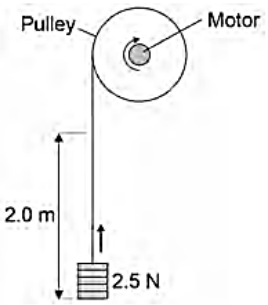
Energy and power GCSE AQA Higher Physics Past Papers Questions

01.

A student investigated the efficiency of a motor using the equipment in **Figure 4**.

Figure 4



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

. 1 Give **one** variable that the student controlled in his investigation.

[1 mark]

. 2 Give **two** reasons for taking repeat readings in an investigation.

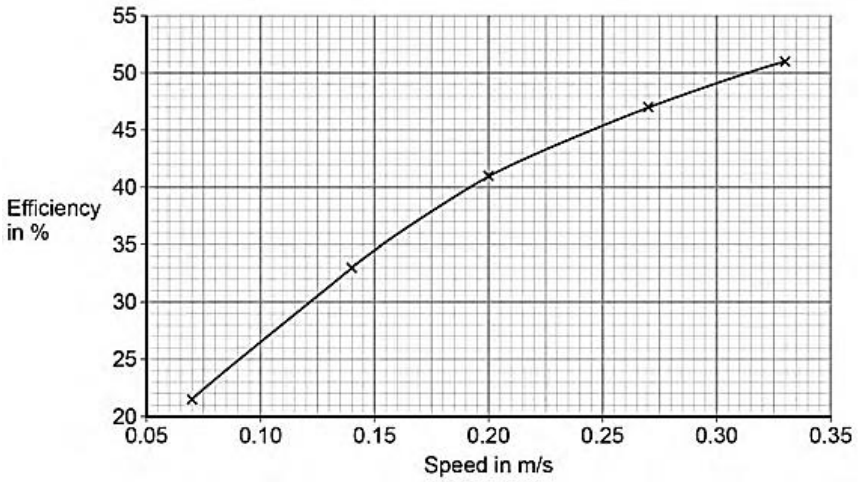
[2 marks]

1

2

Figure 5 shows a graph of the student's results.

Figure 5



3 Give **two** conclusions that could be made from the data in **Figure 5**?

[2 marks]

4 Give the main way that the motor is likely to waste energy.

[1 mark]

5 When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

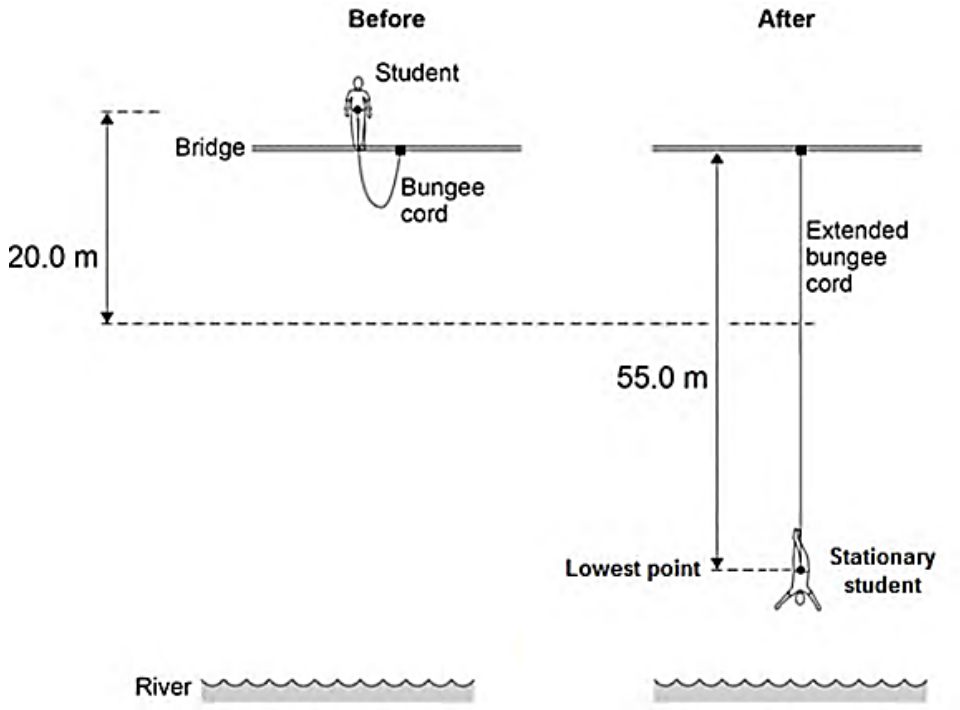
[1 mark]

Efficiency = _____ %

02. **Figure 17** shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.

Figure 17



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N/kg.

1 Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

[1 mark]

2 Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

[2 marks]

Change in gravitational potential energy = _____ J

3 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

[1 mark]

Kinetic energy gained = _____ J

4 Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

[4 marks]

_____

_____

_____

_____

Speed = _____ m/s

5 At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

[3 marks]

_____

_____

_____

_____

Spring constant = _____ N / m

03. **Figure 5** shows a cyclist riding along a straight, level road at a constant speed.

Figure 5

1 Complete the sentences.

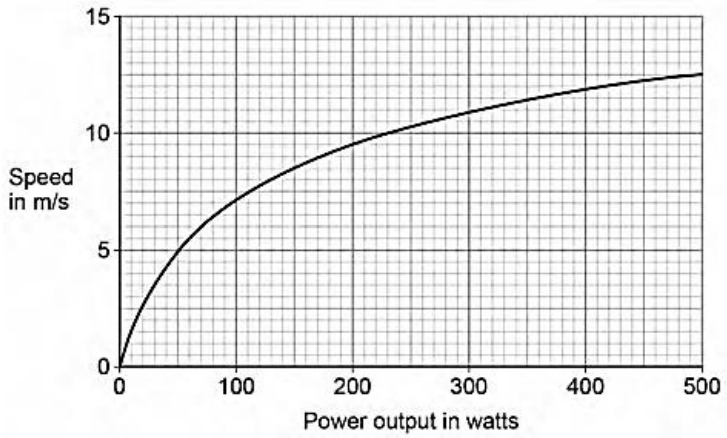
[2 marks]

As the cyclist rides along the road, the _____ energy store in the cyclist's body decreases.

The speed of the cyclist is constant when the work done by the cyclist is _____ the work done against air resistance.

Figure 6 shows how the speed changes as the power output of the cyclist changes.

Figure 6



2 Write down the equation that links power, time and work done.

[1 mark]

_____

3 Calculate the work done by the cyclist when his power output is 200 W for 1800 seconds.

[3 marks]

_____

_____

_____

_____

Work done = _____ J

4 Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 300 W.

[2 marks]

Percentage increase in speed = _____

5 The maximum speed this cyclist can travel on a level road is 14 m/s.

How does cycling uphill affect the maximum speed of this cyclist?

Explain your answer.

[3 marks]

11

04.

Figure 16 shows a wind turbine.

Figure 16

1 At a particular wind speed, a volume of 2.3×10^4 m^3 of air passes the blades each second.

The density of air is 1.2 kg/m^3.

Calculate the mass of air passing the blades per second.

[3 marks]

Mass of air per second = _____ kg

2 The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

Describe the effect on the power output when the wind speed is halved.

[3 marks]

. 3 At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

[3 marks]

Speed of air = _____ m/s

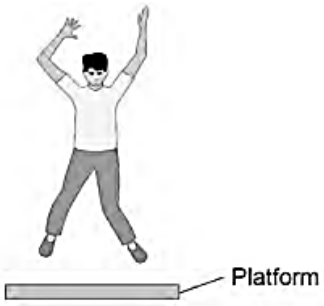
9

05. A scientist investigated how the maximum muscle power of humans varies with age and gender.

The scientist asked volunteers to stand on a platform and to jump as high as they could.

Figure 4 shows a volunteer taking part in the experiment.

Figure 4



An electronic timer measured the time that the volunteer was in the air.

1 The muscle power in watts per kg is calculated using the following equation:

$$\text{muscle power} = \frac{9.8 \times \text{jump height}}{\text{time}}$$

One volunteer has a muscle power of 41 W/kg

He was in the air for 0.12 s

Calculate his jump height.

[3 marks]

2 Write down the equation which links kinetic energy, mass and speed.

[1 mark]

3 One volunteer had a kinetic energy of 270 J and a speed of 3.0 m/s at the moment he left the ground.

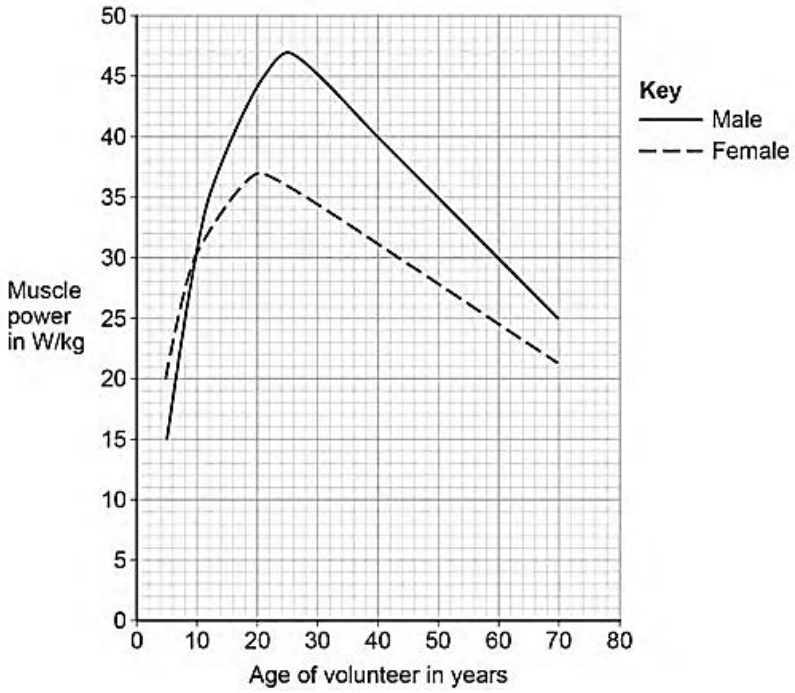
Calculate his mass.

[3 marks]

Mass = _____ kg

Figure 5 shows the scientist's results.

Figure 5



. 4 Compare the muscle power of males with the muscle power of females.

Use data from **Figure 5** in your answer.

[4 marks]

. 5 The muscle power of each volunteer was measured five times.

The highest muscle power reading was recorded instead of calculating an average.

Suggest **one** reason why.

[1 mark]

12

06.

Electric cars have motors that are powered by a battery.

Diesel cars have engines that are powered by diesel fuel.

Table 2 compares one type of electric car with one type of diesel car.

Table 2

Power source	Energy density in MJ / kg	Mass of power source in kg	Total mass of car in kg	Time to recharge battery or refill fuel tank in minutes
Battery	0.95	280	1600	40
Diesel fuel	45	51	1500	3

. 1 The electric car has a range of 400 km with a fully charged battery.

The diesel car has a range of 1120 km with a full tank of diesel.

Explain the difference in the time needed to complete a 500 km journey using the electric car compared with the diesel car.

Assume both cars travel at the same speed.

[2 marks]

. 2 Energy density is the amount of energy stored per kilogram of the energy source.

Show why the diesel car has a greater range than the electric car.

Use data from **Table 2**.

Assume the efficiency of the two cars is the same.

Include calculations in your answer.

[3 marks]

Engineers have developed a way of charging electric cars while they are driving along the road.

Coils of wire buried under the road transfer energy to the car's battery as the car is passing over the coils.

Figure 6 shows a charging lane on a motorway.

Figure 6

3 Suggest **two** advantages of using this method to charge electric cars compared with plugging them into the mains electricity supply.

[2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

4 When electric cars are not being driven, energy stored in their batteries could be used to meet sudden peaks in electricity demand.

Suggest how.

[2 marks]

_____

_____

_____

_____

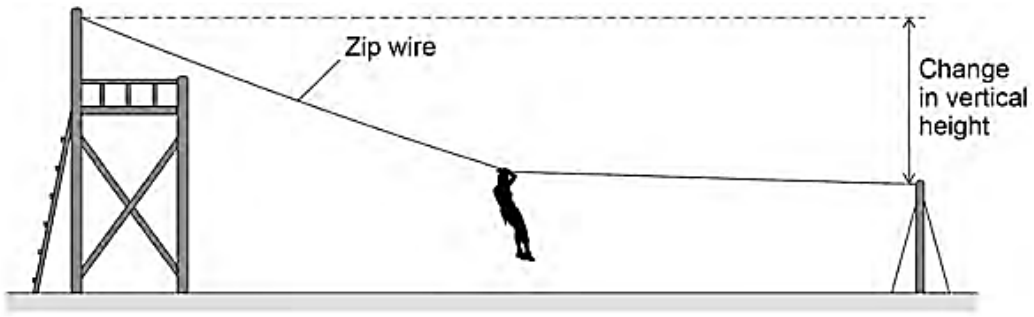
_____

_____

9

07. **Figure 9** shows a person sliding down a zip wire.

Figure 9



. 1 As the person slides down the zip wire, the change in the gravitational potential energy of the person is 1.47 kJ

The mass of the person is 60 kg

gravitational field strength = 9.8 N/kg

Calculate the change in vertical height of the person.

[3 marks]

Change in vertical height = _____ m

. 2 As the person moves down the zip wire her increase in kinetic energy is less than her decrease in gravitational potential energy.

Explain why.

[2 marks]

. 3 Different people have different speeds at the end of the zip wire.

Explain why.

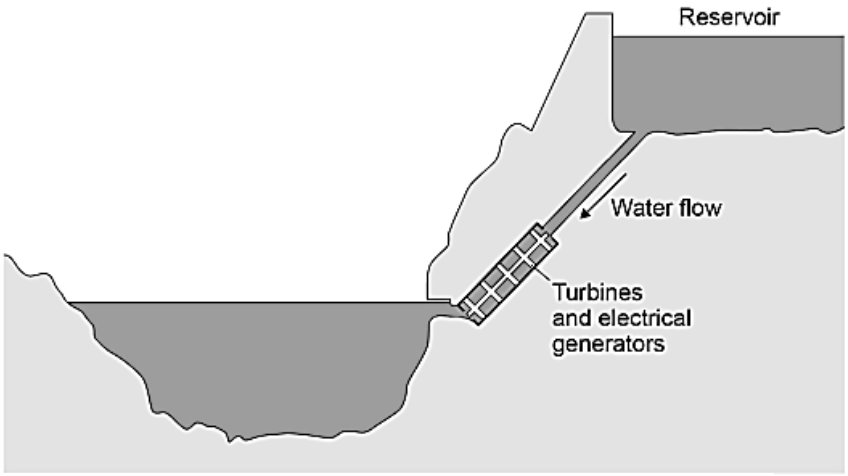
[2 marks]

7

08.

Figure 4 shows a hydroelectric power station.

Figure 4



Electricity is generated when water from the reservoir flows through the turbines.

. 1 Write down the equation which links density (ρ), mass (m) and volume (V).

[1 mark]

_____

. 2 The reservoir stores 6 500 000 m^3 of water.

The density of the water is 998 kg/m^3.

Calculate the mass of water in the reservoir.

Give your answer in standard form.

[4 marks]

_____

_____

_____

_____

_____

Mass (in standard form) = _____ kg

3 Write down the equation which links energy transferred (E), power (P) and time (t).

[1 mark]

4 The electrical generators can provide 1.5×10^9 W of power for a maximum of 5 hours.

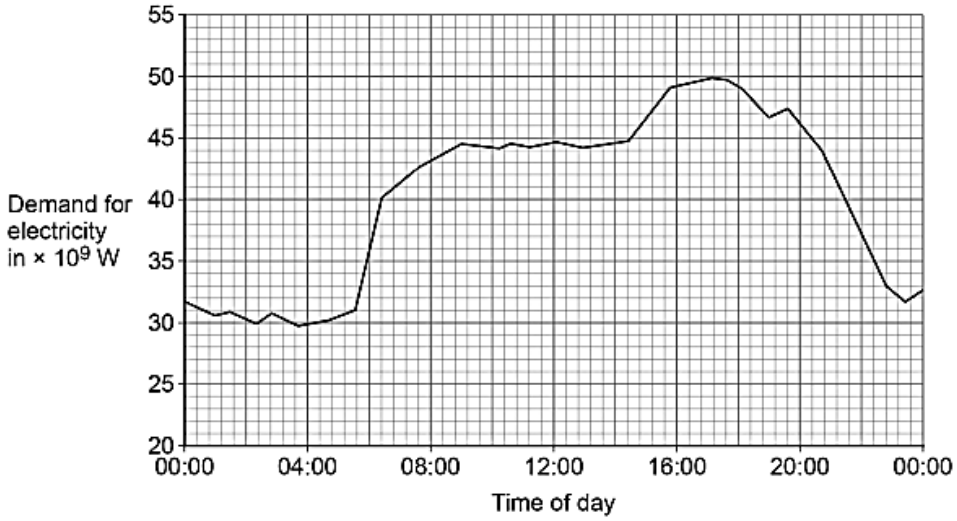
Calculate the maximum energy that can be transferred by the electrical generators.

[3 marks]

Energy transferred = _____ J

5 **Figure 5** shows how the UK demand for electricity increases and decreases during one day.

Figure 5



The hydroelectric power station in **Figure 4** can provide 1.5×10^9 W of power for a maximum of 5 hours.

Give **two** reasons why this hydroelectric power station is not able to meet the increase in demand shown between 04:00 and 16:00 in **Figure 5**.

[2 marks]

1 _____

_____

_____

2 _____

_____

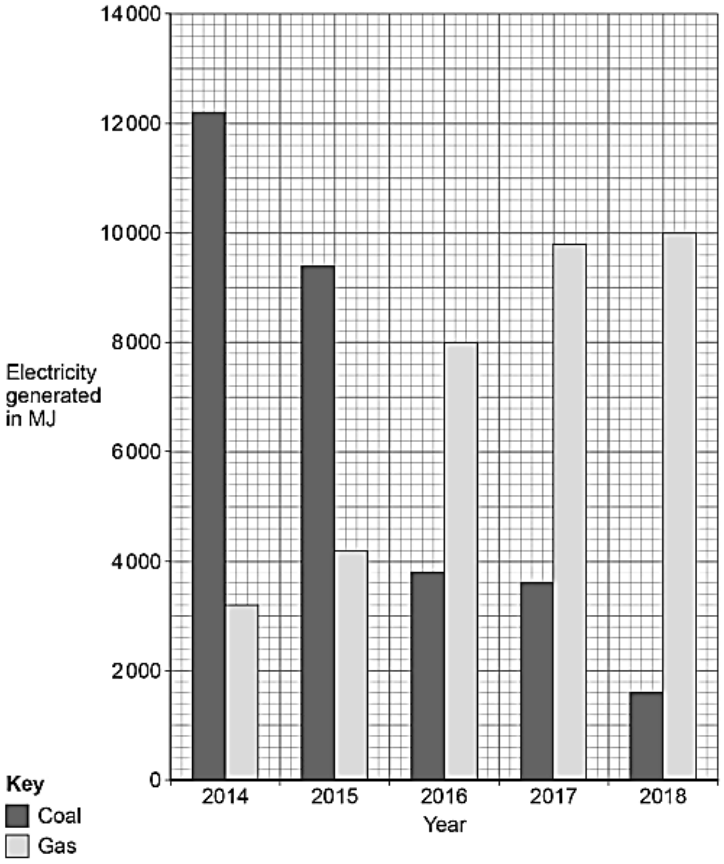
_____

11

09.

Figure 6 shows how much electricity was generated using coal-fired and gas-fired power stations in January for 5 years in the UK.

Figure 6



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

[2 marks]

Percentage increase = _____ %

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

[2 marks]

1 _____

_____

2 _____

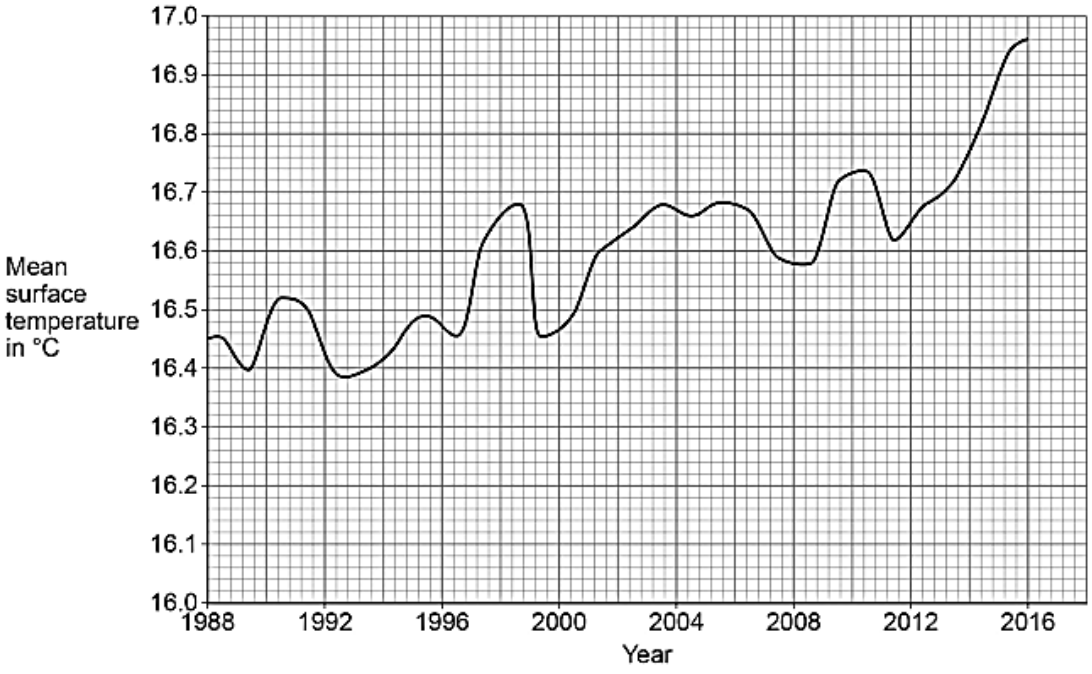
_____

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

Figure 7



. 3 A student does not believe that climate change is occurring.

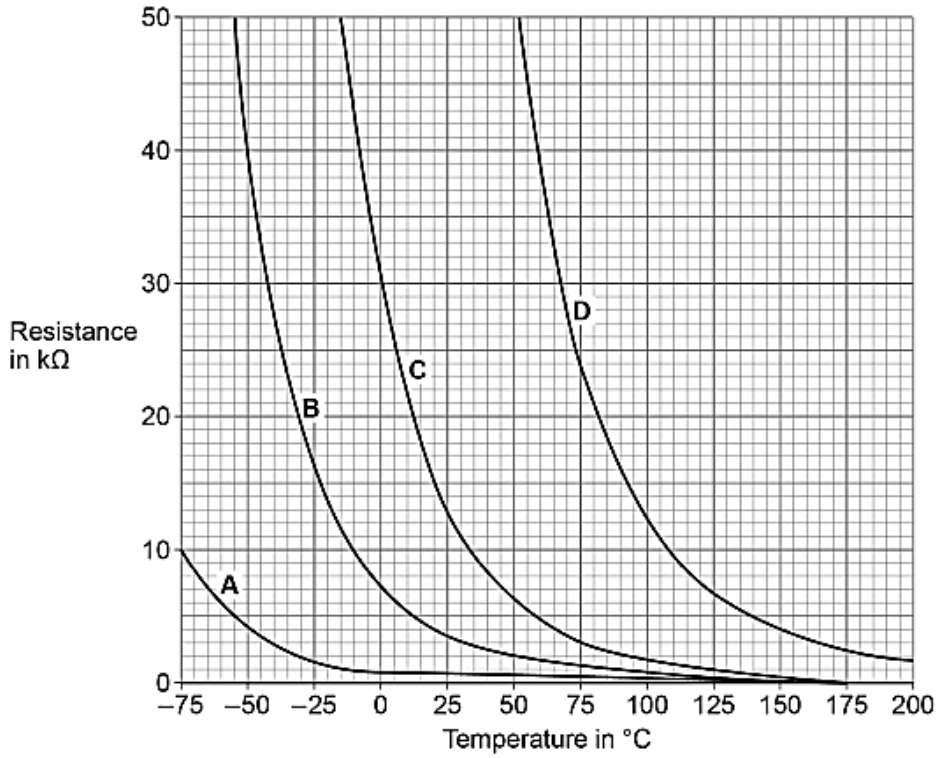
Explain how the data in **Figure 7** suggests the student is wrong.

[2 marks]

. 4 A thermistor can be used to measure temperature.

Figure 8 shows how the resistance of four different thermistors A, B, C and D, varies with temperature.

Figure 8



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

Tick (✓) **one** box.

Explain your answer.

[3 marks]

A	B	C	D
☐	☐	☐	☐

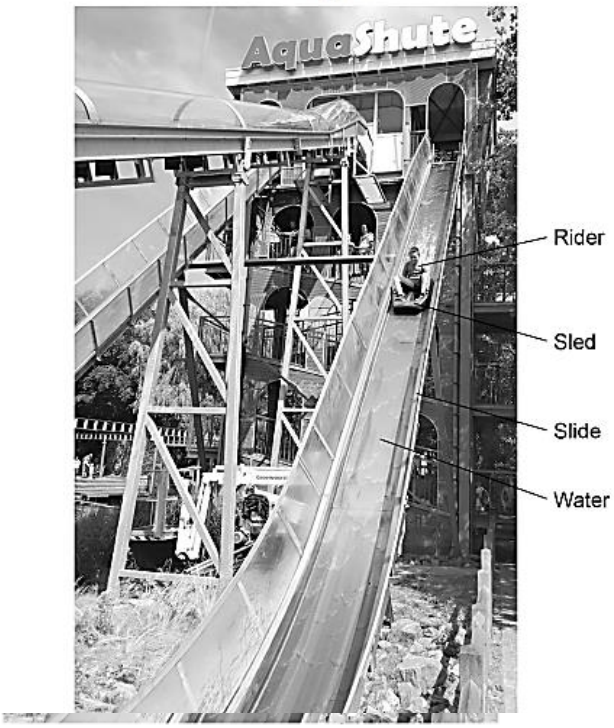
9

10.

Figure 9 shows a theme park ride called AquaShute.

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

Figure 9



1 A light gate and data logger can be used to determine the speed of each rider and sled.

What two measurements are needed to determine the speed of a rider and sled?

[2 marks]

Tick (✓) **two** boxes.

- Gravitational field strength ☐
- Length of sled ☐
- Mass of rider and sled ☐
- Temperature of surroundings ☐
- Time for sled to pass light gate ☐

. 2 The decrease in gravitational potential energy of one rider on the slide was 8.33 kJ.

The rider moved through a vertical height of 17.0 m.

gravitational field strength = 9.8 N/kg

Calculate the mass of the rider.

[4 marks]

Mass of rider = _____ kg

. 3 At the bottom of the slide, all riders and their sleds have approximately the same speed.

Explain why.

[4 marks]

10

11. _____

. 1 During one year, 1.25×10^{18} J of energy was transferred from the National Grid.

number of seconds in 1 year = 3.16×10^{7}

Calculate the mean energy transferred from the National Grid each second.

Give your answer to 3 significant figures.

[2 marks]

_____

_____

_____

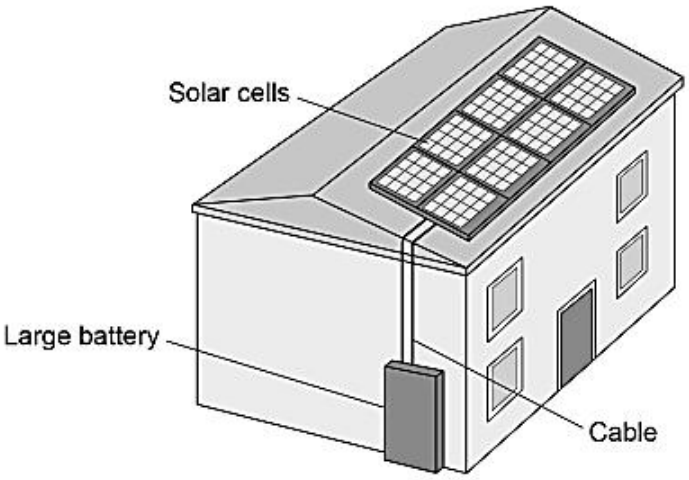
Energy each second (3 significant figures) = _____ J

Figure 5 shows a house with a solar power system.

The solar cells generate electricity.

When the electricity generated by the solar cells is not needed, the energy is stored in a large battery.

Figure 5



. 2 The charge flow through the cable between the solar cells and the battery in 24 hours was 27 000 coulombs.

Calculate the mean current in the cable.

[4 marks]

Mean current = _____ A

. 3 At one time, the total power input to the solar cells was 7.8 kW.

The efficiency of the solar cells was 0.15

Calculate the useful power output of the solar cells.

[3 marks]

Useful power output = _____ W

. 4 It is unlikely that **all** of the electricity that the UK needs can be generated by solar power systems.

Explain why.

[2 marks]

_____

_____

_____

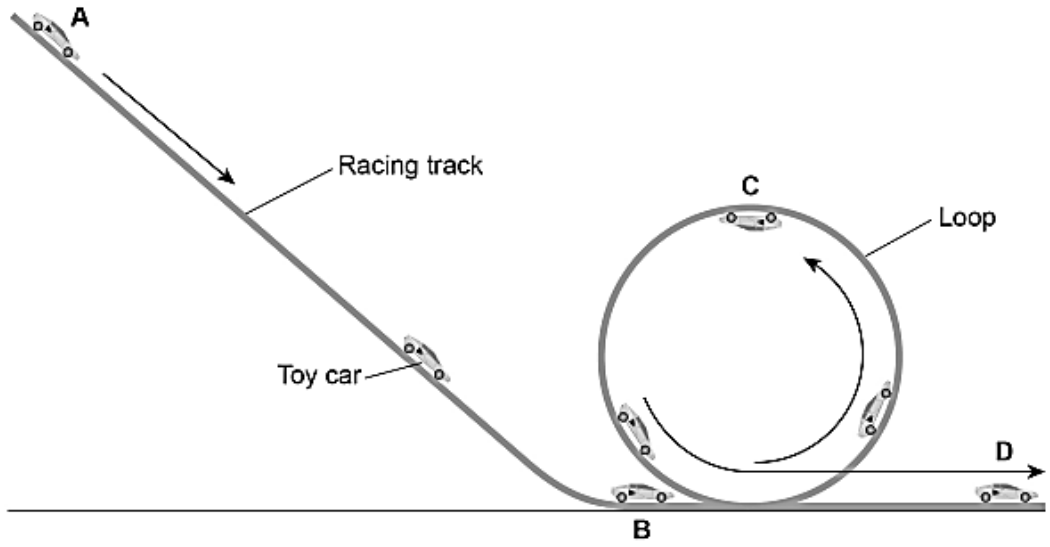
_____

11

12.

Figure 11 shows a toy car in different positions on a racing track.

Figure 11



1 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'?

[1 mark]

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. ☐

. 2 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

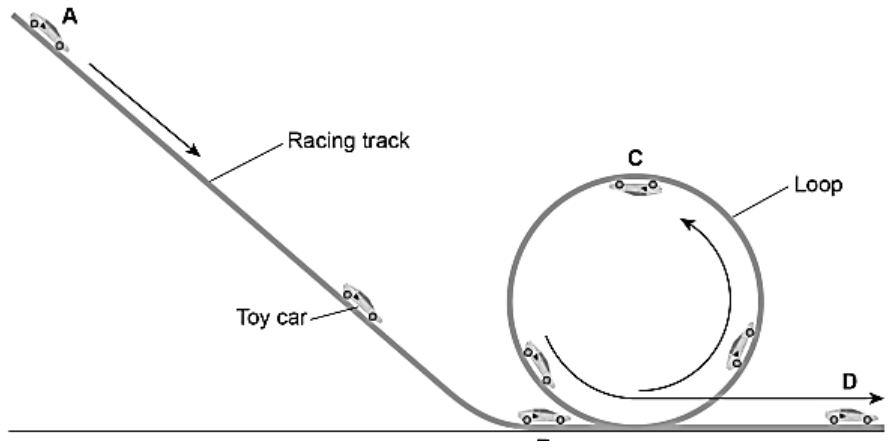
Calculate the maximum possible speed of the toy car when it reaches position **B**.

[5 marks]

Speed = _____ m/s

Figure 11 is repeated below.

Figure 11



3 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.

[2 marks]

Tick (✓) **one** box.

Less than 0.20 J ☐

Exactly 0.20 J ☐

More than 0.20 J ☐

Reason _____

_____

_____

8

13.

Figure 1 shows a large wind farm off the coast of the UK.

Figure 1

The mean power output of the wind farm is 696 MW, which is enough power for 580 000 homes.

. 1 Calculate the mean power needed for 1 home.

Give your answer in watts.

[2 marks]

Mean power needed for 1 home = _____ W

. 2 On one day the demand for electricity in the UK was 34 000 MW.

Suggest **two** reasons why wind power was not able to meet this demand.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

. 3 Some of the energy from the wind used to rotate a wind turbine is wasted.

An engineer oils the mechanical parts of a wind turbine.

Explain how oiling would affect the efficiency of the wind turbine.

[3 marks]

_____

_____

_____

_____

_____

. 4 In most homes in the UK there are many different electrical devices.

Explain why people should be encouraged to use energy efficient electrical devices.

[2 marks]

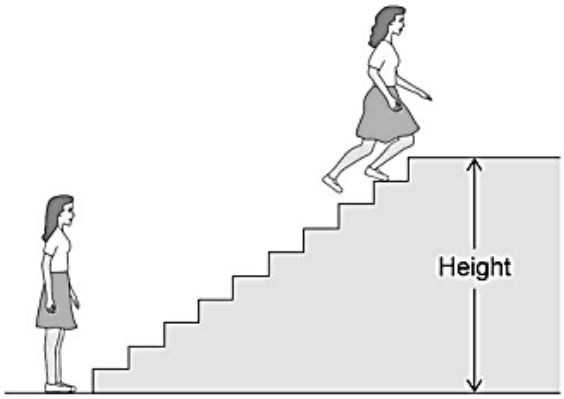
_____

—
9

14.

Figure 10 shows a girl doing an experiment to determine her power output by running to the top of some stairs.

Figure 10



. 1 The mass of the girl was 60.0 kg.

The height of the stairs was 175 cm.

The girl ran to the top of the stairs in 1.40 s.

gravitational field strength = 9.8 N/kg

Calculate the power output of the girl.

Use the Physics Equations Sheet.

[5 marks]

Power = _____ W

2 The **total** power output of the girl was greater than the answer to question **09.1**.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

3 A boy took more than 1.40 s to run up the same stairs.

The power output of the boy was the same as the power output of the girl.

What conclusion can be made about the boy's mass?

[1 mark]

Tick (✓) **one** box.

The boy's mass was greater than the girl's mass. ☐

The boy's mass was lower than the girl's mass. ☐

The boy's mass was the same as the girl's mass. ☐

8

15.

A remote village in the UK uses a hydroelectric generator to provide electricity.

. 1 In one day, 2 500 000 kg of water passes through the hydroelectric generator.

The change in gravitational potential energy of the water is 367.5 MJ.

gravitational field strength = 9.8 N/kg

Calculate the mean change in vertical height of the water as it moves through the hydroelectric generator.

Use the Physics Equations Sheet.

[4 marks]

Mean change in vertical height = _____ m

. 2 The generator transfers 3.0 kW of electrical power.

Calculate the time taken for the generator to transfer 2.16×10^7 J of energy.

Use the Physics Equations Sheet.

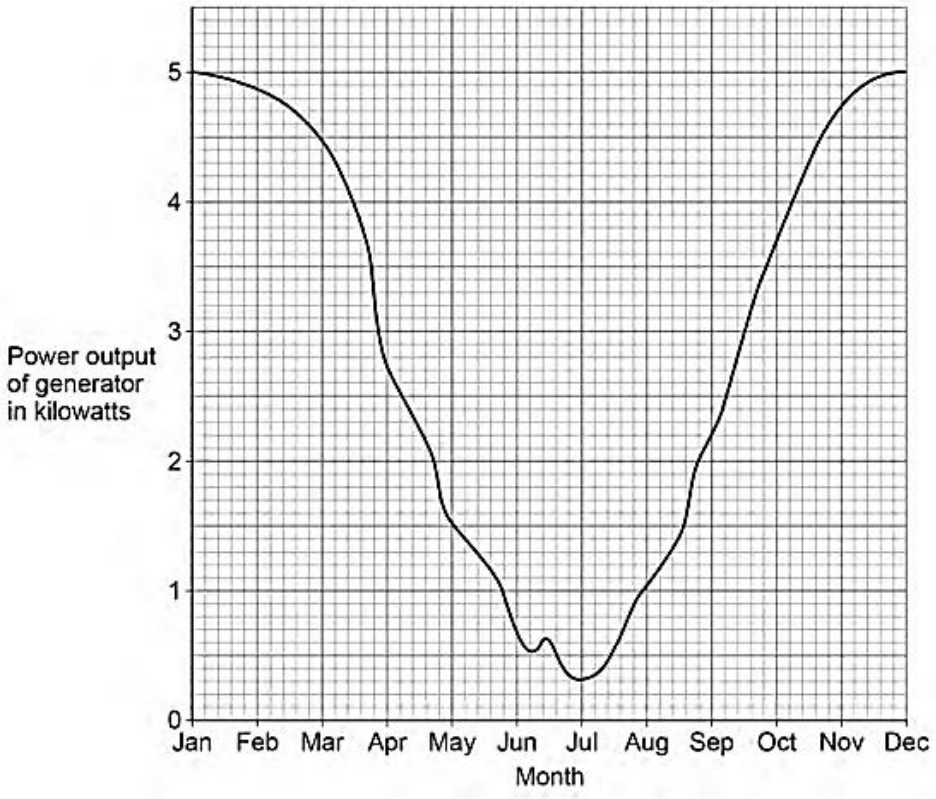
Give your answer in standard form.

[5 marks]

Time taken (in standard form) = _____ s

3 **Figure 5** shows how the power output of the generator varied during one year.

Figure 5



A solar power system is installed in the remote village in addition to the hydroelectric generator.

Explain why this improves the reliability of the electricity supply to the village.

Use information from **Figure 5**.

[2 marks]

11