OCR
Oxford Cambridge and RSA

Cambridge National

Engineering

Unit **R101:** Engineering Principles

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

Mark Scheme for January 2017

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

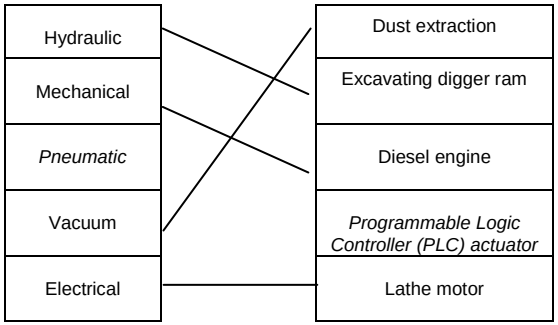
It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

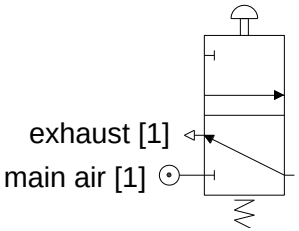
Question			Answer/Indicative content	Mark	Guidance
1	(a)	(i)	Candidates match the correct term with the correct example;  (4 x 1)	**[4]**	Do **not** credit Pneumatic to Programmable Logic Controller (PLC) actuator as this is given in the question.
		(ii)	Examples of mechanical applications e.g; • Gearbox drive • Jack • Conveyer • Pulley and lever mechanism • Vehicle engine 1 mark for example, 1 mark for description of use e.g.; Driven gears are used to transmit power to an output at a higher/slower/reverse speed. Human leverage is used to extend lifting leverage lifting the car. (2x1)	**[2]**	Accept appropriate examples and description of application.

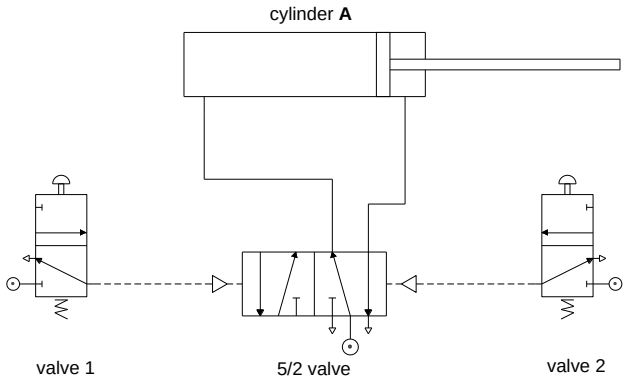
Question			Answer/Indicative content	Mark	Guidance
		(iii)	Correct example e.g. Pillar drill motor (1) Lawnmower (1) Fan (1) Compressor motor (1) Remote control car (1) (1x1)	**[1]**	Accept AC and DC examples. Accept mechanical motor ("car motor" meaning engine) as a BOD.
	(b)	**(i)**	A description of electrically powered drive used to produce mechanical work/motion e.g.; An electric motor (1) is used through a gearbox to turn (1) the chuck holding the workpiece/drill bit. An electrical motor/coil (1) is used to create kinetic energy /motion (1) (2x1)	**[2]**	Accept appropriate variations.
		(ii)	Examples of electro–mechanical device e.g.; • Motor • Relay • Solenoid • Actuator • Servo (1x1)	**[1]**	Accept other examples such as RCD, Hybrid car, Do **not** accept generator (nor wind turbine) as this is given in the question.
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
2	(a)	(i)	A Effort (1) B Fulcrum (1) C Lever Arm (1) (3x1)	[3]	
		(ii)	The spanner/tools is rotated pivoting (1) on the fulcrum at the nut. The length of the spanner is the leverage making it easier (1) to turn the nut. Effort is applied by pulling at the opposite end of the nut (1) pivoting on the fulcrum/nut (1). The tool has a long lever,(1) which reduces the effort making it easier to turn the nut (1) (2x1)	[2]	Award 1 mark for a description of less effort being required (1)
		(iii)	1 mark for a correct example of a lever e.g.; The claw of a hammer to pull out a nail (1) A wheel barrow to lift a load (1) A crow bar to lift a heavy lid (1) A wheel brace to change a wheel (1) A door handle (1) Nut cracker, crowbar (1) (1x1)	[1]	Do not accept Wrench.

Question			Answer/Indicative content	Mark	Guidance
	(b)	**(i)**	Arrow drawn clockwise direction (1)  (1x1)	**[1]**	Look for NR/ no attempt to annotate Fig.2
		(ii)	Gearbox/transmission (1) Oil pumps (1) Power take off (1) Pillar drill/drill (1) Helicopter gearbox (1) (1x1)	**[1]**	Accept 'gearbox' Lathe - BOD
		(iii)	Allows 90^{o} output (1) Smooth transmission/meshing of gears (1) Quieter than spur gears (1) Can be meshed in parallel or crossed orientations (1) (1x1)	**[1]**	Accept 'changes direction or gear {accepting this means 90^{o}'] (not rotation, not turns the other/opposite way'.
	(c)		No slippage (1) No adjustment of belt tension required (1) No belts to replace (1) More torque can be transmitted (1) More compact (1) (1x1)	**[1]**	'Gears are more efficient than pulleys' – BOD
			Total	**[10]**	

Question			Answer/Indicative content	Mark	Guidance
3	(a)		P=IV (1) 1.1 x 9 = 9.9W (1)	[2]	1 mark for correct substitution in the formula i.e. Give mark for V/IxR or W/IxV triangles. Correct answer with no working 2 marks.
	(b)		All components used (1) Correct parallel circuit (1) (2x1)	[2]	
	(c)	(i)	The lamps will be brighter than in a series circuit. (1x1)	[1]	Accept Increases
		(ii)	The current consumption will be greater in the parallel circuit (1) The current will be halved through each path (1) (1x1)	[1]	Accept Increases
	(d)		$1/R_T = 1/R_1 + 1/R_2$ $1\ 1/R_T = 1/180 + 1/180$ $= 180/2$ (1) 90 Ω (2) (2x1)	[2]	No marks for stating the formula. 1 mark for transposing formula with workings *Or* 2 marks for the correct answer. No marks for 180+180.
	(e)		E**lectro**… Motive…. F**orce**…… (EMF) is the energy per unit charge that is converted from **chemical**…., **m**echanical, or other forms of energy into electrical energy in a battery. (2x1)	[2]	1 mark for correct **Electro**… Motive…. **Force** 1 mark for c**hemical**.
			Total	[10]	

Question			Answer/Indicative content	Mark	Guidance
4	(a)	(i)	 (2x1)	[2]	Look for NR/ no attempt to annotate Fig.4
		(ii)	Uni-directional flow control valve (1) (1x1)	[1]	Accept Uni-directional valve
		(iii)	The spring is used to return the piston to the rest/instroke position (1) (1x1)	[1]	Accept 'return spring'
		(iv)	When the button is pressed, the 3/2 valve operates /moves to the 2nd position (1) air flows through the valve to the cylinder (1). This activates the cylinder, to push the piston positive (1). When the button is pressed, air flows to the cylinder (1) a unidirectional-flow control valve is used to slow the speed of the piston on the outstroke (1). The instroke will be full speed (1). (3x1)	[3]	
	(b)		Area = 3.14 x 20 x 20 = 1256mm^2 (1) F= 0.4 x 1256 (1) **502.4N** (1) (3x1)	[3]	No marks for stating the formula as it is given in the question: Force (F) = pressure (p) x area (a) Allow for rounding. 3 marks if correct answer seen
			Total	[10]	

Question			Answer/Indicative content	Mark	Guidance
5	(a)			[3]	Pilot air to 5/2 valve from valves 1 & 2 (1) Main air to cylinder **A** left hand connection. (1) Exhaust to cylinder **A** right hand connection (1) (3x1) 1 mark for each correct connection. Ignore additional connections made by the candidate.
	(b)		Description of a working system e.g. A **12v electrical supply** is connected to the 5/2 solenoid valve (1) when a **push switch** is operated (1), allowing the 5/2 solenoid valve to open, providing **air supply** (1) to outstroke the **single acting cylinder** (1). (3x1)	[3]	Accept any three correct descriptive points.
	(c)		One example of a hydraulic application, e.g. • Hydraulic ram used on a digger (1) • Forklift (1) • Hydraulic press (1) (1x1)	[1]	Accept any other suitable hydraulic application.
	(d)		A pneumatic cylinder (1) is connected to a flat plate that used to push the product. As the product reaches the operator, a push button operated 3/2 valve is pressed (1) to operate a single acting cylinder to outstroke and move the product. (1) The cylinder will instroke and remain in this position until the push button is pressed again. (1) (3x1)	[3]	Up to 2 marks for each appropriate component and up to 2 marks for an appropriate description of the operation. Award up to 2 marks for some understanding of production lines.
			Total	[10]	

Question			Answer/Indicative content	Mark	Guidance
6	(a)		Kinetic energy is converted to **mechanical** energy, which is then converted to **electrical** energy.	**[1]**	1 mark in total for both answers being correct.
	(b)		If the current flows in only one direction it is called direct current, or DC (1) Batteries and cells supply DC electricity (1), with a typical battery supplying maybe 1.5V. (3x1)	**[3]**	1 mark for example, up to two marks for a detail explanation. Mention of current flowing 1 way only (1) or 'doesn't pulse back and forth' (1) Use diodes/rectifier (1) Allow a comparison to AC(1) and conversion from AC to DC (1)

Question			Guidance	Marks	Answer
6*	(c)		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. **Level 3 (5 – 6 Marks)** Detailed discussion showing clear understanding of the advantages of using kinetic power sources compared to using non-sustainable sources. 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. **Level 2 (3 – 4 Marks)** Adequate discussion showing an understanding of the advantages of using kinetic power sources compared to using non-sustainable sources. 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. **Level 1 (0 – 2 Marks)** Basic discussion showing limited understanding of the advantages of using kinetic power sources compared to using non-sustainable sources. There will be little or no specialist terms. Answers may well be ambiguous or disorganised. Errors of spelling, punctuation and grammar may be intrusive. **0** = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at the end of the response.	**[6]**	Kinetic energy is the energy of motion or movement. There are ways to harness kinetic energy to either generate useful mechanical work or electricity. This makes use of energy that would be otherwise be wasted. Kinetic engery may also generate friction which creates heat which is not wanted. A wind turbine is a commonly found way of using the wind to produce kinetic energy by turning the blades of the turbine. This is connected to the alternator rotor and is used to supply alternating current. Kinetic energy produced from the wind and waves is a sustainalble source of energy that can be harnessed to produce useful power. Kinetic energy from sustainalble sources such as wind and waves is unpredictable and therefore cannot be relied on to provide continuitiy of energy supply. Kinetic engery sources can produce less polution compared to fossil fuels and extraction. Innovative examples of using kinetic energy to generate an electrical current include a type of speed bumps that when vehicles slow to drive over can create a current. Another example is regenerative braking on some cars and trains. Power produced by the use of kinetic energy has the advantage of being sustainable producing little or few negative by-products, unlike burning fossil fuels such as coal and gas. The impact on the environment is therefore reduced. Mechanisms used to produce useful kinetic energy are usually very large and required servicing and repairs and their presence on the landscape is often unpopular with the public.
			Total	**[10]**	

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

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553