



## **Cambridge National**

### **Engineering**

Unit **R101**: Engineering Principles

Level 1/2 Cambridge National Award/Certificate in Principles in Engineering and Engineering Business

### **Mark Scheme for June 2015**

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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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Question		Answer/Indicative content	Mark	Guidance
1	(a) i	<p>Up to two marks for a clear description.</p> <p>Description to include;            It will lift the load more easily (1) than a single pulley (1)            The pulley system will halve the effort (1) and require twice the length of pull (1).            The pulley is used to reverse the direction of the 'pull' (1).            One pulley is used to allow a downward pull and the other pulley to half the effort. (1) (2x1)</p>	2	<p>Do NOT accept 'not as heavy,' 'makes the load lighter' unless qualified with 'for the effort applied by the person.'</p> <p>Accept responses that refer to 'pulling the rope further,' 'easier to lift.'</p> <p>Answers should relate to the system in fig1. Do NOT accept generic responses related to multiple pulley systems e.g. 'the more pulleys you use the less effort is required.'</p>
	ii	<p>Up to two marks for a clear explanation.</p> <p>A ratio (1) of input to output (1)</p> <p>It is the measure of effectiveness with which a mechanical system performs. (1) Usually a ratio of power delivered by a mechanical system (1), to the power supplied to it. (1)</p> <p>The effectiveness/efficiency of a mechanical system/machine (1)</p> <p>The amount of effort you have to put in compared to the power delivered (1)</p> <p>The effort/power being put in to the effort/power coming out (1)</p> <p>A measure of effectiveness of a machine (1)</p> <p>(2x1)</p>	2	<p>Do not accept a repeat of the question.</p> <p>Do not accept 'make the job easier,' 'how much easier it is to do the task,' 'how much easier it is.'</p> <p>Do NOT accept responses related to mechanical advantage; 'reduction of effort.'</p>

Question		Answer/Indicative content	Mark	Guidance												
	iii	Watt or W (1x1)	1	Accept multiples i.e. kW												
(b)	i	$WkE = \frac{1}{2} mv^2$ $\frac{1}{2} \times 1000 \times 5^2$ $500 \times 25 = 12,500J$ or (12.5kJ)	3	<p>Award (1) mark for working out (<math>\frac{1}{2} \times 1000 \times 5^2</math>) or (500 x25).</p> <p>Award (2) marks for correct answer with no units with or without working out (12,500) or (12.5).</p> <p>Award (3) marks for correct answer with no working. Must have units. (12,500J) or (12.5kJ).</p>												
	ii	<table border="1"> <thead> <tr> <th>Form of Energy</th> <th>Definition</th> <th>Example</th> </tr> </thead> <tbody> <tr> <td>Mechanical</td> <td>Energy associated with motion and position of an object.</td> <td>Flywheel</td> </tr> <tr> <td>Potential</td> <td>Energy is stored (because of an objects position – under tension / pressure)</td> <td>Compressed/extended spring . Elastic band. Bungee rope. Archery bow.</td> </tr> <tr> <td>Heat</td> <td>Transfer of energy from hot to cold / one body to another / across particles / at different temperatures</td> <td>Heating, forming of metals, fire, oven, radiator</td> </tr> </tbody> </table>	Form of Energy	Definition	Example	Mechanical	Energy associated with motion and position of an object.	Flywheel	Potential	Energy is stored (because of an objects position – under tension / pressure)	Compressed/extended spring . Elastic band. Bungee rope. Archery bow.	Heat	Transfer of energy from hot to cold / one body to another / across particles / at different temperatures	Heating, forming of metals, fire, oven, radiator	4	<p>Accept other suitable answers for Potential and Heat energy. BOD for energy is stored/stored energy BoD for 'spring'</p> <p>Do NOT accept answers similar to those below; Potential:</p> <ul style="list-style-type: none"> <li>• 'Holding an object in the air.' Must be related to holding and object under 'compression' or 'tension'</li> <li>• 'Bouncy ball.'</li> <li>• 'The amount of energy that could be produced,'</li> <li>• 'Energy which has the potential to do something.'</li> </ul> <p>Heat: Answers must refer to the transfer of energy across bodies / particles / objects that are at different temperatures</p> <ul style="list-style-type: none"> <li>• 'Warm other things up.'</li> <li>• 'Thermal energy given off by something'</li> </ul> <p>Do NOT accept microwave</p>
Form of Energy	Definition	Example														
Mechanical	Energy associated with motion and position of an object.	Flywheel														
Potential	Energy is stored (because of an objects position – under tension / pressure)	Compressed/extended spring . Elastic band. Bungee rope. Archery bow.														
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Question			Answer/Indicative content	Mark	Guidance
			<p>Energy transferred by particles 'bouncing / bumping' into one another across bodies of different temperatures.</p>		
			(4x1)		
		iii	<p>Up to 4 marks for clear description.</p> <p>Mechanical energy from the engine is used to drive the alternator, charging the battery providing current. The <b>chemical (1)</b> energy produced by the battery creates <b>electrical (1)</b> energy in the form of current which powers the horn, producing <b>sound (1)</b> energy and powers the headlights producing <b>light (1)</b> energy.</p> <p style="text-align: right;">(4x1)</p>	<b>4</b>	<p>Completed statements in the correct order/place within the statements; 4 marks</p> <p>Chemical Electrical Sound – Accept BOD 'Noise' Light</p>

Question			Answer/Indicative content	Mark	Guidance
2	(a)	i	Compound (1x1)	1	
		ii	Up to 2 marks for clear description. <ul style="list-style-type: none"> <li>• Takes up less space/ compact (1)</li> <li>• Fast input and slow output [or visa-versa] (1)</li> <li>• Reduced input effort gives increased output (1)</li> <li>• Large speed changes (reduction) [or visa-versa] can be achieved in a compact space, high speed low torque input shaft to produce low speed high torque output [or visa-versa] (2)</li> </ul> (2x1)	2	1 mark for identifying each correct advantage  Award BOD for: 'Can have less energy in and more comes out.' (1) 'Makes the gear go slower' (1)  Responses related to 'speed' must include reference to 'increased' or 'decreased' based on input / output.
		iii	Lathe, vehicle gearbox, clock, friction toy cars, wind-up torch (1x1)	1	Accept other suitable answers  Do not accept vague responses; car, tram, bike, engine.
	(b)	i	(Distance moved by the) Driven pulley/ (Distance moved by the) Driver pulley. (1) (1x1)	1	Accept Driven/Driver. Accept correct formula e.g. 240/120 Award BOD for 'A / B' if diagram in Fig.1 labelled.
		ii	= 240/120 (1)    2 or 2 : 1 (1) (2x1)	2	Error carried forward to allow award of (1) mark for the correct solution of formula (120/240). Second mark not awarded for incorrect solution.  Award (1) mark for showing correct working out.  Award (2) marks for the correct answer (2 or 2:1)  Do NOT award for a repetition of (b)i: 'Driven pulley/Driver pulley.'

Question		Answer/Indicative content	Mark	Guidance
	iii	<p>Velocity /Speed of rotation of driven pulley wheel = rev/min of driven/2 = <math>200/2 = 100</math> rev/m at driven pulley wheel</p> <p><math>200/2 = 100</math> rev/m (1x1)</p>	1	Accept '100' without 'rpm'
3	(a)	<p>Up to 3 marks for clear description.</p> <ul style="list-style-type: none"> <li>• A generator is driven mechanically (1)</li> <li>• Driven by an external source (1)</li> <li>• Kinetic energy into electricity / electrical energy</li> <li>• Generates electricity (1)</li> <li>• Copper / wire coil (1) rotating in a magnetic field / magnet(s) (1)</li> <li>• electrical current is produced in the armature windings/coil is rotated in the field (1)</li> <li>• the armature is passed through the magnetic field of the field coils. (1)</li> <li>• Produces as current by spinning a coil of wire inside a magnetic field (2)</li> <li>• Current is induced into the armature by the magnetic field.(2)</li> <li>• Magnet and coil / wire (1)</li> </ul> <p>(3x1)</p>	3	<p>Allow 2 marks for; Generator converts mechanical energy to electrical energy charging the battery.</p> <p>Award one mark for reference to 'magnet and coil / wire.'</p> <p>Higher marks only achieved by including 'rotation / rotation spin through magnets / magnetic field.'</p>
	(b)	<p>Potential difference is voltage (1) across points in a circuit (1) or across a component (1)</p> <p>(2x1)</p>	2	<p>Do NOT award mark for 'voltage' if response contains 'difference in voltage,' 'drop in voltage.'</p> <p>Accept BOD for 'in a circuit.'</p>

Question		Answer/Indicative content	Mark	Guidance	
	(c)	<ul style="list-style-type: none"> <li>• Correct sine wave (1)</li> <li>• Correct position on axis (1)</li> <li>• Indication that wave is repeated more than once (1)</li> </ul> (3x1)	3		
4	(a)	i	0.1A (1) or 100mA (1) (1x1)	1	Only award mark with the appropriate units: A or mA
		ii	Correct symbol for a voltmeter (1) Voltmeter in correct position across the component R2 (1)  (1x1)	2	Award 1 mark a physical drawing of a multimeter shown measuring Volts across the correct resistor.
		iii	$P = VI$  $2/12 = 1/6 = 0.16A$ or 160mA	2	2 marks for correct answer with no workings. Units must be present.  1 mark for correct rearrangement of formula and substitution of values i.e. $2/12 = 1\text{mark}$  Allow 167mA, 0.167A, 0.17A
5	(a)	1 mark for up to 3 correct points  Compressor to produce the air (1) Pressure gauge (1) Pressure release valve / regulator (1) Receiver / tank / reservoir to store the air (1) Air lines / pipes to move / deliver the air (1) Filter to clean the air (1)  (3x1)	3	Do NOT accept reference to 'pump,' 'air pump,' 'piston pump' or similar.  Do NOT accept 'cylinder' as air storage vessel	



Question		Answer/Indicative content	Mark	Guidance
	(b) i	Double acting cylinder. Linear actuator Dual-port / acting actuator  (1x1)	1	Accept DAC.
	ii	By hand / manually (1) By pressing buttons on the valves (1)  (1x1)	1	Award BOD for 'switch'
	iii	When the valve A button is pressed (1) signal air is supplied to the 5/2 valve (1) and air supply is provided to the double - acting cylinder which outstrokes and lifts the barrier.(1) The barrier will stay up until valve B button is pressed, signal air changes the state of the 5/2 valve (1) to allow the cylinder piston to in stroke and to lower the barrier(1)  <b>Button / valve A is pressed (1)</b> <b>5/2 valve operates (1)</b> <b>Air supply to cylinder / DAC barrier operates (1)</b> <b>Button / valve B is pressed, 5/2 valve state changes (1)</b> <b>In stroke the cylinder, barrier closes (1)</b>  (5 x 1)	5	Do NOT accept 'valves A and B being pressed at the same time.'  Do NOT accept 'barrier opens /closes' without reference to operation of cylinder.  Accept button A or B is pressed to raise or lower the barrier.

Question		Answer/Indicative content	Mark	Guidance
6	(a)	<p>Award up to 3 marks for detailed description.</p> <p>Pneumatic systems use <b>compressed</b> air (1) Pneumatic systems that allow the compressed air to escape once used to actuate a tool/cylinder etc (1). Hydraulic systems use fluid that is <b>not compressed</b> (1) but is moved under pressure in sealed systems (1)</p> <p>Pneumatics uses <b>compressed</b> air (1) Compressed air is allowed to escape once used to actuate a tool/cylinder etc (1). Hydraulic systems use fluid liquid that is <b>not compressed</b> (1) Fluid in hydraulic systems is moved under pressure (1) Hydraulic systems are sealed (1)Pneumatic systems can operate / react at high speed (1) Hydraulic systems can be used for heavy load applications (1)</p> <p>(3x1)</p>	3	<p>Do NOT accept pneumatics uses 'air' unless qualified with 'compressed'</p> <p>Do NOT accept hydraulics uses 'fluid' unless qualified with 'under pressure.'</p>
6	(b)	<p>Hydraulic fluid is pumped under pressure (1) and controlled through valves to either force out (extend) the ram (1) or reduce pressure allowing the ram (cylinder) to return (1) The bucket is controlled by a number of rams/cylinders. (1)</p> <p>(4x 1)</p>	4	

Question	Answer	Marks	Guidance
6* (c)	<p>Award up to six Marks for a discussion or detailed explanation of the advantages of using pneumatics with some comparison to hydraulics relative to food manufacturing to meet the needs of industry.</p> <p><b>Level 3 (5 – 6 Marks)</b> Detailed discussion showing clear understanding of the advantages of using pneumatics rather than hydraulics. 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 advantages of using pneumatics rather than hydraulics. 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 advantages of using pneumatics rather than hydraulics. 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>	<b>[6]</b>	<p>Pneumatics are widely used in the food processing industry for mass production of food products including packaging.</p> <p>Pneumatics can be used with precision and at high speed to rapidly actuate processors, move and seal products.</p> <p>Hydraulics however operate a comparatively slower speeds.</p> <p>Pneumatics more suitable for light loads and fast operation.</p> <p>Pneumatic systems are less likely to contaminate food products as there are no spillages or hazardous leaks.</p> <p>A compressor located remotely and be used to supply compressed air for the pneumatics across a large facility. There are no fluids to dispose of and compressed air is economically produced.</p> <p>Pneumatics perform well in production due to the low cost and high reliability.</p>
	<b>Total</b>	<b>60</b>	

**OCR (Oxford Cambridge and RSA Examinations)**  
1 Hills Road  
Cambridge  
CB1 2EU

**OCR Customer Contact Centre**

**Education and Learning**

Telephone: 01223 553998

Facsimile: 01223 552627

Email: [general.qualifications@ocr.org.uk](mailto:general.qualifications@ocr.org.uk)

[www.ocr.org.uk](http://www.ocr.org.uk)

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