

Surname	Centre Number	Candidate Number
Other Names		0



GCSE

3445UA0-1



APPLIED SCIENCE (Double Award)
UNIT 1: Energy, Resources and the Environment

HIGHER TIER

WEDNESDAY, 12 JUNE 2019 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	11	
2.	8	
3.	11	
4.	11	
5.	6	
6.	12	
7.	16	
Total	75	

ADDITIONAL MATERIALS

In addition to this paper you will 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.

INFORMATION FOR CANDIDATES

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

Question **5** is a quality of extended response (QER) question where your writing skills will be assessed.

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

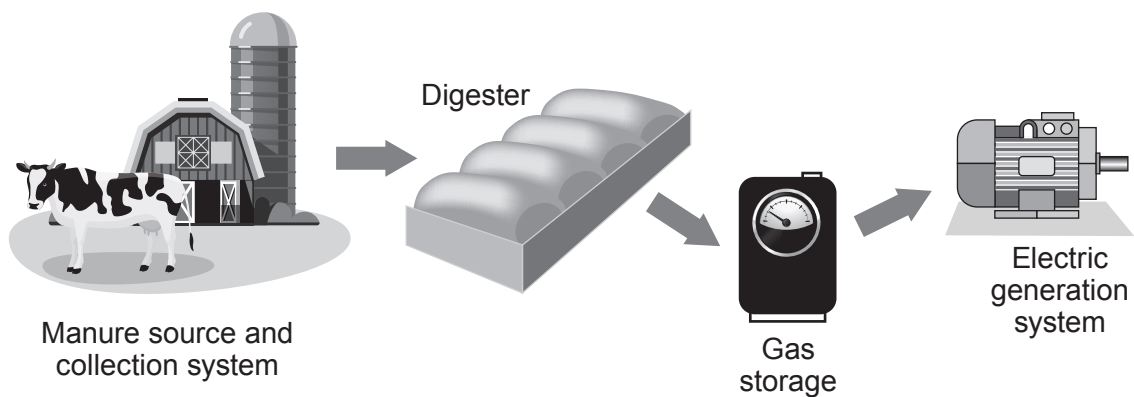
A periodic table is printed on page 16.

Answer all questions.

1. A farmer has installed a biogas generator to save money. The farmer's monthly electricity bill before installation was £3 000. The farmer spent £120 000 to buy and install the biogas generator. After installation the monthly electricity bill was expected to reduce to £600.

The biogas generator works by using the animal waste produced on the farm. This waste is digested by bacteria and the product, methane gas, is used to generate electricity. Methane is a greenhouse gas and produces carbon dioxide and water when it is burned

The animal waste used in the digester is a renewable energy source.



- (a) The biogas generator can provide some of the farm's electricity.

Use the information above to calculate the expected payback time for the biogas generator. [3]

Payback time = months

- (b) The farmer considered installing wind turbines to generate electricity before investing in the biogas generator.

Give **two** disadvantages of using wind power rather than the biogas generator. [2]

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(c) The biogas generator needs to produce 160 000 kWh of electricity per year to power the farm. A typical cow produces 10 tonnes of waste per year of which the farmer is only able to collect 3 tonnes. For every tonne of waste collected 480 kWh of heat energy is produced, which generates 160 kWh of electricity.

(i) Use the equation:

$$\% \text{ Efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100$$

to calculate the efficiency of this biogas generator [2]

% Efficiency =

(ii) The farmer owns 120 cows. He thinks that he will be able to collect enough waste to power his farm for a year. [4]

Explain whether you agree with the farmer. Show your workings as part of your answer.

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2. In a diffusion experiment, gelatin was mixed with a pink pH indicator and allowed to set. The gelatin was then cut into different sized cubes. The cubes were placed in a beaker containing dilute acid. As the acid diffused through the gelatin the cubes became colourless. The time taken to change from pink to colourless was recorded.

The surface area and volume of the cubes were calculated using the following equations:

$$\text{surface area of cube} = \text{length} \times \text{width} \times \text{number of sides}$$

$$\text{volume of cube} = \text{length} \times \text{width} \times \text{height}$$

- (a) The results of the experiment are shown below.

Length of side of gelatin cube (cm)	Time taken to become colourless (s)	Surface area of cube (cm ²)	Volume of cube (cm ³)	Surface area:volume ratio
1	20	6	1	6:1
5	41	150	6:5
7	104	343	6:7
10	610	600	1000

- (i) **Complete** the table. [3]
- (ii) Sarah suggested that diffusion of the acid into the gelatin is quicker in the smaller cubes because the time taken for them to become colourless is less. Explain whether you agree with Sarah. [2]

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(b) Red blood cells transport oxygen around the body to allow respiration to occur in the tissues. Red blood cells have a volume of 90 units and a surface area of 136 units. Explain how the surface area:volume ratio of red blood cells make them suitable for their function. [3]

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3. In 1912, Alfred Wegener suggested that all of the continents on Earth were once joined together in one supercontinent called Pangaea. These continents have since drifted apart. Wegener suggested a hypothesis called 'Continental Drift'. In the 1960's scientists further developed Wegener's hypothesis using a new theory called 'Plate Tectonics'.

(a) (i) State **three** pieces of evidence that Wegener used to support his hypothesis of 'Continental Drift'. [3]

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(ii) Explain the theory of 'Plate Tectonics'. [3]

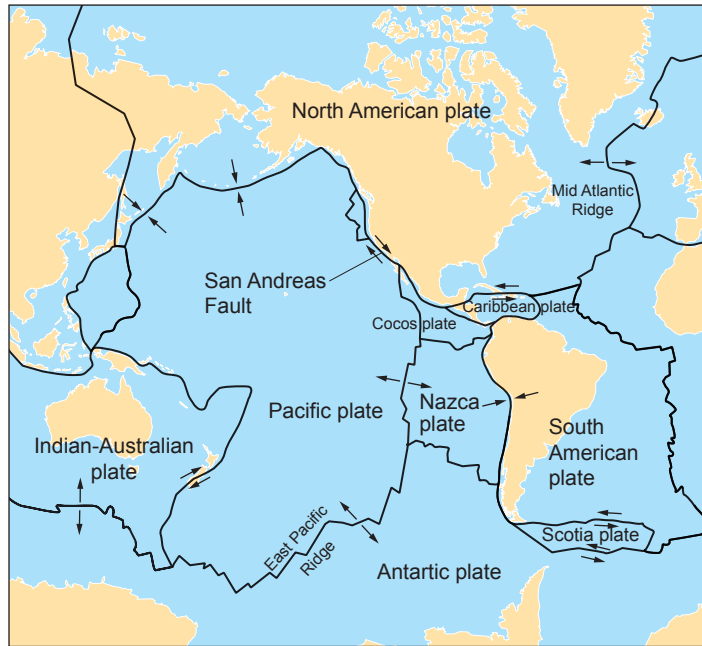
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- (b) The map below shows some of the tectonic plates on Earth and the arrows show the direction of their movement.



Tectonic plates move relative to each other and are monitored closely by geologists using a seismometer. The Pacific and North American plate are very closely monitored by the US government as large populations of people can be affected, especially in the state of California. The boundary between the Pacific and North American tectonic plates is described as a conservative boundary where the plates slide past each other causing powerful earthquakes. The San Andreas Fault lies on this boundary.

Tectonic plate boundaries can also be described as constructive and destructive.

- (i) **Label** on the map **one** constructive (C) and **one** destructive (D) tectonic plate boundary. [1]

- (ii) Describe these **two** types of boundary and the **consequences** of their movement.

Destructive [2]

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Constructive [2]

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4. Port Talbot steel works in South Wales is one of the largest in the UK. It produces 5 million tonnes of steel every year.

The materials required for the production of one tonne of iron are shown in the table below. The melting point of iron is 1535 °C.

- (a) Describe the purpose of the following raw materials in the blast furnace. [2]

Haematite

Limestone

- (b) The blast furnace relies on the processes of reduction and oxidation. In one stage carbon monoxide is formed from coke.

- (i) **Complete** the balanced symbol equation for the extraction of iron in the blast furnace. [3]



- (ii) State the substances that are reduced or oxidised in the reactions that must take place to produce iron in the blast furnace. [2]

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- (c) The materials required for the production of one tonne of iron are shown in the table below. The melting point of iron is 1535 °C.

Raw material	Mass of raw material (tonnes)	Cost per tonne of raw material (£)
haematite (iron ore)	1.75	60.50
coke	0.25	120.90
limestone	0.25	80.00
air	4.00	2.25

Calculate the **monthly** raw material cost, for the Port Talbot steel works. Give your answer to two significant figures. [4]

= £ million/month

6. Digestion of food is required to provide nutrition for the human body.

(a) (i) Explain how digestion provides nutrition. [2]

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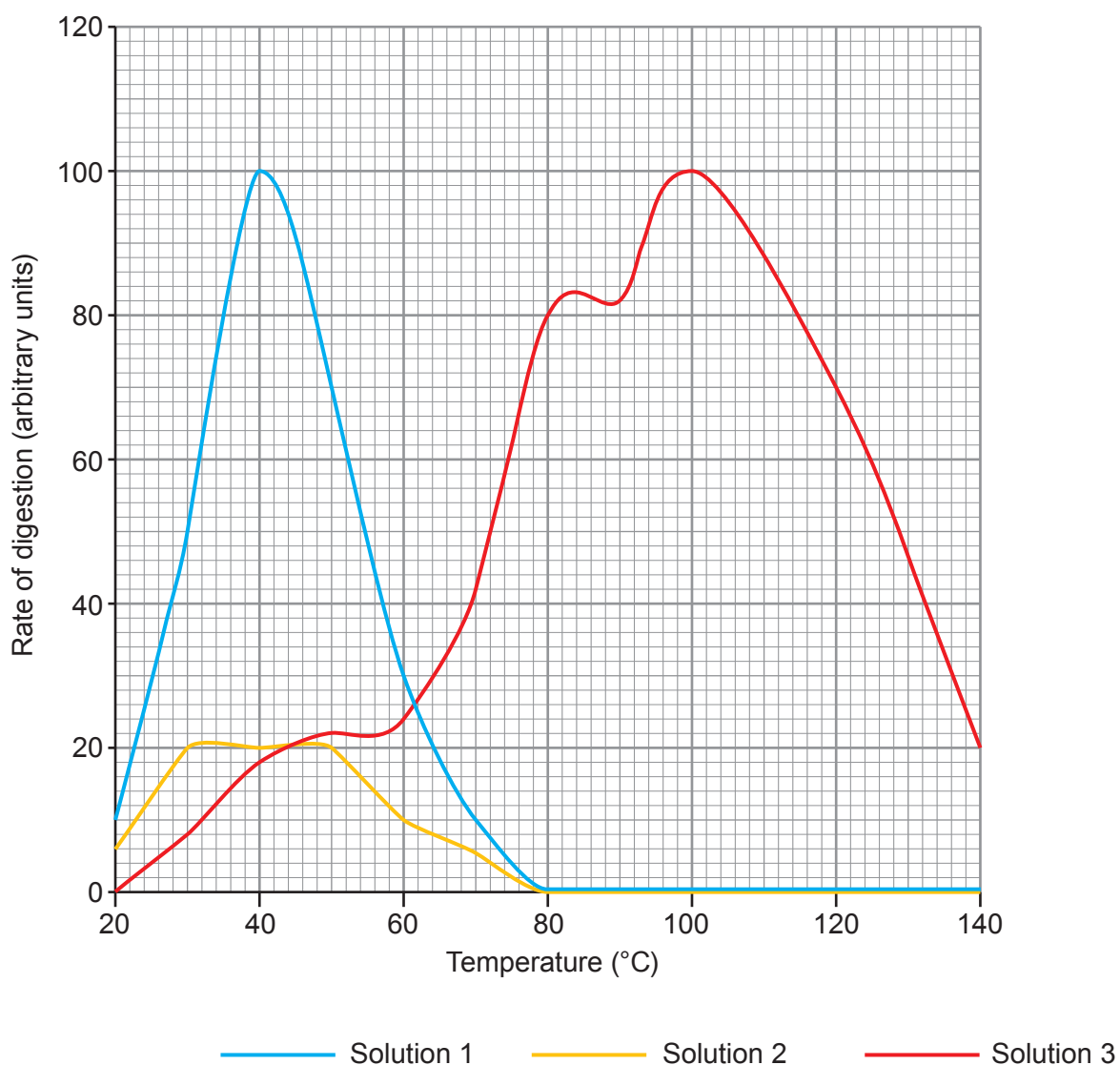
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(ii) Describe the process of peristalsis in the digestive system. [2]

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(b) A group of students were given two solutions of a human enzyme (**solution 1 and solution 2**) and one solution of bacterial enzyme (**solution 3**). All solutions were the same concentration and volume. They measured the rate of digestion using each enzyme solution. A computer calculated the rate of digestion and the results are shown below.



Use the data in the graph and your knowledge to answer the following questions.

- (i) Using the results for **solution 1**, describe and explain the effect of temperature on the rate of digestion between 20 and 60 °C. [4]

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- (ii) Suggest **one** reason why the results shown for **solution 2** are different to **solution 1**. [1]

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- (iii) State a suitable control in this experiment. [1]

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- (iv) **Solution 3** contains an enzyme from a species of bacteria that is found in a hot volcanic region.

Describe the differences between the action of this bacterial enzyme and the enzyme found in humans. [2]

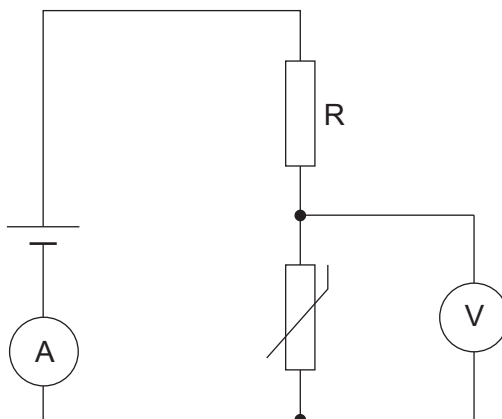
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7. Students were investigating the properties of circuits containing LDRs and thermistors.

(a) The students set up the following circuit.



The temperature of the thermistor was increased.

- (i) On the axes below, sketch how you would expect the resistance of the thermistor to change as the temperature increased. [1]

Resistance
(Ω)



Temperature ($^{\circ}\text{C}$)

- (ii) Explain how increasing the temperature of the thermistor affects the readings on the ammeter and voltmeter. [5]

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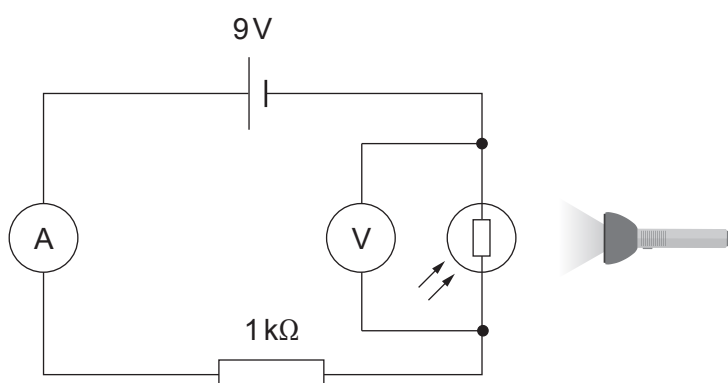
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(b) The students then investigated an LDR with a torch and the following circuit.



(i) State the independent variable in this experiment.

[1]

(ii) State the dependent variable in this experiment.

[1]

(iii) Use the equations:

$$R = R_1 + R_2$$

and

$$V = IR$$

to calculate the readings on the ammeter and the voltmeter in the circuit when the resistance of the LDR is 2.5 kΩ.

[5]

Ammeter: A

Voltmeter: V

- (iv) Describe how you would modify this investigation to determine the I-V characteristics of the LDR. [3]

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END OF PAPER

THE PERIODIC TABLE

Group 1 2 3 4 5 6 7 0

7 Li Lithium 3	9 Be Beryllium 4	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	59 Co Cobalt 27
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	103 Rh Rhodium 45
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	192 Ir Iridium 77
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89	227 Fr Francium 87	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89	227 Ac Actinium 89
70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	115 In Indium 49	119 Sn Tin 50
65 Zn Zinc 30	63.5 Cu Copper 29	59 Ni Nickel 28	59 Co Cobalt 27	56 Fe Iron 26	55 Mn Manganese 25	112 Cd Cadmium 48	119 Sn Tin 50
112 Cd Cadmium 48	108 Ag Silver 47	106 Pd Palladium 46	103 Rh Rhodium 45	101 Ru Ruthenium 44	99 Tc Technetium 43	127 I Iodine 53	131 Xe Xenon 54
201 Hg Mercury 80	197 Au Gold 79	195 Pt Platinum 78	192 Ir Iridium 77	190 Os Osmium 76	186 Re Rhenium 75	210 Po Polonium 84	222 Rn Radon 86
204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	204 Tl Thallium 81	204 Tl Thallium 81	204 Tl Thallium 81	210 Po Polonium 84	222 Rn Radon 86

1 H Hydrogen 1

Key

relative atomic mass

A_r	Symbol
	Name
Z	atomic number