A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

Level 3 Certificate/Extended Certificate

APPLIED SCIENCE

Unit 3 Science in the Modern World

ASC3

Wednesday 18 January 2023 **Afternoon**

Time allowed: 1 hour 30 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

MATERIALS

For this paper you must have:

- **a clean copy of the pre-release SOURCES A, B, C and D**
- **a calculator.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do NOT write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do all rough work in this book. Cross through any work you do NOT want to be marked.**

INFORMATION

- **You will be provided with copies of the pre-release SOURCES A, B, C and D.**
- **There are two sections in this paper – SECTION A and SECTION B.**
- **You should answer all questions in each section. You should spend approximately 1 hour on SECTION A and 30 minutes on SECTION B.**
- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 60.**

ADVICE

Read each question carefully.

DO NOT TURN OVER UNTIL TOLD TO DO SO

SECTION A

This section is based on SOURCES A, B, C and D.

Answer ALL questions in this section.

0 1

SOURCE A is an article about nanotechnology from a website aimed at young people.

0 1 . 1

The nanometre is the unit used in nanotechnology.

How many nanometres are there in one metre? [1 mark]

Tick (✓) ONE box.

- ☐ **100 000**
- ☐ **1 000 000**
- ☐ **100 000 000**
- ☐ **1 000 000 000**

0 1 . 2

Describe TWO ways that the author of SOURCE A has made this article suitable for young people. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

[Turn over]

3

0 2

SOURCE A describes examples of products made using nanotechnology.

0 2 . 1

Why do nanoparticles make good catalysts? [1 mark]

0 2 . 2

The author of SOURCE A refers to chemical pesticides.

Chemical pesticides are NOT examples of products made using nanotechnology.

Explain why the author of SOURCE A refers to chemical pesticides. [3 marks]

[Turn over]

4

0 3 . 1

The author of SOURCE B makes the point that the ideas behind nanotechnology have been around for a long time.

Explain how the author of SOURCE B does this.
[2 marks]

0 3 . 2

SOURCE B refers to examples of media such as books, video games and films.

Suggest TWO reasons why the author included references to media in this article. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

[Turn over]

4

0 4

SOURCE B compares a nanocar constructed by scientist Ben Feringa to a fictional vehicle in the film 'Fantastic Voyage'.

0 4 . 1

The nanocar constructed by scientist Ben Feringa was different to the fictional vehicle.

Give TWO differences between the nanocar and the fictional vehicle. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 4 . 2

Formula 1 cars have a width of 1.80 metres.

Calculate the width of the nanocar.

Use information from SOURCE B.

Give your answer in metres. [2 marks]

Width of nanocar = _____ metres

4

0 5

SOURCE B describes ways that food manufacturers are using nanotechnology.

In one example, nanocapsules are used to add Omega-3 oil to foods to improve the nutritional value.

0 5 . 1

Explain the advantage of using nanocapsules rather than adding the Omega-3 directly to the food. [2 marks]

0 5 . 2

Give the name of the type of scientist employed by food manufacturers to develop ways to change the taste and texture of foods. [1 mark]

_____

_____

_____

[Turn over]

3

0 6

SOURCE C describes the development of a new technique to deliver drugs into the body.

The technique involves magnetic nanoparticles and liposomes.

0 6 . 1

What is a liposome? [1 mark]

0 6 . 2

What is the liposome used for in this technique? [1 mark]

0 6 . 3

Describe how placing the nanoparticles in a magnetic field allows the drug to be released. [2 marks]

0 6 . 4

Suggest ONE role of a pharmacologist when this technique is used with patients. [1 mark]

[Turn over]

0 6 . 5

New medical techniques must get regulatory approval to ensure they are safe to use with patients.

The author of SOURCE C believes that it should be easy to get regulatory approval for this new technique using magnetic particles.

Give ONE reason why it should be easy to get regulatory approval. [1 mark]

_____

_____

_____

_____

6

0 7

SOURCE D refers to animals like chameleons that can change the colour of their skin.

0 7 . 1

Suggest ONE reason why chameleons change the colour of their skin. [1 mark]

_____

_____

_____

[Turn over]

0 7 . 2

Chromatophores in the chameleon allow the colour change to take place.

Describe what happens to the pigments in the chromatophore that causes the colour change.
[3 marks]

0 7 . 3

The artificial chromatophores have nanoparticles instead of pigments.

What are these nanoparticles made from? [1 mark]

Tick (✓) ONE box.

- ☐ **Algae**
- ☐ **Gold**
- ☐ **Polymer**
- ☐ **Water**

[Turn over]

0 7 . 4

The co-author of SOURCE D, Sean Cormier, states that 'this work is a big advance in using nanoscale technology to do biomimicry'.

Suggest what Sean Cormier means by the term 'biomimicry'. [1 mark]

_____

_____

_____

6

0 8

SOURCES C and D were both published on a website called 'PHYS.ORG'.

Suggest TWO reasons why SOURCES C and D may be more reliable than newspaper articles. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

[Turn over]

2

0 9

Describe the advantages and disadvantages of the use of nanotechnologies described in SOURCES A, B, C and D. [9 marks]

[Turn over]

[Turn over]

[Turn over]

9

SECTION B

Answer ALL questions in this section.

1 0

TABLE 1 shows a selection of objects and their sizes measured in nanometres (nm).

Use TABLE 1 to answer Question 10.

TABLE 1

OBJECT	Size / nm
Length of bacterial cell	200
Diameter of human hair	80 000
Thickness of one piece of paper	100 000

1 0 . 1

Calculate how many bacteria would fit end to end across the diameter of a human hair. [1 mark]

Number of bacteria = _____

1 0 . 2

A 1.5 metre tall person is 1 500 000 000 nm tall.

A scientific journal is 1.5 cm thick.

Calculate how many pages the scientific journal has.
[3 marks]

Number of pages = _____

4

[Turn over]

1 1

Graphene is a nanotechnology material made from a single layer of carbon.

When graphene was first made in 2004, scientists claimed it was the strongest material in the world.

TABLE 2 shows data for three different materials.

Use TABLE 2 to answer Question 11.

TABLE 2

MATERIAL	Strength / arbitrary units	Mass of 1 cm^3 / g	Ability to stretch / % of original length
Graphene	130 000 000 000	0.64	20
Structural steel		7.85	0.002
Kevlar	375 700 000	1.44	2

1 1 . 1

Graphene is 325 times stronger than structural steel.

Compare the strength of structural steel with Kevlar.

Use a calculation to justify your answer. [2 marks]

1 1 . 2

Give the name of the type of scientist who would test graphene for properties such as strength and ability to stretch. [1 mark]

[Turn over]

Kevlar is a man-made fibre that is described as 'bulletproof'.

Graphene may be used instead of Kevlar to make helmets and body armour in the future.

1 1 . 3

Give TWO reasons why graphene may be better than Kevlar for making helmets and body armour.

Suggest an explanation for each of your reasons.

Use data from TABLE 2. [4 marks]

Reason 1 _____

_____

_____

Explanation _____

_____

_____

Reason 2 _____

_____

_____

Explanation _____

_____

_____

1 1 . 4

Give the name of the type of scientist who would design helmets and body armour made from graphene.
[1 mark]

_____

_____

[Turn over]

8

1 2

Computers process information using transistors on microchips.

The processing power of computers has increased over time.

TABLE 3 shows data about transistors from 1971 to 2020.

Use TABLE 3 to answer Question 12.

TABLE 3

YEAR	Size of a transistor / nm	Number of transistors / thousands per microchip
1971	10 000	2.5
1977	3000	29
1984	1000	275
1990	600	1180
1996	250	7500
2001	130	42 000
2014	14	6 000 000
2020	5	

1 2 . 1

One trend shown in TABLE 3 is that the size of a transistor has decreased from the year 1971 to 2020.

Calculate the percentage decrease in the size of a transistor from the year 1971 to 2020. [2 marks]

Percentage decrease = _____ %

[Turn over]

1 2 . 2

Describe TWO other trends shown in TABLE 3, on page 34. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

1 2 . 3

An American engineer, Gordon Moore, predicted that the number of transistors per microchip would double every 2 years.

This is known as Moore's Law.

Calculate how many transistors there were on a microchip in 2020.

Assume that the number of transistors continues to increase according to Moore's Law after 2014.

Use data from TABLE 3, on page 34. [3 marks]

Number of transistors = _____

END OF QUESTIONS

7

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

BLANK PAGE

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
TOTAL	

Copyright information

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2023 AQA and its licensors. All rights reserved.