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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 2016

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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.

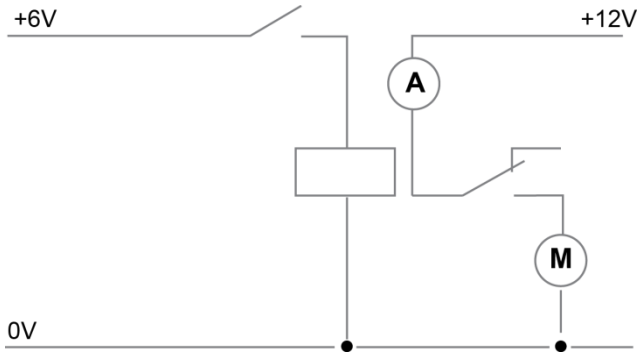
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

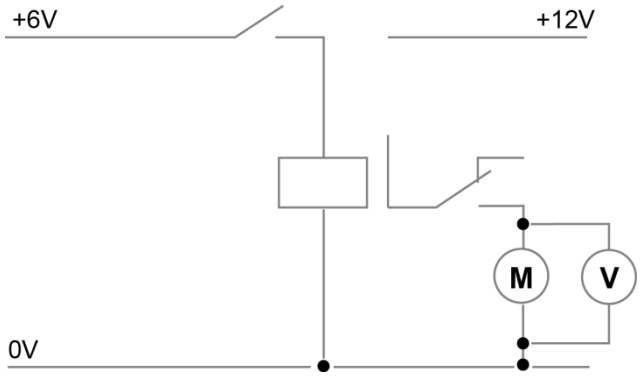
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Question			Answer/Indicative content	Mark	Guidance
1	(a)	(i)	Candidates match the correct term with the correct label **A** = Load **B** = Fulcrum **C** = Effort (1x 3)	3	
		(ii)	Class 1 Lever (1x1)	1	Accept a pair of Class 1 levers
		(iii)	Any type of recognised lever e.g. • BBQ tongs • Tweezers • Scissors • Playground seesaw • Wheel barrow • Spanner (1x1)	1	
	(b)	(i)	Bevel gear (1x1)	1	
		(ii)	Any appropriate application of bevel gears e.g. • Differential • Hand drill • Hand mixer • Change the rotation through 90 degrees • Change the rotation direction • Lathe / milling machine • Differential / gearbox (1x1)	1	Do not award ‘car’ unless exemplified with ‘gearbox’ / ‘differential’ / ‘gear train.’

Question			Answer/Indicative content	Mark	Guidance
	(c)	**(i)**	2 correct benefits of using toothed belt drives e.g. • To provide increased grip • To provide synchronous timing • Quiet drive • No lubrication required • Reduced wear/no metal to metal • No slippage / reduced slipping / more friction • High torque applications • Improved power transfer (2x1)	**2**	
		(ii)	• Gears • Chain drive • Flat belt • Round belt • Vee belt (1x1)	**1**	Accept references to gears and pulley systems
	(d)		• Component **X** is used to set the belt tension • Tighten the belt / reduce slack • To enable the belt to be changed (1x1)	**1**	
2	**(a)**		Description of a dynamic load e.g. • A live load that can vary or move • A car moving across a bridge • The wind against a structure • A person carrying a load • Pushing a wheel barrow • Child on a seesaw • Any load that can change when applied with motion (2x1)	**2**	Do not accept one word answers e.g. wheelbarrow / crane. Answers must be exemplified with a description of how the load is dynamic.

Question			Answer/Indicative content	Mark	Guidance
	(b)		$a = \frac{v - u}{t}$ $a = \frac{20 - 0}{4}$ (1) 20/4 =5 (1) Answer 5m/s^{-2} (3) (3x1)	**3**	1 mark for correct values in formula 2 marks for correct answer without units 3 marks for correct answer with units - m/s^{-2}
	(c)		Up to 2 marks for clear explanation, 1 mark for example/application. An object can store energy as the result of its position (1). For example, the heavy ball of a demolition machine (1) is storing energy when it is held at an elevated position / This stored energy of position is referred to as potential energy (1). An object that can store energy / How much energy something could release (1) for example, a stretched elastic band / spring under tension (1) (3x1)	**3**	
3	**(a)**		1 mark for each correct response in the correct place i.e. Voltage can be supplied to a circuit by a battery which can be made up of one or more cells. Potential difference is the measure of voltage across a circuit component. (2x1)	**2**	
	(b)	**(i)**	Series (1x1)	**1**	

Question			Answer/Indicative content	Mark	Guidance
		(ii)	2 correct benefits e.g. • The lamps will be brighter than in Circuit 1 • The voltage is the same across all parallel components / voltage is shared • If one lamp fails, the other will still work. (2x1)	**2**	Do not accept 'same brightness.' Accept 'the lamps have less resistance.'
		(iii)	I = P/V 10 / 12 = .83A (1) or 830mA (1) (2x1)	**2**	Accept $\frac{5}{6}$
	(c)	**(i)**	In series with the motor (1x1)	**1**	Accept the ammeter positioned in line under the motor. 

Question			Answer/Indicative content	Mark	Guidance
		(ii)	Voltmeter is drawn Across the motor Correct symbol (1) Correct placement (1) (2x1)	**2**	
		(iii)	Explanation may include the following points: The battery provides power to the relay and the motor (1). A switch is used to provide current to the relay coil (1) which is used to reduce the load on the switch contacts (1) The relay contacts close when the relay is switched (1) this causes current to flow through the circuit to the motor (1) The motor circuit is isolated from the relay circuit (1) this allows the motor to run on a different supply voltage (1) The battery supplies power to the motor when the switch is closed (1). When the switch is closed the battery provides power to the relay / solenoid / electromagnet (1) the relay contacts close which powers the motor (1). The motor circuit is isolated (1) (4x1)	**4**	Award two marks for single point well explained
4	**(a)**	**(i)**	**Y** = Shuttle valve (1x1)	**1**	

Question			Answer/Indicative content	Mark	Guidance
		(ii)	Air from the left hand side will go through to the output (1) and block off the right hand side input or vice versa (1) (2x1)	**2**	Only allows air from one direction at a time / stops the air going to valve B
		(iii)	When either valve **A <u>OR</u> B** is pressed/activated (1), the shuttle valve moves to allow air to the cylinder(1). The cylinder will outstroke or go positive (1). The single acting cylinder will go positive if valve **A <u>OR</u>** valve **B** are pressed (1) but not when both of them are pressed (1). When the valve **A** or **B** button is released the single acting cylinder will retract. (1) (3x1)	**3**	
	(b)	**(i)**	Compressibility means compressing the air so that the compressed air provides force to act upon the cylinder or valve (1). The value of the force or pressure being pre-set (1). The load acting on the cylinder (1) can have the effect of increasing the compression of the air.(1) Compressibility is the amount the air can be compressed in the cylinder. (1) The higher the compression / the more it is compressed the larger the force on the cylinder (1) (2x1)	**2**	Accept reference to 'change in matter.'
		(ii)	The hydraulic fluid cannot be compressed (1), the amount of fluid in the cylinder is used to vary the force (1). Therefore, hydraulics is more suitable for heavy load applications. (1) (2x1)	**2**	

Question			Answer/Indicative content	Mark	Guidance
	(c)		The filter is used to filter out contaminants (1) which can cause damage and wear to components / stop the system getting blocked (1) (2x1)	**2**	
5	**(a)**	**(i)**	Mechanical. (1x1)	**1**	
		(ii)	Portable source of power as the vehicle takes the hydraulic power source with it. (1) No electrical power required (1) (1x1)	**1**	
		(iii)	Appropriate hydraulic application e.g. • Mechanical digger rams used to lift a bucket or shovel • Fork lift truck rams used to lift forks • Lifting platform or tail lift • Car jack • Car breaking / suspension system • Hydraulic press • Lifting machines (1x1)	**1**	
	(b)	**(i)**	Appropriate energy conversion e.g. Chemical to electrical Solar/light to electrical Kinetic to electrical	**1**	Allow other valid examples. Do not accept ‘mechanical to kinetic’ or ‘chemical to kinetic.’

Question			Answer/Indicative content	Mark	Guidance
		(ii)	Description of any appropriate application e.g. • A wind turbine is driven mechanically by the wind (1). This creates kinetic energy that is converted to electrical energy (1) • A cell/ battery (1) converts the energy released from a chemical source to electrical energy (1). • Fossil fuels are chemical energy. (1) Burning these in power stations generates heat. (1) (2x1)	**2**	Do not award marks for a simple repeat of **(b)(i)** e.g. chemical to electrical.
6	**(a)**		Appropriate / feasible description of a means of driving the conveyor rollers e.g. using an electrical motor with pulleys, gears, belts to mechanise the rollers in motion. E.g. An electric motor (1) is used with a pulley (1) and a chain drive or belt (1) to drive a pulley/drum or gears on the conveyor roller. (3x1)	**3**	

Question			Guidance	Marks	Answer
6*	(b)		Award up to six marks for a discussion or detailed explanation of the reasons for choosing AC or DC power supplies for a range of applications. **Level 3 (5 – 6 Marks)** Detailed discussion showing clear understanding of the advantages of using Alternating Current rather than Direct Current. 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 Alternating Current rather than Direct Current. 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 v Alternating Current rather than Direct Current. 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]**	Electrical currents are produced as alternating current and therefore there is no need to use rectifiers to convert to DC when AC supply is used. In AC power supplies the current flows back and for the alternating in direction which is measured in Hertz per second. In DC power supplies the current is flowing in one direction only. Generators produce alternating current which can be converted to DC. AC is used for high voltage and continual high current applications. DC is used for low current applications requiring a set voltage When DC is generated at high voltages the generator commutator is prone to damage through arcing. Alternating current is affected less by voltage drop over larger distances and resistance can be less in current carrying conductors. Alternating current can be stepped up or down using transformers where needed. Small current produces less heat and can be transmitted through a thin conductor. Thus it is possible to transmit AC at high voltages. This reduces the size of conductor, transmission losses and increases transmission efficiency. Direct Current is safer to users however is not suitable for transmission over large distances. Mechanical generators can be used in a portable mode to produce AC. DC allows for devices such as tools to become portable yet re-chargeable using AC.

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

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553