

Surname	Centre Number	Candidate Number
Other Names		0



GCSE

4791/02

ADDITIONAL APPLIED SCIENCE

**UNIT 1: Science at Work in Applied Contexts
HIGHER TIER**

A.M. WEDNESDAY, 8 January 2014

1 hour

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	10	
2.	6	
3.	6	
4.	14	
5.	13	
6.	11	
Total	60	

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answer to question **4(b)** and **6(c)**.

You are reminded to show all your working. Credit is given for correct working even when the final answer given is incorrect.

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Answer all the questions in the spaces provided.

1. The alloy nitinol is a smart material made from nickel and titanium.

(a) Describe what is meant by a smart material.

[2]

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(b) The table shows some properties of nickel, titanium and nitinol.

Property	Nickel	Titanium	Nitinol
melting point (°C)	1453	1677	1310
density (g/cm ³)	8.9	4.5	6.5
electrical resistivity (Ωcm)	95×10^{-6}	53×10^{-6}	82×10^{-6}
thermal conductivity (W/cm °C)	0.91	0.91	0.18
tensile strength (MPa)	450	434	195

Compare the properties of the alloy nitinol with the pure metals it is made from.

[4]

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(c) The table gives information about different types of smart materials.

Type of smart material	Unusual property
Shape-memory alloy	If bent out of shape, when it is heated above a certain temperature it will return to its original shape.
Piezoelectric	If squeezed rapidly, it produces a small electrical voltage.
Electroluminescent	Give out light when an electric current is applied to them.
Thermochromic	Change colour as the temperature changes.
Polymer gel	Expands when it absorbs fluid.

State which type of smart material should be used for **each** of the following:

(i) disposable nappies; [1]

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(ii) frames for reading glasses; [1]

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(iii) sensors for alarm systems; [1]

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(iv) forehead strip thermometer. [1]

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2. A forensic scientist tests some powder from a crime scene, to find out the ions it contains. To do this, she must carry out flame tests and precipitation reactions on solutions of the powder.

Tests for Negative Ions

Negative Ion	Symbol	Test	Results
carbonate	CO_3^{2-}	add dilute hydrochloric acid	carbon dioxide gas is given off
chloride	Cl^-	add dilute nitric acid then silver nitrate	thick white precipitate
nitrate	NO_3^-	add iron(II) sulfate solution followed by concentrated sulphuric acid	brown ring forms
sulfate	SO_4^{2-}	add solution of barium chloride	white precipitate

Tests for Positive Ions

Positive Ion	Symbol	Test	Results
aluminium	Al^{3+}	add dilute sodium hydroxide solution	white precipitate that dissolves as more sodium hydroxide solution is added
copper	Cu^{2+}	add dilute sodium hydroxide solution	pale blue precipitate that does not dissolve as more sodium hydroxide is added
iron(II)	Fe^{2+}	add dilute sodium hydroxide solution	pale green precipitate formed
iron(III)	Fe^{3+}	add dilute sodium hydroxide solution	red-brown precipitate formed
lead	Pb^{2+}	add dilute sodium hydroxide solution	white precipitate that dissolves as more sodium hydroxide is added
magnesium	Mg^{2+}	add dilute sodium hydroxide solution	white precipitate that does not dissolve as more sodium hydroxide is added

Flame tests

Metal ion	Flame test colour
barium	yellow-green
calcium	red
copper	green
lead	blue
lithium	pink
potassium	lilac
sodium	orange

The forensic scientist carried out some of the tests on solutions of the powder. The tests and her observations are recorded in the table below.

Test	Observation	Conclusions
sodium hydroxide added	pale blue precipitate that did not dissolve as more sodium hydroxide added
flame test	green flame
hydrochloric acid added	carbon dioxide given off
nitric acid added followed by silver nitrate solution	thick white precipitate formed

- (i) **Complete** the table above to show the conclusions reached by the forensic scientist. [4]
- (ii) State the chemical formulae for **two** compounds in the powder. [2]

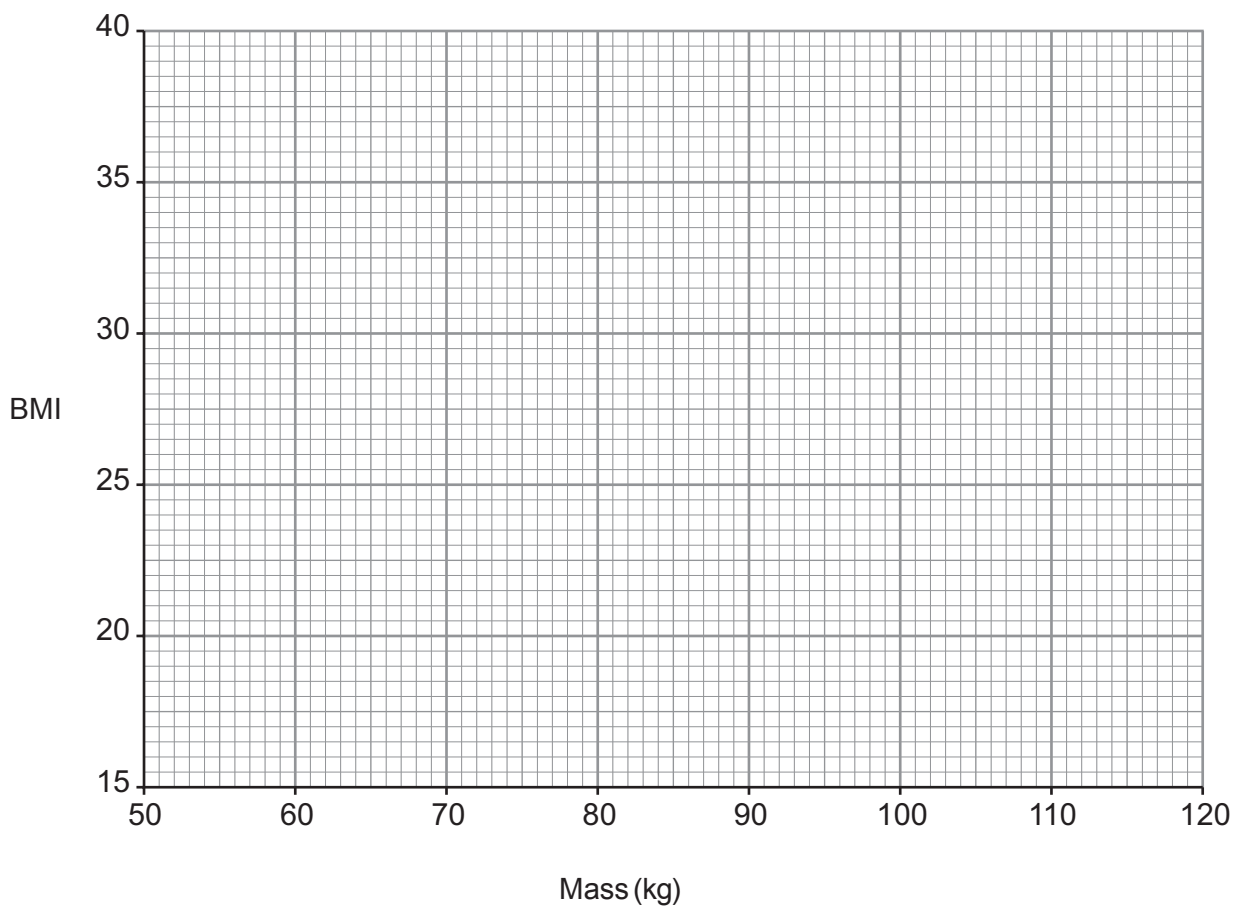
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3. The table shows how the Body Mass Index (BMI) of a 180 cm tall adult varies with mass.

Mass (kg)	BMI
50	15
60	19
80	25
100	31
120	37

- (a) (i) Use the data to plot a graph on the grid below.

[2]



- (ii) Use the graph to **estimate** the BMI for a mass of 90 kg.

[1]

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(b) BMI values indicate the following body types.

Underweight (< 18.5)

Normal (18.5-25)

Overweight (25-30)

Obese (> 30)

Use the information above to find the maximum mass of a 180 cm tall adult before they are classed as obese. [1]

..... kg

(c) The equation used to calculate BMI is given by:

$$\text{BMI} = \frac{\text{mass}}{\text{height}^2}$$

Use this equation to calculate the BMI for a **160 cm** tall adult who has a mass of 70 kg. [2]

BMI =

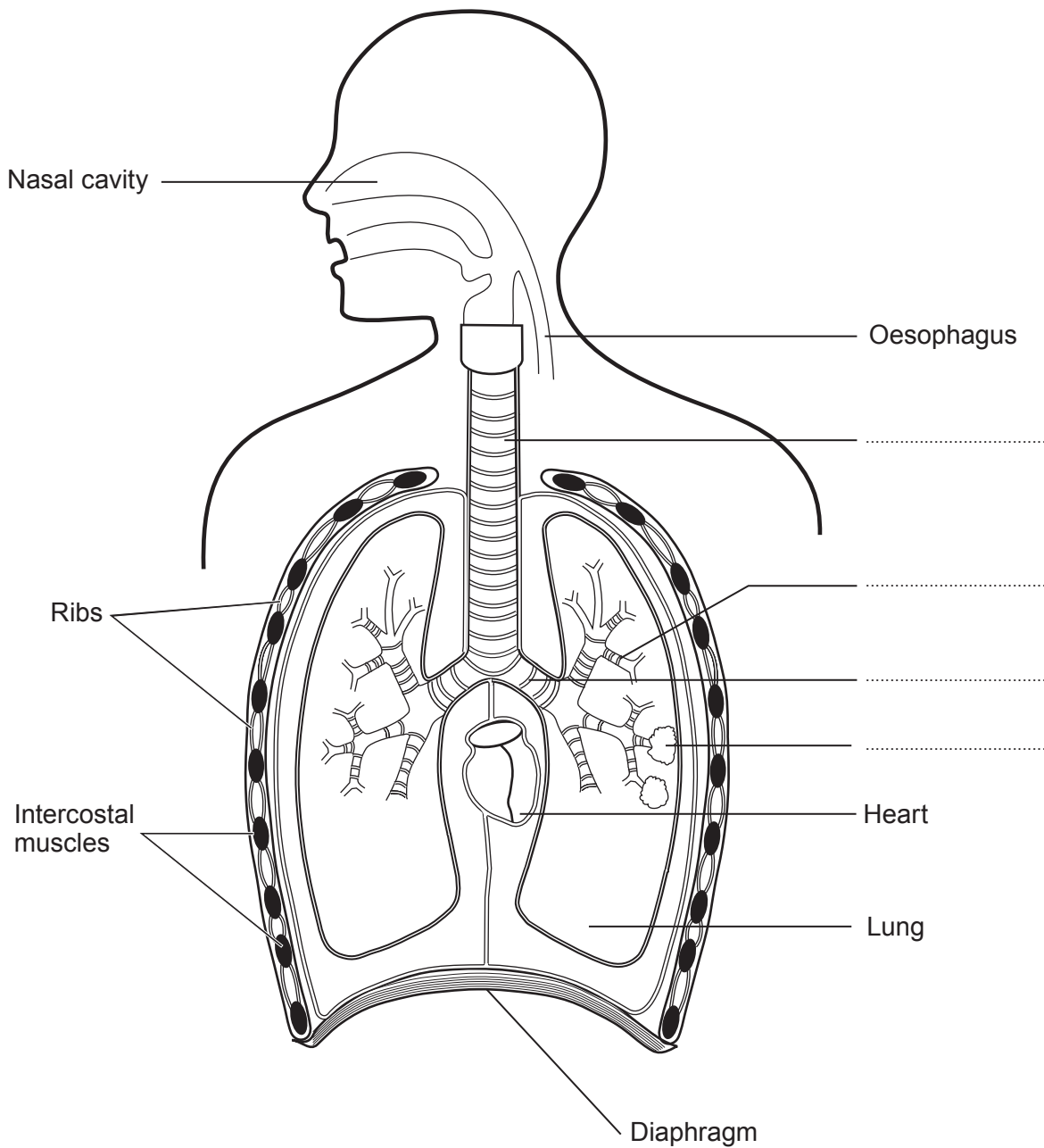
4. Some healthcare practitioners monitor our respiratory system.

(a) They need to be able to identify the parts of this system.

Label the following parts on the diagram below.

[3]

bronchiole	trachea	alveoli	bronchus
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(c) Inhaled air contains:

- 78 % nitrogen
- 21 % oxygen
- 0.04 % carbon dioxide
- a little water vapour

Describe how the content of exhaled air compares with inhaled air.

[3]

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(d) Explain why the breathing rate changes during exercise.

[2]

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5. The photograph shows images of a sprinter at different times during a training run. The images are taken at 0.1 s intervals.



- (a) (i) Describe how the body shape changes between **A** and **F**. [3]

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- (ii) What advice would a trainer give to the sprinter to improve his performance? [1]

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- (iii) Which letter shows the position of the sprinter 0.3 s after position **A**? [1]

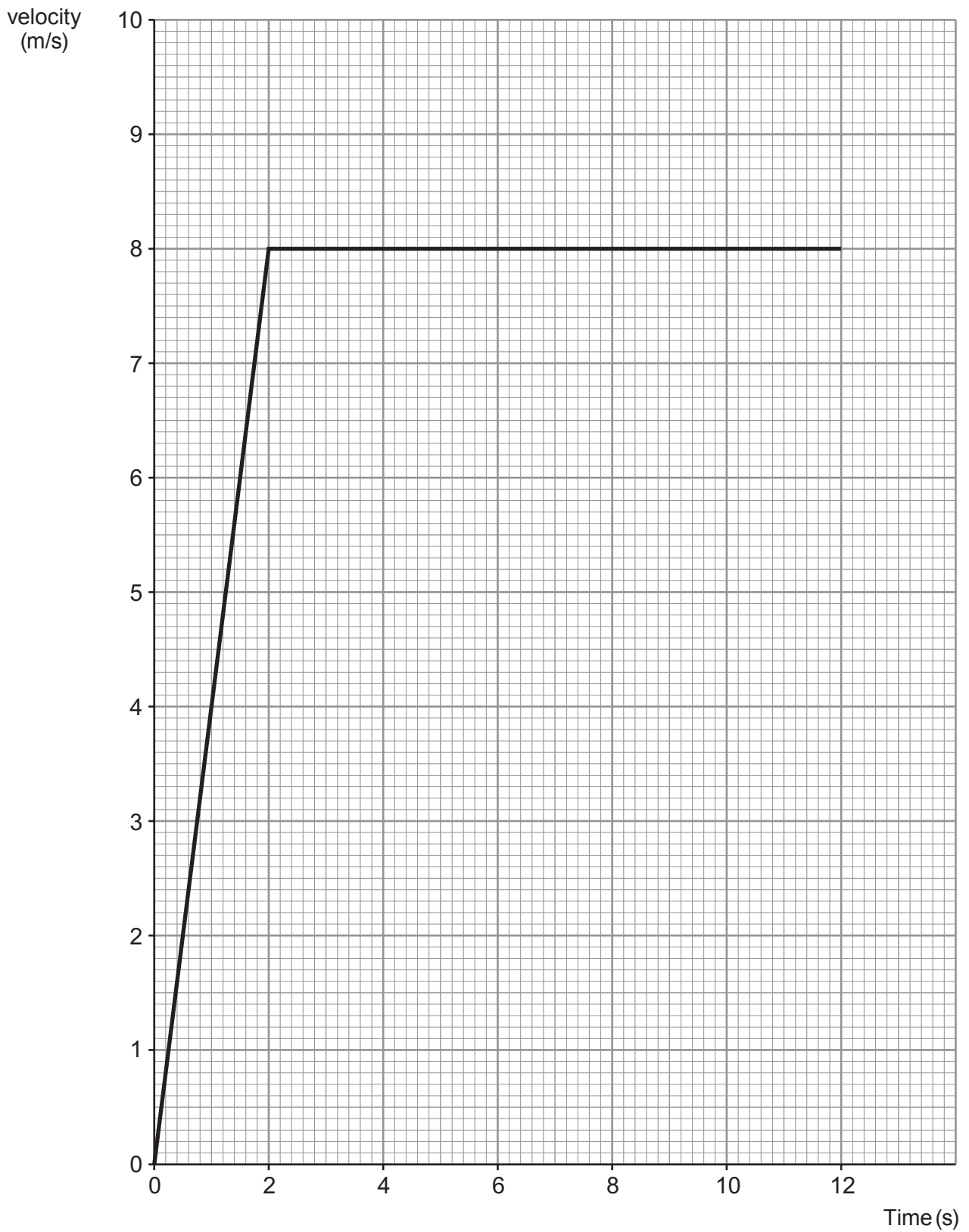
- (iv) The distance between **A** and **F** is 3m. [3]

Calculate the mean velocity of the sprinter over this distance using the equation:

$$\text{Mean velocity} = \frac{\text{distance}}{\text{time}}$$

Mean velocity = m/s

- (b) The graph below shows how the velocity of the sprinter changed during another training run.



- (i) Calculate the acceleration of the sprinter using the equation:

[2]

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$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$\text{Acceleration} = \dots\dots\dots \text{ m/s}^2$$

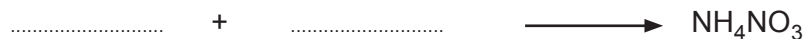
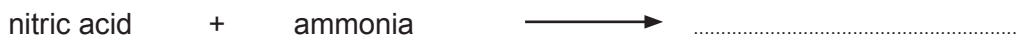
- (ii) Calculate the distance covered by the sprinter in the first 12 s of the training run. [3]

$$\text{Distance} = \dots\dots\dots \text{ m}$$

6. Fertilisers can be prepared by neutralisation reactions.

(a) One neutralisation reaction is shown in the equations below. [3]

Complete **both** equations.



(b) Name **two** substances, other than nitrates, which plants need from the soil for healthy growth. [2]

1.

2.

(c) Explain why the use of artificial fertilisers on farms can be harmful to fish. [6 QWC]

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