Energy part 3 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **93 minutes**

Marks: **90 marks**

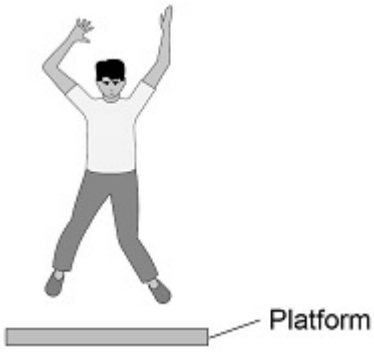
Comments:

1. 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 1 shows a volunteer taking part in the experiment.

Figure 1



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

(a) 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.

_____

_____

_____

_____

Jump height = _____ m

(3)

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

_____

(1)

(c) 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.

_____

_____

_____

_____

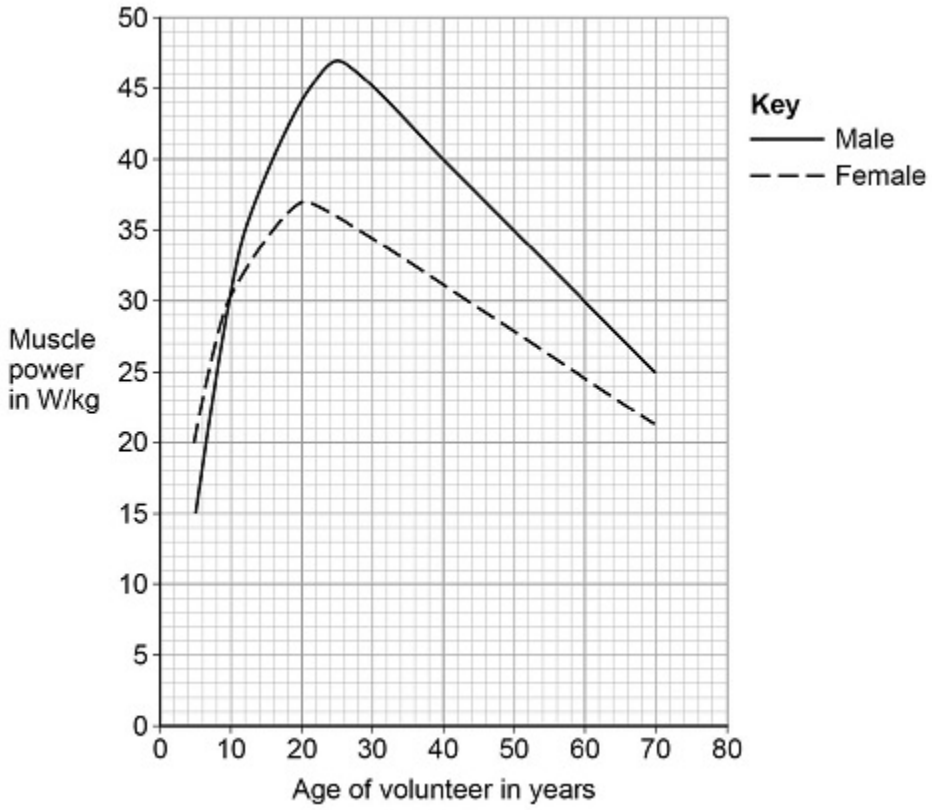
_____

Mass = _____ kg

(3)

Figure 2 shows the scientist's results.

Figure 2



(d) Compare the muscle power of males with the muscle power of females.

Use data from **Figure 2** in your answer.

(4)

(e) 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.

_____

_____

_____

_____

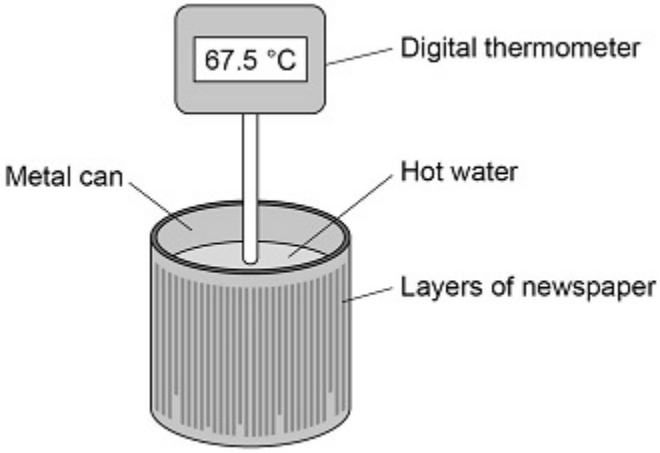
(1)

(Total 12 marks)

2. A student investigated the insulating properties of newspaper.

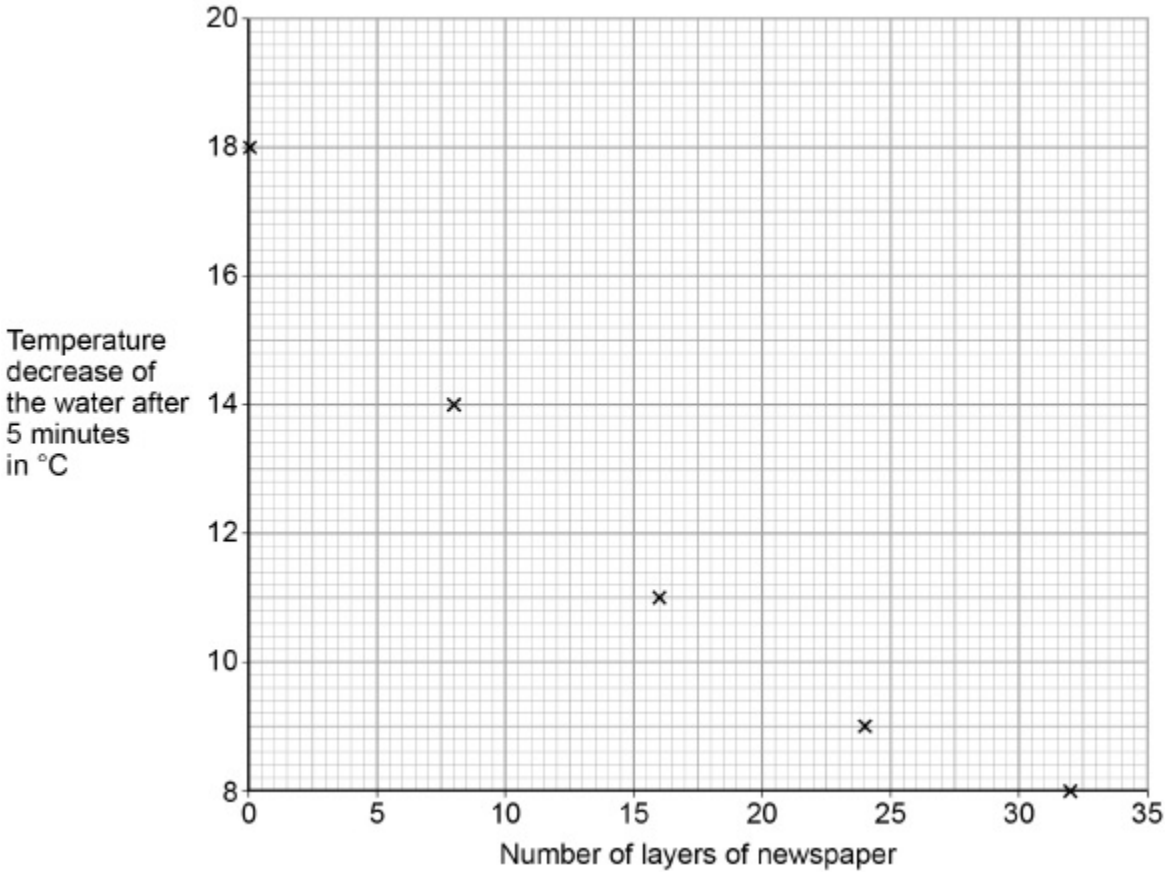
Figure 1 shows the apparatus the student used.

Figure 1



The student's results are shown in **Figure 2**.

Figure 2



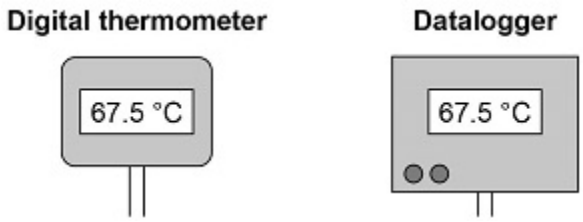
(a) Describe a method the student could have used to obtain the results shown in **Figure 2**.

(6)

(b) The student could have used a datalogger with a temperature probe instead of the digital thermometer.

Figure 3 shows the readings on the digital thermometer and the datalogger.

Figure 3



The datalogger records 10 readings every second.

The student considered using a temperature probe and datalogger.

Explain why it was **not** necessary to use a temperature probe and datalogger for this investigation.

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

3. Light bulbs are labelled with a power input.

(a) What does power input mean?

Tick (✓) **one** box.

The charge transferred each second by the bulb. ☐

The current through the bulb. ☐

The energy transferred each second to the bulb. ☐

The potential difference across the bulb. ☐

(1)

(b) Write down the equation which links current, potential difference and power.

_____

(1)

(c) A light bulb has a power input of 40 W

The mains potential difference is 230 V

Calculate the current in the light bulb.

_____

_____

_____

Current = _____ A

(3)

The following table shows information about three different light bulbs.

Light bulb	Total power input in watts	Useful power output in watts	Efficiency
P	6.0	5.4	0.90
Q	40	2.0	0.05
R	9.0	**X**	0.30

(d) Write down the equation which links efficiency, total power input and useful power output.

_____

(1)

(e) Calculate the value of **X** in the table above.

_____

_____

_____

_____

X = _____ W

(3)

(f) In addition to power input, light bulbs should also be labelled with the rate at which they emit visible light.

Suggest why.

_____

_____

_____

_____

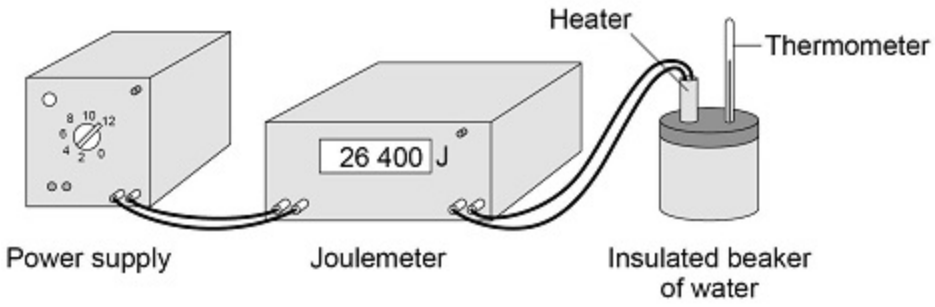
(2)

(Total 11 marks)

4. A student carried out an experiment to determine the specific heat capacity of water.

Figure 1 shows the equipment the student used to heat the water.

Figure 1



(a) Why did the student insulate the beaker of water?

Tick (✓) **one** box.

To increase energy transfer to the surroundings. ☐

To reduce energy transfer to the surroundings. ☐

To stop energy transfer to the surroundings. ☐

(1)

(b) One hazard in this experiment is the hot water.

Give **one** risk to the student caused by this hazard.

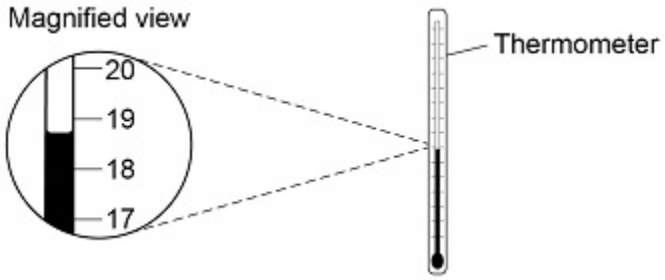
_____

_____

(1)

(c) **Figure 2** shows the thermometer that the student used.

Figure 2



What is the resolution of the thermometer?

Tick (✓) **one** box.

1 °C ☐

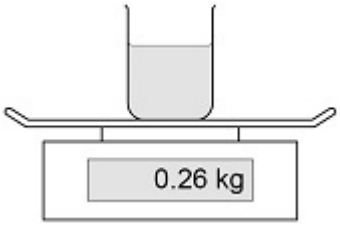
3 °C ☐

19 °C ☐

(1)

(d) **Figure 3** shows the beaker of water on a balance.

Figure 3



The mass of the water was 0.20 kg

What was the mass of the beaker?

Tick (✓) **one** box.

0.06 kg ☐

0.20 kg ☐

0.26 kg ☐

0.46 kg ☐

(1)

(e) The energy transferred to the water was 26 400 J

The mass of water was 0.20 kg

The temperature increase of the water was 30 °C

Calculate the specific heat capacity of water using the data from this experiment.

Use the Physics Equations Sheet.

Choose the unit from the box.

J/kg	**J/kg°C**	**J/°C**

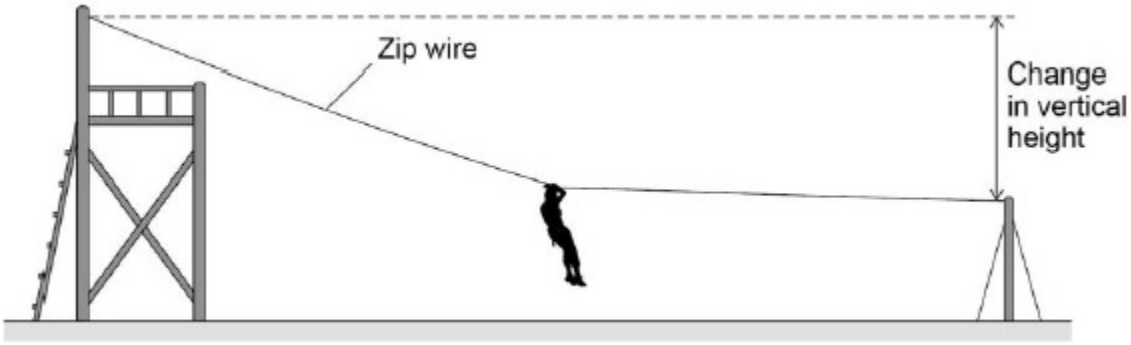
Specific heat capacity = _____ Unit _____

(4)

(Total 8 marks)

5. **Figure 1** shows a person sliding down a zip wire.

Figure 1



(a) 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.

Change in vertical height = _____ m

(3)

(b) 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)

(c) Different people have different speeds at the end of the zip wire.

Explain why.

_____

_____

_____

_____

_____

_____

_____

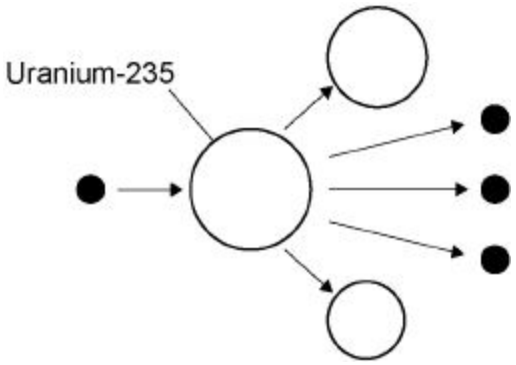
(2)

(Total 7 marks)

6. Nuclear power can be used to generate electricity through nuclear fission.

Figure 1 shows the process of nuclear fission.

Figure 1



(a) Complete the sentences.

Choose answers from the box.

gamma rays	**light rays**	**proton**	**neutron**	**nucleus**	**X-rays**

During the process of nuclear fission, a uranium _____

absorbs a _____ .

Electromagnetic radiation is released in the form of _____ .

(3)

(b) The UK needs at least 25 000 000 kW of electrical power at any time.

A nuclear power station has an electrical power output of 2 400 000 kW

Calculate how many nuclear power stations are needed to provide 25 000 000 kW of electrical power.

_____

_____

_____

_____

Number of nuclear power stations = _____

(2)

(c) State **two** environmental issues caused by generating electricity using nuclear power stations.

1. _____

_____

2. _____

_____

(2)

(d) The UK currently generates a lot of electricity by burning natural gas. This process releases carbon dioxide into the atmosphere.

Figure 2 shows how the concentration of carbon dioxide in the atmosphere has changed over the past 115 years.

Figure 2

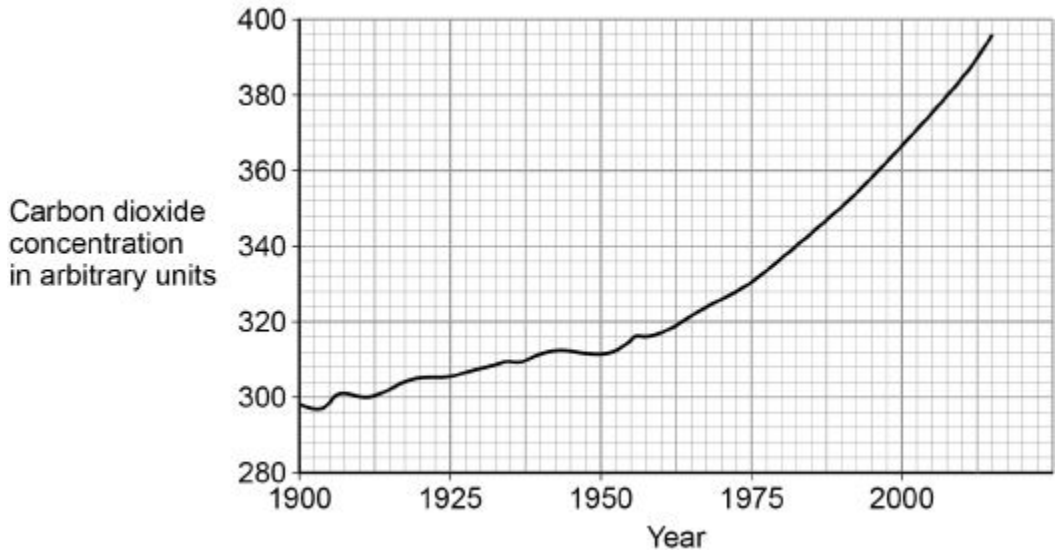
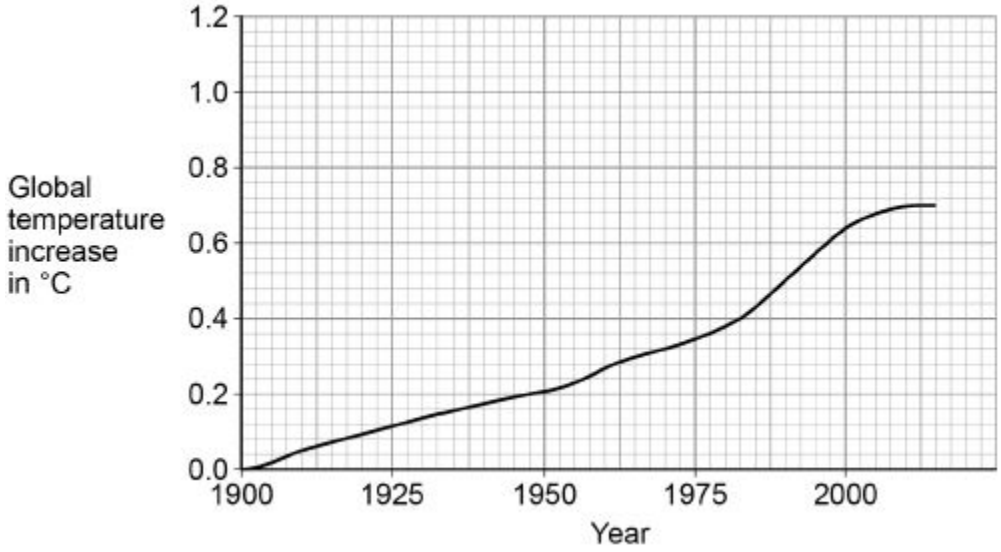


Figure 3 shows how the global temperature has changed over the past 115 years.

Figure 3



Give **one** similarity and **one** difference between the data in **Figure 2** and **Figure 3**.

Similarity _____

_____

_____

Difference _____

_____

_____

(2)

(Total 9 marks)

7. Nuclear power stations generate electricity through nuclear fission. Electricity can also be generated by burning shale gas.

(a) Shale gas is natural gas trapped in rocks. Shale gas can be extracted by a process called fracking. There is some evidence that fracking causes minor earthquakes. Burning shale gas adds carbon dioxide to the atmosphere.

Describe the advantages of nuclear power compared with the use of shale gas to generate electricity.

(3)

(b) What is the name of **one** fuel used in nuclear power stations?

(1)

(c) Describe the process of nuclear fission.

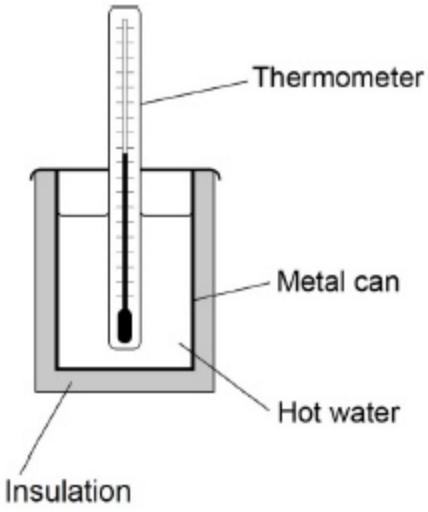
(4)

(Total 8 marks)

8. A student investigated the properties of three insulating materials.

Figure 1 shows the apparatus the student used.

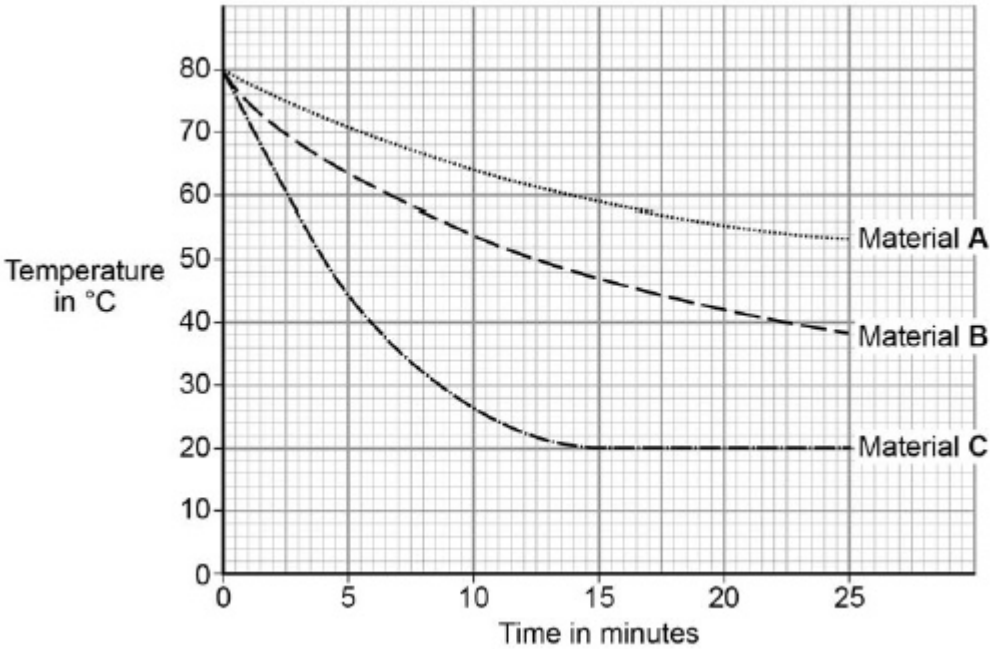
Figure 1



In the investigation, different insulating materials were used to insulate a metal can filled with hot water.

Figure 2 shows how the temperature measured by the thermometer changed over 25 minutes for each of the materials.

Figure 2



(a) What was the temperature of the room where the student carried out the investigation?

Tick **one** box.

20 °C ☐ 38 °C ☐ 53 °C ☐ 80 °C ☐

(1)

(b) Material C has the highest thermal conductivity.

How does the graph in **Figure 2** show this?

_____

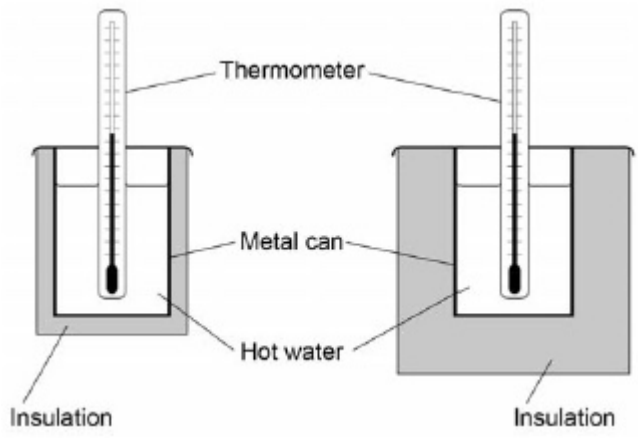
_____

(1)

(c) Another student repeated the investigation using the equipment shown in **Figure 3**.

Figure 1 shows the first set of equipment used.

Figure 1 **Figure 3**



Suggest how using the equipment in **Figure 3** will have affected the student's results.

_____

_____

_____

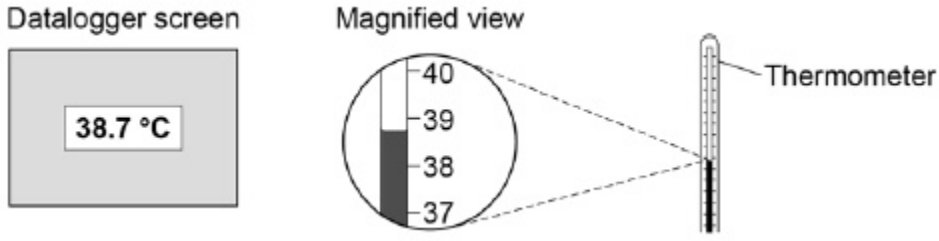
_____

(2)

(d) The students could have used a temperature probe and datalogger instead of a thermometer.

Figure 4 shows the datalogger screen and the thermometer.

Figure 4



Complete the sentences.

Choose the answers from the box.

higher	**lower**	**the same**

Compared to the thermometer, the datalogger and temperature probe have

a resolution that is _____ .

Compared to the thermometer, the chance of misreading the datalogger and

temperature probe is _____ .

(2)

(e) The table gives information about four types of insulation that could be used in the walls of houses.

Type of insulation	**Thermal conductivity in W/m °C**
Felt wool	0.070
Mineral wool	0.040
Polyurethane foam	0.030
Rock wool	0.045

Which type of insulation would be most effective in reducing the rate of cooling of a building?

Tick **one** box.

Felt wool	☐
Mineral wool	☐
Polyurethane foam	☐
Rock wool	☐

Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 8 marks)

9. The image shows a battery-powered drone.

(a) Complete the sentences.

Choose the answers from the box.

chemical		**elastic potential**
gravitational potential	**kinetic**	**nuclear**

As the drone accelerates upwards

its _____ energy increases

and its _____ energy increases.

The _____ energy store

of the battery decreases.

(3)

(b) In the USA, drones are not allowed to be flown too high above the ground.

Suggest **one** possible risk of flying a drone too high above the ground.

_____

_____

_____

(2)

(c) Write down the equation that links energy transferred, power and time.

_____

(1)

(d) The drone can fly for 25 minutes before the battery needs recharging.

The power output of the battery is 65.0 W

Calculate the maximum energy stored by the battery.

_____

_____

_____

_____

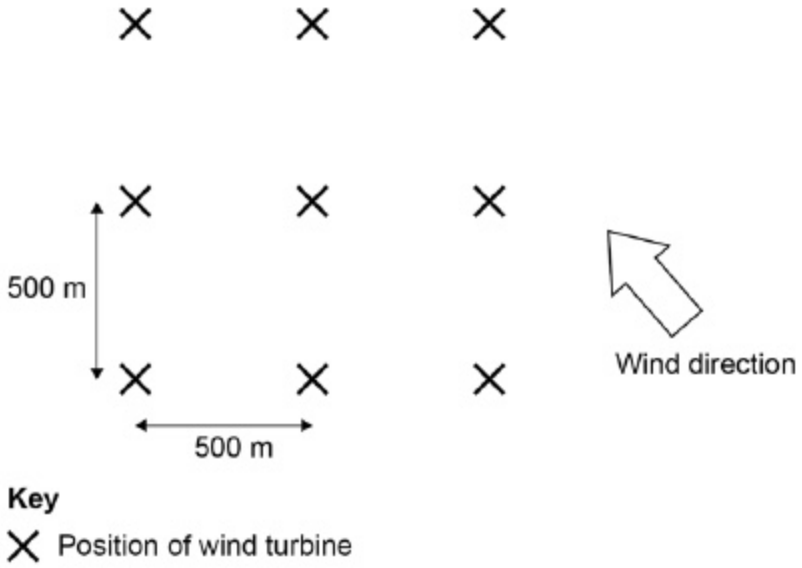
Maximum energy = _____ joules

(3)

(Total 8 marks)

10. The wind turbines in a wind farm must have a minimum distance of 500 m between them for maximum efficiency.

The diagram shows the position of nine wind turbines in a wind farm.



(a) Suggest **one** way in which the layout of this wind farm ensures maximum efficiency when the wind direction changes.

_____

_____

_____

(1)

The average mass of air passing through the blades of one wind turbine is 51 000 kg per second.

The density of air is 1.2 kg / m^3

(b) Write down the equation that links density, mass and volume.

_____

(1)

(c) Calculate the volume of air passing through the blades of one wind turbine in one second.

Give the unit.

Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

_____

Volume in one second = _____ Unit _____

(5)

(d) The average power output from one of the wind turbines in the diagram is 1.6×10^6 W

The average power output of a nuclear power station is 2.4×10^9 W

Calculate the number of wind turbines needed to generate power equal to one nuclear power station.

_____

_____

_____

Number of wind turbines = _____

(2)

(e) The UK requires a minimum electrical power of 2.5×10^{10} W at any time.

Give **two** reasons why wind turbines alone are unlikely to be used to meet this requirement.

1. _____

_____

2. _____

_____

(2)

(Total 11 marks)

1. (a)

*an answer of 0.50 scores **3** marks*
*allow a correct answer that rounds to 0.50 for **3** marks*

$$41 = \frac{9.8 \times h}{0.12}$$

1

$$h = \frac{41 \times 0.12}{9.8}$$

1

h = 0.50 (m)

1

(b) kinetic energy = 0.5 × mass × (speed)^2
or
$E_k = ½\ mv^2$

1

(c)

*an answer of 60 (kg) scores **3** marks*

$270 = ½ \times m \times 3^2$

1

$$m = \frac{270}{(½ \times 3^2)}$$
or
$$m = \frac{270}{4.5}$$

1

m = 60 (kg)

1

(d) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear.

3–4

Level 1: Relevant features are identified and differences noted.

1–2

No relevant content

0

Indicative content

- males have a greater muscle power than females for most of their lives
- males have a greater muscle power than females above 9/10 years old
- males have a lower muscle power than females below 9/10 years old
- there is a similar pattern for males and females as age increases
- males have a peak muscle power at 25 years old whereas females have a peak muscle power at 20/21 years old
- at 9/10 years old males have the same muscle power as females
- peak muscle power for males (47 W/kg) is greater than peak muscle power for females (37 W/kg)
- the rate of increase of muscle power is greater for males than females (between 5 and 25 years old)
- the rate of decrease of muscle power is greater for males than females.

Ignore comments relating to strength

(e) any **1** from:

- maximum height reached is a better indicator of maximum muscle power

  allow maximum time in the air for maximum height reached / jumped
- maximum / peak muscle power was being investigated, not mean / average muscle power
- volunteer may not use maximum effort on the first try
- performance may improve with practice
- performance may get worse with tiredness

1

[12]

2. (a) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- Wrap N layers of newspaper around the metal can
- Heated water in a kettle
  or
  Using a Bunsen burner
- Put hot water in the metal can
- Use a measuring cylinder to measure the volume of water
- Measure initial and final temperature with the digital thermometer
- Use a stopclock / stopwatch to measure a time of 5 minutes
- Calculate temperature decrease
- Repeat with different number of layers of newspaper
- Repeat with no layers of newspaper
- Use same initial temperature of hot water
- Use same volume of water each time

Level 3: Workable method which includes changing the number of layers and includes at least one control variable (same volume of water or same starting temperature)

(b) the digital thermometer and the datalogger have the same resolution

allow both measure to 1 d.p.
ignore accuracy
ignore precision
they give the same result is insufficient

1

only need to measure the start and end temperature
or
only need 2 readings
or
only need to calculate the temperature change

1

[8]

3. (a) The energy transferred each second to the bulb.

1

(b) power = potential difference × current
or

$P = VI$

1

(c)

*an answer of 0.17 (A) scores **3** marks*

$40 = I \times 230$

1

$I = \frac{40}{230}$

1

$I = 0.17$ (A)

*a correct answer that rounds to 0.17 (A) scores **3** marks*

1

(d)

$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$

1

(e)

*an answer of 2.7 (W) scores **3** marks*

$0.30 = \frac{\text{useful power output}}{9.0}$

1

useful power output = 0.30 × 9.0

1

useful power output = 2.7 (W)

1

(f) bulbs also transfer thermal energy

allow light bulbs emit infrared radiation as well as visible light

ignore so people know how bright the bulb is

1

the efficiency of the light bulb also needs to be considered

allow the cost to power the light bulb depends on the efficiency

allow to see how much energy is wasted

1

[11]

4. (a) To reduce energy transfer to the surroundings

1

(b) scald / burn (to skin)

ignore risk of electric shock

1

(c) 1 °C

1

(d) 0.06 kg

1

(e)

*a numerical answer of 4400 scores **3** marks*

26 400 = 0.20 × c × 30

1

$$c = \frac{26\,400}{(0.20 \times 30)}$$

or

$$c = \frac{26\,400}{6}$$

1

c = 4400

1

J / kg °C

1

[8]

5. (a)

*an answer of 2.5 (m) scores **3** marks*

1470 = 60 × 9.8 × h

this mark may be awarded if E_p is incorrectly / not converted

1

$$h = \frac{1470}{60 \times 9.8}$$

or

$$h = \frac{1470}{588}$$

this mark may be awarded if E_p is incorrectly / not converted

1

h = 2.5 (m)

this answer only

1

(b) (work done against) air resistance

or

(work done against) friction (between zip line and pulley)

1

causes thermal energy to be transferred to surroundings

ignore sound energy

1

(c) different people have different surface areas

allow streamlining

allow body position

body size is insufficient

1

so would be affected by air resistance differently

or

initial speed may not be zero (1)

which would add to the total energy (of the system) (1)

allow people have different masses / weights (1)

so people have different terminal velocities (1)

reference to mass changing the kinetic energy or gravitational potential energy negates both these marks

1

[7]

6. (a) nucleus

1

neutron

1

gamma rays

1

in this order only

(b) $\frac{25\,000\,000}{2\,400\,000}$

1

11

*an answer of 10.4 with no working scores **1** mark*

1

*an answer of 11 scores **2** marks*

(c) any **two** from:

- waste is radioactive

  allow nuclear waste

- waste has a long half-life

  allow waste remains dangerous for a long time

- waste is toxic
- waste needs to be buried

  allow waste is difficult to dispose of

- risk of catastrophic accidents

  allow named accident e.g. Fukushima, Chernobyl, Three Mile Island

- fuel is non-renewable

2

(d) **similarity:**
(carbon dioxide concentration and global temperature have) both increased

allow they both show a positive correlation

1

difference:
the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off

allow carbon dioxide (concentration) increases more quickly than temperature (increase)

1

[9]

7. (a) any **three** from:

- no carbon dioxide emitted (to produce electricity)

  no greenhouse gases is insufficient

- doesn't cause global warming

  allow climate change or greenhouse effect for global warming

- nuclear power doesn't cause earthquakes
- more energy released per kg of fuel (compared to shale gas)

3

(b) uranium
or
plutonium

ignore any numbers given

1

(c) a neutron is absorbed by a (large) nucleus

a description in terms of only atoms negates first two marking points

1

the nucleus splits into two (smaller) nuclei

1

releasing energy (and gamma rays)

1

and (two / three) neutrons

1

[8]

8.

(a) 20 (°C)

1

(b) largest temperature decrease

allow larger temperature decrease

1

(c) insulation is thicker

1

so temperature decrease will be lower (for all insulation types)

1

(d) Higher

1

Lower

1

(d) polyurethane foam

1

lowest thermal conductivity

1

[8]

9.

(a) gravitational potential

1

kinetic

1

chemical

1

(b) flying drones may damage aircraft
or
falling drones may injure people
or
damage buildings / vehicles

allow any sensible suggestion of a hazard caused by a flying / falling drone

1

(c) energy transferred = power × time

allow E = Pt

1

(d) t = 25 × 60 = 1500 (s)

1

E = 65 × 1500

1

E = 97 500 (J)

an answer of 97 500 (J) scores 3 marks

allow 2 marks for an answer of 1625 (J)

1

[8]

10. (a) minimum distance between wind turbines is at least 500 m in all directions

turbines can rotate to face into wind and still maintain the minimum distance

1

(b) density = mass/volume

allow ρ = m / V

1

(c) $1.2 = \frac{51000}{V}$

1

$V = \frac{51000}{1.2}$

1

V = 42 500

1

V = 43 000

1

m^3

*an answer of 43 000 scores **4** marks*

*an answer of 42 500 scores **3** marks*

1

(d) $2.4 \times 10^9 / 1.6 \times 10^6$

1

1500

*an answer of 1500 scores **2** marks*

1

(e) wind power is unreliable

1

(very) large numbers of wind turbines would need to be constructed

allow calculation of this (15 625)

1

[11]