Pearson Edexcel

Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCSE
In Design & Technology (5EP02/01)

Paper: Knowledge and understanding of Electronic Products

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.

- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.

- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.

- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.

- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.

- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1	A	**(1)**
Question Number	Answer	Mark
2	D	**(1)**
Question Number	Answer	Mark
3	C	**(1)**
Question Number	Answer	Mark
4	B	**(1)**
Question Number	Answer	Mark
5	A	**(1)**
Question Number	Answer	Mark
6	C	**(1)**
Question Number	Answer	Mark
7	C	**(1)**
Question Number	Answer	Mark
8	B	**(1)**
Question Number	Answer	Mark
9	C	**(1)**
Question Number	Answer	Mark
10	D	**(1)**

Question Number	Answer	Mark
11(a)		**4**

• Ultraviolet (light) box • UV (light) box • UV (exposure) box/unit • (**Not** lightbox)	Used to expose photo sensitive / photo resist board
Diode	• Allows / directs current / electricity in one direction only • To prevent / block current going the wrong way • Prevents back/reverse EMF • Used as a rectifier (Accept any answer which exhibits understanding related to the above)
• Solenoid	An electromechanical component that converts electrical energy into linear motion
PCB rubber	• Clean copper tracks / PCB / circuit board • Remove coating / resist / emulsion / oxidation from copper tracks / PCB / circuit board **Do not accept references to removal of copper from tracks.**

4 x 1

Question Number	Answer	Mark
11(b)i	One from: • Relay • RL1 • Motor • Fan	**1**

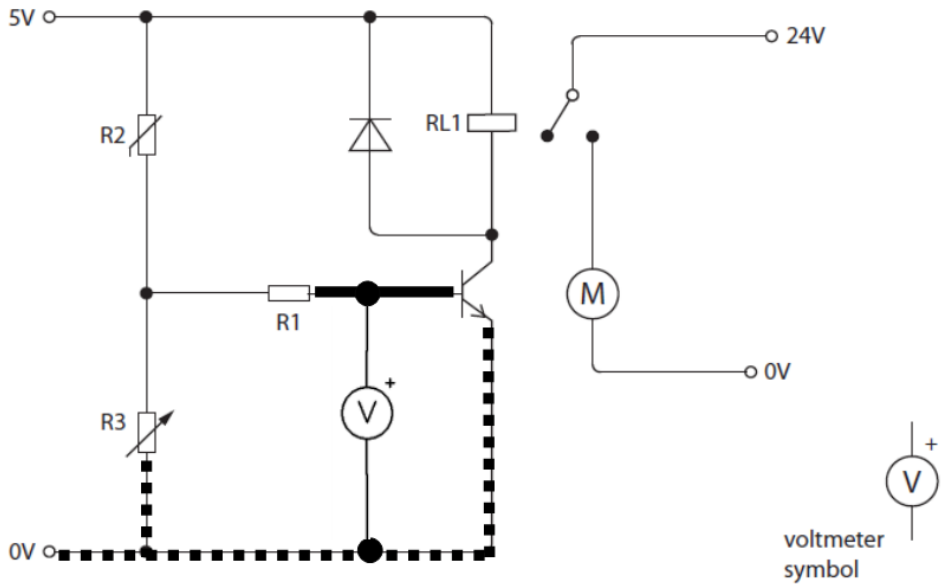
Question Number	Answer	Mark
11(b)ii	One from: • Thermistor • Variable resistor • Potentiometer • R2 • R3	**1**

Question Number	Answer	Mark
11(c)	One from: • The **<u>diode</u> (1)** protects transistor/it from a voltage spike/**<u>reverse EMF</u>**/back EMF/current flowing in the wrong direction **(1)** • The **<u>diode</u> (1)** is there to safely prevent the current flowing through the transistor/it by offering the path of least resistance / dissipate the current **(1)** Accept references to flyback/flywheel/clamp diode or other appropriate terms One from: • The **<u>resistor at base/R1/fixed resistor</u> (1)** protects transistor/base from **<u>excess current</u> (1)** • transistor/base/it is protected by **<u>Current limiting</u>** (1) **<u>resistor at base/R1/fixed resistor</u>** (1) **Accept**: identification of component (1) justification (1). **Understanding must be evident.** **It must be clear that candidates are referring to the correct component.**	**4**

Question Number	Answer	Mark
11(d)	**One from:** • Connects a low voltage circuit and a high voltage circuit **remotely** (1) so that a more **powerful** motor can be used (1) • Acts as a **non-physical** interface between/connects a primary and secondary circuit (1) so that a **higher voltage** motor can be used (1) • Allows the **high voltage** motor to be activated by the thermistor circuit (1) without being **physically** connected (1) • The low voltage circuit is **protected from the high voltage** secondary circuit (1) because it is **physically isolated** (1) Accept answers which exhibit understanding relating to the **non-physical connection** between the circuits and the use of a **higher voltage** in the secondary circuit.	**2**

Question Number	Answer	Mark
11(e)	**One from:** • It is a **variable resistor**/resistance can be changed (1) to **adjust the temperature** level which triggers the circuit (1) • It allows you to change/**set the temperature** at which the output turns on/off (1) by **adjusting the voltage levels** at the transistor/base (1) • It allows you to **calibrate** the circuit (1) so that the **temperature** level which switches on the output can be **adjusted** (1) • You can use it to **adjust resistance** (1) to **change temperature** which switches on the fan (1) • It is part of an **adjustable potential divider** circuit (1) which **sets the temperature** which activates the fan (1) **Accept** appropriate combinations.	**2**

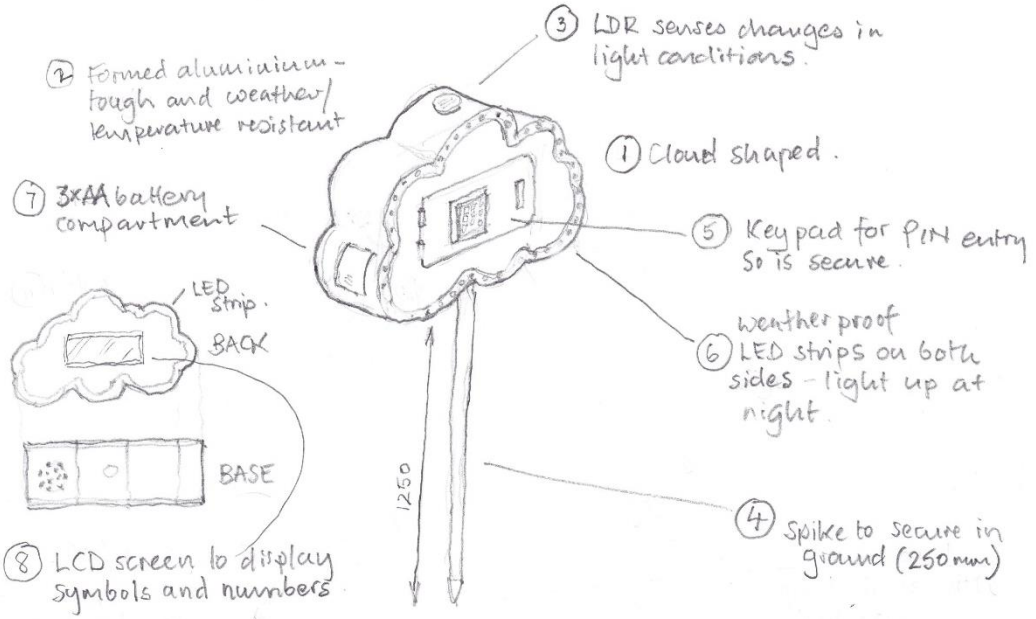
Question Number	Answer	Mark
11(f) i	• Ammeter/Multimeter **(1)**	**1**

Question Number	Answer	Mark
11(f) ii	• Voltmeter needs to be connected to the areas of the circuit below (1)  Accept answers which correctly connect the printed voltmeter symbol in the question. Accept answers which connect existing symbol correctly Do not penalise omission of 'junction' symbols	**1**

Question Number	Answer	Mark
12	**Design idea** **No marks are awarded for the quality of graphical communication.** • **Have a weather theme** e.g. appropriate graphics, 'weather shape' such as clouds, raindrop *(visual)* • **Be made from materials which are weather proof** e.g. Acrylic, HIPS, Aluminium, ABS. Exterior grade timbers such as teak, cedar. Treated or painted pine/MDF/mild steel – or – stainless steel, aluminium/brass/copper/glass – or – appropriate alternative *(annotated)* • **Be able to sense a change in weather conditions** e.g. LDR, thermistor, propeller, motor and propeller, anemometer, moisture sensor *(visual and annotated)* • **Be able to be fixed securely, 1 metre above the ground in open fields** e.g. post, wide base, guide wires, holes and pegs, weighted base, constructed platform – **at least** 1m above ground *(visual and annotated/dimensioned)* • **provide a secure means of access to the electronic circuit** e.g. key lock, keypad for PIN entry, PTMs for PIN entry (at least 3 for PIN), padlock, tamper proof screws (**not** e.g. DPDT) *(visual and annotated)* • **Be visible at night** e.g. light source: LED, backlit/colour LCD (**not** LCD alone), bulb/lamp, Fluorescent/Phosphorescent/Glow-in-the-dark paint/stickers/polymer Must be light emitting rather than reflective *(visual and annotated)* • **Have an independent power supply** e.g. named battery such as 9v, PP3, AA, AAA, coin cells rechargeable, solar/wind power, wind-up (**not** e.g. direct USB, mains) *(annotated)* • **Have an output which can display different symbols, letters and numbers** e.g. dot matrix display, LED dot matrix display, LCD (**not** e.g. 7 segment display) *(visual and annotated)* *Visual*: must show solutions – no annotation necessary unless solution is unclear *Annotated*: Must label to identify specific component or to clarify answer *Visual and annotated*: Must show solution and label to identify specific component or feature	

Design idea 1

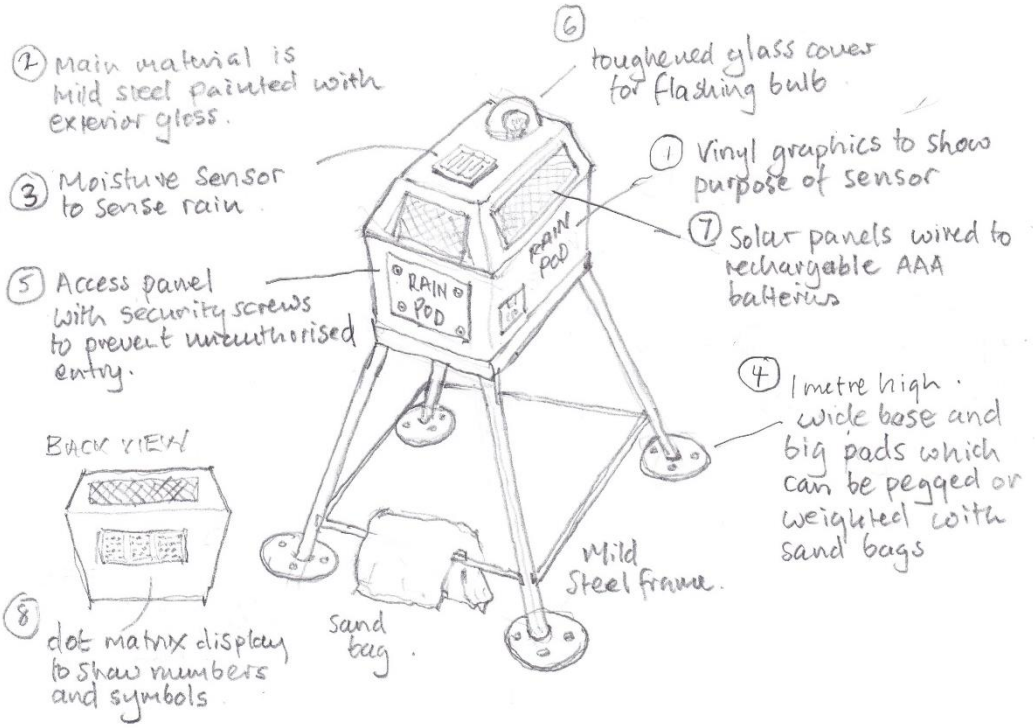
Example of candidate response: **8**



Design idea 2

Marks for design idea 2 can only be awarded where specification points are resolved in a technically different approach compared with solutions in design idea 1.

Example of candidate response: **8**



Question Number	Answer	Mark
13(a) i	• It has powerful **fans** (1) which **cool** laptop/processor/stops laptop from overheating/improves performance (1) • It has a grill with lots of **holes** (1) which allow air to flow **freely** (1) • It has fold out **tabs** (1) to prevent laptop/tablet **falling** off the stand (1) • Aluminium **grill** (1) acts as a heat sink to keep the tablet **cool** (1) **Accept** appropriate combinations. **Accept**: identification of feature (1) justification (1) Do **not** accept **'strong'** or similar unless qualified/accompanied by a technical point Do **not** credit information repeated from question stem for justification	**2**
Question Number	Answer	Mark
13(a) ii	• **Adjustable** angle/aluminium bar (1) more **comfortable**/ergonomic/screen can be seen at the right angle (**not simply 'adjustable to any angle/position')** (1) • Fold out **tabs** (1) stops laptop **slipping** off (1) • Allows greater **freedom**/easier to **multi-task** (1) as **hands** do not have to be used to hold laptop/tablet (1) **Accept** appropriate combinations. **Accept**: identification of feature (1) justification (1) Do **not** accept **'strong'** or similar unless qualified/accompanied by a technical point Do **not** credit information repeated from question stem for justification Do **not** accept the same answer/justification for both questions (i) and (ii).	**2**
Question Number	Answer	Mark
13(b)	Any **two from**: • **Light weight**/Low density/ high strength to weight ratio (1) makes it portable (1) • **Corrosion resistant** (1) will not be damaged by moisture if drink is spilled on it (1) • **Malleable** (1) so bar can be formed/bent into shape (1) • **Tough/durable** (1) impact resistant, will last a long time/resistant to damage/will not break/shatter if something is dropped on it (1) • **Thermally conductive**/good conductor of heat (1) helps to cool laptop/tablet (1) • **Softer** than other metals (1) easier to machine/create holes (1) • **Aesthetically pleasing**/adds a premium feel/look to the product (1) attracting more customers/increased sales (1) **Accept** appropriate combinations. **Accept**: identification of property (1) justification (1) Do **not** accept **'easy/simple to use'/'cheap'/'strong'/'recyclable' or similar** unless qualified/accompanied by a technical point.	**4**

Question Number	Answer	Mark
13(c)	• You can control **wall thickness**/create **solid** component (1) better rigidity/optimise design of stand (1) • Vacuum forming requires a **larger draft angle** (1) limiting design/form/shape possible of stand (1) • Injection moulding is more suitable for **mass production** of stand (1) because it is more automated (1) • **Full automation** is possible (1) Lower cost-per-part of stand compared to vacuum forming/lower wage costs (1) • Close **tolerances/intricate** details are possible (1) to achieve relatively complex form of stand (1) • Requires very little **post-production** work (1) reducing costs/unit production time of stand (1) • Very little **waste** (1) scrap from stand can be reground to be reused (1) • Vacuum forming could result in **webbing** (1) because of complex form/shape of stand (1) • Can use **inserts/fillers** within the mould (1) for added strength of stand (1) • **More than one material** can be used/**co-injection** moulding (1) so the stand could be reinforced/strengthened (1) • **Features/holes** can be formed (1) reducing need for e.g. drilling operations (1) Accept 'opposite' explanations e.g. 'Injection moulding does not require such a large draft angle …' **Accept** appropriate combinations. Do **not** accept repeated points or repeated expansions. Do **not** accept generic terms such as **'easy/simple to use'/'cheap'/'accurate'/'fast' 'strong/strength'** or similar generic terms, in **isolation**, unless justified with appropriate technical point.	**4**

Question Number	Answer	Mark
13.(d)	It is important to reward the range and depth of knowledge and understanding exhibited in candidate responses. L3 answers should expand points beyond the obvious, in some detail, and display high levels of knowledge and understanding. The tabulated bullet points are only indicative of areas which might form a basis of discussion and do not represent an effective way of answering the question. The points below **<u>are not exhaustive</u>** and other appropriate responses should be accepted.	**6**

- Only one area (Function or Sustainability) addressed maximum L2
- Generalised lists may gain little or no credit.
- Bullets or tables are limited to L2 at most but only if high levels of understanding and comparative argument are evident. Most generic lists are likely to be L1 or zero.
- Accept references to other areas such as Form or Material requirements if related by the candidate to Function or Sustainability.

HIPS/Aluminium stand	Pine stand
Function	
• Function of stand is to hold laptop/tablet to make it **easier/more comfortable** to use • Function of stand is to be **desk standing** – and is not designed to use on lap • Function of **fans/larger grill** for more effective cooling • Function of **holes** is to allow airflow • Function of stand is to be **adjustable** – has several positions for comfort/to suit different users • Function of **curved edges** designed to be safe • Function of **fold up tabs** stop slippage • Function of stand is to be allows it to be **folded flat** so more compact • It is **smaller** therefore more portable • Function of HIPS and aluminium is partly to provide protection from **liquid damage**	• Function of stand is to hold laptop/tablet to make it **easier/more comfortable** to use • Function of stand is to **bridge body** when **seated** so more comfortable /can be used on couch/in bed • Function of stand is designed to be **foldable** but it is less compact • Function of table allows it to be **adjustable** – can be tilted • Fan cooling – Function of **fans and large holes** carved in wood to allow airflow from fan to protect/improve performance • Designed to be **larger**, therefore heavier – but larger size facilitates more features/larger working area so more functional • The stand incorporates storage **drawer** – with the function to store accessories • Function of **recessed storage** area – for cup or e.g. paper clips to stop them sliding off • Function of **carved fan holes** to make stand more attractive • Function of **curved edges** designed to be safe/ergonomic • Function of **struts** added is to strengthen design • **Varnish** provides protection from liquid damage

Sustainability	
• HIPS is a plastic/polymer which is not **biodegradable** so will persist in landfill sites • HIPS is derived from crude oil which can damage the environment during **extraction** • HIPS is **recyclable** so can be turned into other products • HIPS is **not widely recycled** so needs to be sent to specialist companies • HIPS produces **toxic emissions** when burnt which need to be filtered • Aluminium **extraction and processing** can damage the environment • Aluminium needs to be **imported** adding to carbon footprint • Aluminium extraction and processing uses a lot of **energy** • Aluminium is **widely recycled** so can be processes by local recycling centres • Forming processes such as injection moulding require **energy** but are highly efficient • The stand could be **easily disassembled** into separate materials for sorting	• Pine is **renewable** resource if it is sourced from managed forests/FSC accredited suppliers • Pine can be **sourced locally** so has less environmental impact • Pine **can be recycled** but is not widely recycled so needs to be sent to specialist companies • Pine is **biodegradable** so will rot away in landfill sites • Pine can be **burnt** to recover energy • Pine **finishes** such as varnish can be toxic if burnt • The **extraction and processing** of mild steel can damage the environment • Mild steel extraction and processing uses a lot of **energy** • The stand could be **disassembled** into separate materials for sorting as it is held together by nuts and bolts • The stand requires **more processes** such as sawing and sanding so is not produced as efficiently

Question Number	Exemplar L3 answer (NOTE: to check)	Mark
13.(d)	Both stands have ergonomic, adjustable components which allow them to perform their function of making laptop use more comfortable. However, the form of stand A suggests that it is used on a table whereas stand B is designed to be used on a chair. The larger grill of stand A suggests that it would cool the laptop more effectively helping to improve the performance and lifespan of the laptop. The smaller form and use of light weight HIPS and aluminium make stand A more portable. However, stand B does have more features such as the place holder which would prevent items sliding off and the drawer which could be used to store accessories, but does not have fold out tabs to stop the laptop sliding off. Both stands are made from recyclable materials. However only aluminium is widely recycled so can be processed locally reducing the environmental impact of transport. However, pine is the only renewable material evident especially if it is sourced from managed forests. Nevertheless, the stand A would involve more efficient manufacturing processes such as injection moulding which would use less energy. In summary, stand A would appeal to users who want a more portable product to be used on a desk whereas stand B might appeal to more environmentally aware consumers who want more features such as storage.	

Level	Mark	**13.(d)** Descriptor
	0	No rewardable material
Level 1	1-2	Candidate identifies the area(s) of comparison with no development OR identifies and develops one area. Shows limited understanding of the comparison. Writing communicates ideas using everyday language but the response lacks clarity and organisation. The candidate spells, punctuates and uses the rules of grammar with limited accuracy.
Level 2	3-4	Candidate identifies some areas of comparison with associated developments showing some understanding of the comparison. Writing communicates ideas using D&T terms accurately and showing some direction and control in the organising of material. The candidate uses some of the rules of grammar appropriately and spells and punctuates with some accuracy, although some spelling errors may still be found.
Level 3	5-6	Candidate identifies a range of areas of comparison with associated developments showing a detailed understanding of the comparison. Writing communicates ideas effectively, using a range of appropriately selected D&T terms and organising information clearly and coherently. The candidate spells, punctuates and uses the rules of grammar with considerable accuracy.

Question Number	Exemplar L3 answer (NOTE: to check)	Mark
13 (d)	Both stands have ergonomic, adjustable components which allow them to perform their function of making laptop use more comfortable. However, the form of stand A suggests that it is used on a table whereas stand B is designed to be used on a chair. The larger grill of stand A suggests that it would cool the laptop more effectively helping to improve the performance and lifespan of the laptop. The smaller form and use of light weight HIPS and aluminium make stand A more portable. However, stand B does have more features such as the place holder which would prevent items sliding off and the drawer which could be used to store accessories, but does not have fold out tabs to stop the laptop sliding off. Both stands are made from recyclable materials. However only aluminium is widely recycled so can be processed locally reducing the environmental impact of transport. However, pine is the only renewable material evident especially if it is sourced from managed forests. Nevertheless, the stand A would involve more efficient manufacturing processes such as injection moulding which would use less energy. In summary, stand A would appeal to users who want a more portable product to be used on a desk whereas stand B might appeal to more environmentally aware consumers who want more features such as storage.	

Question Number	Answer	Mark
14(a)	• Senses **<u>light/when it is dark</u>** (1) Changes **<u>resistance</u>** (1) • Changes **<u>resistance</u>** (1) in response to changing levels of **<u>light</u>** intensity (1) **Accept** answers which exhibit understanding of **changing resistance** in response to **changing light levels** Do **not** accept LDR/Light Dependent Resistor in isolation without description.	**2**
Question Number	Answer	Mark
14 (b)	• **<u>Compares the voltages/signals</u>** (1) at the inverting and non-inverting **<u>inputs</u>** (1) • **<u>Compares the voltages/signals</u>** at the inputs (1) and **<u>amplifies the difference</u>** (at the output) (1) • When **<u>voltage/signal at one input rises above</u>** the voltage/signal at the other input (1) **<u>output changes</u>** (1) Candidates need to address the **operation of inputs** but credit can be awarded for answers which go on to describe operation of the output. **Accept** combination of references to: • Compares voltages / Changing relationship between input voltages (1) • Reference voltage / threshold voltage (1) • Changing output in response to changing inputs (1) • Inverting/non-inverting inputs (1) • Sourcing/sinking high/low outputs (1) • Gain (1) Do **not** accept '...amplifies voltage...' in isolation	**2**
Question Number	Answer	Mark
14 (c)	• Component X amplifies **<u>voltage</u>** (1) • Component Y amplifies **<u>current</u>** (1)	**2**

Question Number	Answer	Mark
14 (d)	Any 4 of the following: • Plastic/thermoplastic is **heated**/placed in oven **(1)** • Plastic/thermoplastic is **clamped** into the dome blower/machine **(1)** • Air/compressed air is **blown** into the dome blower **(1)** • The plastic **expands**/rises/stretches **(1)** • The plastic is allowed to **cool** down/**harden** **(1)** • The air is switched **off** / the product **unclamped**/removed **(1)** **Accept** any order. If **no** reference to injection of air maximum award of (maximum total 1). Do **not** accept references to preparation or post processes such as 'get acrylic/cut acrylic to size' or 'trimming'. Do **not** accept description of clearly different process, such as vacuum forming (total 0). Do **not** accept individual statements referencing e.g. mould (0). Do **not** accept one word answers – these do not constitute a description (0).	**4**

Question Number	Answer	Mark
14 (e)	A correct answer without working - 2 marks maximum **Accept** standard form / Apply **ECF** method / Award final calculation mark only when at least **one** other stage is correct. Examples:	**4**

V = IR	
R = V/I (or values arranged correctly)	Correct transposition of formula (1)
V = 9 – 3 = **6**	Correct voltage calculation (1)
I = 20mA = **0.02** A (or **20 x 10^{-3}** A)	Correct conversion from mA to A (1)
R = 6 / 0.02 = **300**	Correct calculation/answer (1)

R = 9/0.02	**2 marks**; one for arranging values in formula correctly / one mark for correct conversion of mA to A
R = 450	**1 mark**; Correct calculation
Total: 3 marks	

R = 3/0.02	**2 marks**; one for arranging values in formula correctly / one mark for correct conversion of mA to A
R = 150	**1 mark**; Correct calculation
Total: 3 marks	

R = 9/0.2	**1 mark**; one for arranging values in formula correctly
R = 45	**1 mark**; Correct calculation
Total: 2 marks	

R = 9/0.002	**1 mark**; one for arranging values in formula correctly
R = 4500	**1 mark**; Correct calculation
Total: 2 marks	

14(f) QWC: It is important to reward the range and depth of knowledge and understanding exhibited in candidate responses. L3 answers should expand points beyond the obvious in some detail and display high levels of knowledge and understanding. The tabulated bullet points are only indicative of areas which might form a basis of discussion and should not represent an effective way of answering the question. • Reward appropriate arguments • Do not credit repeated points or repeated expansions • No appropriate reference to either advantages and disadvantages or virtual modelling and breadboard modelling - max 4 marks. • Bullets or tables are limited to L2 at most but only if high levels of understanding and comparative argument are evident. Most are likely to be L1 or zero. For indicative content see table below:	**6**

Virtual modelling

Advantages	Disadvantages
• Component **values** can be adjusted easily • Completely **safe** – no electricity • Problems and **errors** can be addressed easily and inexpensively • Allows **experimentation** • Designs can be **saved** for future use • Designs can be **exported** electronically and almost instantly to all members of the design team • Can be used to **auto-route** PCB track pattern saving time and money • Component **library** and other features speeds up the process • Most designs can be **simulated** so problems can be identified before manufacture saving time and money • **Manufacture** ready designs can be sent electronically anywhere in the world allowing the designer to use the most cost efficient manufacturers • Can be used to generate engineering files and **parts** lists automatically, saving time and money • Virtual **testing** equipment can be used to check values are correct	• Although some software is freely available the best software needs to be **paid** for • Commercial software requires **modern computers** • Some auto-routing is not very **efficient** • Software can be hard to learn requiring expensive **training** • There may be **compatibility** issues • Computers can **crash** and work lost • Intellectual property on computers more open to **theft/hacking** • Does not always reflect real life / some component values do not give a true reflection of a circuit output and may not work.

Prototyping Board / Breadboard

Advantages	Disadvantages
• Components can be **moved** easily • Boards can be **reused** • No soldering is required so it is easy to change connections and **replace** components • Components will not be **damaged** so they will be available to re-use afterwards • Problems and **errors** can be addressed easily and inexpensively • Allows **experimentation** • Proves circuit will work in **real world**	• Complicated layout can be **confusing** • Circuits are **larger** • Process is **slower** • Temporary – prone to **loose** connections • Multiple/**complex** breadboards may be required for larger circuits

Level	Mark	Descriptor
	0	No rewardable material
Level 1	1-2	Candidate identifies the issues with no development OR identifies and develops one area. Shows limited understanding of the issues. Writing communicates ideas using everyday language but the response lacks clarity and organisation. The candidate spells, punctuates and uses the rules of grammar with limited accuracy.
Level 2	3-4	Candidate identifies some issues with associated developments showing some understanding of the issues. Writing communicates ideas using D&T terms accurately and showing some direction and control in the organising of material. The candidate uses some of the rules of grammar appropriately and spells and punctuates with some accuracy, although some spelling errors may still be found.
Level 3	5-6	Candidate identifies a range of issues with associated developments showing a detailed understanding of the issues. Writing communicates ideas effectively, using a range of appropriately selected D&T terms and organising information clearly and coherently. The candidate spells, punctuates and uses the rules of grammar with considerable accuracy.

Question Number	Exemplar L3 answer	Mark
13.(d)	Breadboard modelling allows designers to check that circuits work. Circuit design software does not always reflect real world conditions because ideal values are used and some variables are ignored. Faults can be identified and fixed using both methods but it is quicker to simulate and test circuits on computers because the software can flag problems such as overloaded components. It is much quicker and cheaper to get started with breadboard because modelling software can be expensive, requiring modern computers leading to high set up costs. There may also be additional cost implications as staff will need to be trained. All you need for breadboarding is some components and relatively inexpensive equipment. It is much easier to understand a circuit on screen and components or values can be changed more rapidly, speeding up the design process. It is also possible to collaborate with other designers and work can be saved and stored more easily for later use. Breadboard circuits can be confusing, especially if they are larger, requiring more than one board and take longer to develop as a result. In summary, breadboard circuits are used to test real world designs more effectively and cheaply but complicated designs can be developed more rapidly using software.	

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