

## **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 2017**

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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.

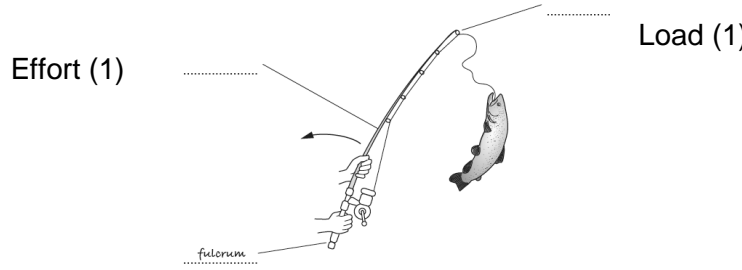
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These are the annotations, (including abbreviations), including those used in scoris, which are used when Marking

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

Question		Answer/Indicative content	Mark	Guidance												
1	(a) (i)	<p>One mark for each correct line drawn:</p> <table border="1"> <thead> <tr> <th>Energy form</th> <th>Example</th> </tr> </thead> <tbody> <tr> <td>Mechanical</td> <td>Solar panel</td> </tr> <tr> <td>Heat</td> <td>Radiator</td> </tr> <tr> <td>Sound</td> <td>Battery cell</td> </tr> <tr> <td>Light</td> <td>Turning gears</td> </tr> <tr> <td>Chemical</td> <td>Vibrating drum</td> </tr> </tbody> </table> <p>(4 x 1)</p>	Energy form	Example	Mechanical	Solar panel	Heat	Radiator	Sound	Battery cell	Light	Turning gears	Chemical	Vibrating drum	[4]	Do <b>not</b> award line drawn from 'Light' to 'Solar panel' as that is given in the question.
Energy form	Example															
Mechanical	Solar panel															
Heat	Radiator															
Sound	Battery cell															
Light	Turning gears															
Chemical	Vibrating drum															
	(ii)	<p>One mark from e.g.:</p> <ul style="list-style-type: none"> <li>• Gearbox (1)</li> <li>• Bicycle (1)</li> <li>• Clock (1)</li> <li>• Wind-up toy (1)</li> <li>• Lathe (1)</li> </ul> <p>(1 x 1)</p>	[1]	Accept any appropriate examples.												
	(iii)	<p>Up to <b>two</b> marks for a description of an appropriate example e.g.:</p> <ul style="list-style-type: none"> <li>• An electric motor (1) is used through a gearbox to turn a chuck (1)</li> <li>• Electrical energy power the lathe (1) to be able to turn the material (1)</li> <li>• A current passed through the coil of a relay (1) closes switch contacts. (1)</li> </ul> <p>(1 x 2)</p>	[2]	Accept appropriate application examples e.g.;												

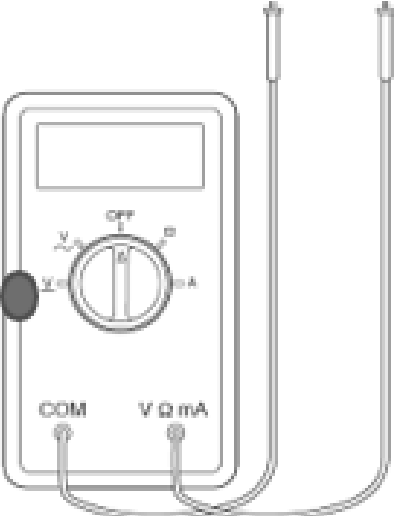
	<b>(b)</b>	<b>(i)</b>	<p>Up to two marks for a description e.g.:</p> <p>Mechanical / kinetic power (1) from turning handle will generate electricity (1)</p> <p>Mechanical power (1) used to turn a handle creates an electric current (1) to light the torch.</p> <p>Kinetic energy (1) of winding the torch creates electrical energy (1).</p> <p style="text-align: right;">( 1 x 2)</p>	<b>[2]</b>	Accept appropriate variations.
		<b>(ii)</b>	<p>One mark from e.g.;</p> <ul style="list-style-type: none"> <li>• A compressed spring (1)</li> <li>• A stretched elastic band (1)</li> <li>• Pendulum about to be released (1)</li> <li>• A rollercoaster at its highest point. (1)</li> </ul> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	Accept other appropriate examples. Award a mark for a good example.
			<b>Total</b>	<b>[10]</b>	
<b>2</b>	<b>(a)</b>	<b>(i)</b>	<p>Correctly labelled:</p>  <p style="text-align: right;">(2x1)</p>	<b>[2]</b>	

		(ii)	Class 3 lever (1) (1x1)	[1]	
		(iii)	Up to three marks for an explanation e.g.: The fishing rod is a class 3 lever/which uses the effort before or in front of the load/with the fulcrum acting as a lever (1). The scissors are a pair of class 1 levers (1) with the pivot in between the load and the effort/force (1) Scissors have two levers (1) (3x1)	[3]	
2	(b)	(i)	One mark for each way stated up to a maximum of two marks. • The input uses AC/high voltage (1) • The output is DC/low voltage (1) • A transformer steps down the input (1) (2x1)	[2]	
		(ii)	One mark for each benefit given up to a maximum of two marks: • Portable (1) • Low voltage making them safe (1) • Do not need to keep replacing batteries (1) (2x1)	[2]	No marks for 'they are rechargeable' as this is given in the question.
			<b>Total</b>	<b>[10]</b>	
3	(a)	(i)	Velocity ratio = driver /driven (1) $180/90 = 2:1$ or 2 (2) (2x1)	[2]	1 mark if correct formula seen but incorrect final answer given  Award 2 marks if correct answer seen.
		(ii)	2000* (1) (1x1)	[1]	Allow 500 for ECF Allow ecf for VR from (i): Output speed = input speed x velocity ratio Output speed = $1000 \times 2^* = 2000$ rpm

	<b>(iii)</b>	<p>One mark for each advantage up to a maximum of two marks from:</p> <ul style="list-style-type: none"> <li>• Belts and pulleys do not require lubricating like gears do (1)</li> <li>• Belts can be adjusted to assist with changing the belt. (1)</li> <li>• Quiet operation (1)</li> <li>• Some belts can slip if there is a seizure/collapsed bearing (1)</li> <li>• Belts can be maintained /Easily changed when worn (1)</li> <li>• Pulleys reduce the effort needed (1)</li> <li>• Requires less effort to lift a load (1)</li> </ul> <p style="text-align: right;">(2x1)</p>	<b>[2]</b>	
	<b>(iv)</b>	<p>One mark from:</p> <ul style="list-style-type: none"> <li>• Power steering pump (1)</li> <li>• Lift pump (1)</li> <li>• Power take off (1)</li> <li>• Fork lift truck (1)</li> <li>• Digger rams (1)</li> </ul> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	Accept responses where a valid application of a hydraulic pump is given e.g. digger ram
	<b>(v)</b>	<p>One mark from:</p> <ul style="list-style-type: none"> <li>• Gears (1)</li> <li>• Shaft drive (1)</li> </ul> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	
	<b>(b)</b>	<p>Up to three marks for an explanation.</p> <p>Marking points could include e.g.:</p> <p>The engine recreates rotation through the pulley to turn the generator (1).</p> <p>The rotating armature coil cuts the magnetic lines of force (1)</p> <p>produced by the field coils (1)</p> <p>Current is induced into the armature (1)</p> <p>The commutator converts the AC current to a DC current (1).</p> <p style="text-align: right;">(3x1)</p>	<b>[3]</b>	Accept a simple explanation of a coil passing through a magnetic field for 1 mark.
		<b>Total</b>	<b>[10]</b>	





4	(d)	(i)	<p>One mark for correct arrow drawn on Fig. 5: Arrow shows the multimeter set to ( <u>V</u> ) DC Volts (1)</p>  <p style="text-align: right;">(1x1)</p>	[1]	
		(ii)	<p>The reading would be a negative reading e.g. -12v (1x1)</p>	[1]	
			<b>Total</b>	<b>[10]</b>	
5	(a)	(i)	<p>Up to three marks for an explanation. Marking points could include e.g.:</p> <p>An electrical supply is used to provide power to the motor (1) A motor-driven mechanical piston engine draws in air and compresses the air (1) Compressor pumps air into the reservoir (1)</p>	[3]	Award up to 3 marks for a correct explanation. Allow other valid stages e.g. pressure regulation.

		<p>The motor stops when the pressure reaches a pre-set value (1) and starts again when the pressure falls below this. (1)          Compressed air is stored in the receiver (1) and delivered to the pneumatic system when required (1)          Pressure gauge is used to monitor pressure (1)          Pressure relief valve releases excess pressure (1)</p> <p style="text-align: right;">(3x1)</p>		
	<b>(ii)</b>	<p>Using a pressure gauge (1)</p> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	
	<b>(iii)</b>	<p>One mark from:</p> <ul style="list-style-type: none"> <li>• There is a leak in the system (1)</li> <li>• The pre-set pressure has been regulated down. (1)</li> <li>• The compressor is off (1)</li> <li>• There is air in the system (hydraulic) (1)</li> </ul> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	
<b>(b)</b>	<b>(i)</b>	<p>Up to four marks for an explanation e.g.:</p> <p>The user cranks the handle which is attached to a small piston (1) controlling a low pressure circuit. (1) The low pressure circuit operates a ball valve to control the fluid from the reservoir (1) into the high pressure circuit. Increasing the volume of hydraulic fluid increases the pressure to lift the main piston/ram to lift the load (1).</p> <p>Effort is applied to the handle (1) oil moves the ball valve (1) more oil/pressure in high pressure reservoir (1) oil fills up underneath the ram (1) the ram lifts the load (1)</p> <p style="text-align: right;">(4x1)</p>	<b>[4]</b>	<p>Up to 4 marks for an appropriate explanation of the operation made up of relevant points to increase the pressure in a lifting mode, and /or reducing pressure to lower the load.</p>

		<b>(ii)</b> One mark for and appropriate example e.g.: <ul style="list-style-type: none"> <li>• hydraulic arm / ram grab (1)</li> <li>• lifting/access platform (1)</li> <li>• vehicle ramp/lift (1)</li> <li>• crane (1)</li> <li>• digger/excavator (1)</li> <li>• hydraulic press (1)</li> <li>• hydraulic stair lift (1)</li> </ul> <p style="text-align: right;">(1x1)</p>	<b>[1]</b>	Accept other appropriate examples.
		<b>Total</b>	<b>[10]</b>	

Question		Answer/Indicative content	Mark	Guidance
6	(a)	<p>Up to three marks for a description e.g.:</p> <ul style="list-style-type: none"> <li>• Electronic scales [or other sensor] (1) weigh/scan the product (1) and a pneumatic cylinder (1) is used to push under limit /overweight products off the line.</li> <li>• A control system (1) is used to energise a solenoid valve (1) and an actuator is used to stamp (1) the product to apply a label.</li> <li>• A PLC (1) is used to automate the operation of an actuator (1) to assemble (1) the product.</li> <li>• Electric motor (1) is used to move a conveyor belt (1) pneumatics arm seals the packaging (1)</li> </ul> <p>(3x1)</p>	[3]	Answers must contain at least one electrical and pneumatic example for full marks.
	(b)	<p>One mark from:</p> <ul style="list-style-type: none"> <li>• Transmission / gearbox (1)</li> <li>• Suspension (1)</li> <li>• Power generation (1)</li> </ul> <p>(1x1)</p>	[1]	

Question		Guidance	Marks	Answer
6	(c)*	<p>Award up to six marks for a discussion or detailed explanation of the advantages of using kinetic energy sources, with some comparison to other types of power generation such as the use of fossil fuels.</p> <p><b>Level 3 (5 – 6 Marks)</b> Detailed discussion showing clear understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.</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><b>Level 2 (3 – 4 Marks)</b> Adequate discussion showing an understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.</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><b>Level 1 (0 – 2 Marks)</b> Basic discussion showing limited understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.</p> <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>	[6]	<p>Hydraulics are used in heavy industrial equipment due to the ability to apply a great amount of force.</p> <p>Hydraulic fluid is pumped under pressure to enter the cylinder and hold heavy loads, or release to move the ram and lower a load.</p> <p>Hydraulic fluid does not compress which makes it suitable for lifting and holding heavy loads, such as with platform lifts, and jacks.</p> <p>Hydraulic cylinders can be controlled using control valves to stop at any linear point along the length of the cylinder making them suitable for manoeuvring in areas where space is limited or to control the depth of reach such as with a fork lift.</p> <p>Several hydraulic cylinders/rams can be configured into an arm such as with excavating equipment to control a series of lifting, reaching, digging, scooping functions.</p> <p>Two hydraulic cylinders can be interconnected to use a light mechanical effort to control a much heavier operation such as with a jack or hydraulic press.</p> <p>Hydraulics can be used to create a hydraulic motor to produce a rotary motion.</p>
		<b>Total</b>	<b>[10]</b>	

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