AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

Level 3 Certificate/Extended Certificate
APPLIED SCIENCE

Unit 3 Science in the Modern World

Wednesday 18 January 2023 Afternoon Time allowed: 1 hour 30 minutes

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.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or 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.

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

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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?

Tick (✓) **one** box.

[1 mark]

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 _____

_____

3

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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]

4

Turn over for the next question

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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

4

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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

Turn over for the next question

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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]

3

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Turn over for the next question

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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]

Do not write outside the box

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

Turn over for the next question

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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]

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?

Tick (✓) **one** box.

[1 mark]

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

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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

Turn over for the next question

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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 _____

_____

2

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Turn over for the next question

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0 9 Describe the advantages and disadvantages of the use of nanotechnologies described in **Sources A**, **B**, **C** and **D**.

[9 marks]

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Extra space

9

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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

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Turn over for the next question

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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]

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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]

_____

8

Turn over for the next question

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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 = _____ %

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1 2 . 2 Describe **two** other trends shown in **Table 3**.

[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**.

[3 marks]

Number of transistors = _____

7

END OF QUESTIONS

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