



Mark Scheme

January 2018

Pearson BTEC Level 3 – Applied Science

Unit 1: Principles and Applications of  
Science

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# Unit 1: Applications of Science I – sample marking grid

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## General marking guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do, rather than be penalised for omissions.
- Examiners should mark according to the marking grid, not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks, if the learner's response is not rewardable according to the marking grid.
- Where judgement is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

## Specific marking guidance

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The marking grids have been designed to assess learner work holistically. Rows in the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

- Examiners should first make a holistic judgement on which band most closely matches the learner's response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer, in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band, depending on how they have evidenced each of the descriptor bullet points.

## Section A: Structures and functions of cells and tissues

Question Number	Answer	Additional guidance	Mark
1(a)	<p>Any two from:</p> <p>(cell membrane) channels to transport (water/ions) (1)</p> <p>partially/selectively/semi permeable cell membrane (to water/ions) (1)</p> <p>short distance across cell wall/thin cell wall (for diffusion)(1)</p> <p>mitochondria for {energy/ active transport}(1)</p> <p>vacuole for low water potential (1)</p> <p>doesn't contain chloroplasts for room for absorbed (of water) (1)</p>	<p>Credit any marking points if labelled in the diagram</p> <p>Allow canals</p> <p>ignore increased surface area</p>	2
1(b)	<p>Any two from:</p> <p>no/minimal light in the soil/roots not exposed to/can't get light (1)</p> <p>photosynthesis cannot take place/no photosynthesis (1)</p> <p>the genes for chloroplasts are not switched on in these cells(1)</p> <p>to allow more space for the organelles it does require/for absorbed water(1)</p>	<p>Allow underground</p>	2
total			4 marks

Question Number	Answer	Additional guidance	Mark
2(a)	(rough endoplasmic reticulum has) <u>ribosomes</u> (attached to its surface)	ORA  ignore anything else on its surface  allow contains ribosomes	1
2(b)	synthesis of proteins/assembly of amino acids (into protein/polypeptide)/produces proteins/named proteins (1)  formation of vesicles (1)  transport of proteins (1)	allow create/make protein  allow packaging /folding  allow supply  allow sends proteins to other parts of cell	2
total			3 marks

Question Number	Answer	Additional guidance	Mark
3(a)	(an organ) has a specific/vital/essential function(s)/e.g. of a function (1)  (and) consists of several tissues (1)	allow job  ignore whether tissues same or different  ignore examples of organs	2
3(b)	{secretion/production} of mucus (increases) (1)  (mucus) traps pathogens/named pathogen/stimulants/particles (1)  keeps the lungs moist/prevents drying out (1)	ignore context of cilia  ignore excrete	2
3(c)	any four from  MP1: (emphysema) is the {destruction/damage} of the (alveoli) {walls/membranes/septa/squamous epithelium/endothelium/ lining of the air sacs} (1)  MP2: (alveoli walls) thicken/scarring (1)  MP3: inflammation/swelling (of alveoli) (1)  MP 4: (abnormally) large(r) air spaces (in the lungs) (1)  MP 5: decreased surface area (1)  MP 6: no/reduced gas exchange/less diffusion of oxygen into blood (1)  MP 7: (alveoli) do not recoil/not stretchy/ lose elasticity (1)	allow air sac throughout for alveoli        Reduced surface area for gaseous exchange is awarded 2 marks   allow can't breathe out	4
total			8 marks

Question Number	Answer	Additional guidance	Mark
4(a)	<p>conversion (1) 0.004mm</p> <p>evaluation (1) <math>0.1/0.004 = 25</math></p> <p>OR</p> <p>conversion (1) <math>0.1 \times 1000 = 100</math></p> <p>evaluation (1) <math>100/4 = 25</math></p>	<p>25 alone gains 2 marks</p> <p>ECF evaluation</p> <p>allow power of ten error for one mark</p>	2
4(b)	<p>an explanation that makes reference to the following points:</p> <p>(aerobic) respiration/(lots of) ATP/energy (1)</p> <p>Any one from:</p> <p>reference to cell division (1) growth (1) {chemical/metabolic} reactions (1) DNA replication (1) protein synthesis (1) any valid named example (1)</p>	<p>allow make energy</p> <p>ignore references to reproduction or fertilisation or baby</p>	2
4(c)	<p>(zona pellucida) hardens/thickens/becomes impermeable (1)</p> <p>therefore prevents more (than one) sperm cell entering (the egg cell)/prevents polyspermy (1)</p>	changes is insufficient	2
total			6 marks

Question Number	Answer	Additional guidance	Mark
5(a)	<p>one from :            (myelin makes nerve impulse conduction){have a greater speed/faster}(1)</p> <p>(myelin) insulates (1)</p> <p>and one from:</p> <p>action potential generated only at the nodes(1)</p> <p>(because impulse) can jump {along axon/ from one node (of Ranvier) to the next}/saltatory conduction (1)</p> <p>(therefore) prevents loss of ions (1)</p> <p>helps maintain (electrochemical) gradient (1)</p>	<p>ORA throughout</p> <p>Allow signal/ message</p>	2
5 (b)	100 (mV)	<p>ignore any signs</p> <p>allow one hundred</p>	1



Question number	Indicative content
5 (c)	<ul style="list-style-type: none"> <li>• at A resting potential at <math>-70\text{mV}</math></li> <li>• sodium-potassium pump operating/ 3 <math>\text{Na}^+</math> out for every 2 <math>\text{K}^+</math> in</li> <li>• concentration gradient of sodium ions greater outside axon</li> <li>• inside of axon negative with respect to outside/ more + ions on outside of axon</li> <li>• polarised</li> </ul> <p>A-B</p> <ul style="list-style-type: none"> <li>• depolarisation occurs between A and B as</li> <li>• sodium ion channels open</li> <li>• permeability to sodium ions increases</li> <li>• sodium ions enter axon by diffusion</li> <li>• {increased/changed} membrane potential, <math>-70</math> to <math>-55\text{ mV}</math></li> <li>• threshold reached</li> <li>• all or nothing law</li> <li>• voltage-gated sodium ion channels open/ positive membrane potential/action potential at <math>+30\text{mV}</math></li> <li>• sodium ion channels close {at <math>+30\text{ mV}</math>/at B/at action potential}</li> </ul> <p>B-C</p> <ul style="list-style-type: none"> <li>• potassium ion channels open/stay open/close more slowly</li> <li>• permeability to potassium ions increases</li> <li>• potassium ions leave axon (rapidly) by diffusion</li> <li>• repolarisation</li> <li>• {hyperpolarisation/over shoot} at <math>-90\text{mV}</math></li> <li>• reference to refractory period/inability to fire another action potential as threshold cannot be reached</li> <li>• resting membrane potential (<math>-70\text{ mV}</math>) re-established at C</li> <li>• by sodium-potassium ion pump/by active transport of ions</li> </ul>
Total for question 5: 9 marks	

**Mark scheme (award up to 6 marks)** refer to the guidance on the cover of this document for how to apply levels-based mark schemes\*.

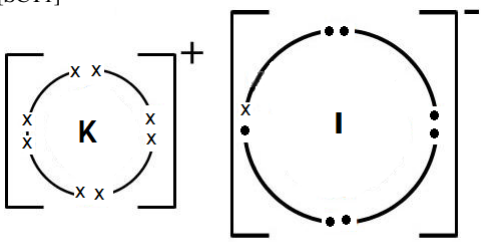
<b>Level</b>	<b>Mark</b>	<b>Descriptor</b>
	0	No awardable content
<b>Level 1</b>	1-2	<ul style="list-style-type: none"> <li>• Demonstrates adequate knowledge of scientific facts/concepts with generalised comments made</li> <li>• Generic statements may be presented rather than linkages being made so that lines of reasoning are unsupported or partially supported</li> <li>• The explanation shows some structure and coherence</li> </ul>
<b>Level 2</b>	3-4	<ul style="list-style-type: none"> <li>• Demonstrates good knowledge and understanding by selecting and applying some relevant scientific knowledge facts/concepts to provide the discussion being presented.</li> <li>• Lines of argument mostly supported through the application of relevant evidence</li> <li>• The explanation shows a structure which is mostly clear, coherent and logical</li> </ul>
<b>Level 3</b>	5-6	<ul style="list-style-type: none"> <li>• Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of scientific facts/concepts to provide the discussion being presented.</li> <li>• Line(s) of argument consistently supported throughout by sustained application of relevant evidence</li> <li>• The explanation shows a well-developed structure which is clear, coherent and logical</li> </ul>

## Section B: Periodicity and properties of elements

Question Number	Answer	Additional guidance	Mark
6 (a)	malleable/high melting point/unreactive/does not corrode	allow ductile  ignore high boiling point  ignore not very reactive  ignore does not rust  ignore strong	1
6 (b)	An explanation that makes reference to any <b>three</b> points from the following:  take marking points from clear diagrams  metallic structure (1)  {delocalised/sea of/free} electrons (1)  (electrons) move (1)  (electrons) carry (electric) {charge/current} (1)	allow metallic bonding  allow description of a metallic structure  ignore references to ions  allow transfer or pass for carry  do not allow to carry electricity	3
total			4 marks

Question Number	Answer	Additional guidance	Mark
7 (a)	substitution (1) $(2 \times 12) + (6 \times 1) + 16 =$  evaluation (1) 46	correct answer alone scores 2 marks  allow 1 mark for correct multiples  allow 1 mark for correct atomic masses used	2

7 (b)	<p>An explanation that makes reference to four of the following points:</p> <p>take marking points from clear diagrams</p> <p>water has the highest boiling point as it has {more/stronger} intermolecular forces (1)</p> <p>(therefore) more {heat/energy} needed to separate water molecules (1)</p> <p>explanation of hydrogen bonding (1)</p> <p>water has two hydrogen bonds per molecule (1)</p> <p>methanol and ethanol only have one hydrogen bond per molecule (1)</p> <p>explanation of Van der Waals (1)</p> <p>ethanol has (a higher boiling point than methanol as there are) more electrons/ ethanol molecule has larger surface area/ more carbons /ethanol is a larger molecule (1)</p> <p>(therefore), {more/stronger} {Van der Waals/intermolecular} forces in ethanol than methanol (1)</p> <p>stronger Van der Waals means that ethanol has a higher boiling point than methanol (1)</p>	<p>allow London dispersion forces/induced dipole/temporary dipole-dipole for Van der Waals</p> <p>allow ORA throughout</p> <p>hydrogen bonds are the strongest intermolecular force / Van der Waals forces are not as strong as hydrogen bonds (1)</p>	4
total			6 marks

Question Number	Answer	Additional guidance	Mark
8 (a)	$\text{KBr} + \text{AgNO}_3 \rightarrow \text{KNO}_3 + \text{AgBr}$  LHS (1) RHS (1)	max 1 mark for any attempt to balance but allow multiples for full marks  max 1 if lowercase used and/or superscripts  ignore state symbols  allow 1 mark for correct link from bromide to nitrate	2
8 (b)	(strong electrostatic) attraction between (oppositely charged) ions	reject atoms	1
8 (c)(i)	[SCT1]   one potassium (ion) and one iodide (ion) (1)  correct dots and crosses on ions (1)  correct charges on <u>both</u> ions (1)	max 1 for a covalent bond  ignore any inner electrons drawn  allow empty outer shell for potassium  allow no brackets around the ions  allow dots or crosses or a mixture of both	3

<p>8 (c)(ii)</p>	<p>calculation of number of moles: (1)</p> $\frac{16.6}{166} = 0.1$ <p>conversion of volume : (1)</p> $\frac{500}{1000} = 0.5$ <p>calculation of concentration (1)</p> $\frac{0.1}{0.5} =$ <p>evaluation: (1)</p> $= 0.2$ <p>OR</p> <p>calculation of number of moles: (1)</p> $\frac{16.6}{166} = 0.1$ <p>substitution (1)</p> $(0.1) = \frac{\text{concentration} \times 500}{1000}$ <p>rearrangement (1)</p> $\text{concentration} = \frac{0.1 \times 1000}{500}$ <p>evaluation (1)</p> $= 0.2$	<p>correct answer alone scores 4 marks</p> <p>allow ecf</p> <p>power of ten error (3)</p> <p>allow ecf</p> <p>power of ten error (3)</p>	<p>4 expert</p>
total			10 marks

Question Number	Answer	Additional guidance	Mark
9 (a)	D 4		1
9 (b)(i)	$O(g) + e^- \rightarrow O^-(g)$ (2)  correct formulae (1) correct state symbols (1)	allow -/e/electron for $e^-$  reject $O_2$  ignore state symbols on electron	2
9 (b)(ii)	$1s^2 2s^2 2p^5$		1

Question Number	Indicative content	Mark
9 (c)	<p>Responses may include the following.</p> <p>General</p> <ul style="list-style-type: none"> <li>• first ionisation energy is the energy required to remove one mole of electrons from one mole of atoms in their gaseous state</li> <li>• increase/rise in graph is because more energy is required to remove the electron(s)</li> <li>• because electrons are harder to remove</li> <li>• decrease/fall in graph means less energy is required to remove the electron(s)</li> <li>• because electrons are easier to remove</li> </ul> <p>increase Li to Be</p> <ul style="list-style-type: none"> <li>• in the same shell/s-orbital/energy level but increased nuclear charge/number of protons</li> </ul> <p>drop at B</p> <ul style="list-style-type: none"> <li>• electron is in the same quantum/energy level but an orbital further away from the nucleus / p orbital</li> <li>• less attraction on the electron/shielded by s orbital</li> </ul> <p>overall increase from B to Ne</p> <ul style="list-style-type: none"> <li>• (with increasing atomic number) there is an increasing nuclear charge/increasing number of protons</li> </ul> <p>drop at O</p> <ul style="list-style-type: none"> <li>• first electron to be removed is in a pair (in p orbital)</li> <li>• ionisation energies then continues increase due to increasing nuclear charge until Na</li> </ul> <p>drop at Na</p> <ul style="list-style-type: none"> <li>• electrons are in the third quantum/energy level (therefore) further away from the nucleus / more shielding is present</li> </ul> <p>increase from Na to Mg</p> <ul style="list-style-type: none"> <li>• increase in the charge of the nucleus/ number of protons</li> </ul> <p>Accept any other valid response.</p>	6 expert

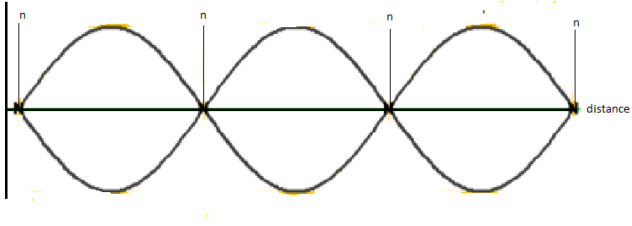


Level	Mark	Descriptor
	0 marks	<ul style="list-style-type: none"> <li>No rewardable material</li> </ul>
<b>Level 1</b>	1-2 marks	<ul style="list-style-type: none"> <li>Demonstrates adequate knowledge and understanding of scientific facts/concepts to the given context with generalised comments made.</li> <li>Generic statements may be presented rather than linkages to the context being made so that lines of reasoning are unsupported or partially supported</li> <li>The comparison will contain some similarities and differences showing some structure and coherence</li> </ul>
<b>Level 2</b>	3-4 marks	<ul style="list-style-type: none"> <li>Demonstrates good knowledge and understanding by selecting and applying some relevant scientific facts/concepts to provide the comparison being presented.</li> <li>Lines of argument mostly supported through the application of relevant evidence drawn from the context</li> <li>Demonstrate an awareness of both similarities and differences leading to a comparison which has a structure which is mostly clear, coherent and logical</li> </ul>
<b>Level 3</b>	5-6 marks	<ul style="list-style-type: none"> <li>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of scientific facts/concepts to provide the comparison being presented.</li> <li>Line(s) of argument consistently supported throughout by sustained application of relevant evidence drawn from the context</li> <li>The comparison shows a logical chain of reasoning which is supported throughout by sustained application of relevant evidence</li> </ul>
Total for question 9: 10 marks		

## Section C: Waves in communication

Question Number	Answer	Additional guidance	Mark
10 (a)	B - radio waves		1
10 (b)(i)	<p>An explanation that makes reference to the following:</p> <p>they can carry a lot of information/data (1)</p> <p>(because microwaves have a) high frequency / {high/wide} bandwidth (1)</p> <p>OR</p> <p>there is less/no {overlap/interference} (1)</p> <p>(because microwaves) can be divided into separate channels (1)</p> <p>OR</p> <p>they can travel {long distances /to satellite} (1)</p> <p>(because microwaves are) not absorbed by/pass through the (Earth's)atmosphere/ionosphere</p>	<p>ignore any references to low frequency and health</p> <p>accept short wavelength for high frequency</p> <p>accept less noise/ there is a clear signal</p> <p>accept long range</p>	2

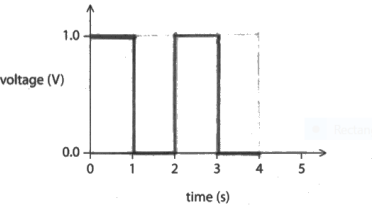
10 (b)(ii)	<p>An explanation that makes reference to the following:</p> <p>disruption of signals/signal lost/signal attenuated /signal blocked (1)</p> <p>(because of) buildings/hills/mountains/obstacles/underground or they diffract less or rain /water (vapour) in the atmosphere or not in line of sight (1)</p> <p>OR</p> <p>data/information is not secure (1)</p> <p>can be hacked (1)</p>	<p>ignore any references to low frequency and health</p> <p>accept signal or energy reduced/ signal cannot reach (everywhere)</p>	2
total			5 marks

Question Number	Answer	Additional guidance	Mark
11 (a)(i)	(Q =) displacement	ignore units	1
11 (a)(ii)	<p>any position labelled node with an N (1)</p> 	accept more than one correct node	1

11 (b)	<p>Substitution (1)</p> $16.2 = \sqrt{\frac{T}{0.30}}$ <p>Squaring both sides (1)</p> $262 = \frac{T}{0.30}$ <p>Rearrangement (1)</p> <p>(T =) 262 x 0.30</p> <p>Evaluation (1)</p> <p>(T =) 78.7 (N)</p>	<p>allow substitution and rearrangement in either order</p> <p>262.44</p> <p>16.2<sup>2</sup> x 0.3 is worth 3 marks</p> <p>accept for 2 marks  16.2 x 0.3  (16.2 x 0.3)<sup>2</sup>  16.2 x 0.3<sup>2</sup></p> <p>accept any number that rounds to 79 (N), 80(N)</p> <p>78.7 alone gains full marks</p> <p>POT error gains 3 marks</p> <p>Selecting the correct formula gains one compensation mark if no other mark is awarded</p>	4
total			6 marks

Question Number	Answer	Additional guidance	Mark
12 (a)	600 (nm)		1

12 (b)(i)	<p>An explanation that makes reference to any <b>two</b> to the following:</p> <p>there is constructive {superposition/interference/waves} (for all wavelengths or frequencies) (1)</p> <p>the path differences (from the diffraction grating) are identical (1)</p> <p>(all) {wavelengths/waves} are in phase (1)</p>	<p>Ignore references to destructive interference</p> <p>accept 'a peak/trough (from one part of the grating) will always meet a peak/trough (from another part of the grating)'</p> <p>for peaks/ troughs accept maxima / minima</p> <p>accept coherent for in phase</p>	2
12 (b)(ii)	<p>An explanation that makes reference to any four from the following:</p> <p><b>at the diffraction grating; -</b></p> <p>(sunlight is made up of colours/waves with) different frequencies or wavelengths (1)</p> <p>the angle through which the light {diffracts/changes direction/bends} depends on {wavelength / frequency} (1)</p> <p><b>on the screen a pattern of coloured bands is produced because: -</b></p> <p>constructive interference occurs when the path difference is a whole number of wavelengths (1)</p> <p>so</p> <p>each colour will meet/form a bright line at the screen in a different place (to each other) (1)</p>	<p>allow amount for angle suitable use of the equation <math>n\lambda = d \sin\theta</math></p> <p>allow in phase for path difference is <math>n\lambda</math></p> <p>allow bands for lines</p> <p>accept dark bands are produced by light from different parts of the grating meeting (with non-whole number of path-lengths /out of phase /destructive interference)</p>	4
total			7 marks

Question Number	Answer	Additional Guidance	Mark
13 (a)	<p>Two horizontal lines at 1 V (1)</p> <p>Each pulse one second (1)</p> 	<p>ignore starting point</p> <p>Ignore any part of diagram after four seconds</p> <p>Do not accept curves. triangular waves, crosses</p> <p>Diagram shown would be awarded two marks</p>	2
13 (b)	C      sampling data		1

13 (c)	<p>Substitution (1)</p> $\frac{3.0 \times 10^8}{2.0 \times 10^8} = \frac{\sin 30}{\sin r}$ <p>Rearrangement (1)</p> $(\sin r =) \frac{\sin 30 \times 2.0 \times 10^8}{3.0 \times 10^8}$ <p>OR <math>\frac{\sin 30}{1.5}</math></p> <p>OR <math>\frac{0.5}{1.5}</math></p> <p>OR <math>\sin 30 \times \frac{2}{3}</math></p> <p>OR <math>\sin r = 0.33</math></p> <p>Evaluation (1)</p> <p>19.47 (°)</p>	<p>allow substitution and rearrangement in either order</p> <p>any of these seen <b>anywhere</b> in calculation are worth 2 marks</p> <p><math>\sin 30 \times 0.67</math> (or 0.6 recurring)</p> <p>allow 19.5° , 19° alone gains full marks</p> <p>48.59 °/49° is awarded 2 marks Correct but inversion of values at start</p> <p><math>\sin 30 \times 0.66</math> is awarded 1 mark seen anywhere in calculation</p> <p>Selecting the correct formula gains one compensation mark if no other mark is awarded</p>	3
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Question number	Indicative content
13 (d)	<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• signals carry more information / data <b>because</b> the signal can be multiplexed / multiple channels (frequencies) used /greater bandwidth</li> <li>• signals are resistant to hacking <b>because</b> they are more secure /can be encrypted</li> <li>• breaking the cable to eavesdrop is very hard without being detected</li> <li>• signal can be regenerated <b>so</b> there is little/no loss of information <b>OR so</b> it can be used over very long distances</li> <li>• less susceptible to noise/(electrical) interference <b>so</b> a better-quality output is produced /clear(er) signal</li> <li>• the broadband rate of information transfer (speed) of optical fibres is greater <b>because</b> light has great(er) range of frequencies / high(er) frequency</li> <li>• data can be directly used by devices <b>because</b> most devices use digital systems</li> <li>• no loss of data at the (digital) device <b>because</b> there is no interface / need to convert signal</li> <li>• less energy wasted/lost <b>because</b> of total internal reflection (TIR)</li> </ul> <p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• digital signals use a greater bandwidth than analogue signals <b>so</b> more channels are needed to transmit data</li> <li>• information /data can be scrambled/lost <b>because</b> of sampling errors</li> <li>• they easily damaged /broken (if bent too much) <b>because</b> they are fragile/brittle</li> <li>• jointing/repair of optical fibres is difficult <b>so</b> needs specialist equipment/technician /is expensive</li> <li>• poor joints lead to loss of signal strength, <b>so</b> signal is poor</li> </ul>



		<ul style="list-style-type: none"> <li>{handshaking/ synchronisation} needs to take place <b>so</b> that devices can {transfer information/talk to each other}</li> </ul>
<p><b>Mark scheme (award up to 6 marks)</b> refer to the guidance on the cover of this document for how to apply levels-based mark schemes*.</p>		
Level	Mark	Descriptor [SCT2]
	0	No awardable content
<b>Level 1</b>	1-2	<ul style="list-style-type: none"> <li>Demonstrates adequate knowledge of scientific facts/concepts with generalised comments made</li> <li>Generic statements may be presented rather than linkages being made so that lines of reasoning are unsupported or partially supported</li> <li>The explanation shows some structure and coherence</li> </ul>
<b>Level 2</b>	3-4	<ul style="list-style-type: none"> <li>Demonstrates good knowledge and understanding by selecting and applying some relevant scientific knowledge facts/concepts to provide the discussion being presented.</li> <li>Lines of argument mostly supported through the application of relevant evidence</li> <li>The explanation shows a structure which is mostly clear, coherent and logical</li> </ul>
<b>Level 3</b>	5-6	<ul style="list-style-type: none"> <li>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of scientific facts/concepts to provide the discussion being presented.</li> <li>Line(s) of argument consistently supported throughout by sustained application of relevant evidence</li> <li>The explanation shows a well-developed structure which is clear, coherent and logical</li> </ul>