

Energy part 2 AQA Triple Physics

Name:

Class:

Date:

Time:

71 minutes

Marks:

69 marks

Comments:

1.

Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 1 shows different-sized hailstones.

Figure 1



A hailstone falls from a cloud and accelerates.

(a) Why does the hailstone accelerate?

(1)

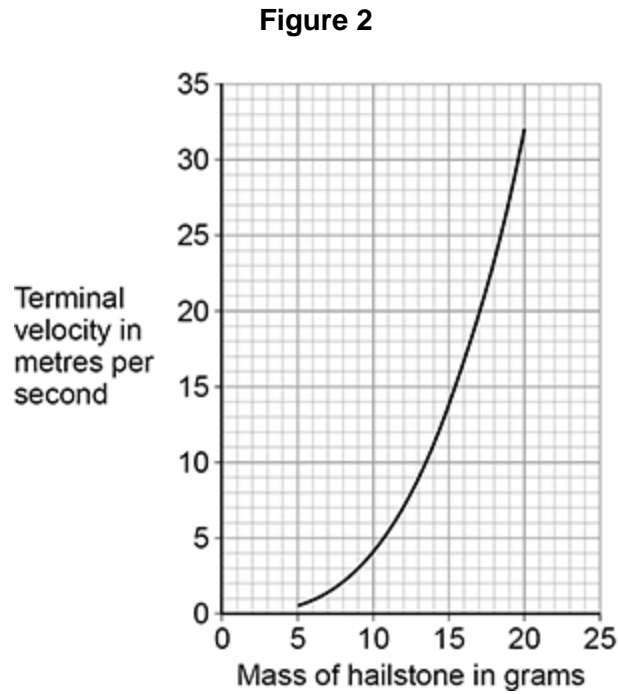
(b) The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

(3)

A scientist investigated how the mass of hailstones affects their terminal velocity.

Figure 2 shows the results.



(c) Why does terminal velocity increase with mass?

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases.

As mass increases the volume of a hailstone increases.

As mass increases the weight of a hailstone increases.

(1)

- (d) Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

(3)

- (e) The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

Tick (✓) **one** box.

1 N m

1 N/m

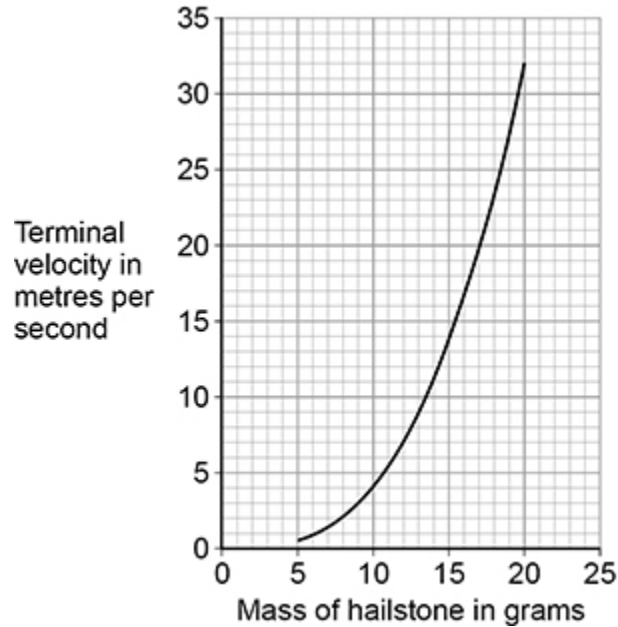
1 N/m²

1 N m²

(1)

Figure 2 is repeated below.

Figure 2



(f) A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took 0.060 s to stop moving.

Determine the average force on the hailstone as it hit the ground.

Use information from **Figure 2**.

Use the Physics Equations Sheet.

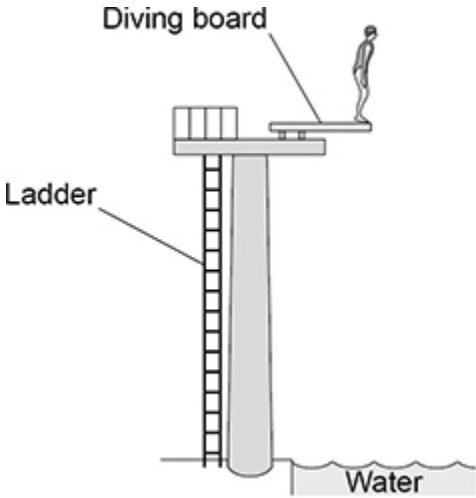
Average force = _____ N

(3)

(Total 12 marks)

2.

The figure below shows a diver about to dive off a diving board.



(a) Complete the sentences.

Choose answers from the box.

elastic potential	gravitational potential	kinetic	nuclear
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As the diver falls towards the water there is a decrease in her _____ energy.

As the diver falls towards the water there is an increase in her _____ energy.

(2)

(b) Write down the equation which links kinetic energy (E_k), mass (m) and speed (v).

(1)

(c) At the instant the diver hits the water, the kinetic energy of the diver is 5040 J.

The speed of the diver is 12 m/s.

Calculate the mass of the diver.

Mass = _____ kg

(3)

(d) Most of the kinetic energy of the diver is transferred to the water.

How does this affect the thermal energy of the water?

Tick (✓) **one** box.

The thermal energy decreases.

The thermal energy stays the same.

The thermal energy increases.

(1)

(Total 7 marks)

3.

Energy from the Sun is released by nuclear fusion.

(a) Complete the sentences.

Nuclear fusion is the joining together of _____.

During nuclear fusion the total mass of the particles _____.

(2)

(b) Nuclear fusion of deuterium is difficult to achieve on Earth because of the high temperature needed.

Electricity is used to increase the temperature of 4.0 g of deuterium by 50 000 000 °C.

specific heat capacity of deuterium = 5200 J/kg °C

Calculate the energy needed to increase the temperature of the deuterium by 50 000 000 °C.

Use the Physics Equations Sheet.

Energy = _____ J

(3)

(c) The idea of obtaining power from nuclear fusion was investigated using models.

The models were tested before starting to build the first commercial nuclear fusion power station.

Suggest **two** reasons why models were tested.

1 _____

2 _____

(2)

(d) Generating electricity using nuclear fusion will have fewer environmental effects than generating electricity using fossil fuels.

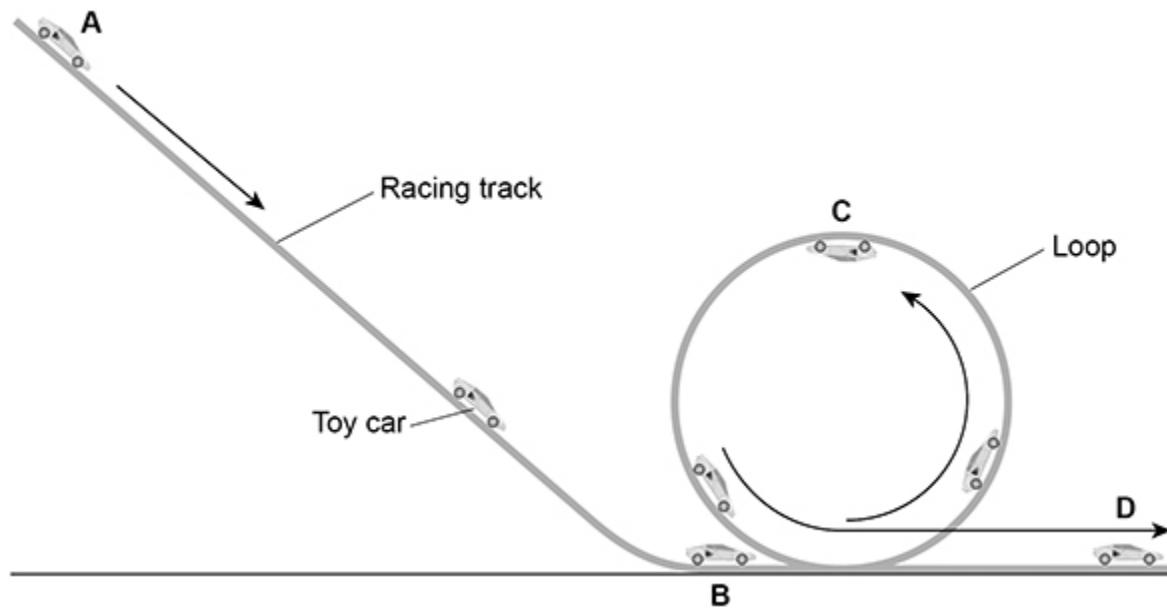
Explain **one** environmental effect of generating electricity using fossil fuels.

(2)

(Total 9 marks)

4.

The figure below shows a toy car in different positions on a racing track.



(a) The toy car and racing track can be modelled as a closed system.

Why can the toy car and racing track be considered 'a closed system'?

Tick (✓) **one** box.

The racing track and the car both have gravitational potential energy.

The racing track and the car are always in contact with each other.

The total energy of the racing track and the car is constant.

(1)

- (b) The car is released from rest at position **A** and accelerates due to gravity down the track to position **B**.

mass of toy car = 0.040 kg

vertical height between position **A** and position **B** = 90 cm

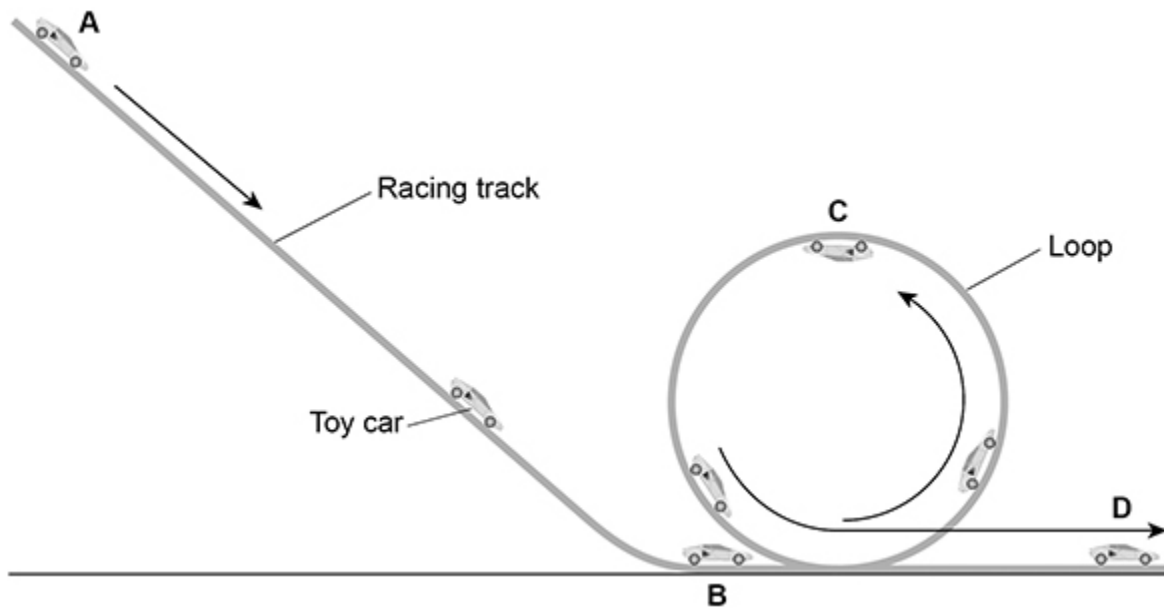
gravitational field strength = 9.8 N/kg

Calculate the maximum possible speed of the toy car when it reaches position **B**.

Speed = _____ m/s

(5)

The figure above is repeated below.



(c) At position **C** the car's gravitational potential energy is 0.20 J greater than at position **B**.

How much kinetic energy does the car need at position **B** to complete the loop of the track?

Give a reason for your answer.

Tick (✓) **one** box.

Less than 0.20 J

Exactly 0.20 J

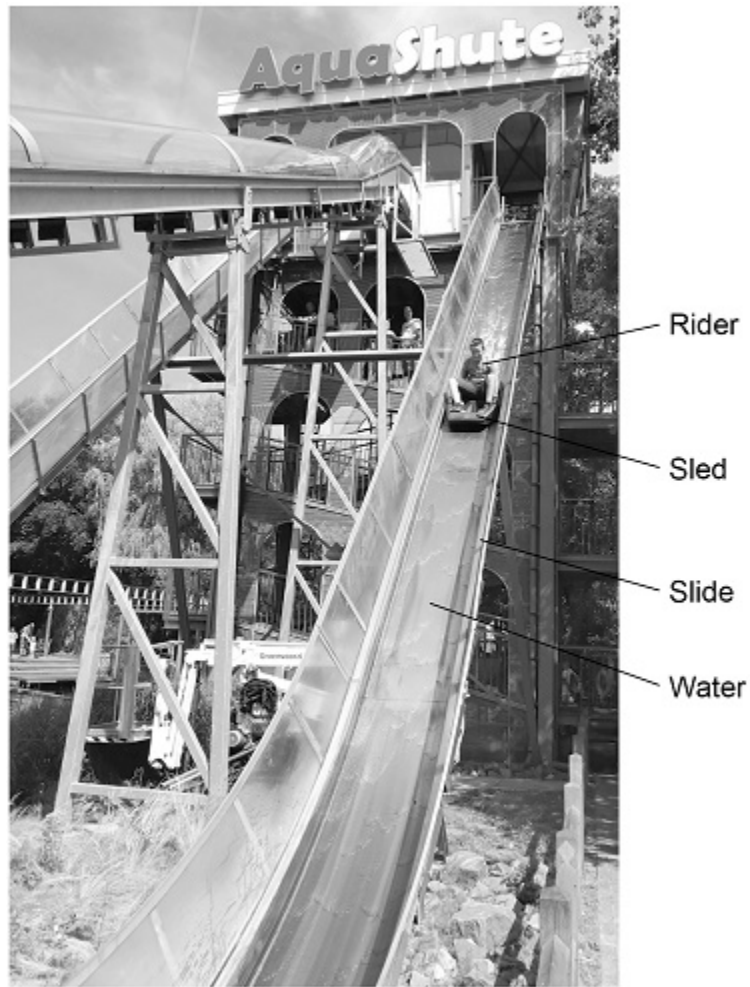
More than 0.20 J

Reason _____

(2)
(Total 8 marks)

5.

The photograph below shows a theme park ride called AquaShute.



(a) Riders of the AquaShute sit on a sled and move down a slide.

There is a layer of water between the sled and the slide.

How does the layer of water affect the friction between the sled and the slide?

Tick (✓) **one** box.

The friction is decreased.

The friction is increased.

The friction is not affected.

(1)

(b) The mass of one rider is 62.5 kg.

The height of the slide is 16.0 m.

gravitational field strength = 9.8 N/kg

Calculate the gravitational potential energy of the rider at the top of the slide.

Use the equation:

$$\text{gravitational potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height}$$

$$\text{Gravitational potential energy} = \text{_____ J}$$

(2)

(c) At the bottom of the slide the speed of the rider is 12 m/s.

The mass of the rider is 62.5 kg.

Calculate the kinetic energy of the rider at the bottom of the slide.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

$$\text{Kinetic energy} = \text{_____ J}$$

(2)

(d) When a rider reaches the bottom of the slide, the sled decelerates and stops.

Give **two** factors that will affect how far the sled will move before it stops.

1 _____

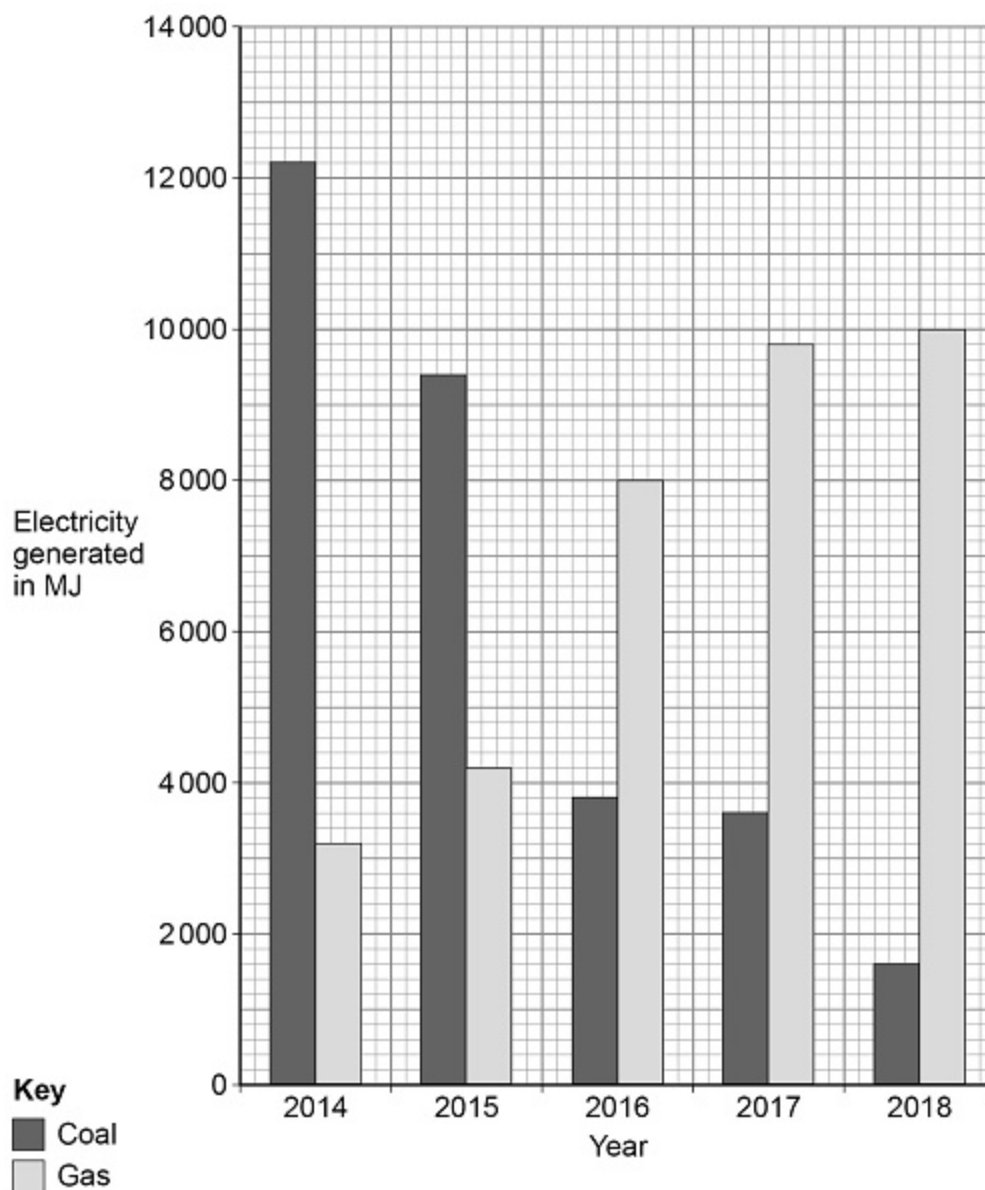
2 _____

(2)
(Total 7 marks)

6.

Figure 1 shows how much electricity was generated using coal-fired and gas-fired power stations in January for 5 years in the UK.

Figure 1



- (a) Determine the percentage increase in electricity generated using gas-fired power stations from 2014 to 2018.

Percentage increase = _____%

(2)

- (b) Give **two** environmental advantages of using a gas-fired power station to generate electricity compared with using a coal-fired power station.

1 _____

2 _____

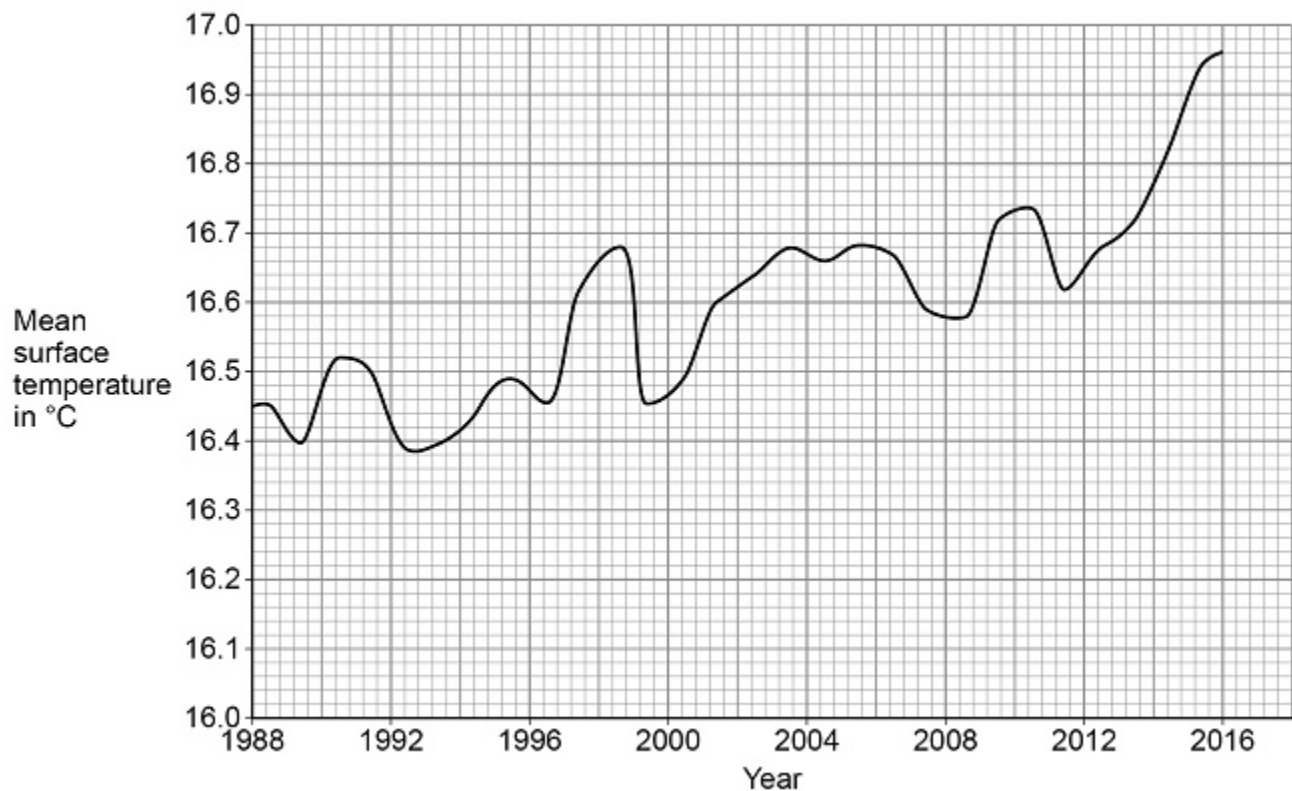
(2)

The mean surface temperature of the sea changes throughout the year.

A change in the mean surface temperature from year to year indicates climate change.

Figure 2 shows how the mean surface temperature changed between 1988 and 2016.

Figure 2



(c) A student does not believe that climate change is occurring.

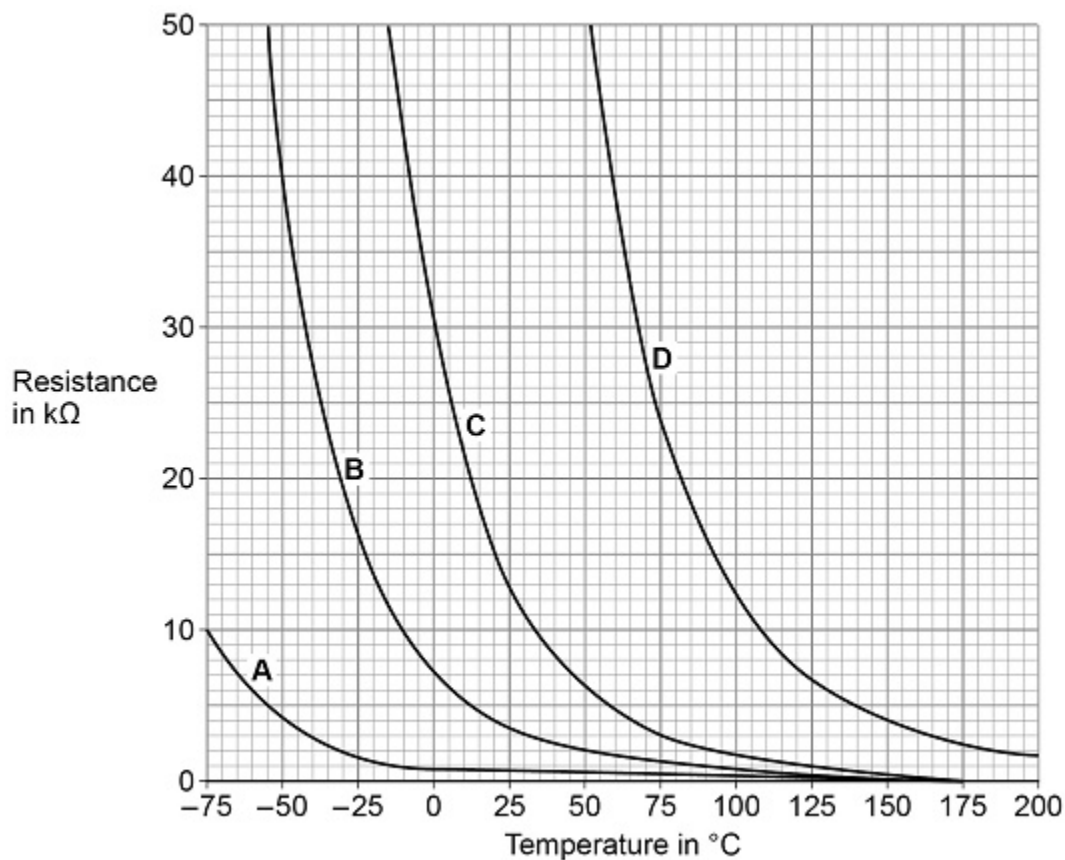
Explain how the data in **Figure 2** suggests the student is wrong.

(2)

(d) A thermistor can be used to measure temperature.

Figure 3 shows how the resistance of four different thermistors A, B, C and D, varies with temperature.

Figure 3



Which of the four thermistors would be the most suitable to measure the surface temperature of the sea?

Tick (✓) **one** box.

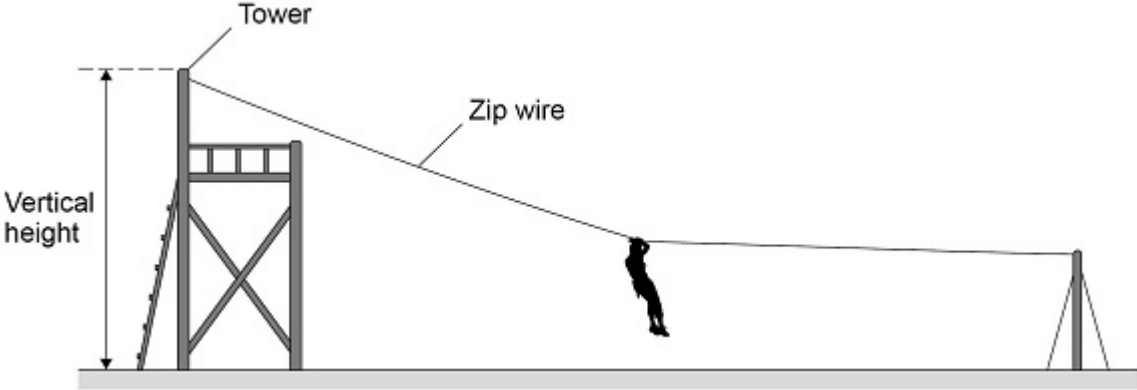
Explain your answer.

A	B	C	D
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(3)
(Total 9 marks)

7.

The following figure shows a person sliding down a zip wire.



(a) Describe how the vertical height of the tower could be measured accurately.

(2)

(b) When using the zip wire, the person moved through a vertical height of 2.0 m

The person has a mass of 45 kg

gravitational field strength = 9.8 N/kg

Calculate the change in gravitational potential energy of the person.

Use the equation:

$$\text{gravitational potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height}$$

Change in gravitational potential energy = _____ J

(2)

(c) Give **three** factors that affected the kinetic energy of the person as she reached the bottom of the zip wire.

1 _____

2 _____

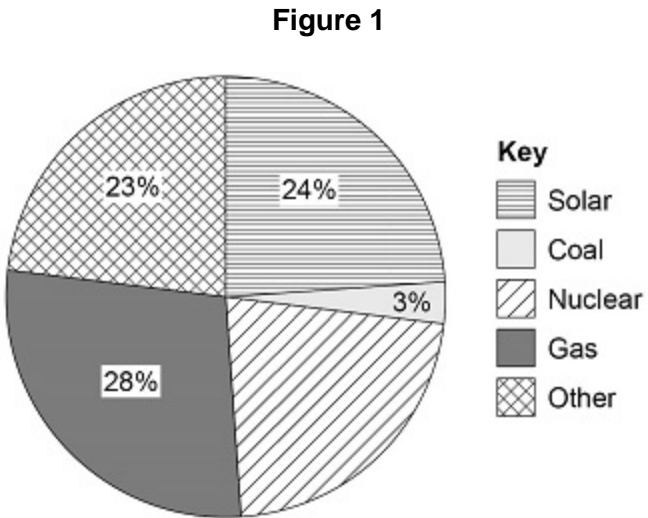
3 _____

(3)

(Total 7 marks)

8.

Figure 1 shows how different energy resources were used in the United Kingdom (UK) to generate electricity on one day in June 2018.



(a) The UK government plans to stop using coal-fired power stations by 2025.

Explain **one** environmental problem caused when electricity is generated by burning coal.

(2)

(b) Give **two** renewable energy resources that could make up the 'Other' energy resources in **Figure 1**.

1 _____

2 _____

(2)

(c) Determine the percentage of electricity generated in nuclear power stations that day.

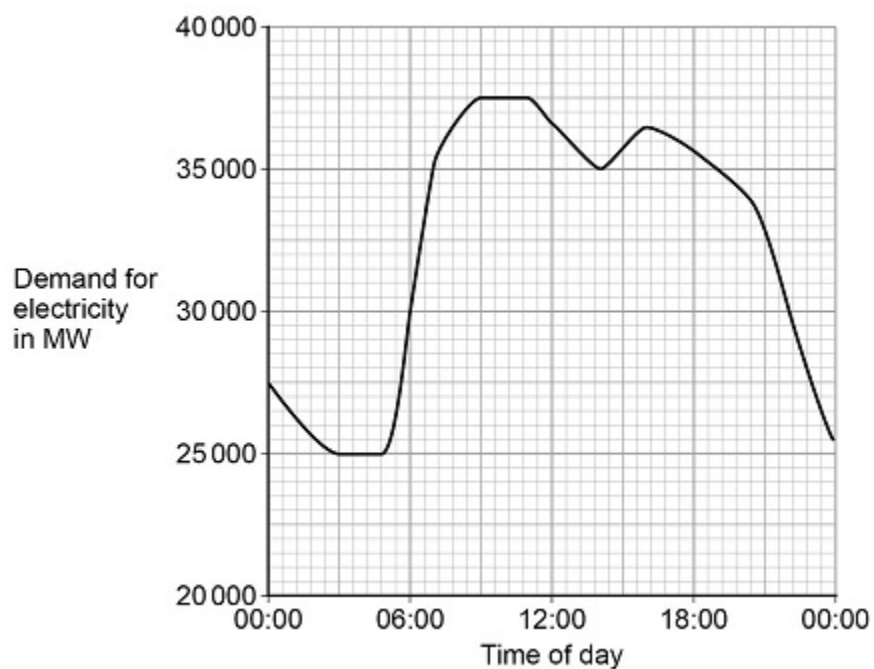
Use data from **Figure 1**.

Percentage of electricity generated in nuclear power stations = _____%

(2)

Figure 2 shows how the demand for electricity varied with the time of day.

Figure 2



(d) What was the difference between the maximum demand and minimum demand for electricity during this day?

Difference = _____ MW

(2)

(e) **Figure 2** shows that the demand for electricity increased between 06:00 and 09:00

Solar power could have met the demand if there were enough solar panels installed in the UK.

Explain why.

(2)
(Total 10 marks)

Mark schemes

1. (a) there is a resultant force acting
allow weight/gravity is greater than air resistance
allow (initially) weight/gravity is the only force acting 1
- (b) as the velocity of the hailstone increases air resistance increases
allow speed for velocity 1
- until air resistance becomes equal to the weight of the hailstone 1
- so the resultant force is (equal to) zero 1
- (c) as mass increases the weight of a hailstone increases 1
- (d) kinetic energy depends on both mass and velocity
allow $E_k = \frac{1}{2} mv^2$ 1
- as mass increases so does terminal / maximum velocity
a statement is required 1
- kinetic energy $\propto m$ and kinetic energy $\propto v^2$ so as mass doubles
kinetic energy more than doubles
this mark can be scored by relevant calculations 1
- (e) 1 N m 1

(f) mass = 0.0185 (kg)

allow 0.018 to 0.019 inclusive

1

$$F = \frac{0.0185 \times 25}{0.060}$$

allow a correct substitution using an incorrectly / not converted value of m

1

$$F = 7.708 \text{ (N)}$$

allow 7.7 (N)

allow correct calculation using an incorrectly / not converted value of m

1

if no other marks are awarded

a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then correctly converted giving an answer between 6.50 and 6.54 scores 2 marks

a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then not converted giving an answer between 6500 and 6542 scores 1 mark

[12]

2.

(a) gravitational potential

this order only

1

kinetic

1

(b) kinetic energy = $0.5 \times \text{mass} \times \text{speed}^2$

or

$$E_k = \frac{1}{2}mv^2$$

1

(c) $5040 = 0.5 \times m \times 12^2$

1

$$m = \frac{5040}{0.5 \times 12^2}$$

1

$$m = 70 \text{ (kg)}$$

1

(d) the thermal energy increases.

1

[7]

3.

(a) nuclei

do not accept atoms

1

decreases

1

(b) $m = 0.004$ (kg)

1

$$E = 0.004 \times 5200 \times 50\,000\,000$$

allow a correct substitution of an incorrectly/not converted value of m

1

$$E = 1.04 \times 10^9 \text{ (J)}$$

or

$$E = 1\,040\,000\,000 \text{ (J)}$$

allow a correct calculation using an incorrectly/not converted value of m

1

(c) any **two** from:

- to make sure the fusion process is possible
- to develop an understanding of the process
- to make adaptations to the process
- to assess the efficiency of the process
- to make predictions
- assess safety risks
- to assess environmental impact
- set-up cost is lower (for small scale experiments)

2

- (d) releases carbon dioxide
allow releases greenhouse gases

1

which causes global warming
allow which causes climate change

OR

releases particulates
which causes global dimming

or

which cause breathing problems

OR

releases sulfur dioxide
which cause acid rain

OR

releases nitrogen oxides
which cause breathing problems

or

which causes acid rain

1

[9]

4.

- (a) the total energy of the racing track and the car is constant.

1

- (b) $E_p = 0.040 \times 9.8 \times 0.90$

allow a correct substitution of an incorrectly/not converted value of h

1

$$E_p = 0.3528 \text{ (J)}$$

this answer only

1

$$0.3528 = 0.5 \times 0.040 \times v^2$$

allow a correct substitution of a calculated E_p

1

$$v^2 = \frac{0.3528}{0.5 \times 0.040}$$

allow a correct rearrangement using a calculated E_p

1

$$v = 4.2 \text{ (m/s)}$$

allow an answer consistent with their calculated E_p

1

(c) more than 0.20 J

1

(because) the car needs to be moving at the top of the loop

or

(because) the car needs to be moving to complete the loop

or

not all E_k at **B** will be transferred to E_p at **C**

this mark is dependent on scoring the first mark

allow energy dissipated to the surroundings

1

[8]

5.

(a) the friction is decreased

1

(b) $E_p = 62.5 \times 9.8 \times 16.0$

1

$$E_p = 9800 \text{ (J)}$$

1

(c) $E_k = 0.5 \times 62.5 \times 12^2$

1

$$E_k = 4500 \text{ (J)}$$

1

(d) Any **two** from:

- speed (at bottom of slide)
- friction (between sled and ground)
allow mass/weight of rider (and sled)
allow surface type
- air resistance

2

[7]

6.

(a) % increase = $\frac{(10\,000 - 3200)}{3200} \times 100$

1

$$\% \text{ increase} = 212.5 \text{ (\%)}$$

1

(b) Any **two** from:

- no sulfur dioxide released
- doesn't cause acid rain
- no particulates released
- doesn't cause global dimming
- less carbon dioxide released (per kg of fuel burned)
- less global warming

allow less climate change

allow less greenhouse gases

- no solid waste
- gas mining is less destructive than coal mining

ignore less air pollution

2

(c) mean sea surface temperature shows a (steady) increase

1

over the time period on the graph

conditional on scoring 1st marking point

allow between a correct pair of dates at least 10 years apart

or

from 16.45 (°C) to 16.96 (°C)

allow a correct pair of temperatures at least 10 years apart

1

(d) thermistor C

1

(because) the change in resistance is greatest

conditional on scoring 1st marking point

allow the gradient is highest

allow more sensitive to temperature change

1

between 0 and 25 °C

conditional on scoring 2nd marking point

allow between 16 and 17 °C

if thermistor C is not chosen, allow for 1 mark each:

not thermistor A because there is no/little change in resistance

not thermistor B as there is only a small change in resistance

not thermistor D as there is no data available between 0 and 40 °C

1

[9]

7.

(a) use a tape measure

allow use a metre rule

allow use a laser measure

1

one person holding the top and another person holding the bottom

or

use a set square to ensure tape measure is vertical

allow use a plumb-line to ensure tape measure is vertical

or

take repeat readings and calculate a mean

1

(b) $E_p = 45 \times 9.8 \times 2.0$

an answer of 880 (J) or 882 (J) scores 2 marks

1

$E_p = 880$ (J)

1

(c) any **3** from:

- change in vertical height
- mass / weight
- speed / velocity
- air resistance or drag

allow body position

allow wind

- friction (between zip line and pulley)
- gradient / angle (of the zip wire)
- length of zip wire

ignore gravitational field strength

3

[7]

8.

(a) carbon dioxide released

greenhouse gases is insufficient carbon emissions is insufficient allow CO₂

1

causing global warming

allow climate change

allow named consequence of global warming

allow greenhouse effect

air pollution is insufficient

OR

particulates released (1)

causing global dimming (1)

OR

sulfur dioxide released (1)

allow SO₂

causing acid rain (1)

1

(b) any **2** from:

*do **not** accept solar*

- wind
- tidal
- wave
- hydroelectric

allow pumped storage

hydro is insufficient

- geothermal
- biofuel

allow biomass or named biofuel, eg wood

2

(c)

*an answer of 22 (%) scores **2** marks*

100 – 78

*allow **1** mark for calculating percentage of named resources (78%)*

1

22 (%)

1

(d)

an answer of 12 500 (MW) scores 2 marks

maximum demand = 37 500 (MW)

and

minimum demand = 25 000 (MW)

1

difference in demand = 12 500 (MW)

1

(e) solar panels generate electricity from light

solar panels make energy is insufficient

1

power output would increase throughout the morning

or

power output would increase (between 06:00 and 09:00)

or

(between 06:00 and 09:00) the Sun is rising / shining

1

[10]