AQA

Level 3 Certificate/Extended Certificate
APPLIED SCIENCE
ASC3
Unit 3 Science in the Modern World

Mark scheme

January 2023

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.1	1 000 000 000		1	AO1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.2	any **two** from: • explains the scientific terms • key words in bold • written like a story • refers to familiar items such as Lego • sub-headings / simple language makes it easier to read.		2	AO3

Total Question 1		3

Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.1	large surface area (of nanoparticles)		1	AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.2	(author has made) comparison between nanotechnology / nanomaterials and chemical pesticides		1	AO3
	because pesticides were thought to be safe when they were first used		1	
	but pesticides have caused a lot of damage		1	

Total Question 2		**4**

Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1	refers to a story / Microhands		1	AO3
	that was written in 1931 **or** that was written nearly 100 years ago		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.2	any **two** from: • they are examples of science fiction • the ideas are being used in nanotechnology • people may be familiar with these types of media • make the article more interesting.		2	AO3

Total Question 3		4

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	any **two** from: • not used to transport people • not injected into a person • used to navigate around atoms **or** made from atoms • uses wheels • used in a race.	allow no people in the car or not controlled from the inside allow molecular-sized allow fictional vehicle is shrunk small allow fictional vehicle is a submarine assume that the answer refers to the nanocar unless otherwise stated allow vice versa if it is clear that this is the fictional vehicle	2	AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.2	$\dfrac{1.8}{666\ 666\ 666}$ $= 2.7 \times 10^{-9}$		1 1	AO2

Total Question 4		**4**	

Question 5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1	(omega-3 oil is) not released until it reaches the stomach		1	AO3
	(so) there is no unpleasant taste	allow taste is disguised	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.2	any **one** from: • food technologist • biotechnologist • molecular technologist • product developer.	allow food scientist	1	AO1

Total Question 5		3

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1	lipid filled with water		1	AO1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.2	carry drug (and nanoparticles)	allow nanoparticles and drug are placed inside allow target drug at a particular area	1	AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.3	the particles heat up		1	AO3
	(layer of) liposome becomes more porous	allow lipids change from solid to liquid	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.4	monitor the effect (of the liposome / technique) on the human body / cell		1	AO1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.5	any **one** from: • (similar magnetic particles) already used in MRI scans • (we already know the) magnetic particles are compatible with the body • not invasive		1	AO3

Total Question 6		6	

Question 7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.1	any **one** from: • camouflage • avoid predators • sneak up on their prey • attract a mate • warning to other animals • absorbs heat.	allow to communicate their mood	1	AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.2	contractile fibres move the pigments		1	AO3
	when pigments are spread out chromatophore / cell is coloured	assume pigments are the subject of the description unless otherwise stated	1	
	when pigments are squeezed together chromatophore / cell is clear		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.3	gold		1	AO1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.4	copying living things		1	AO3

Total Question 7		**6**

Question 8

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08	any **two** from: • written by experts / scientists • peer-reviewed • refers to other scientists • referenced.		2	AO1

Total Question 8		**2**

Question 9

Question	Answers	Mark	AO/ Spec. Ref.
09	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 3 and apply a 'best-fit' approach to the marking.	9	AO3

0 marks	Level 1 (1–3 marks)	Level 2 (4–6 marks)	Level 3 (7–9 marks)
incorrect no answer	- uses **1** source and discusses advantages or disadvantages - discussion shows little attempt at structure - little use of scientific vocabulary	- uses **at least 2** sources and discusses advantages and / or disadvantages - discussion shows some attempt at structure - some use of scientific vocabulary	- uses **3 or 4** sources and discusses advantages and disadvantages - discussion is well-structured with minimal repetition or irrelevant points - good use of scientific vocabulary

Source	Advantages	Disadvantages
A	Substances behave differently so can be used differently on the nanoscale. Lots of good examples of use so far: - Nanowhiskers used to prevent dirt from penetrating the fibres of materials - Sunscreens coat skin with titanium dioxide particles to protect from UV rays - Nano-coatings for scratch resistant bumpers and anti-slip steps, corrosion resistant paints and wound dressings. Lots of potential uses in future: - Nanotubes are strong and can be very long so have uses such as carbon ladder to the stars - Nanochips used in computers, iPods, OLEDs – very small - Nanobots could be used for many things including repairing the human body or cleaning up dangerous environments. Without nanotechnology we would have no medicines, transportation, etc	Could harm human life as nanoparticles could be toxic to the body or the environment. We do not yet know what effects nanoparticles could have. Could nanobots run riot and destroy all life? Grey goo.

B	Examples of ways that nanotechnology is useful: • Medi-gels to stop bleeding in the human body without applying pressure • Improving wound healing • Use in self-repairing materials that break under stress • Tiny vehicles which could have lots of uses • Altering the taste and texture of foods.	Not really any disadvantages given except to say that all the examples are not yet fully developed and will still take time to perfect.
C	Magnetic nanoparticles could be used to deliver drugs to the body – precisely timed, non-invasive and specifically targeted location in body. Nanoparticles have been found which will allow this to happen as they are magnetic and heat up when in a magnetic field. Controlled by temperature. Can be prepared within minutes in the lab and can hold any water-soluble drug. Can be approved quickly as drugs are already approved.	Drugs have so far only been injected directly into the specific location required. The idea of using gradients of magnetic fields to push particles through the body to the target organ has not yet been developed. Not yet developed for drugs other than water-soluble ones at the moment.
D	Material developed that can change colour – can be used for camouflage and big colour-changing sheets. Changing size and shape of clusters will alter the colours. Heat or illumination cause the changes so easy to control.	Only a single layer has been developed so far so can only change to a single colour. Gold is used and will be expensive if a lot is needed.

Total Question 9		**9**

Question 10

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.1	$\left(\dfrac{80\ 000}{200}\right)$ = 400		1	AO2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.2	(1.5 × 10 000 000 =) 15 000 000		1	AO2
	$\dfrac{15\ 000\ 000}{100\ 000}$	allow incorrectly converted value divided by 100 000	1	
	= 150 (pages)	allow calculated answer using incorrectly converted value	1	

Total Question 10		**4**	

Question 11

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
11.1	$\dfrac{1\ 300\ 000\ 000\ 000}{325}$ = 400 000 000 **or** $\dfrac{1\ 300\ 000\ 000\ 000}{375\ 700\ 700}$ = 346 Structural steel is stronger than Kevlar		1 1	AO2 AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
11.2	material scientist		1	AO1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
11.3	any **two** from: • (Reason) graphene is stronger than Kevlar (Explanation) it won't break under pressure • (Reason) graphene is lighter than Kevlar (Explanation) it will be more comfortable to wear • (Reason) graphene is more stretchy than Kevlar (Explanation) it will absorb impact.	allow provides more protection	4	AO3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
11.4	product developer	allow product designer allow technologist	1	AO1

Total Question 11			**8**

Question 12

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
12.1	10 000 – 5 = 9995		1	AO2
	$\frac{9995}{10\,000} \times 100 = 99.95\%$		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
12.2	the number of transistors (per microchip) increases with time		1	AO3
	as size of transistor decreases the number of transistors (per microchip) increases		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
12.3		an answer of 48 000 000 000 **or** 48 000 000 thousand gains **3** marks		AO2
	6 000 000 doubled (= 12 000 000)		1	
	doubled 3 times (= 48 000 000)		1	
	multiplied by 1000 (= 48 000 000 000)		1	

Total Question 12			7