

Design & Technology (Electronic Control systems)

General Certificate of Secondary Education **GCSE J301**

General Certificate of Secondary Education (Short Course) **GCSE J041**

Mark Schemes for the Units

January 2010

J041/J301/MS/R/10J

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Design and Technology (Electronic Control Systems) (J301)**

**General Certificate of Secondary Education (Short Course)
Design and Technology (Electronic Control Systems) (J041)**


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A512 Sustainable Design

SECTION A

Question		Expected Answers	Marks	Rationale
1	(a)	When thinking of the 6Rs which describes 'reduce'. Answer – c.	[1]	
2		Solar power devices are fitted to houses to: Answer – d.	[1]	
3		When buying fairtrade goods you can expect the product to: Answer – b.	[1]	
4		Carbon Dioxide emissions is linked to: Answer – a.	[1]	
5		The symbol stands for: Answer – d.	[1]	
6		Give a reason for using a symbol to indicate the power adaptor is double insulated rather than words. Symbols need no language / may catch the eye easier / quicker to comprehend / relate to the property they imply/ recognised easily / no literacy involved / easily to understand in any country	[1]	

Question	Expected Answers	Marks	Rationale
7	<p>What label or letters show wood is from a managed renewable resource? Forest Stewardship Council is an organisation established to promote the responsible management of the world's forests. Program for the endorsement of forest certification. FSC and/or Tree logo with or without</p>  text FSC	[1]	
8	<p>Which group of plastic is not easily recyclable? Thermosetting plastics cannot be reformed or recycled into 'new' plastic for manufacturing. Allow rubber(s)</p>	[1]	
9	<p>A light bulb package is marked 230v 11W. State why this indicates this is a low energy light bulb Watts are the measurement of power, this is a low number (especially when compared to conventional incandescent bulbs).</p>	[1]	
10	<p>What is the name of home recycling of vegetables and garden waste? Composting, (or description "where vegetables and garden/green waste are home recycled into compost in a compost bin" or).</p>	[1]	Not biodegradable ie not property of a waste
11	<p>LED lights are very efficient compared to filament bulbs. True.</p>	[1]	
12	<p>Gas powered patio heaters are an efficient use of non renewable energy. False.</p>	[1]	
13	<p>Manufacturing can cause environmental problems. True.</p>	[1]	

Question	Expected Answers	Marks	Rationale
14	Leaving a television on standby uses no energy. False.	[1]	
15	Rechargeable Nickel Cadmium (nicad) batteries should be disposed of in a landfill site. False.	[1]	
	Section A Total	[15]	

SECTION B

Question			Expected Answers	Marks	Rationale
16	(a)		<p>Sustainability is beginning to affect consumer products. Renewable energy can power electrical products. State how renewable electrical energy is produced.</p> <p>Renewables – solar /solar panels– (photovoltaic, wind – windmill, water – water wheels – wave generator, geothermal.</p>	[2]	
16	(b)		<p>Technology push can create new types of products.</p>		
16	(b)	(1)	<p>How is new technology used in the design and manufacture of this product?</p> <p>Battery storage of electricity, control systems for electric drive, high torque electric motors, computer abs, anti-collision, service interval light, fault codes, CAD/CAM in manufacture Satnav, hybrid, regenerative braking, any reasonable new technology involving cars but should be specific, new materials.</p>	[2]	Not things like 'more efficient' unless qualified
16	(b)	(2)	<p>State two environmental issues with electric cars.</p> <p>Special materials for batteries and motors. Charging stations need integrating with existing petrol stations, addition of charging points in existing parking facilities. Silent running a danger to pedestrians. Disposal of batteries, electricity may not be from renewable sources. Minimal emissions. Be specific to electric cars. Positive environmental comments.</p>	[2]	
16	(b)	(3)	<p>Describe how renewable energy can be made to run electric cars.</p> <p>electricity produced from a renewable source, transmission of electricity – using national grid charging points at home or energy station Storage of energy. Micro generation, heat recovery, regenerative braking. Solar panels, hydrogen qualified, 2 points justified (2*2), 4 valid points. Emission comments. Energy harvesting. No vague cost comments.</p>	[4]	

Question			Expected Answers	Marks	Rationale
16	(c)	(i)	<p>When collecting the sun's energy with mirrors the power can be focussed to give very high temperatures. State three ways this energy can be used. Solar furnace for melting materials with no extra energy Steam generator for transferring energy to turbine/engine Direct electric conversion with silicon cells. Heat storage method / storage heaters / heating water, cooking, Water route (water to steam) not just heating. Specific conversion to electricity (Solar Electric panel)</p>	[3]	Don't allow multiples
16	(c)	(ii)	<p>State where is the best place to place a solar energy farm. In desert areas where land has no other use and sun is available. Maximum sun qualified.</p>	[1]	
16	(c)	(iii)	<p>Give a method of storing this energy for use during the night. Can be stored as heat in solids or liquids. Stored as electricity in batteries. Pumped storage with water in reservoir, allow capacitors</p>	[1] [15]	
17	(a)		<p>List three more specification points the designer of the wind up torch would have used for the product.</p> <ul style="list-style-type: none"> • Easy to operate with a switch • Good light output • Efficient storage of electric power • Easily held by user • Clipped to a belt • Use LEDs to give low power use for light. • Rubber grip • Handle storage • Energy storage • Long life cycle • Easy to separate parts 	[3]	

Question		Expected Answers	Marks	Rationale
17	(b)	<p>Give two reasons for using LEDs as the light source for the torch.</p> <p>Low power use from storage battery Long life bulb High intensity light source Fit more into a smaller space Safer to use in case of breakages. High efficiency Small, compact</p>	[1+1]	
17	(c)	<p>The wind up torch, shown in Fig.3 is to be modified for use by young children.</p> <p>On Fig.4 use sketches and notes to show two improvements to make the product better suited to this user group.</p> <p>Bigger handle to grip for winding, sketches Bigger switch to make it easier to operate, sketch Reshape the body to make it easier to hold, sketch. Make smaller for a child's hand, colours, waterproof, rubberised, shockproof. Any 4 by either means Relate to improvements for children. No comments on instructions</p>	[4]	

Question	Expected Answers	Marks	Rationale
17 (d)	<p>*(d) Discuss the issues a designer may have to consider when designing products for people with disabilities.</p> <p>Points need to focus on disabilities-related to grip, use of colour for discrimination of parts, sound output to entertain users, size of product for stability in use and visual stimulus, weight of product, safe use of product.</p> <p>Level 1 (0-2) marks</p> <p>Basic discussion, showing limited understanding of different types of disability (may not mention any) and how products must respond to these needs. Simple list</p> <p>Level 2 (3-4) marks</p> <p>Adequate discussion, implying consideration or understanding of different disability and sound understanding of how products must respond to these needs. 1 or 2 points</p> <p>Level 3 (5-6) Through discussion, showing a clear understanding of the types of disability. Good examples of products which have been modified and product which have been specifically designed for disabled use. 2 or 3 points</p>	[6]	Nature of disability is not mentioned in the stem therefore allow discussion around any reasonable disability. Be guided by the level descriptions and read through first to “get a feel” for the response.

Question	Expected Answers	Marks	Rationale
18	<p>New products should take account of their potential effects on the environment. Sustainability issues should be part of the product specification.</p>		
18 (a)	<p>How does the designer consider the following? Responsible use of materials. Minimum, recycled, no pollution, reuse, sourcing from renewable/sustainable, sustainable, least harmful, fair trade materials, Explanations. 3 points. Physical properties for use, standard parts, least harmful to environment, allow repair if qualified.</p>	[3]	
18 (b)	<p>Carbon footprint in manufacture? Low technology manufacture, low energy in machines and materials, transport to minimum, recycle heat energy in factory, use of renewable/recycled materials. 3 points. Appropriate use of relevant 6R, CO2 emission/reduction allowed participation in carbon offsetting.</p>	[3]	
18 (c)	<p>Packaging which is environmentally friendly? Material of low energy, recycled materials, dispose as compost, construction with minimum materials, ease of recycling after use, compostable materials, reuse or return to maker for reuse. Impact on environment. 3 points.</p>	[3]	Watch for repetition from 18(a)
18 (d)	<p>Life time of the product? Product built robustly, easy to repair, quality of design that does not age, no fashion items, limit energy in use, upgrades / software upgrades, compatible with future product, built-in obsolescence. Lifespan if justified. Built in obsolescence, repairable. 3 points</p>	[3]	Watch for duplication from 18(e)

Question		Expected Answers	Marks	Rationale
18	(e)	<p>Disposal and recycling of the product at the end of its life? Small number of materials, easy to take apart, all materials labelled for identification, reuse items, planning for disposal Energy needed to dispose of. Components will not affect environment when disposed off, energy to dispose, repair justified. 3 points</p>	[15]	
			Section B Total	[45]
			Paper Total	[60]

A514A 01 Electronics Paper

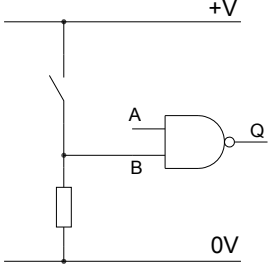
Question			Expected Answer	Mark	Rationale
1	(a)	(i)	Switch is push to make , 1 mark.	[1]	
1	(a)	(ii)	Potentiometer, 1 mark. Allow variable resistor.	[1]	
1	(b)	(i)	Reasons for using an LED could include: <ul style="list-style-type: none"> • longer life; • smaller sizes available; • more resistant to shock or vibration; • brighter light/higher intensity light; • allow mark for reasons relating to cost if justified. 1 mark for a valid reason.	[1]	
1	(b)	(ii)	Symbol for fixed resistor, preset potentiometer, potentiometer, variable resistor.	[1]	
1	(c)		Ergonomic features include: <ul style="list-style-type: none"> • small enough to fit into hand; • can be operated one handed; • can be used either right or left handed; • single touch tuning; • ridges on the on/off/volume control; • all controls clearly labelled. 1 mark each for two features that demonstrate use of ergonomic thinking.	[2]	


Question		Expected Answer	Mark	Rationale
1	(d)	<p>Discussion could include:</p> <ul style="list-style-type: none"> • smaller size; • remote reading/no line of sight requirement; • the tag can stand a harsh environment; • accuracy of reading/longer life than barcodes; • can receive and transmit data; • greater data capacity; • Problems of ensuring deactivation; • Consumers may not want details of their purchases to remain readable; • Maintaining civil liberties is another argument put forward. 		
		<p>Level 1 (0-2) marks Basic discussion of implications using at least one of above points, may be one-sided points put forward.</p> <p>Level 2 (3-4) Adequate use of examples, showing understanding of RFID operation and some comparison to use of bar code.</p> <p>Level 3 (5-6) Through discussion of implications showing a clear understanding of application of devices as well as moral issues related to their use. At least two examples of use/benefits included. Comparison made to use of bar codes.</p>	[6]	
			TOTAL	[12]

Question			Expected Answer	Mark	Rationale
2	(a)	(i)	The resistance of the thermistor falls .	[1]	
2	(a)	(ii)	Substitution into formula 1 mark – $1.2 = \frac{R2}{10K + R2} \times 5$ Arrangement of values, 1 mark $1.2(10K+R2) = 5R2$ $12K + 1.2R2 = 5R2$ $12K = 5R2 - 1.2R2 = 3.8R2$ Correct answer, 1 mark $R2 = 12K/3.8 = \mathbf{3.16K}$ Allow 3 marks for correct answer with no working shown.	[3]	
2	(b)		Explanation to show understanding that analogue values are variable through a range, digital values are stored in binary. The conversion takes an analogue value and changes it into a binary value reflecting the size of the analogue value. 2 marks for clear explanation, 1 mark for explanation of either analogue or digital.	[2]	
2	(c)	(i)	Most likely cause of static will be type of clothing worn or type of floor covering. Manufactured fabrics in clothing or carpets will cause static. Allow mark for any other valid cause.	[1]	
2	(c)	(ii)	Prevention of static damage can be ensured by: <ul style="list-style-type: none"> • earthing on a metal pipe, radiator or water pipe; • using a wrist strap attached to an earthing point; • shoe strap contacted with floor; • low static floor coverings. 1 mark for valid method.	[1]	
2	(d)	(i)	Checks to include: <ul style="list-style-type: none"> • orientation of either IC, IC holder or capacitor; • value of any components used; • components flat against PCB; • legs or pins bent to hold in position while soldering. 1 mark each for two suitable checks.	[2]	

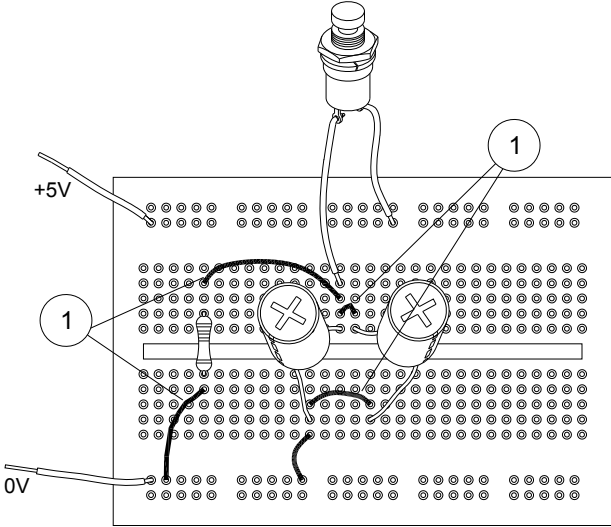
Question			Expected Answer	Mark	Rationale
2	(d)	(ii)	<p>Any three in right order 1 mark. All correct 2 marks.</p> <pre> graph TD A[allow iron to heat] --> B[wipe tip on sponge] B --> C[tin the iron] C --> D[place iron on joint] D --> E[allow heat to conduct] E --> F[feed in solder] </pre>	[2]	
TOTAL				[12]	

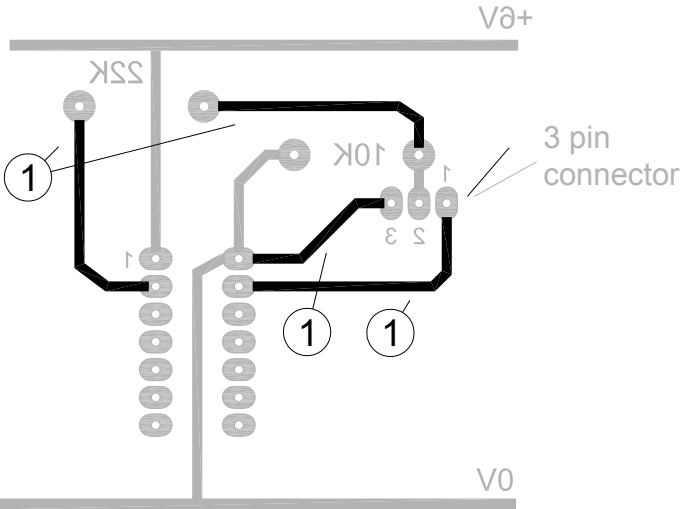
Question			Expected Answer	Mark	Rationale															
3	(a)	(i)	Circuit 1 is AND logic, 1 mark. Circuit 2 is OR logic, 1 mark.	[2]																
3	(a)	(ii)	The logic IC is a Quad 2 input NAND 1 mark each for any two from QUAD, 2 input, or NAND . 2 x 1 marks	[2]																
3	(a)	(iii)	Truth table completed accurately, 1 mark. <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>Q</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	B	Q	0	0	1	0	1	1	1	0	1	1	1	0	[1]	
A	B	Q																		
0	0	1																		
0	1	1																		
1	0	1																		
1	1	0																		
3	(b)		Explanation to include; <ul style="list-style-type: none"> • greater voltage range which will suit standard battery voltages; • current draw 1000 times lower; • tying unused inputs is not difficult at the design stage; • slightly slower switching speed is not noticeable in most applications. Clear justified explanation of one point, 2 marks. 2 points mentioned in less detail, 1 mark each point.	[2]																

Question	Expected Answer	Mark	Rationale
3 (c)	<p>Pull down resistor connected correctly, 1 mark, switch correct 1 mark.</p> 	[2]	
3 (d)	Any valid test instrument: multimeter, logic probe, logic clip, oscilloscope.	[1]	
3 (e)	<p>Benefits of CAD simulation include:</p> <ul style="list-style-type: none"> • large range of components available; • components can be changed quickly and results seen; • range of simulation test instruments available; • can quickly be converted into PCB often with the same software; • can be sent via internet for testing/evaluation. <p>Allow other valid benefits; do not allow cost related benefits. 1 mark each for two benefits.</p>	[2]	
TOTAL		[12]	

Question			Expected Answer	Mark	Rationale
4	(a)	(i)	Methods could include, two part snap plastic rivets, self tapping screws, 'pine tree' clips, push rivets, screw on rivets. Method clearly described or sketched, 1 mark Non-permanent method chosen 1 mark.	[2]	
4	(a)	(ii)	Reasons for a non-permanent method will include repair/maintenance, avoiding errors in assembly. 1 mark for valid reason.	[1]	
4	(b)		Recycling symbol/recycle now logo, 1 mark. WEEE symbol for disposal of electronic goods, 1 mark. 	[2]	
4	(c)		Relay choice depends on: peak current through relay contacts; contact arrangement – SPDT, DPDT etc. coil voltage. 1 mark each for two factors mentioned	[2]	
4	(d)		Other methods of connection include plug and socket mounted on PCB, plug and socket in line with cable, spring loaded terminals, 'BT type' press in terminals. Method named 1 mark, description of use 1 mark.	[2]	
4	(e)	(i)	Strain relief could be on cable only, cable tie, knot in cable, grommet with screw down section; could be mounted on the PCB – bar screwed across cable onto PCB. 1 mark for clear sketches/notes, 1 mark for workable method.	[2]	



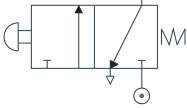
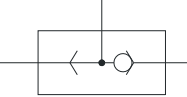
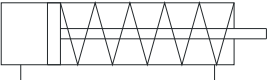
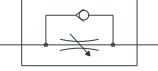


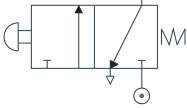
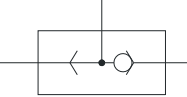
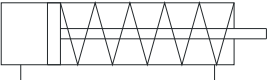
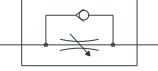


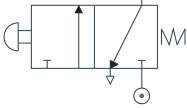
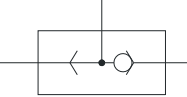
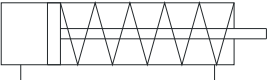
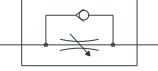
Question			Expected Answer	Mark	Rationale
4	(e)	(ii)	Grommet is used to protect the outer sleeve of the cable from rubbing against the hole in the casing. Extended grommets can also prevent the cable from bending. 1 mark for understanding shown.	[1]	
				TOTAL	[12]

Question			Expected Answer	Mark	Rationale
5	(a)	(i)	Choice of capacitor will be influenced by: <ul style="list-style-type: none"> • value of capacitor; • axial or radial according to space on circuit; • through hole or surface mount; • circuit voltage, working voltage of capacitor; • available space on PCB. 1 mark for suitable influence on choice	[1]	
5	(a)	(ii)	Capacitors connected in parallel (could go direct to 0V), 1 mark. Resistor connected to capacitors/switch junction and 0V, 1 mark. <div style="text-align: center; margin-top: 20px;">  </div>	[2]	

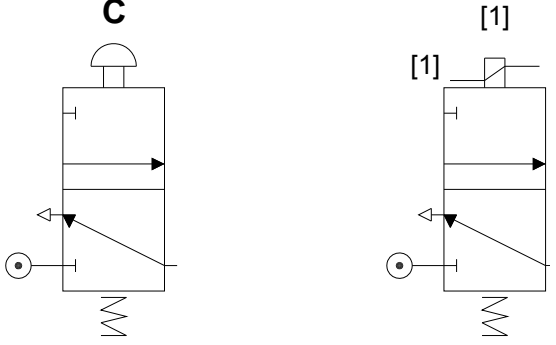
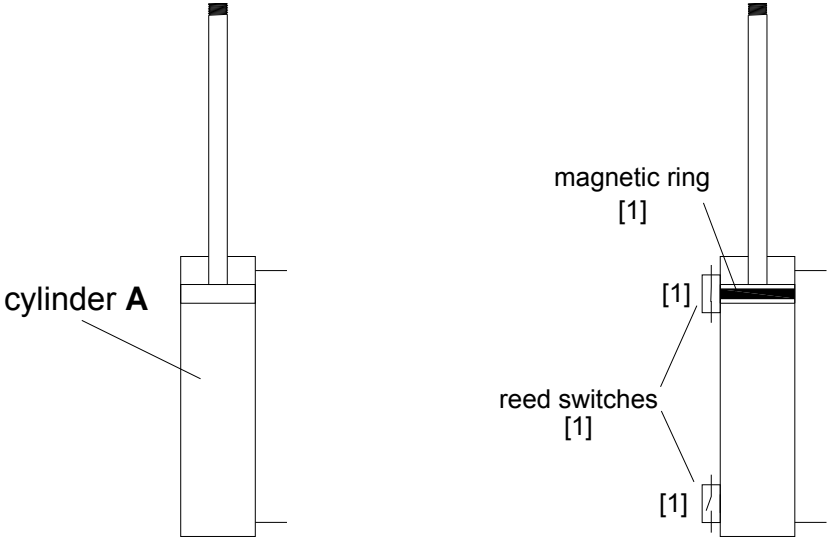
Question	Expected Answer	Mark	Rationale
5 (b)	<p>1 mark for each correct track, 3 x 1 marks.</p> 	[3]	
5 (c)	<p>Changes could include:</p> <ul style="list-style-type: none"> • Reduction in size; • ICs arranged with minimum space between them; • No IC holders used; • Screen layer to assist in the placing of discrete components; • Mounting holes added at correct spacing for case; • Solder resist mask applied for wave soldering; • Link wires aligned and spaced for 0 ohm resistors. 	[6]	

Question	Expected Answer	Mark	Rationale
	<p>Level 1 (0-2) marks Basic description of changes using at least one of above points; points mentioned may not be justified.</p> <p>Level 2 (3-4) More precise use of examples, showing understanding of PCB manufacture and changes needed. Two or more of above points mentioned.</p> <p>Level 3 (5-6) Through description of changes needed showing a clear understanding of both prototyping and production PCBs. Understanding of financial implications of saving space on PCB.</p>		
	TOTAL	[12]	

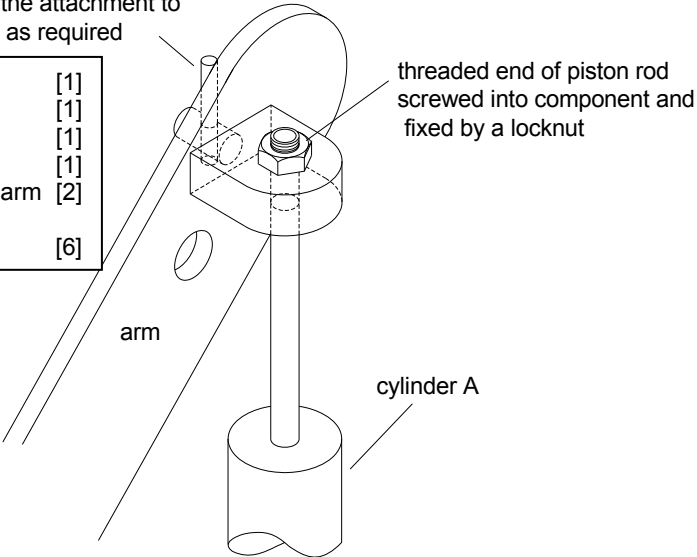
A514B 02 Pneumatics Paper

Question		Expected Answer	Marks	Rationale														
1	(a)	<table border="1"> <thead> <tr> <th>component name</th> <th>component symbol</th> </tr> </thead> <tbody> <tr> <td>A exhaust</td> <td></td> </tr> <tr> <td>B air supply</td> <td></td> </tr> <tr> <td>C push button 3/2 spring return valve</td> <td></td> </tr> <tr> <td>D shuttle valve</td> <td></td> </tr> <tr> <td>E single acting cylinder</td> <td></td> </tr> <tr> <td>F unidirectional restrictor</td> <td></td> </tr> </tbody> </table>	component name	component symbol	A exhaust		B air supply		C push button 3/2 spring return valve		D shuttle valve		E single acting cylinder		F unidirectional restrictor		[1] [2] [2] [2] [2]	
		component name	component symbol															
		A exhaust																
		B air supply																
		C push button 3/2 spring return valve																
		D shuttle valve																
		E single acting cylinder																
F unidirectional restrictor																		
1	(b)	A single acting cylinder has one air supply, 1 mark. it contains a spring 1 mark. which returns the piston rod when the supply is removed 1 mark.	[3]															
TOTAL			[12]															

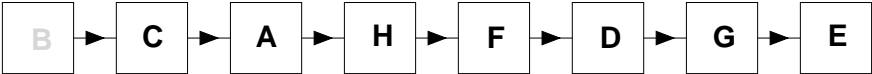
Question	Expected Answer	Marks	Rationale
2 (a)	<p>I mark for each point as shown below.</p>	[6]	
2 (b)	<p>When valve C is pressed and released: main air is sent to valve E to instroke the cylinders [1] causing the arms to lift where they will stay [1] when valve D is pressed valve E will switch over [1] and the arms will drop as the cylinders outstroke [1].</p>	[4]	
2 (c)	<p>These springs cause the valve to return [1] and the resting position takes over [1]</p>	[2]	
TOTAL		[12]	

Question		Expected Answer	Marks	Rationale
3	(a)		[2]	
3	(b)		[4]	

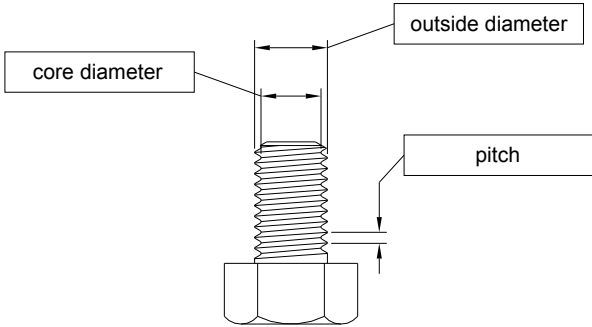
Question		Expected Answer	Marks	Rationale
3	(c)	<p>Feedback can be in the form of:</p> <ul style="list-style-type: none"> • a trip switch operated by the end of the piston rod which sends a signal to another valve to change state; • the trip switch could be replaced by a roller, air bleed or any other suitable switch; • In computer control the magnetic ring on the piston can close a microswitch which sends a feedback signal to the computer; • An operator can use a push button or other type of switch to change the state of another valve in the circuit. <p>Any other type of suitable feedback.</p> <p>Level 1 (0-2) marks Basic description of feedback using at least one of above points.</p> <p>Level 2 (3-4) Adequate use of examples, showing understanding of pneumatic feedback.</p> <p>Level 3 (5-6) Thorough description of feedback, showing a clear understanding of automatic and manual feedback of devices. At least two examples from above included.</p>	[6]	
TOTAL			[12]	

Question	Expected Answer	Marks	Rationale
4 (a)	<p>This is one possible answer of many.</p> <p>pin through spindle to allow the attachment to rotate as required</p> <div style="border: 1px solid black; padding: 5px;"> <p>Design [1] Fixing to piston rod [1] Lock to piston rod [1] Fixing to arm [1] Movement between arm [2] Total [6]</p> </div>  <p>threaded end of piston rod screwed into component and fixed by a locknut</p> <p>arm</p> <p>cylinder A</p>	[6]	
4 (b)	<p>Safety requirements will include:</p> <p>The compressor must be safely connected to an electricity supply and earthed in accordance with health & safety regulations.</p> <p>Pulleys and belts must be fully protected.</p> <p>The reservoir or receiver must have a gauge with a electrical cut out which will cut electrical supply to the compressor when the set pressure is reached.</p> <p>There should be a pressure release valve which will open and vent the pressure to the atmosphere in case of a failure to shut the compressor down.</p> <p>There should be a drain tap at the lowest point of the receiver or reservoir to empty the water produced from the compressed air.</p> <p>The receiver or reservoir must be pressure checked yearly.</p>		

Question	Expected Answer	Marks	Rationale
	<p>In the circuit there should be gauges to display the pressure. There should be a safe way of releasing pressure to the atmosphere away from personnel. Allow any other valid safety requirements.</p> <p>Level 1 (0-2) marks Basic understanding of safety requirements using at least one of above points.</p> <p>Level 2 (3-4) Adequate use of examples, showing understanding of safety procedures.</p> <p>Level 3 (5-6) Thorough description of feedback showing a clear understanding of automatic and manual feedback of devices. At least two examples from above included, showing some understanding of statutory requirements.</p>	[6]	
	TOTAL	[12]	

Question	Expected Answer	Marks	Rationale
5 (a)	<p>1 mark for each letter in the correct place.</p> 	[7]	
5 (b)	<p>Use the formula $F = P \times A$.</p> <p>$F = P \times A$</p> <p>$20 = P \times \text{Area of piston} - \text{Area of piston rod (for instroking)}$ [1]</p> <p>$P = \frac{20}{\text{Area of piston} - \text{Area of piston rod (for instroking)}}$ [1]</p> <p>$P = \frac{20}{(\pi \times 10^2) - (\pi \times 2^2)}$ or $\frac{20}{(\pi \times 20) - (\pi \times 4)}$</p> <p>$P = \frac{20}{314.15 - 6.28}$ [1]</p> <p>$P = \frac{20}{307.87}$ [1]</p> <p>$P = 0.006\text{N/mm}^2$ [1]</p>	[5]	
TOTAL		[12]	

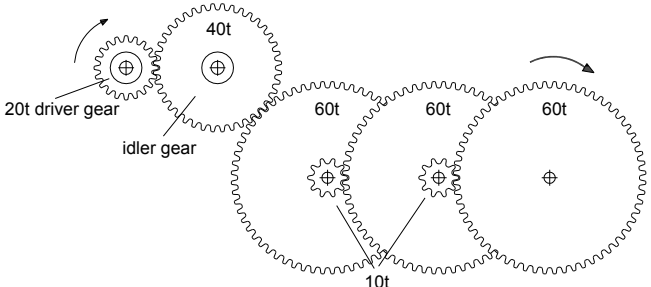
A514C 03 Mechanics Paper

Question	Expected Answer	Mark	Rationale		
Part A					
1	(a)		<p>1 mark for each correct label, 3 x 1.</p>  <p>The diagram shows a bolt and a nut. Three labels with arrows point to specific features: 'core diameter' points to the inner diameter of the bolt, 'outside diameter' points to the outer diameter of the bolt, and 'pitch' points to the distance between two adjacent threads on the bolt.</p>	[3]	
1	(b)		<p>Recognised methods will include:</p> <ul style="list-style-type: none"> • stiff nut / aerotight nut / nyloc; • split pin through nut and shaft; • 'loctite' type adhesive; • spring washer / star washer / shake proof washer; • two nuts locked together. <p>1 mark for suitable method</p>	[1]	

Question		Expected Answer	Mark	Rationale
1	(c)	<p>Benefits for open ended spanner could include:</p> <ul style="list-style-type: none"> • easy to fit onto nut with long or continuous thread; • often two sizes on one spanner; • greater tolerance on nut size; • not cranked, will fit into a smaller space. <p>1 mark for clear benefit.</p> <p>Benefits for ring ended spanner could include:</p> <ul style="list-style-type: none"> • more positive / better fit onto nut; • greater number of fitting positions; • angled head will help to prevent damage to knuckles; • less chance of slipping around nut. <p>1 mark for clear benefit.</p>	[1]	

Question		Expected Answer	Mark	Rationale
1	(d)	<p>Explanation could include elements of the following:</p> <ul style="list-style-type: none"> • Stock levels, less storage needed; fewer different orders to be placed; • Reduced costs for spare parts; research and development costs reduced • Same parts can be used for new or different designs; • Components are interchangeable; • Fewer specialist tools required for fitting. <p>Level 1 (0-2) marks Basic comments describing some of the benefits of standardisation. Restricted to the nuts, bolts, washers and springs examples..</p> <p>Level 2 (3-4) Adequate explanation, showing understanding of the implications of standard parts. At least one example used in the explanation.</p> <p>Level 3 (5-6) Clear explanation, showing an understanding of how components are used in manufacturing. Three different factors given with explanation of effect.</p>	[6]	
TOTAL			[12]	

Question			Expected Answer	Mark	Rationale
2	(a)	(i)	Lever 1 is first order , Lever 2 is third order . 1 mark for each.	[1] [1]	
2	(a)	(ii)	Features of the bell crank should include: Motion is transferred through 90°. Relies on tension in operating wire so one way motion only. No mechanical advantage as effort and load are an equal distance from fulcrum. Allow mark for other valid features of the crank. 2 x 1 marks	[1] [1]	
2	(b)	(i)	Support bars are pressed and shaped to increase rigidity and prevent bending. It will also increase the load bearing capacity of the shelf. 1 mark for a valid reason.	[1]	
2	(b)	(ii)	Motion conversion is from oscillating in arm A to reciprocating in pin B. Allow linear for pin B. 1 mark for each correct term.	[2]	
2	(c)	(i)	$90 \times 40 = 20 \times \text{load at Y}$, 1 mark. $3600 / 20 = \mathbf{180N}$, 1 mark. Allow 2 marks for answer with no working.	[2]	
	(c)	(ii)	ABS will be used because of: <ul style="list-style-type: none"> • strength and rigidity compared to other plastics; • it can be successfully injection moulded; • it is available in a range of colours; • it is more shockproof and will stand up to being dropped without fracturing. 2 x 1 marks for suitable reasons for choice of ABS.	[1] [1]	
2	(c)	(iii)	The load being moved is the resistance to compression of the spring .	[1]	
				Total	[12]

Question	Expected Answer	Mark	Rationale
3	<p>(a) (i) Reasons for gearbox in a servo motor could be:</p> <ul style="list-style-type: none"> • increase torque in output; • decrease in speed at output; • prevent the need for an external method of reducing speed at output. <p>2 x 1 marks for valid reasons.</p>	<p>[1] [1]</p>	
	<p>(a) (ii) Understanding that idler plays no part in the calculation, 1 mark Reduction ratios correct 3:1, 6:1, 6:1, 1 mark. Final ratio 108:1 1 mark</p>	<p>[3]</p>	
	<p>(a) (iii) Arrow to indicate clockwise motion at output, 1 mark.</p>  <p>The diagram shows a gear train starting with a 20t driver gear on the left. It meshes with a 40t gear. This 40t gear meshes with an idler gear. The idler gear meshes with a 60t gear. This 60t gear meshes with a 10t gear. Finally, the 10t gear meshes with a 60t output gear on the right. An arrow above the output gear indicates clockwise rotation.</p>	<p>[1]</p>	
3	<p>(b) Method of fixing could be keyway, spline, pin, or other recognised method. Clear description 2 marks. Allow 1 mark for use of welding.</p>	<p>[2]</p>	

Question		Expected Answer	Mark	Rationale
3	(c)	<p>Benefits of system 2, the worm gear will include:</p> <ul style="list-style-type: none"> • fewer gears in system; • less frictional loss; • cannot slip - will only operate one way; • takes up less space. • Will turn output through 90°[1] <p>2 x 1 mark for each valid benefit.</p>	[1] [1]	
3	(d)	<p>Oil is used as coolant as well as lubricant, Grease would not keep the contacting surfaces apart in a high speed system. Oil is better at removing metal fragments from teeth, grease could keep fragments in contact with working surfaces of gears. Clear explanation of one point, 2 marks. Less detail on two points, 2 marks, less detail on one point, 1 mark.</p>	[2]	
TOTAL			[12]	

Question			Expected Answer	Mark	Rationale
4	(a)	(i)	Distance moved by piston is 70mm , 1 mark.	[1]	
4	(a)	(ii)	Vertical supports each side of piston, 1 mark Evidence of how the supports are held on the backboard, 1 mark Use of enough thickness of side support to accommodate piston being 8mm away from backboard, 1 mark.	[3]	
4	(b)	(i)	Suitable shape for cam; any that will give a single rise and fall, (not snail cam), 1 mark. Cam in correct position with lobe touching valve stem, 1 mark.	[2]	
4	(b)	(ii)	Method could be compression spring under valve holding it against cam, rubber band holding valve base or stem to a fixed point. <ul style="list-style-type: none"> flexible fixing, e.g. spring or rubber band 1 mark; method of fixing to backboard or other parts of model, 1 mark; workable method, 1 mark. 	[3]	
4	(c)		Instructions on edge polishing will include: <ul style="list-style-type: none"> Preparation of edges using file, or plane, Removal of scratches with abrasive paper (wet and dry), Polishing using acrylic polish or using buffing machine, Use of two or more grades of abrasive 2 x 1 marks for clear instructions.	[1] [1]	
4	(d)		Environmental reason should relate to ease of recycling when dispose of, or ease of recycling at manufacturing stage, 1 mark.	[1]	
TOTAL				[12]	

Question			Expected Answer	Mark	Rationale
5	(a)	(i)	Benefits of using a CAD system for the designer could include: <ul style="list-style-type: none"> • ease of editing drawings; • mechanism can be simulated; • 3D CAD will allow model to be viewed from all angles; • Textures and finishes can be tried; • Calculations on centre of gravity, mass etc. carried out quickly. 1 mark for a valid benefit.	[1]	
5	(a)	(ii)	Benefits of using a CAD system for the manufacturer could include: <ul style="list-style-type: none"> • ease of storage and distribution of drawings; • drawings may not be needed; • ease of editing if design is modified; • rapid prototyping can be used; • can be taken straight to manufacturing machines (CAM). 2 x 1 marks for valid benefits.	[1] [1]	
5	(b)	(i)	Explanation to include: <ul style="list-style-type: none"> • ability to withstand axial and radial loading; • reduced friction when compared to plain bearing; • sealed bearing means no lubrication needed; • standard sizes so easily replaced. Clear explanation of one point, 2 marks. Less detail on two points, 2 marks, less detail on one point, 1 mark.	[2]	
5	(b)	(ii)	Other bearings could be: plain, tapered roller, needle. 1 mark.	[1]	

Question		Expected Answer	Mark	Rationale
5	(c)	<p>Explanation of safety factor could include elements of the following:</p> <ul style="list-style-type: none"> • Unknown loads applied, unknown materials used; • Over engineering to provide safety factor; • ISO and BSI tests to determine safe levels of use; • Understanding of maximum loading at which point a device could fail; • Reduction on the maximum to allow a difference between safe and maximum loads; • If a set load is expected item could be made to withstand 4 times the load, safety factor of 4. <p>Examples could be drawn from cranes, lifts, public transport, aircraft, ladders, lifting equipment and storage containers, e.g. compressed air or gases. Problem when in use should relate to manufacturer not being able to supervise the use of an item.</p> <p>Level 1 (0-2) Basic comments describing at least one example of a safety factor being used. No clear examples given and no reference to problem.</p> <p>Level 2 (3-4) Adequate explanation, showing understanding of designing in a safety factor. At least two examples used in the explanation. Some mention of problems facing manufacturer.</p> <p>Level 3 (5-6) Clear explanation, showing an understanding of consequence of no safety factor, examples used and thought given to problem of supervision of users. [6]</p>		
TOTAL			[12]	

Grade Thresholds

General Certificate of Secondary Education
Design and Technology (Electronic Control Systems) (J041 J301)

January 2010 Examination Series

Unit Threshold Marks

Component		Max Mark	A*	A	B	C	D	E	F	G
A512	RAW	60	50	44	38	33	27	21	16	11
	UMS	80	72	64	56	48	40	32	24	16

The total entry for the examination was 291*

* There were no entries for the other units, there was no aggregation.

Statistics are correct at the time of publication.

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