>Accept an appropriate example if given.</p>

Question			Answer/Indicative content	Mark	Guidance
			(1x1)		
			Total	[10]	
5	(a)	(i)	<p>An appropriate description with one mark for each of the 3 terms correctly used and additional marks for other appropriate components or operating description. e.g.;</p> <p>The conveyor is electrically driven by a motor through a gear mechanism (1).</p> <p>As a box moves along the conveyor, the box triggers the roller tip 3/2 valve (1) which stops the current to the motor control if the flipper is not clear. (1)</p> <p>The flipper must be flat aligned to the conveyor (1) for the conveyor motor to operate beyond the roller tip (1).</p> <p>After the box passes the roller tip and is on the flipper, an air signal is sent to the single acting cylinder to flip the box (1).</p> <p>The single acting cylinder returns to the conveyor for the next box (1)</p> <p>(5x1)</p>	5	Accept feasible descriptions of a system.
		(ii)	<p>Push button (1)</p> <p>Lever operation (1)</p> <p>Solenoid operated valve (1)</p> <p>(1x1)</p>	1	Allow other valid type of actuation of the valve
	(b)		<p>Award mark for each term used in the correct position within the statements.</p> <p>Compressible gases are used in pneumatic systems, unlike in hydraulics which uses virtually uncompressible</p>	4	

Question			Answer/Indicative content	Mark	Guidance			
			<p>liquids. Both systems are used to either create or reduce pressure using a cylinder to create a useful force.</p> <p>(4x1)</p>					
			Total	[10]				
6	(a)	(i)	<p>Award a mark for an appropriate example e.g. Hydraulic lift pump / tailgate pump, power take off. (1)</p> <p>(1x1)</p>	1	<p>Must be a specific use / hydraulic application.</p> <p>Do not accept generic terms such as 'digger', a specified part of a digger is acceptable. E.g. digger arm</p> <p>Do not accept 'hydraulics pump' as this is a repeat of the question.</p>			
		(ii)	<p>Award marks for appropriate securing of the pump and connection. e.g.;</p> <p>Securing the pump: The pump could be bolted on to a flange (1) Screws - BOD (1)</p> <p>Securing the hoses / connection method The hydraulic hoses would be bolted on mounted connectors for the input and output. (1)</p> <p>(2x1)</p>	2	<p>Candidates may describe a similar mounting method as shown below e.g.</p> <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%;"></td> <td style="width: 33%;"> Hose mounted on flange bolted to pump</td> <td style="width: 33%;"> Flange plate used to bolt pump onto the gearbox</td> </tr> </table> <p>Do not allow 'pulley' Allow 'the shaft can be connected to a gear or drive shaft'.</p>		 Hose mounted on flange bolted to pump	 Flange plate used to bolt pump onto the gearbox
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Question			Answer/Indicative content	Mark	Guidance
		(iii)	Award a mark for an appropriate method of driving the pump, e.g. Drive shaft (1) Pulley drive onto pump splines (1) drive onto pump spline (1) (1x1)	1	Do not allow 'motor' Allow 'gears ' or other mechanical connection

Question	Guidance	Marks	Answer
(b)*	<p>Award up to 6 marks for a discussion of the use of light as an energy source to provide a useful source of power.</p> <p>Level 3 (5 – 6 Marks) Detailed discussion showing clear understanding of the use of light as an energy source to provide a useful source of power. Understanding of the how light is used in everyday life and engineering with an appropriate examples.</p> <p>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>Level 2 (3 – 4 Marks) Adequate discussion showing an understanding of the use of light as an energy source to provide a useful source of power. The response may give an appropriate example application.</p> <p>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>Level 1 (0 – 2 Marks) Basic discussion showing limited understanding of the use of light as an energy source to provide a useful source of power.</p>	6	<p>Examples and relevant points could include:</p> <ul style="list-style-type: none"> • Light energy takes many forms and can come from a variety of sources such as from hot objects such as the sun, lamps and lasers. • Light energy from the sun is a renewable source which is used to generate electricity through photovoltaic (PV) (solar) panels commonly used for supplementing mains electricity, and portable power sources and other heat sources. • Typical applications of light energy from the sun include calculator and instruments, portable chargers, street signage, supplementary electricity supplies to residential and commercial property as natural light energy systems. • One advantage of using the sun as an energy source is that the energy is renewable. • One disadvantage of using the sun as a light energy source is that this source is only available in daylight and the amount of energy that can be sourced during daylight can vary due to weather conditions in. Another disadvantage of using light energy from the sun is that it is not easily stored and therefore is generally a temporary energy source. • Light energy is used in lamps and lasers must first be generated before it is available.

		<p>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>0 = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at the end of the response.</p>		<p>Light energy is not only used for providing working light but is also used in manufacturing processes such as developing, photo etching and printing. Light from lasers is used for scanning/reading imbedded data, marking, cutting, drilling and shaping, joining welding.</p> <ul style="list-style-type: none"> Lasers are used extensively in quality control and packaging, warehousing. Lasers are extremely versatile, accurate and operate at high speeds which make their use essential in some engineering manufacturing sectors. Light energy also produces useful thermal energy and can produce chemical energy which are both used as the main product of light energy in some sectors such as agriculture and pharmaceuticals. In summary, light energy is an essential form of energy used in everyday life and manufacturing.
		Total	[10]	

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