Energy part 4 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

Marks: **67 marks**

Comments:

1. Manufacturing a petrol car causes carbon dioxide to be emitted into the atmosphere.

Driving a petrol car also causes carbon dioxide to be emitted.

(a) Which of the following is an environmental problem caused by the emission of carbon dioxide?

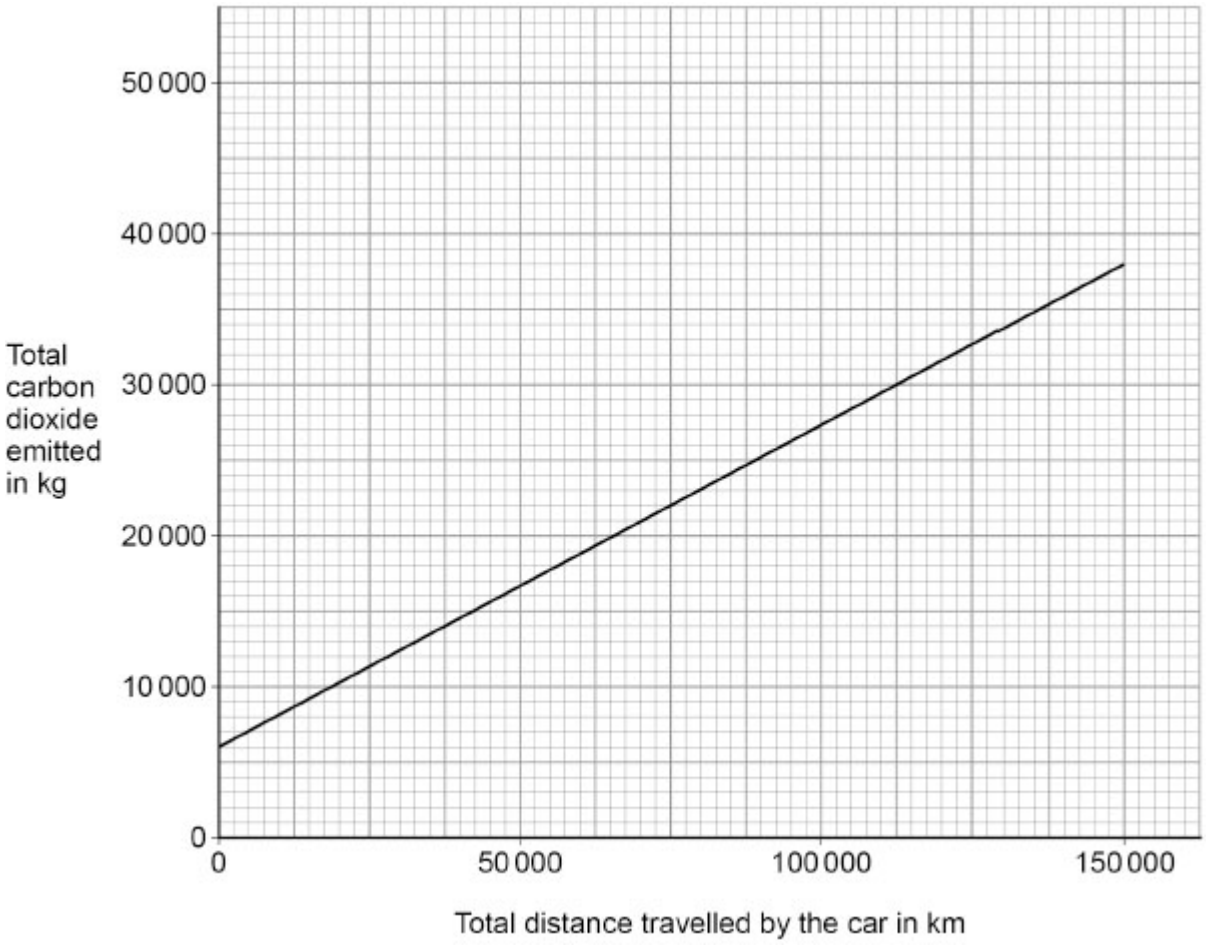
Tick (✓) **one** box.

Acid rain	☐
Damage to the ozone layer	☐
Global warming	☐

(1)

Carbon dioxide is emitted during the manufacture of the car before the car has been driven.

The figure below shows the relationship between the total distance travelled by a petrol car and the total carbon dioxide emitted.



(b) How much carbon dioxide is emitted during the manufacture of the car?

Use the figure above.

Carbon dioxide emitted = _____ kg

(1)

(c) How does the total carbon dioxide emitted change as the total distance travelled by the car increases?

Use the figure above.

_____

_____

(1)

(d) An electric car does **not** emit carbon dioxide as it is driven.

Choose **one** reason why.

Tick (✓) **one** box.

Electric cars are powered by a battery. ☐

Electric cars are powered by nuclear energy. ☐

Electric cars use diesel fuel. ☐

(1)

(e) Some energy resources used to generate electricity cause environmental issues.

Draw **one** line from each method of generating electricity to the environmental issue it causes.

Method of generating electricity	Environmental issue
Hydroelectric dam	Affect habitats of sea creatures
Nuclear power station	Emits carbon dioxide
Wave power	Produces radioactive waste
	Valley needs flooding

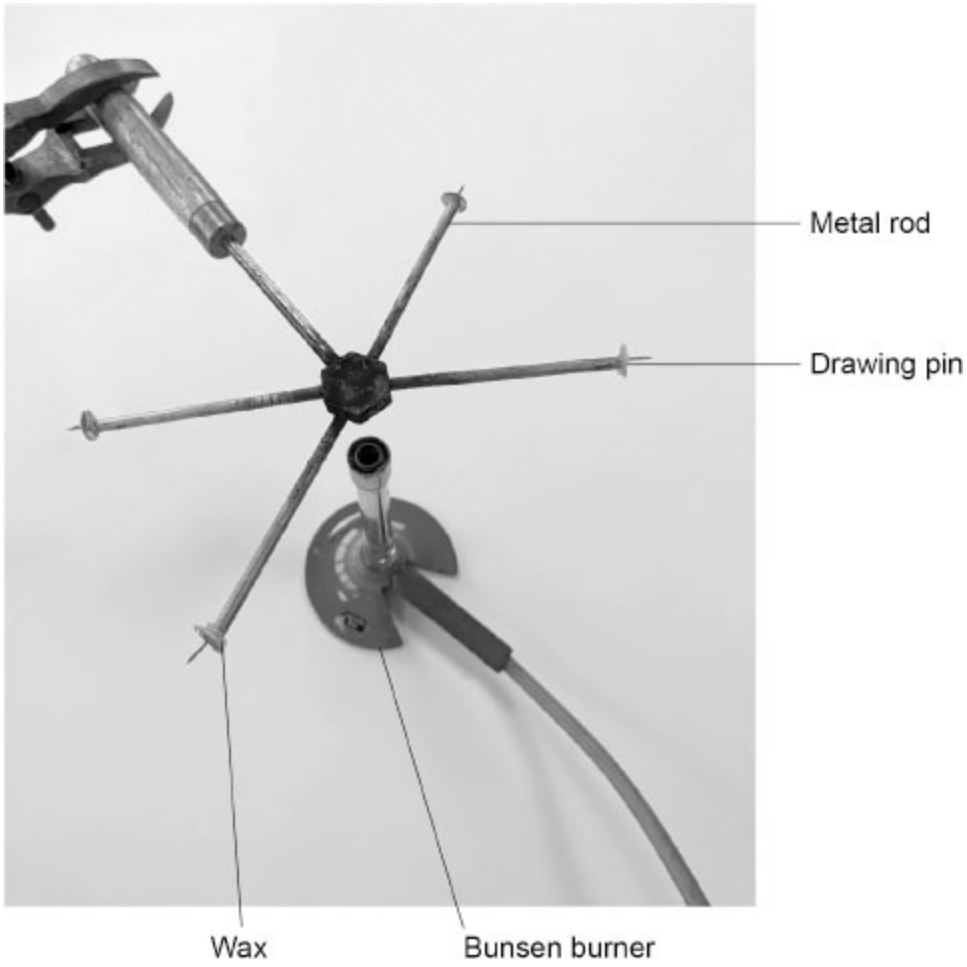
(3)

(Total 7 marks)

2. A student investigated the thermal conductivity of different metals.

Figure 1 shows some of the apparatus used.

Figure 1



Each rod was made from a different metal.

The metal rods are joined at the centre.

The size of each metal rod was the same.

This is the method used.

1. Attach a drawing pin to the end of each metal rod using wax.
2. Light the Bunsen burner.
3. Start a stopclock.
4. Record the time taken for the wax to melt and for the drawing pin to fall off each metal rod.

The table below shows the results.

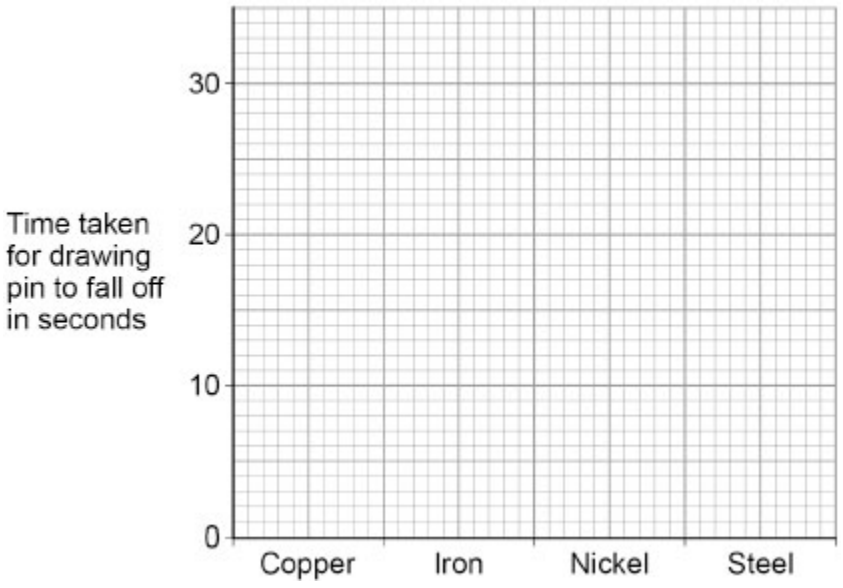
Type of metal	**Time taken for drawing pin to fall off in seconds**
Copper	10
Iron	22
Nickel	18
Steel	24

(a) Complete **Figure 2**.

You should:

- label the *x*-axis
- plot the data from the table above as a bar chart.

Figure 2



(3)

(b) Which type of metal in the table above had the greatest thermal conductivity?

Give a reason for your answer.

Tick (✓) **one** box.

Copper ☐ Iron ☐ Nickel ☐ Steel ☐

Reason _____

_____

_____

(2)

(c) The thermal energy transferred to the nickel rod was 132 J.

The temperature change of the rod was 20 °C.

mass of the nickel rod = 0.015 kg

Calculate the specific heat capacity of nickel.

Use the equation:

$$\text{specific heat capacity} = \frac{\text{thermal energy}}{(\text{mass} \times \text{temperature change})}$$

_____

_____

_____

_____

Specific heat capacity = _____ J/kg °C

(2)

Use the Physics Equations Sheet to answer parts (d) and (e).

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

_____

(1)

(e) At the end of the investigation, the Bunsen burner was turned off.

As the nickel rod cooled to room temperature, the rod transferred 132 J of energy to the room.

The mean power transfer was 0.33 W.

Calculate the time taken for the energy transfer.

_____

_____

_____

Time taken = _____ s

(3)

(Total 11 marks)

3. Tides and wind are two renewable energy resources.

(a) Describe the difference between renewable energy resources and non-renewable energy resources.

_____

_____

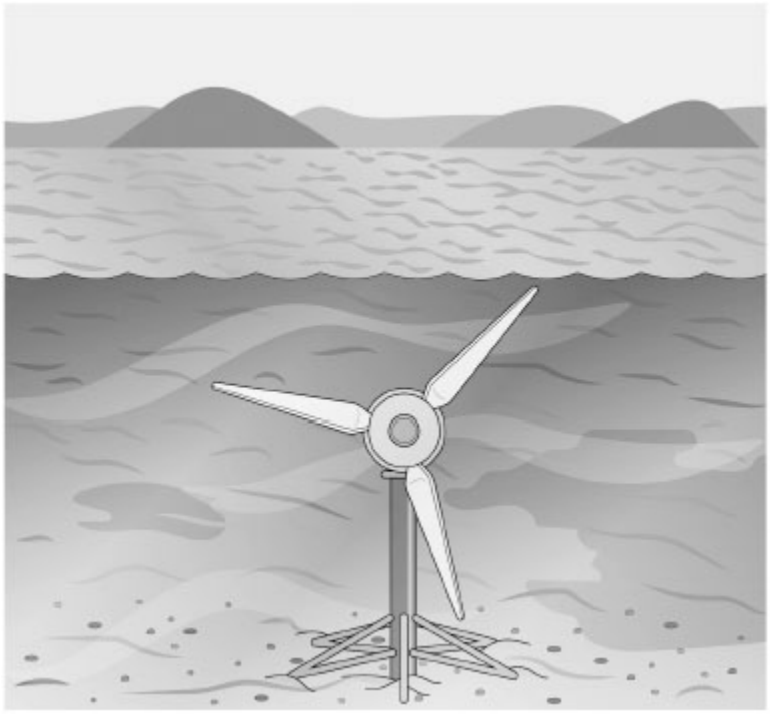
_____

_____

(2)

Figure 1 shows a new design of tidal turbine to generate electricity using the tides.

Figure 1



Use the Physics Equations Sheet to answer parts (b) and (c).

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

_____

(1)

(c) The mass of seawater passing through the tidal turbine each second is 824 000 kg.

The density of seawater is 1030 kg/m^3.

Calculate the volume of seawater passing through the tidal turbine each second.

_____

_____

_____

_____

_____

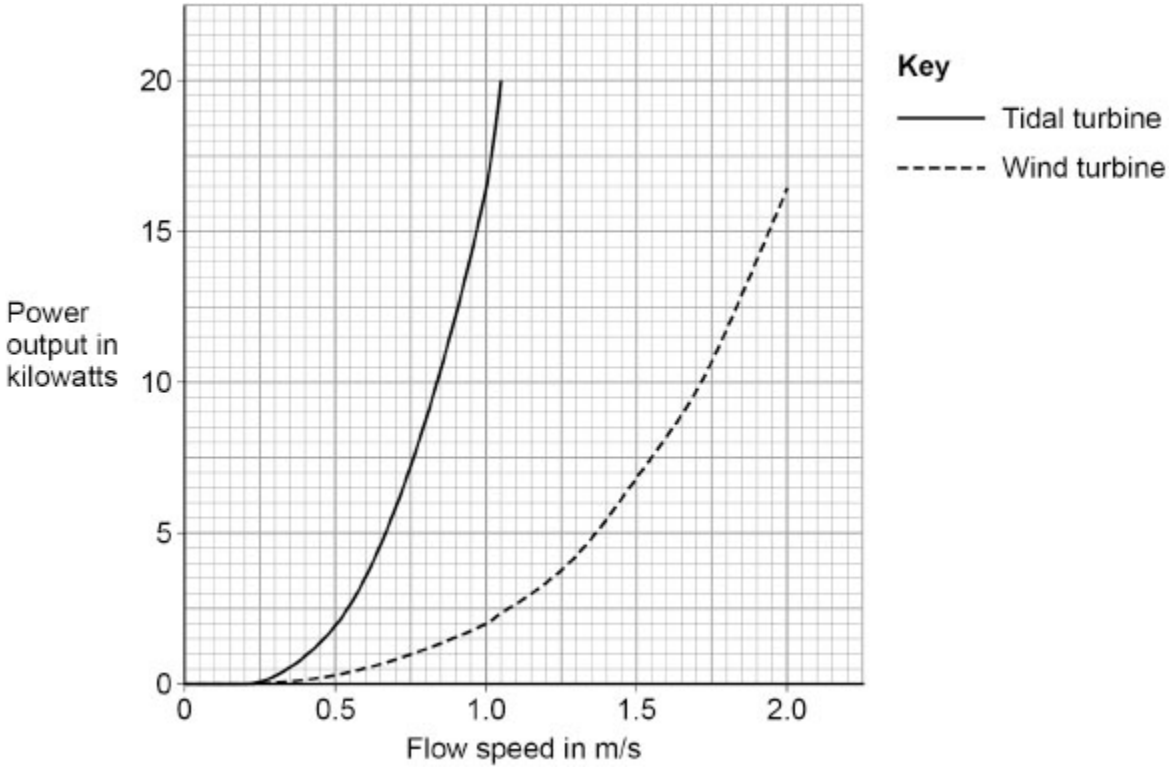
Volume = _____ m^3

(3)

The speed of the tide or the speed of the wind past a turbine is called the ‘flow speed’.

Figure 2 shows how the power output of a tidal turbine compares with a wind turbine for different flow speeds.

Figure 2



(d) As flow speed increases, power output increases.

Give **two** other conclusions that can be made using information from **Figure 2**.

1 _____

_____

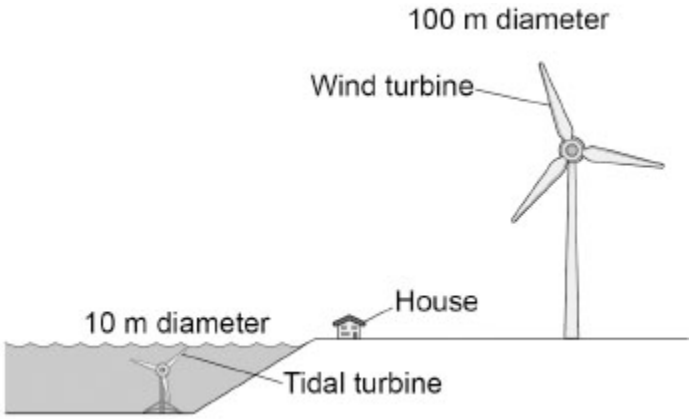
2 _____

_____

(2)

(e) **Figure 3** shows the turbines used to obtain the data for **Figure 2**.

Figure 3



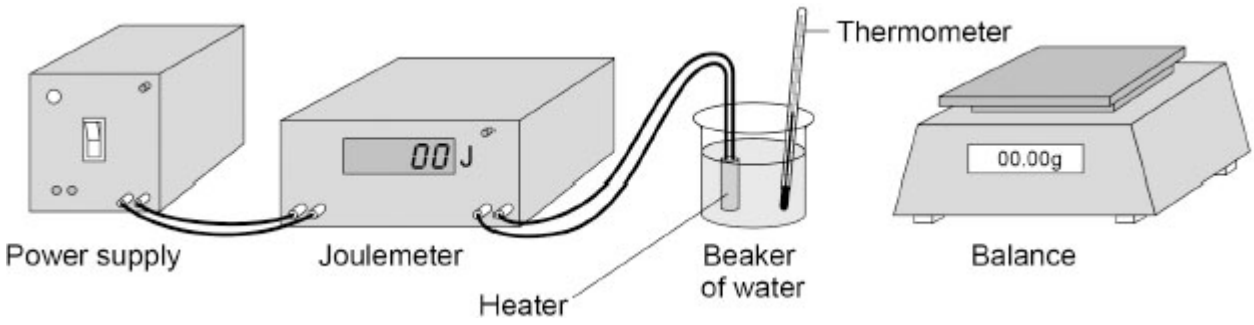
Compare the environmental impacts of the wind turbine and the tidal turbine in **Figure 3**.

(4)

(Total 12 marks)

4. A student determined the specific heat capacity of water.

The figure below shows the apparatus used.



The joulemeter measures energy transfer.

(a) Give **one** hazard in the investigation.

_____

_____

(1)

(b) Describe how the student could determine the specific heat capacity of water using the apparatus in the figure above.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(c) One source of error in the experiment was energy loss to the surroundings.

Suggest **one** change to the apparatus to reduce energy loss to the surroundings.

_____

_____

(1)

(d) The student's value for the specific heat capacity of water was 4410 J/kg °C.

The actual value for the specific heat capacity of water is 4200 J/kg °C.

Calculate the percentage difference between the student's value and the actual value.

Percentage difference = _____ %

(2)

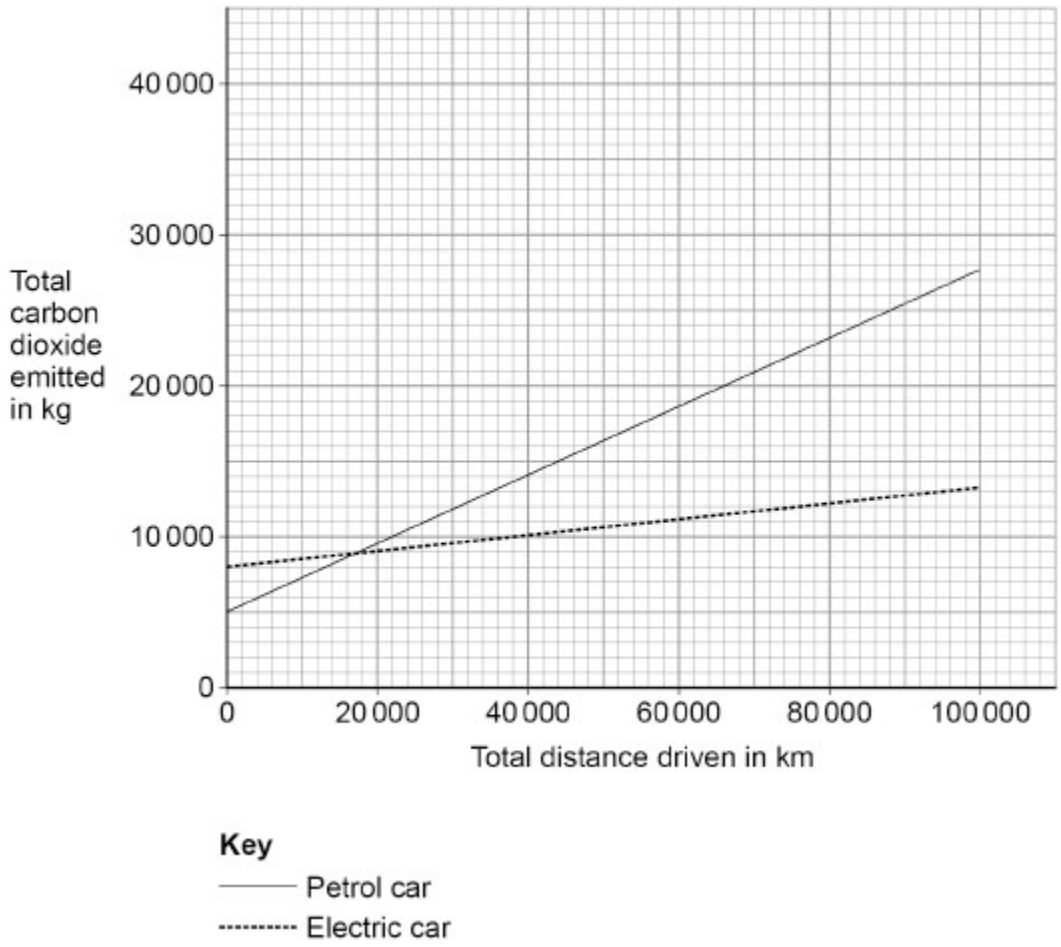
(Total 10 marks)

5. Manufacturing a car produces carbon dioxide.

(a) Explain **one** environmental problem caused by the emission of carbon dioxide.

(2)

The figure below shows the carbon dioxide produced during the lifetime of two types of car.



(b) What mass of carbon dioxide is produced during the manufacture of the electric car?

Mass of carbon dioxide = _____ kg

(1)

(c) At one distance, the amount of carbon dioxide emitted by both cars is the same.

What is this distance?

Distance = _____ km

(1)

Some energy resources emit carbon dioxide when used to generate electricity.

(d) The battery-powered electric car does not emit carbon dioxide as it is driven.

Explain why more carbon dioxide is produced as the distance travelled by the electric car increases.

_____

_____

_____

_____

(2)

(e) Which **two** of the following energy resources do **not** emit carbon dioxide when used to generate electricity?

Tick (✓) **two** boxes.

Biofuel	☐
Nuclear	☐
Oil	☐
Solar	☐
Wood	☐

(2)

(Total 8 marks)

6. Scientists have used lasers to start a nuclear **fusion** reaction.

The scientists used the lasers to heat a small amount of an isotope of hydrogen.

(a) Describe what is meant by ‘isotopes’ of an element.

(2)

(b) Explain how nuclear **fusion** releases energy.

(3)

(c) The fusion reaction releases large amounts of energy.

The fusion reaction takes place in a reactor.

Explain why the walls of the reactor should be made from a material with a very high specific heat capacity.

(2)

(d) Nuclear fusion is safer than nuclear fission.

Nuclear **fission** can lead to an uncontrolled chain reaction.

Give **one** consequence of an uncontrolled chain reaction.

_____

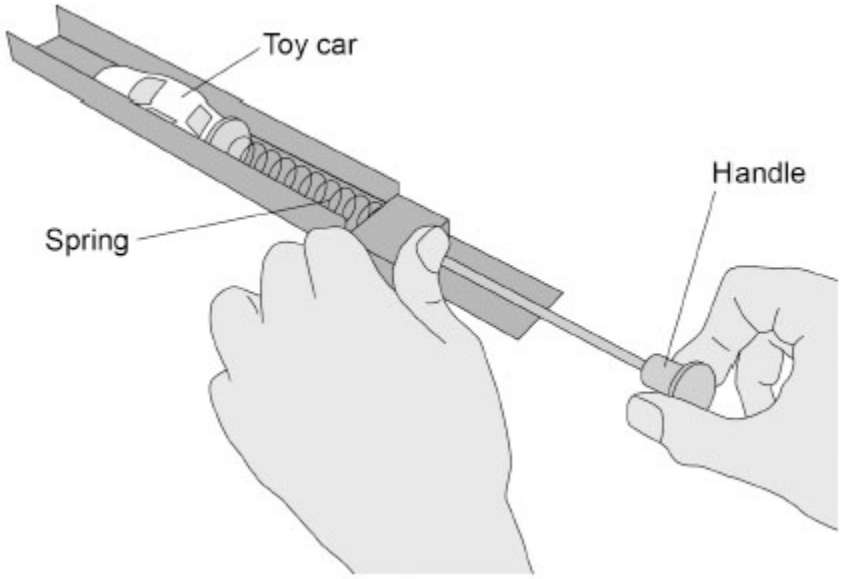
_____

(1)

(Total 8 marks)

7. **Figure 1** shows a device that accelerates a toy car at the start of a race track.

Figure 1



(a) Pulling the handle compresses the spring in the device by 0.075 m.

When the handle is released, the energy stored in the compressed spring is transferred to the toy car.

spring constant = 64 N/m

mass of toy car = 0.052 kg

Calculate the maximum possible speed of the toy car just after the car starts to move.

Use the Physics Equations Sheet.

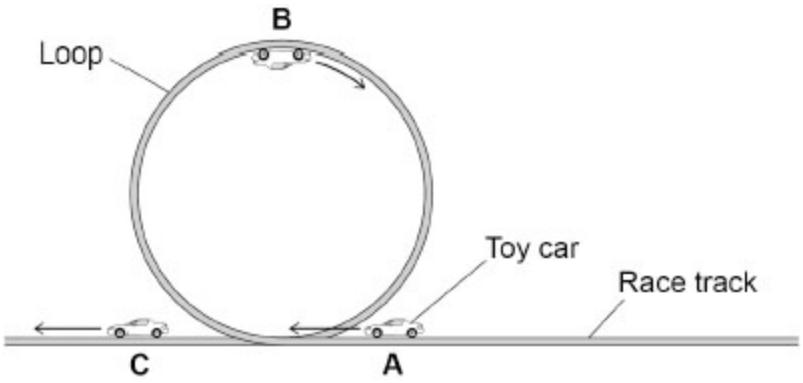
Give your answer to **2** significant figures.

Maximum possible speed (2 significant figures) = _____ m/s

(6)

(b) **Figure 2** shows the path of the toy car along a loop section of the race track.

Figure 2



The car moves along the track from position **A** to position **B** and then to position **C**.

Describe how the energy stores of the car change as the car moves along the track from position **A** to position **C**.

Ignore the effects of friction and air resistance.

_____

_____

_____

_____

_____

_____

(3)

(c) At the end of the race track, the toy car passes through a light gate that measures the speed of the car.

Which **two** measurements are needed to determine the speed of the car?

Tick (✓) **two** boxes.

Length of the toy car ☐

Mass of the toy car ☐

Temperature of the room ☐

Time for the toy car to pass the light gate ☐

Total length of the race track ☐

(2)

(Total 11 marks)

1.

(a) global warming

1

(b) 6000 (kg)

1

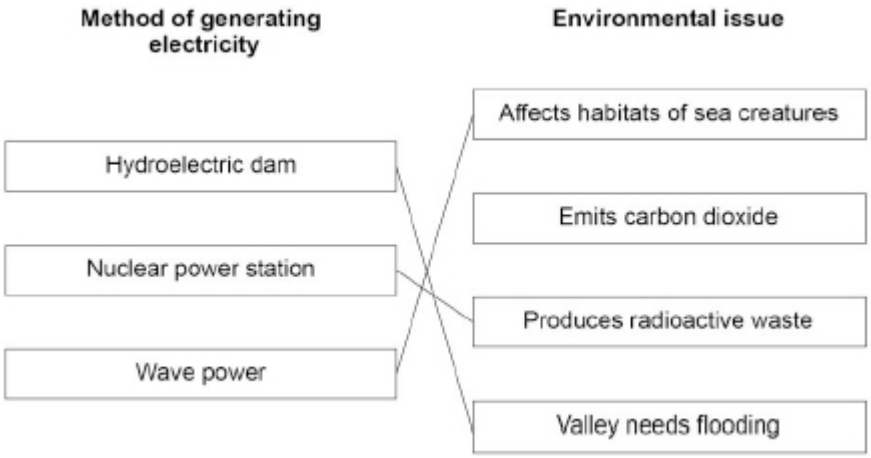
(c) (as the distance travelled increases the amount of carbon dioxide) increases

1

(d) electric cars are powered by a battery

1

(e)



do **not** accept more than one line from a box on the left

3

[7]

2.

(a) x-axis labelled: (type of) metal

1

4 bars correctly drawn

allow a tolerance of ± ½ a small square

*allow **1** mark for 2 or 3 bars drawn correctly*

2

(b) copper

1

least time for drawing pin to fall
or
least time for wax to melt

dependent on MP1

allow less for least

allow pin fell off quicker

allow quickest time to melt the wax

1

(c)

$$c = \frac{132}{(0.015 \times 20)}$$

1

c = 440 (J/kg °C)

1

(d)

$$\text{power} = \frac{\text{energy transferred}}{\text{time}}$$

Or

$$P = \frac{E}{t}$$

1

(e)

$$0.33 = \frac{132}{t}$$

1

$$t = \frac{132}{0.33}$$

1

t = 400 (s)

1

[11]

3. (a) renewable: (an energy resource that is) replenished (as it is used)

allow replaced for replenished

ignore has an infinite supply

ignore not running out

1

non-renewable: (an energy resource that is) finite

allow limited supply

ignore running out

ignore won't last forever

1

(b)

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

or

$$\rho = \frac{m}{V}$$

1

(c)

$$1030 = \frac{824\,000}{V}$$

1

$$V = \frac{824\,000}{1030}$$

1

$V = 800$ (m^3)

1

(d) any **two** from:

- at very low flow speeds there is no power output
- tidal power output is (always) greater than wind power output for the same flow speeds (above 0.25 m/s)
- a change in flow speed makes a bigger difference to tidal power output than wind power output
- there is a non-linear relationship between flow speed and power output

allow wind power needs a higher flow speed to get the same power output (as tidal power)

ignore reference to exponential relationships

*do **not** accept flow speed of tidal is less than flow speed of wind*

ignore comments about reliability or efficiency

2

(e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1-2

No relevant content

0

Indicative content

- wind turbine is much larger than the tidal turbine
- wind turbine causes more visual pollution than the tidal turbine
- tidal turbine is hidden from view (as it is under water)
- tidal turbine is less likely to cause noise pollution (as it is under water)
- wind turbine is likely to make more noise
- wind turbine needs more raw materials (for construction)
- more wind turbines needed for same power output (at the same flow speed)
- wind turbine will harm birds, whereas tidal turbine will not
- tidal turbine may harm fish, whereas wind turbine will not

[12]

4. (a) hot water / beaker
or
heater

ignore descriptions of risk
allow spilt water
allow broken glass / beaker

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

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

3-4

Level 1: The method 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

- measure the mass of the empty beaker on the balance
- fill the beaker with water and measure the total mass of beaker and water
- mass of water = total mass – mass of beaker
- turn power supply on so heater increases the temperature of the water
- measure temperature change / increase with thermometer
- use joulemeter to measure energy transferred to water
- calculate SHC using $E = mc\Delta\theta$

a level 3 answer must have a clear method of how the mass of water is determined

(c) insulate the beaker of water

or

add a lid

allow named insulation

allow use an insulating cup

eg plastic cup

1

(d) difference = 4410 – 4200

or

difference = 210

or

$$\% \text{ difference} = \frac{(4410 - 4200)}{4200} \times 100$$

1

% difference = 5 (%)

*do **not** accept 4.76 (%)*

1

[10]

5. (a) carbon dioxide is a greenhouse gas

allow carbon dioxide causes the greenhouse effect

allow absorbs infrared (radiation)

1

(which) causes global warming

allow climate change

allow examples of climate change eg sea levels rising, extreme weather conditions, etc

1

(b) 8000 (kg)

1

(c) 17 000 (km)

allow an answer between 16 000 (km) and 18 000 (km)

1

(d) the car / battery needs (re)charging

1

(some of the) electricity has been generated using gas / coal / oil

allow fossil fuels

1

(e) nuclear

1

solar

1

[8]

6. (a) (atoms of an element with) the same number of protons

ignore number of electrons

allow same atomic number

1

but a different number of neutrons

allow different mass number

1

(b) light(er) nuclei fuse

allow hydrogen nuclei fuse

ignore bonding / colliding

1

to form heavier nuclei / elements

allow to form helium nuclei

1

some of the mass (of the nuclei) is converted into energy (of radiation)

1

(c) (a large amount of energy transferred) causes a small temperature increase of the walls / material

1

(therefore) the walls of the reactor should not reach melting point

allow (therefore) the walls of the reactor should not melt

1

(d) any **one** from:

- a nuclear explosion
- a (nuclear) meltdown
- a nuclear bomb

allow atomic for nuclear

allow Chernobyl / Fukushima (disaster)

1

[8]

7. (a) $E_e = 0.5 \times 64 \times 0.075^2$

1

$E_e = 0.18$ (J)

the equation $E_e = 0.5ke^2$ must have been used to score subsequent calculation marks

1

$0.18 = 0.5 \times 0.052 \times v^2$

allow a correct substitution using their value of E_e

1

$$v^2 = \frac{0.18}{0.5 \times 0.052}$$

allow a correct rearrangement using their value of E_e

1

$v = 2.631\ldots$ (m/s)

allow a correct calculation using their value of E_e

1

$v = 2.6$ (m/s)

*allow an answer given to 2 sf using **all** the data in the question*

alternative approach:

(F = ke)

(F = 64 × 0.075)

(maximum) F = 4.8 (N) (1)

(F = ma)

(4.8 = 0.052 × a)

(maximum) a = 92.3 (m/s^2) (1)

(mean) a = 46.2 (m/s^2) (1)

($v^2 - u^2 = 2as$)

$v^2 = 2 \times 46.2 \times 0.075$ (1)

or

$v^2 = 6.923$

$v = 2.631\ldots$ (1)

$v = 2.6$ (m/s) (1)

1

(b) kinetic energy decreases moving from **A** to **B**

ignore comments about energy dissipation

allow E_k for kinetic energy

allow E_p for gravitational potential energy

*allow kinetic energy is transferred to gravitational potential energy while moving from **A** to **B** for MP1 and MP2*

1

(and) gravitational potential energy increases moving from **A** to **B**

1

(then) gravitational potential energy decreases from **B** to **C** and kinetic energy increases

*allow gravitational potential energy is transferred to kinetic energy while moving from **B** to **C***

1

(c) length of the toy car

1

time for toy car to pass the light gate

1

[11]