Energy part 5 AQA Triple Physics

Name: ______________________

Class: ______________________

Date: ______________________

Time: **70 minutes**

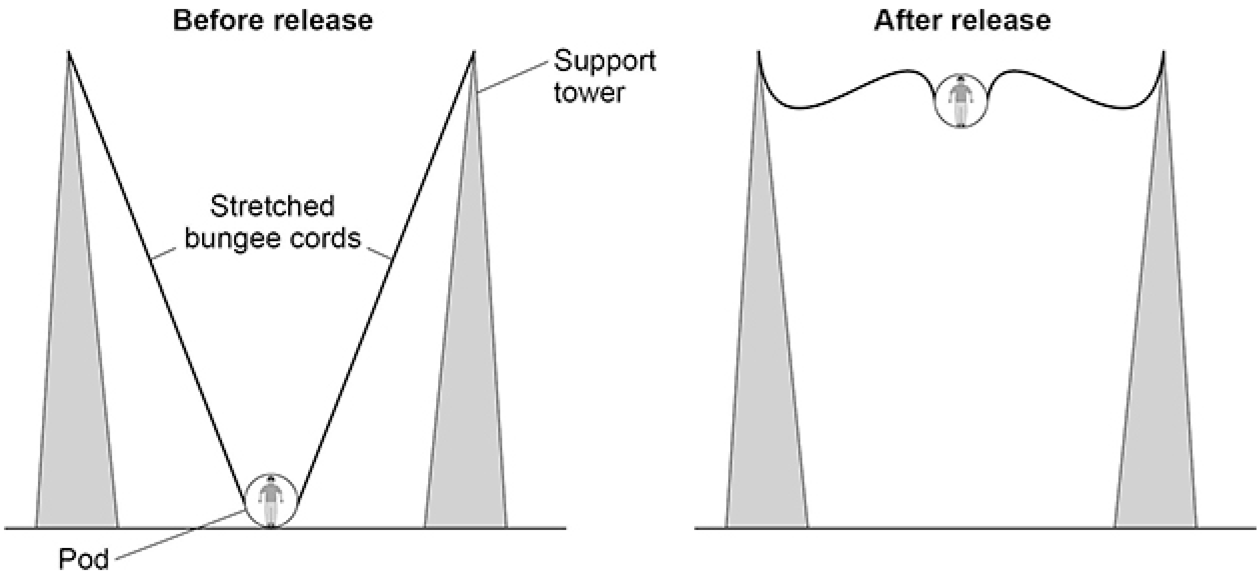
Marks: **66 marks**

Comments:

1. In a ride at a theme park, a person is strapped into a pod that is attached to two stretched bungee cords.

The bungee cords behave like springs.

The figure below shows a person using the ride.



(a) How is the extension of each bungee cord calculated?

Tick (✓) **one** box.

stretched length + original length ☐

stretched length – original length ☐

stretched length × original length ☐

stretched length ÷ original length ☐

(1)

(b) Before the pod is released, the extension of each bungee cord is 7.5 m.

spring constant of the bungee cord = 800 N/m

Calculate the elastic potential energy stored in each stretched bungee cord.

Use the equation:

$$\text{elastic potential energy} = 0.5 \times \text{spring constant} \times (\text{extension})^2$$

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Elastic potential energy = ____________________ J

(2)

(c) The maximum speed of the pod is 15 m/s.

The mass of the pod is 240 kg.

Calculate the maximum kinetic energy of the pod.

Use the equation:

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

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Maximum kinetic energy = ____________________ J

(2)

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

(d) Which equation links gravitational field strength (g), gravitational potential energy (E_p), height (h) and mass (m)?

Tick (✓) **one** box.

$E_p = \frac{m \times g}{h}$ ☐

$E_p = \frac{m}{g \times h}$ ☐

$Ep = m \times g \times h$ ☐

(1)

(e) The pod has 24 000 J of gravitational potential energy when at its maximum height.

The mass of the pod is 240 kg.

gravitational field strength = 9.8 N/kg

Calculate the maximum height reached by the pod.

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Maximum height = ____________________ m

(3)

(f) Why is the maximum gravitational potential energy of the pod less than the initial elastic potential energy of the bungee cords?

Tick (✓) **two** boxes.

Energy is created. ☐

Energy is destroyed. ☐

Energy is transferred to the surroundings. ☐

Work is done against air resistance. ☐

Work is done by the force of gravity. ☐

Work is done by the person in the pod. ☐

(2)

(Total 11 marks)

2. The figure below shows a wind turbine.

Wind turbines may generate electricity when the electricity is not needed.

Two methods that can be used to store the energy from the turbine are:

Method A: Heating water to a high temperature.

Method B: Pumping water uphill into a reservoir.

(a) Which energy store increases when water is heated?

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(1)

(b) Which energy store increases when water is pumped uphill into a reservoir?

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(1)

(c) The table below shows information about the two methods of storing energy.

Method	**Energy stored per 100 kg of water in kJ**	**Percentage of stored energy wasted**	**Installation**
A: Increasing water temperature by 80 °C	33 600	40%	Anywhere
B: Pumping water uphill to a height of 500 m	490	25%	High mountains

Compare the advantages and disadvantages of the two methods of storing energy.

Include calculations in your answer.

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(4)

(d) Decreasing the amount of carbon dioxide released by different activities will help slow down climate change.

Transport and generating electricity are the two activities that released the largest amounts of carbon dioxide in the UK in 2018.

Explain **one** change that would reduce the amount of carbon dioxide released by **each** activity.

Transport ____

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Generating electricity ____

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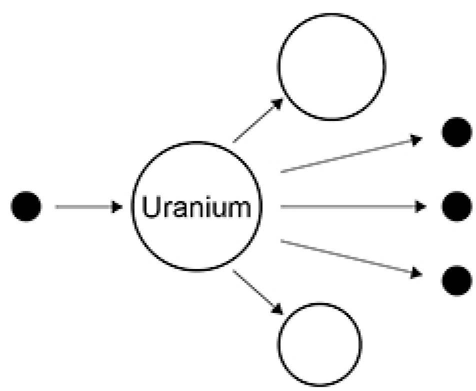
(4)

(Total 10 marks)

3. The process of nuclear fission is used in nuclear power stations.

The figure below shows the process of nuclear fission.



(a) Complete the sentences.

Choose answers from the box.

electrons	**gamma rays**	**neutrons**	**nuclei**	**protons**

In nuclear power stations, energy is released from uranium

______________________________ .

The uranium in above figure splits into two parts and releases three

______________________________ .

The process of nuclear fission releases electromagnetic radiation in the form of

______________________________.

(3)

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

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

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(1)

(c) A nuclear power station has a power output of 500 MW.

Calculate the energy output in 3600 s.

Give your answer in J.

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Energy output = ____________________ J

(3)

(d) Radioactive waste produced by nuclear power stations has a long half-life.

Suggest **one** precaution taken to reduce the hazard caused by radioactive waste from power stations.

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(1)

(e) Nuclear power stations do **not** generate electricity every day of the year.

One nuclear power station generated electricity for 92% of a year.

one year = 365 days

Calculate the number of days during the year that the nuclear power station generated electricity.

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Number of days = ____________________

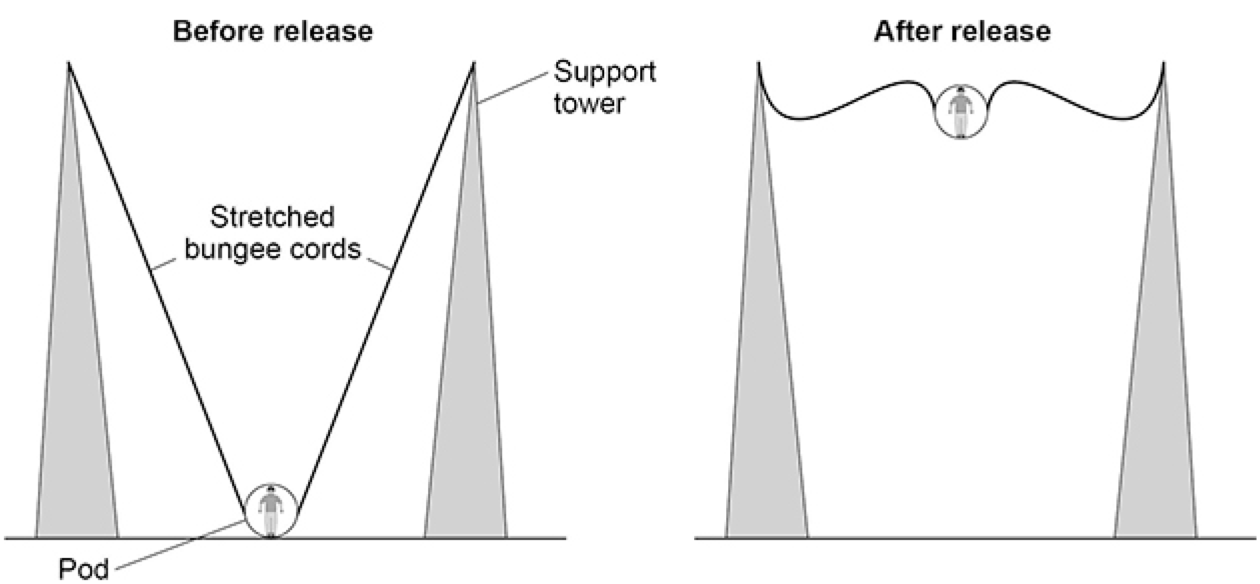
(2)

(Total 10 marks)

4. In a ride at a theme park, a person is strapped into a pod that is attached to two stretched bungee cords.

The bungee cords behave like springs.

The figure below shows a person using the ride.



(a) Which energy store increases as the bungee cords are stretched?

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(1)

(b) When the pod is released, the pod accelerates upwards.

Before the pod is released the extension of **each** of the two bungee cords is 8.0 m.

The spring constant of each bungee cord is 735 N/m.

The mass of the pod is 240 kg.

gravitational field strength = 9.8 N/kg

Calculate the maximum height reached by the pod.

Use the Physics Equations Sheet.

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Maximum height = ____________________ m

(6)

(c) The actual maximum height reached by the pod will be lower than the correct answer to part (b).

Explain why.

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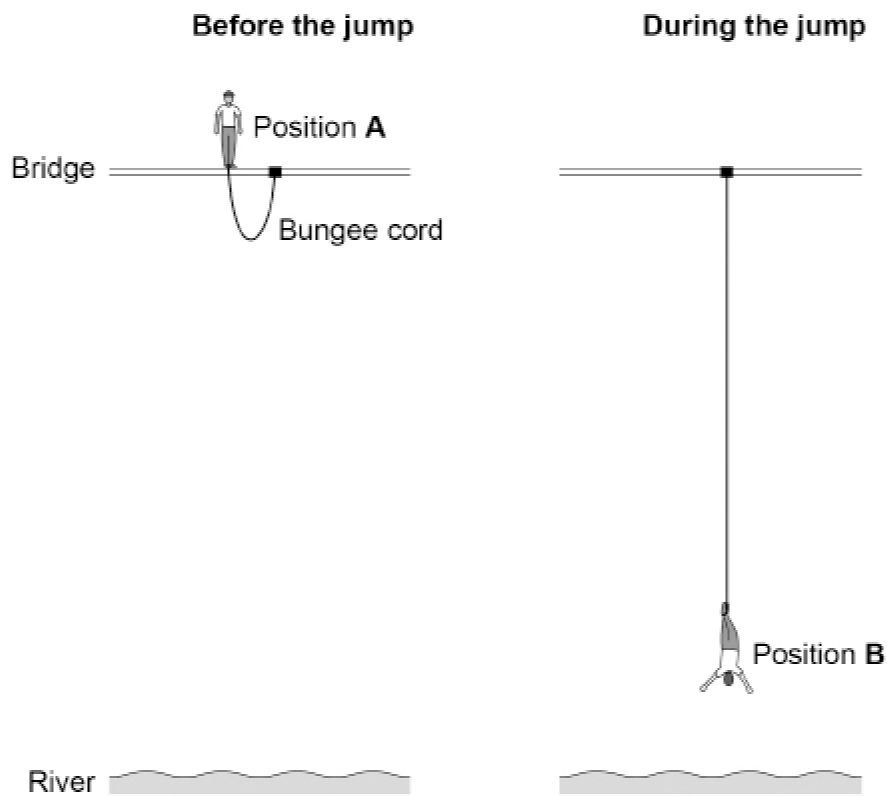
(2)
(Total 9 marks)

5. The figure below shows a student before and during a bungee jump.

The diagram is not to scale.



(a) In position **B**, the student is moving towards the river and the bungee cord is stretching.

How do the energy stores in position **B** compare with the energy stores in position **A**?

Tick (✓) **one** box in **each** row.

Energy store	**Less than at A**	**The same as at A**	**More than at A**
The student's gravitational potential energy			
The student's kinetic energy			
The bungee cord's elastic potential energy			

(3)

(b) The bungee cord behaves like a spring with a spring constant of 78.4 N/m.

At one point in the bungee jump, the extension of the bungee cord is 25 m.

Calculate the elastic potential energy stored by the bungee cord.

Use the equation:

$$\text{elastic potential energy} = 0.5 \times \text{spring constant} \times \text{extension}^2$$

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____

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Elastic potential energy = ____________________ J

(2)

The table below shows information about different bungee cords.

Bungee cord	**Spring constant in N/m**	**Maximum extension before snapping in metres**
A	78.4	36
B	82.0	24
C	84.5	12

(c) Bungee cord **C** will have a smaller extension than **A** or **B** for any bungee jumper.

Give the reason why.

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(1)

(d) Which bungee cord would be safest to use for a person with a large weight?

Give a reason for your answer.

Bungee cord ___________

Reason ____

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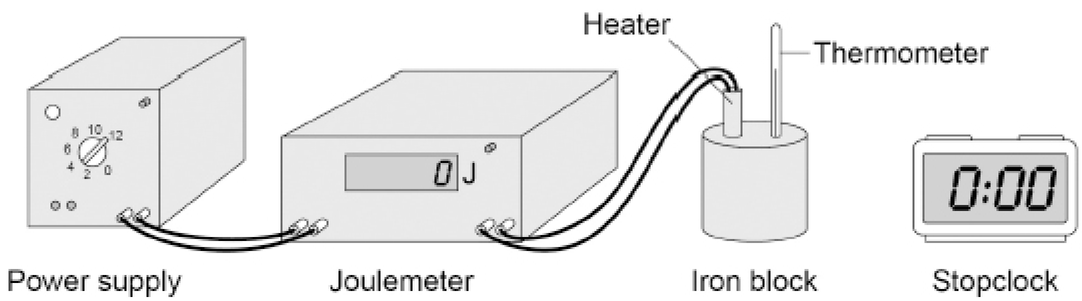
(2)
(Total 8 marks)

6. **Figure 1** shows the equipment a student used to determine the specific heat capacity of iron.

The iron block the student used has two holes, one for the heater and one for the thermometer.

Figure 1



(a) Before the power supply was switched on, the thermometer was used to measure the temperature of the iron block.

The student left the thermometer in the iron block for a few minutes before recording the initial temperature.

Suggest why.

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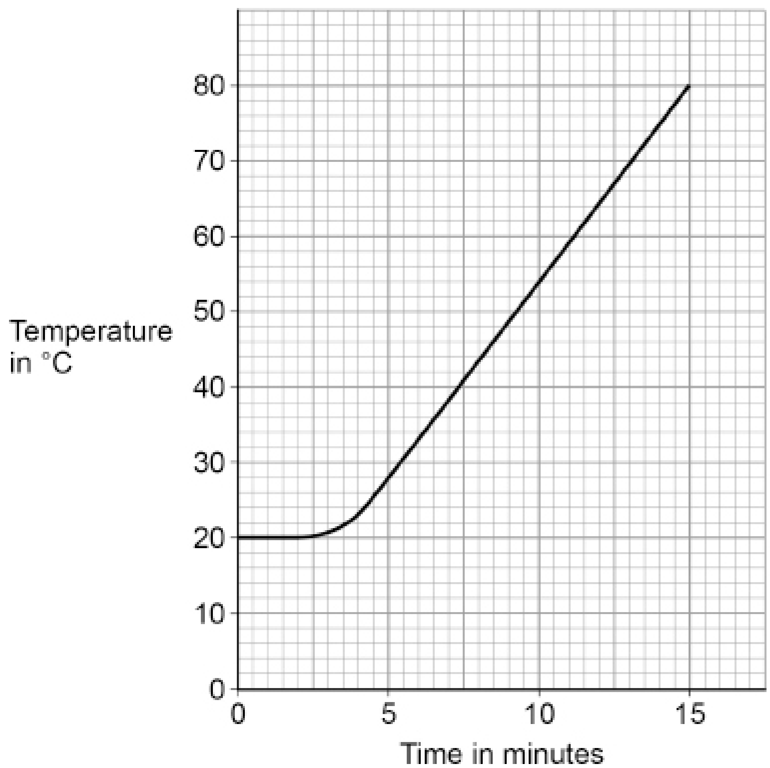
(1)

(b) **Figure 2** shows how the temperature changed after the power supply was switched on.

Figure 2



The energy transferred to the iron block between 5 and 10 minutes was 26 000 J.

The mass of the iron block was 2.0 kg.

Calculate the specific heat capacity of iron.

Use information from **Figure 2** and the Physics Equations Sheet.

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Specific heat capacity = ____________________ J/kg °C

(4)

(c) The student repeated the investigation but wrapped insulation around the iron block.

What effect will adding insulation have had on the investigation?

Tick (✓) **two** boxes.

The calculated specific heat capacity will be more accurate.	☐
The iron block will transfer thermal energy to the surroundings at a lower rate.	☐
The power output of the heater will be lower than expected.	☐
The temperature of the iron block will increase more slowly than expected.	☐
The uncertainty in the temperature measurement will be greater.	☐

(2)
(Total 7 marks)

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

(a) 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.

Mean change in vertical height = ____________________ m

(4)

(b) 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.

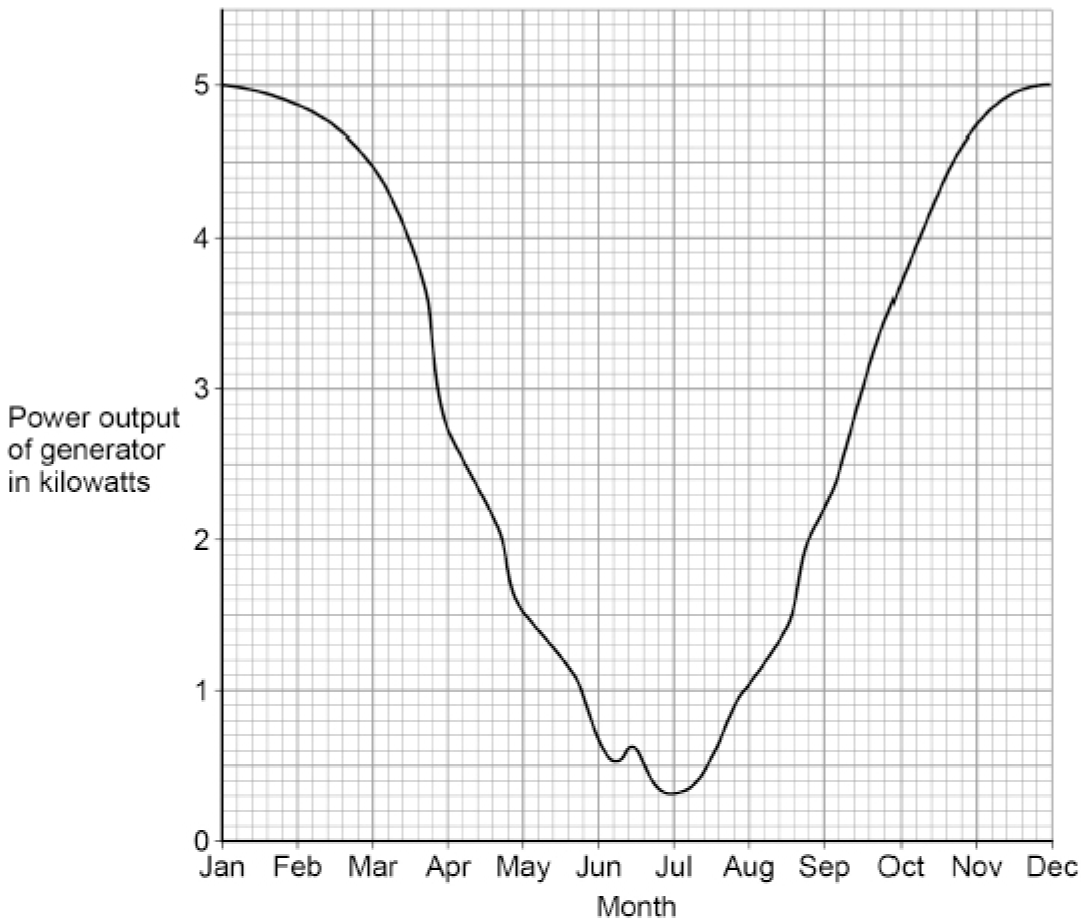
Use the Physics Equations Sheet.

Give your answer in standard form.

Time taken (in standard form) = ____________________ s

(5)

(c) The figure below shows how the power output of the generator varied during one year.



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 the figure above.

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____

(2)
(Total 11 marks)

Mark schemes

1. (a) stretched length – original length **1**

(b) $E_e = 0.5 \times 800 \times 7.5^2$ **1**

$E_e = 22\ 500$ (J) **1**

(c) kinetic energy = $0.5 \times 240 \times 15^2$ **1**

kinetic energy = 27 000 (J) **1**

(d) $E_p = m \times g \times h$ **1**

(e) $24\ 000 = 240 \times 9.8 \times h$ **1**

$$h = \frac{24\ 000}{(240 \times 9.8)}$$ **1**

$h = 10.2$ (m)

allow 10 (m)

allow a correct answer given to more than 3 s.f. **1**

(f) energy is transferred to the surroundings **1**

work is done against air resistance **1**

[11]

2. (a) thermal / internal (energy)

or

kinetic (energy of the water particles)

ignore heat

allow E_k **1**

(b) gravitational potential (energy)

allow E_p / GPE

allow kinetic / E_k **1**

(c) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.

3−4

Level 1: Relevant features are identified and differences noted.

1−2

No relevant content

0

Indicative content

Method A:

- heated water needs insulating (to maintain high temperature)
- energy stored by heating water is much greater (per 100 kg)
- useful energy from heating 100 kg of water = 20 160 (kJ)
- energy wasted (per 100 kg) = 13 440 (kJ)
- efficiency = 60 %

Method B:

- suitable location needed to pump water uphill
- pumping water efficiency is higher
- useful energy from pumping 100 kg of water = 367.5 (kJ)
- energy wasted (per 100kg) = 122.5 (kJ)
- efficiency = 75 %

A level 2 answer should use the data in a relevant calculation that compares the two methods.

(d) **Transport examples:**

don't use (petrol / diesel) cars (for transport)
or
don't burn petrol / diesel (for transport)

allow don't use other transport methods e.g. (diesel) buses

allow fossil fuels for petrol / diesel

1

(instead) use electric cars
or
(instead) use hydrogen-fuelled cars
or
(instead) use a bicycle
or
(instead) use public transport
or
(instead) walk

1

Generating Electricity examples:

don't use coal / oil / gas (to generate electricity)

allow fossil fuels for coal / oil / gas

1

(instead) use renewable methods
or
(instead) use nuclear power

OR

don't use (electrical) appliances when not needed

to reduce the demand for electricity (generated) using coal / oil / gas

allow specific examples of renewable energy resources

allow specific examples e.g. lights

allow fossil fuels for coal / oil / gas

accept other reasonable changes with valid alternative for 2 marks each

1

[10]

3. (a) nuclei

1

neutrons

1

gamma rays

this order only

1

(b) energy = power × time
or
$E = P \times t$

1

(c) P = 500 000 000 (W)

1

E = 500 000 000 × 3600

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

1

E = 1 800 000 000 000 (J)
or
$E = 1.8 \times 10^{12}$ (J)

allow an answer consistent with an incorrectly / not converted value of P

1

(d) any **one** from:

- bury the radioactive waste
- put the radioactive waste in cooling ponds

  allow store it for (at least) one half-life
- transport the radioactive waste in secure vessels
- store the radioactive waste in metal containers
- cover the radioactive waste in concrete

  ignore references to high / medium / low level waste

  ignore label the waste as hazardous

1

(e)

number of days = $\frac{92}{100} \times 365$

1

number of days = 335.8

allow answers of 335 and 336 days

allow an answer of 29.2 (days) for 1 mark

1

[10]

4. (a) elastic potential (energy)

allow E_e / EPE

1

(b) $E_e = 0.5 \times 735 \times 8.0^2$

allow a correct substitution using

k = 1470 (N/m) and e = 8 (m)

or

k = 1470 (N/m) and e = 16 (m)

or

k = 735 (N/m) and e = 16 (m)

1

E_e = 23 520 (J)

this answer only

1

total E_e = 47 040 (J)

this answer only

1

47 040 = 240 × 9.8 × h

allow a correct substitution of their calculated value of E_e (using $E_e = 0.5ke^2$)

1

$$h = \frac{47\,040}{(240 \times 9.8)}$$

allow a correct rearrangement using their calculated value of E_e (using $E_e = 0.5ke^2$)

1

h = 20 (m)

allow an answer consistent with their value of E_e

(using $E_e = 0.5ke^2$)

1

(c) air resistance (opposes the motion of the pod upwards)

1

(so) not all of the elastic potential energy will be transferred to gravitational potential energy

allow the energy transfer is not 100% efficient

allow some energy is transferred to the surroundings

allow some energy is dissipated

ignore energy is wasted

ignore reference to mass of person in pod

1

[9]

5. (a)

Energy store	Less than at A	The same as at A	More than at A
The student's gravitational potential energy	✓		
The student's kinetic energy			✓
The bungee cord's elastic potential energy			✓

additional tick in a row negates the mark for that row

3

(b) $E_e = 0.5 \times 78.4 \times 25^2$

1

$E_e = 24\ 500$ (J)

1

(c) greatest spring constant

allow needs largest force (per metre) to stretch the cord

1

(d) A

1

greatest extension before snapping

MP2 dependent on scoring MP1

1

[8]

6. (a) so the thermometer temperature was the same as the temperature of the iron block

1

(b) $\Delta\theta = (54 - 28) = 26$ (°C)

1

$26\ 000 = 2.0 \times c \times 26$

allow a correct substitution using an incorrect value of Δθ obtained from the graph

1

$$c = \frac{26\ 000}{2.0 \times 26}$$

allow a correct rearrangement using an incorrect value of Δθ obtained from the graph

1

$c = 500$ (J/kg °C)

allow an answer consistent with their value of Δθ obtained from the graph

1

(c) the calculated specific heat capacity will be more accurate

1

the iron block will transfer thermal energy to the surroundings at a lower rate

1

[7]

7. (a) E_p = 367 500 000 (J)

1

367 500 000 = 2 500 000 × 9.8 × h

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

1

$$h = \frac{367\,500\,000}{2\,500\,000 \times 9.8}$$

allow a correct rearrangement using an incorrectly/not converted value of E_p

1

h = 15 (m)

allow an answer consistent with their value of E_p

1

(b) 3 kW = 3000 W

1

$$3000 = \frac{2.16 \times 10^7}{t}$$

all subsequent marks can score using an incorrectly / not converted value of P

1

$$t = \frac{2.16 \times 10^7}{3000}$$

1

t = 7200 (s)

1

$t = 7.2 \times 10^3$ (s)

allow an answer given in standard form from a calculation using data given in the question

1

(c) in the summer the power output from the hydroelectric generator is lower but the solar power output would be greater

allow power output of hydroelectric generator depends on rainfall ***and*** *power output of solar power system depends on light intensity*

1

so less variation in total power output (which improves the reliability of the supply)

allow electricity supply for total power output

1

allow reference to specific months eg April to September

[11]