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EDEXCEL GCSE PHYSICS: QUESTIONS BY TOPIC

## Conservation of Energy (3)

**GCSE Physics (Higher) Topic 3**

9 questions · 91 marks · Mark schemes included

*Pearson Edexcel GCSE (9-1) Physics 1PH0, Higher Tier, June 2018 - June 2025*

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**HOW TO USE THIS BOOKLET**

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

| QUESTION      |                     | SOURCE                | MARKS | PAGE      |
|---------------|---------------------|-----------------------|-------|-----------|
| 1. <b>Q2</b>  |                     | Paper 1 November 2020 | 9     | <b>4</b>  |
| 2. <b>Q2</b>  |                     | Paper 1 June 2022     | 9     | <b>6</b>  |
| 3. <b>Q3</b>  |                     | Paper 1 June 2023     | 9     | <b>8</b>  |
| 4. <b>Q2</b>  |                     | Paper 1 June 2024     | 9     | <b>10</b> |
| 5. <b>Q6</b>  | <i>also Topic 2</i> | Paper 1 June 2025     | 10    | <b>14</b> |
| 6. <b>Q8</b>  |                     | Paper 1 June 2018     | 11    | <b>18</b> |
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| 8. <b>Q10</b> |                     | Paper 1 November 2021 | 11    | <b>24</b> |
| 9. <b>Q7</b>  |                     | Paper 1 June 2018     | 12    | <b>28</b> |



# QUESTIONS

9 questions · 91 marks · lowest tariff first



# 9-MARK QUESTIONS

4 questions in this booklet



- 2 A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 2.

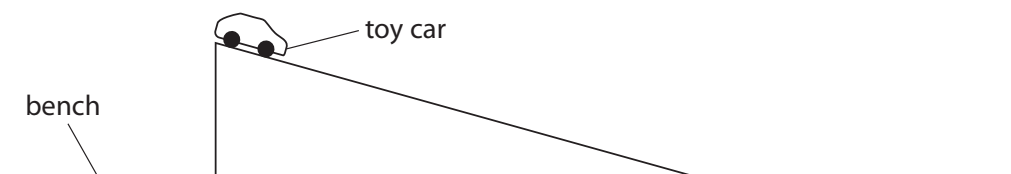


Figure 2

- (a) Describe an energy transfer that occurs when the student lifts the toy car from the bench and places the toy car at the top of the slope.

(2)

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- (b) The student lets the toy car roll down the slope.

Describe how the student could find, by experiment, the speed of the toy car at the bottom of the slope.

(4)

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- (c) The student needs to develop the experiment to determine the loss in potential energy and the gain in kinetic energy as the toy car is rolling down the slope.

State the other measurements the student must make.

(2)

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- (d) When the toy car rolls down the slope, some energy is transferred to the surroundings as thermal energy.

State how the student could calculate the amount of energy transferred to the surroundings.

(1)

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**(Total for Question 2 = 9 marks)**



2 (a) Which statement describes conservation of energy in a closed system?

(1)

- ☐ A when there are energy transfers, the total energy reduces
- ☐ B when there are energy transfers, the total energy does not change
- ☐ C when there are no energy transfers, the total energy reduces
- ☐ D when there are no energy transfers, the total energy increases

(b) A student uses the apparatus in Figure 3 to find out which of two materials, sand or sawdust, is the better insulator.

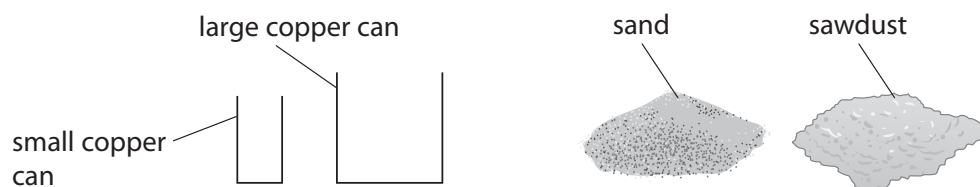


Figure 3

The student also has a kettle to boil water, a thermometer and a stop clock.

- (i) Draw a labelled diagram to show how the student should set up the equipment to investigate which material is the better insulator.

(3)

(ii) Give **three** factors that the student must control in this investigation.

(3)

1.....

2.....

3.....

(c) Expanded polystyrene, used to insulate buildings, has different densities.

Figure 4 shows how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

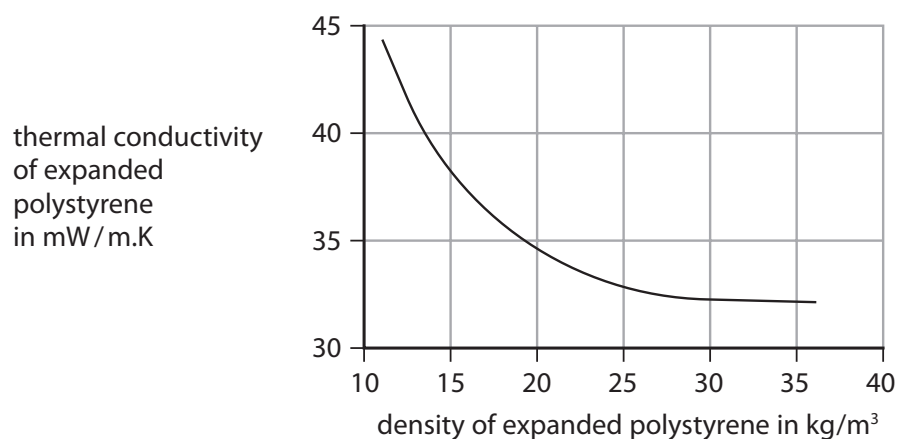


**Figure 4**

Using the graph in Figure 4, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

(2)

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**(Total for Question 2 = 9 marks)**

- 3 (a) Figure 5 shows a football kicked against a wall.

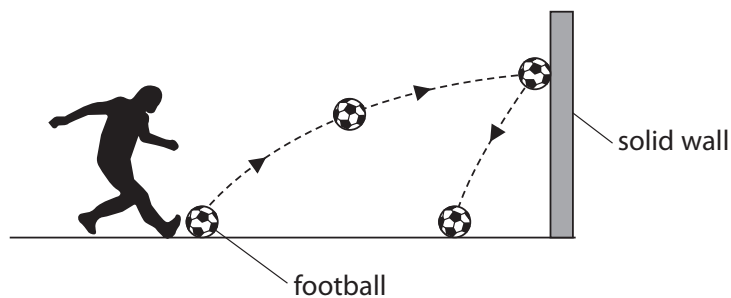


**Figure 5**

The football has a mass of 0.42 kg.

- (i) The football gains 11 J of gravitational potential energy as it moves from the ground to the wall.

Calculate the height at which the ball hits the wall.

(3)

Gravitational field strength = 10 N/kg

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

height = ..... m

- (ii) Calculate the kinetic energy of the football when it is moving at a velocity of 12 m/s.

(2)

Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

kinetic energy = ..... J



(iii) Describe the energy transfers that happen when the ball hits the wall.

(2)

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(b) A stone is held at rest above the ground.

The stone is released and falls until its velocity is  $17 \text{ m/s}$ .

Calculate the distance the stone has fallen when its velocity has reached  $17 \text{ m/s}$ .

(2)

distance = ..... m

**(Total for Question 3 = 9 marks)**



- 2 Figure 2 shows a person on a skateboard at the top of a ramp.

At P, the person is not moving.

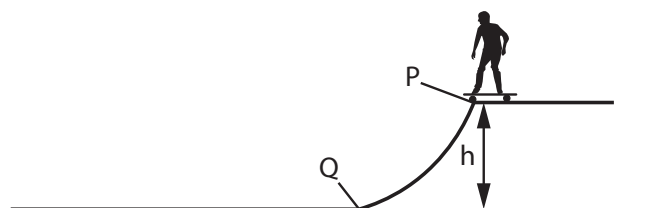


**Figure 2**

- (a) The person rides the skateboard down the ramp from P to Q.

The gravitational potential energy of the person decreases by 980 J.

The mass of the person is 35 kg.

Calculate  $h$ , the height of the ramp.

Use  $g = 10 \text{ N/kg}$ .

Use the equation

$$\text{change in gravitational potential energy} = m \times g \times h$$

(2)

$h = \dots\dots\dots \text{ m}$

(b) The kinetic energy, KE, of the person at Q is 950 J.

The mass of the person is 35 kg.

Calculate the velocity of the person at Q.

Use the equation

$$v^2 = \frac{2 \times KE}{m} \quad (3)$$

velocity = ..... m/s



(c) Figure 3 is a diagram that represents energy changes from P to Q.

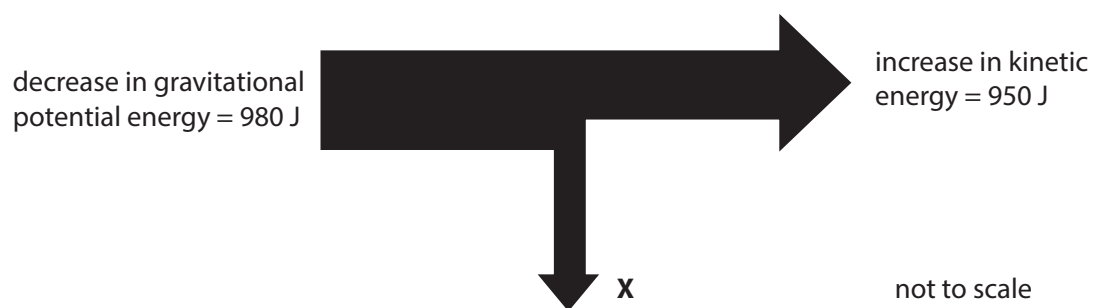


**Figure 3**

(i) State what is represented by **X**.

(1)

(ii) Calculate the value of **X**.

(1)

value of **X** = ..... J

(iii) Calculate the efficiency of the system represented in Figure 3.

(2)

efficiency = .....

**(Total for Question 2 = 9 marks)**

# 10-MARK QUESTIONS

1 question in this booklet



- 6 (a) Figure 10 shows a skier sliding down a slope.

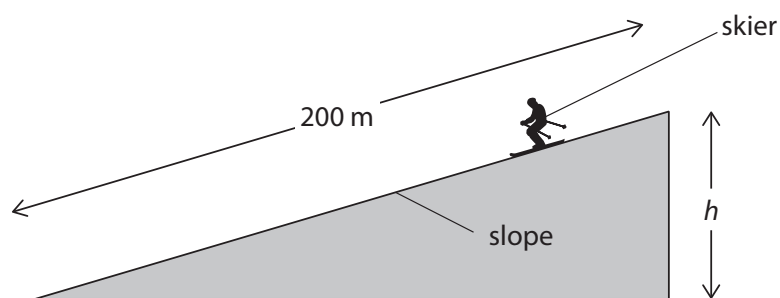


**Figure 10**

- (i) The gravitational potential energy of the skier decreases by 39 000 J between the top and the bottom of the slope.

The mass of the skier is 70 kg.

Calculate the height,  $h$  of the slope.

The value of  $g$  is 10 N/kg.

Use the equation

$$\Delta GPE = m \times g \times h$$

(2)

$$h = \dots\dots\dots \text{ m}$$

- (ii) The skier starts from rest at the top of the slope.

The velocity of the skier at the bottom of the slope is 27 m/s.

Using information from Figure 10, calculate the acceleration of the skier along the slope.

(3)

$$\text{acceleration} = \dots\dots\dots \text{ m/s}^2$$



- (iii) When the skier slides from the top to the bottom of the slope, some energy is dissipated.

Explain how to determine the amount of energy dissipated.

(2)

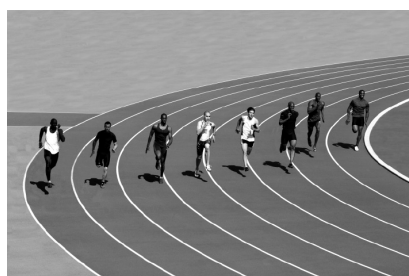
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- (b) Figure 11 shows athletes running at a constant speed on a curved section of a track.



(Source: © Photo and Co/Getty Images)

**Figure 11**

- (i) Even though they are running at a constant speed, the velocity of each athlete is changing.

State why the velocity of each athlete is changing.

(1)

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(ii) The athletes start the race on a straight section of track.

Figure 12 shows a distance / time graph for one of the athletes.

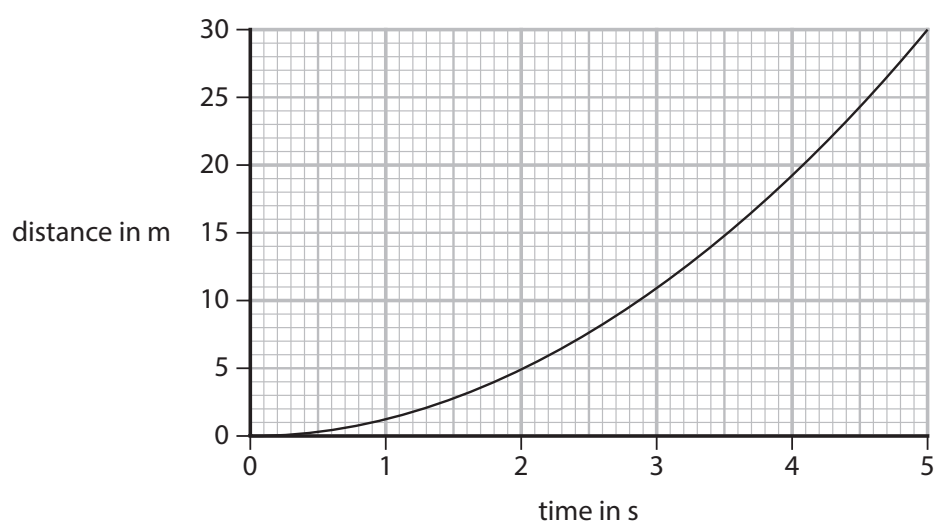


**Figure 12**

Determine the gradient of this graph at a time of 2.5 s.

(2)

gradient = ..... m/s

**(Total for Question 6 = 10 marks)**



# 11-MARK QUESTIONS

3 questions in this booklet



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- 8 (a) A student investigates how different surfaces radiate energy as they cool.

Figure 9 shows some of the apparatus used in a part of the investigation.

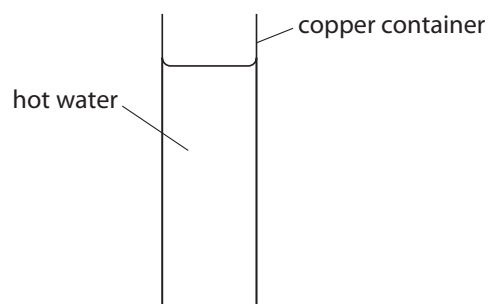


**Figure 9**

Describe how the student could collect data to show how the rate of cooling of the container and water change with time.

(2)

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(b) Figure 10 is a graph of intensity against wavelength for the electromagnetic radiation emitted by a halogen lamp.

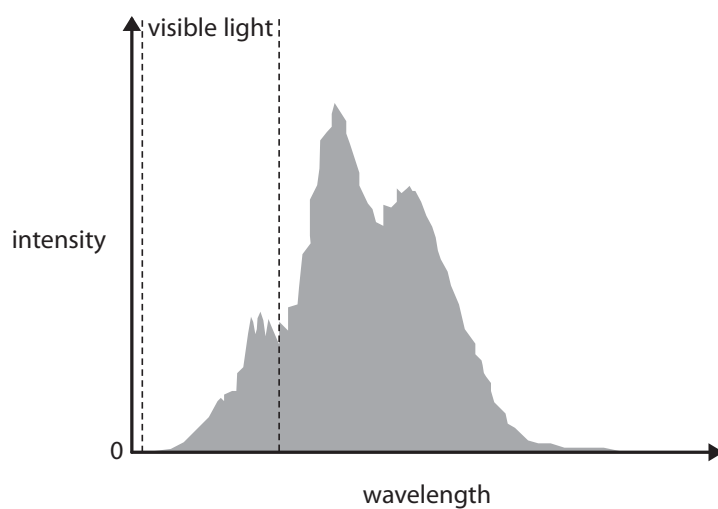


**Figure 10**

Describe how the intensity of the radiation varies with wavelength in Figure 10.

(2)

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- (c) Figure 11 is a graph of temperature against time for a halogen lamp for the first 120 ms after it has been switched on.

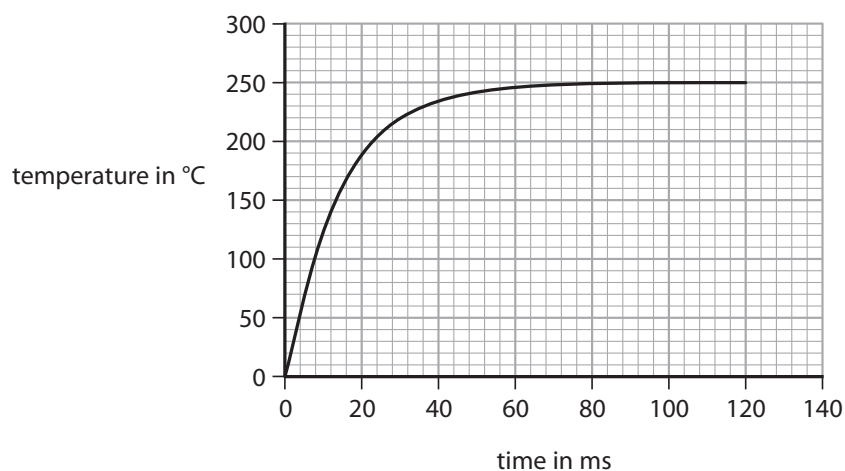


**Figure 11**

- (i) Calculate the gradient of the graph at a time of 30 ms.

State the unit.

(4)

gradient = ..... unit .....

- (ii) Explain why the temperature of the lamp rises and then remains at a constant value.

(3)

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**(Total for Question 8 = 11 marks)**



- 8 (a) A kettle is used to heat water.

Figure 11 shows a graph of temperature against time for the water in the kettle.

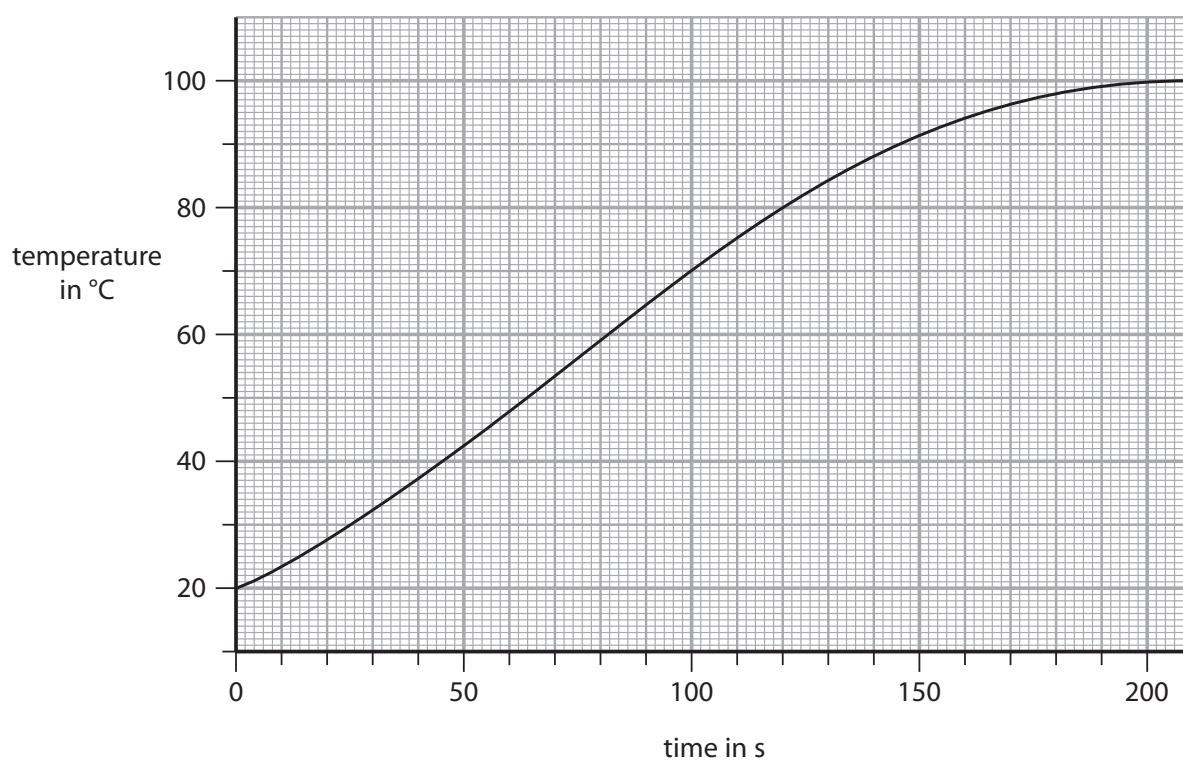


Figure 11

Calculate the rate of increase in temperature at a time of 150 s, by drawing a tangent to the curve in Figure 11 at a time of 150 s.

(3)

..... °C/s

- (b) The kettle has an efficiency of 91% in supplying energy to the water.  
The thermal energy of the water increases by  $3.3 \times 10^5 \text{ J}$  in 200 s.

Calculate the total amount of energy supplied to the kettle in the 200 s.

Use the equation

$$\text{efficiency} = \frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}} \quad (2)$$

total amount of energy supplied = ..... J

\*(c) The global demand for electricity is increasing.

There is a debate about whether nuclear power generation should or should not contribute to meeting this increasing demand.

Discuss the arguments for and against using nuclear power to meet the increasing global demand for electricity.

(6)

**(Total for Question 8 = 11 marks)**



**10** (a) Figure 13 shows wind turbines, used to generate electricity for the National Grid.



(Source: © MarcelClemens/Shutterstock)

**Figure 13**

The wind turns the turbine blades.

The wind is a renewable source of energy.

(i) State **two** other renewable sources of energy.

(2)

1.....

2.....

(ii) For one turbine

- the energy input per second from the wind is 6.2 kJ
- the energy output per second to the National Grid is 2.2 kJ.

Calculate the efficiency of this turbine.

(2)

efficiency = .....

(iii) Suggest a reason why it is impossible for the turbine to use all the kinetic energy of the wind.

(1)

.....

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.....





# 12-MARK QUESTIONS

1 question in this booklet



7 (a) Which of these is a non-renewable source of energy?

(1)

- ☐ A geothermal
- ☐ B natural gas
- ☐ C tidal
- ☐ D solar

(b) Explain why renewable sources provide an increasing fraction of the electricity supply for many countries.

(2)

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(c) Electricity can be generated using a water turbine.

(i) Water gains kinetic energy by falling from the top of a dam.

Calculate the minimum height that 7.0 kg of water must fall to gain 1300 J of kinetic energy.

(3)

minimum height = ..... m

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- (ii) As water enters the turbine at the bottom of the dam, the kinetic energy of 8.0 kg of moving water is 1100 J.

Calculate the speed of the moving water as it enters the turbine.

(3)

speed = ..... m/s



21



(d) Moving air can be used to generate electricity using a wind turbine.

Figure 8 is a graph of kinetic energy against wind speed for a mass of moving air.

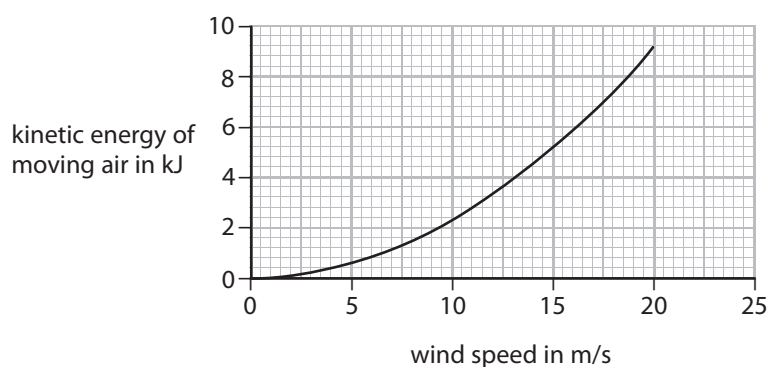


**Figure 8**

Just before the air reaches a wind turbine it has a wind speed of 15 m/s.

When the air has gone through the turbine it has a wind speed of 13 m/s.

As the air moves through the turbine some of its kinetic energy is transferred to the turbine.

Use the graph to determine the percentage of the kinetic energy transferred to the turbine from the air.

(3)

percentage of kinetic energy transferred from the air = ..... %

**(Total for Question 7 = 12 marks)**

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# MARK SCHEMES

official Pearson Edexcel mark schemes



| Question number | Answer                                                                                                                                     | Additional guidance                                                                                                                                                                               | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2 (a)           | <p>A description to include:</p> <p>mention relevant energy store such as GPE or chemical (1)</p> <p>'correct' transfer in context (1)</p> | <p>allow KE or mechanical or thermal or heat</p> <p>chemical to (G)PE or chemical to KE (in lifting)</p> <p>allow misread GPE to KE/thermal on <u>slope</u></p> <p>Allow KE to GPE in lifting</p> | (2)  |



| Question number | Answer                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                                                                                                                               | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>2 (b)</b>    | <p>A description to include:</p> <p>measurement of (relevant) distance (1)</p> <p>measurement of (relevant) time (1)</p> <p>use of speed = <math>\frac{\text{distance}}{\text{time}}</math> (1)</p> <p>detail (1)</p> | <p>one of<br/>distance down slope<br/>or distance along bench<br/>or length of toy car/card</p> <p>'record the distance the car travels and time it' scores 2 marks</p> <p>for example:<br/>speed down slope <math>\times 2</math></p> <p><u>mark</u> distance along bench</p> <p>use a light gate</p> <p>speed gun at the bottom of the slope</p> <p>repeating AND averaging</p> | <b>(4)</b> |

| Question number | Answer                                                                 | Additional guidance                                                                                                                                                                                | Mark       |
|-----------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>2 (c)</b>    | <p>(vertical) height of slope (1)</p> <p>mass (of the toy car) (1)</p> | <p>allow (in this context) weight</p> <p>if no other mark scored<br/>allow 1 mark for quoting either equation<br/>(<math>\Delta</math>)GPE = mgh<br/>OR<br/>KE = <math>\frac{1}{2} mv^2</math></p> | <b>(2)</b> |

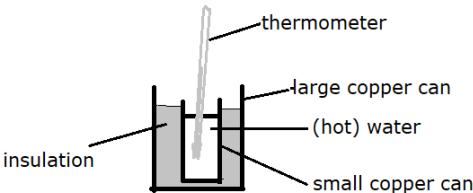
| Question number | Answer                              | Additional guidance                                                                 | Mark |
|-----------------|-------------------------------------|-------------------------------------------------------------------------------------|------|
| 2 (d)           | (original) GPE – KE (at bottom) (1) | allow (idea of)<br>input – output<br><br>allow wrong way round<br>(eg output-input) | (1)  |

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**Total for Question 2 = 9 marks**



| Question Number | Answer                                                                                                                                                                                                                                                                                                       | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2(a)            | <p><b>B. when there are energy transfers, the total energy does not change</b></p> <p><i>A is not correct because the total energy does not reduce</i></p> <p><i>C is not correct because the total energy does not reduce</i></p> <p><i>D is not correct because the total energy does not increase</i></p> | (1)<br>AO1 |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                           | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------|
| 2(b)(i)         | <p>a diagram showing:</p> <p>apparatus labelled to include <b>three</b> from</p> <ul style="list-style-type: none"> <li>• thermometer</li> <li>• water</li> <li>• insulator / sand / sawdust / material</li> <li>• (copper) can</li> </ul> <p>(1)</p> <p>thermometer in the <b>water</b> (1)</p> <p>arrangement for water and insulator in and between copper cans (e.g. as in diagram below) (1)</p>  | <p>independent of arrangement</p> <p>ignore kettle and stop clock</p> <p>accept reverse positions for water and insulator</p> | (3)<br>AO2 |

| Question Number | Answer                                                                                                                                                                                                                                 | Additional guidance                                                                                                                                                                                                                                                        | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2(b)(ii)        | any <b>three</b> factors from:<br><br>{mass / volume} of water (1)<br><br>{volume / thickness / mass} of insulators / materials (1)<br><br>{starting / initial} temperature of water (1)<br><br>time interval / temperature change (1) | accept amount / specified values / "how much"<br><br>accept amount / specified values / "how much"<br><br>accept temperature of hot / boiling water / specified values<br><br>accept specified values of interval or change<br><br>unqualified "same time" is insufficient | (3)<br>AO3 |

|      | Answer                                                                                                                                                                                                                                                       | Additional guidance                                                                                                                                                       | Mark       |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2(c) | a description giving<br><br>as the density (of expanded polystyrene) increases the (thermal) conductivity decreases (1)<br><br>non-linear /<br>gradient decreases /<br>at a decreasing rate /<br>levels off /<br>plateaus /<br>becomes (almost) constant (1) | ORA<br><br>allow inversely proportional / exponential for non-linear in this context<br><br>ignore negative correlation<br><br>unqualified quoted values are insufficient | (2)<br>AO2 |

**Total for Question 2 = 9 marks**

|  | Answer | Additional guidance | Mark |
|--|--------|---------------------|------|
|--|--------|---------------------|------|



| Question number | Answer                                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                              | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3 (a) (i)       | substitution (1)<br>$11 = 0.42 \times 10 \times \Delta h$<br><br>rearrangement (1)<br>$(\Delta h =) \frac{11}{0.42 \times 10}$<br><br>evaluation (1)<br>2.6 (m) | accept substitution and rearrangement in either order<br><br>$(\Delta h =) \frac{\Delta GPE}{m \times g}$<br><br>accept any value which rounds to 2.6 (m)<br>award 2 marks for 2.6 to any other power of 10<br>allow 1 mark for 0.38<br>allow 1 mark for 46(.2)<br><br>award full marks for the correct answer with no working<br><br>give full credit for use of $g=9.8$ or $9.81 \text{ N/kg}$ (gives 2.7 (m)) | (3)<br>AO2 |

| Question number | Answer                                                                                          | Additional guidance                                                                                                                                                       | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3 (a) (ii)      | substitution(1)<br>$(KE = \frac{1}{2} \times 0.42 \times 12^2)$<br><br>evaluation (1)<br>30 (J) | allow 30.2(4) (J)<br>award 1 mark for 30 240 (J)<br>award 1 mark for 2.52 (J)<br>award 1 mark for 60.5 (J)<br><br>award full marks for the correct answer with no working | (2)<br>AO2 |

| Question number | Answer                                                                                                                                                                                                                                                                            | Additional guidance                                                                                                                                                                                                                   | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3(a)(iii)       | A description including:<br>KE/kinetic (energy store)<br>(1)<br><br>(transfers to)<br><br>and <b>one</b> of:<br><br>elastic (potential energy store) (1)<br><br>OR<br><br>thermal (energy of ball/wall/surroundings) (1)<br><br>OR<br><br><u>dissipates</u> (to surroundings) (1) | allow mechanically / mechanical transfer<br><br><br><br><br><br>ignore reference to gravitational potential energy<br><br><br><br>allow heat for thermal<br>allow sound in this context<br><br><br><br>ignore reference to the ground | (2)<br>AO2 |

| Question number | Answer                                                                                                                                                  | Additional guidance                                                                                                                                                                                                                                                                                                                                                     | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3 (b)           | <p>selection <b>and</b> substitution (1)</p> <p><math>17^{(2)} = 2 \times 10 \times \text{distance}</math></p> <p>evaluation (1)</p> <p>14(.45) (m)</p> | <p>use of either<br/> <math>v^2 - u^2 = 2ax</math><br/> or <math>v^2 = 2gh</math></p> <p><math>17^{(2)} = 2 \times a \times \text{distance}</math><br/> allow 289 for <math>17^2</math></p> <p>award full marks for the correct answer without working</p> <p>give full credit for use of <math>g=9.8</math><br/> or <math>9.81 \text{ m/s}^2</math> gives 14.7 (m)</p> | (2)<br>AO2 |

**Total for question 3 =9 marks**

|  | Answer | Additional guidance | Mark |
|--|--------|---------------------|------|
|--|--------|---------------------|------|

| Question number | Answer                                                             | Additional guidance                                                                                                                                                                                                            | Mark                     |
|-----------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>2 (a)</b>    | Substitution or rearrangement (1)<br>$980 = 35 \times 10 \times h$ | $(\Delta h =) \frac{\Delta GPE}{m \times g}$<br><br>or<br>$(\Delta h =) \frac{980}{35 \times 10}$<br><br>allow use of 9.8 N/kg or 9.81 N/kg<br><br>allow substitution into visible incorrectly rearranged algebraic expression | <b>2</b><br><b>A02.1</b> |
|                 | evaluation (1)<br><br>(h = ) 2.8 (m)                               | allow 2.85/2.86/2.9 for use of g = 9.8 N/kg or 9.81 N/kg<br><br>ignore use of negative for decrease in GPE<br><br>award full marks for the correct answer without working                                                      |                          |

| Question number | Answer                                       | Additional guidance                                                                                                                                                                                                                                              | Mark               |
|-----------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| <b>2 (b)</b>    | substitution (1)                             |                                                                                                                                                                                                                                                                  | <b>3<br/>AO2.1</b> |
|                 | $(v^2) = \frac{950 \times 2}{35}$            | $\frac{1900}{35}$                                                                                                                                                                                                                                                |                    |
|                 | evaluation of $v^2$ (1)<br>54(.29)           |                                                                                                                                                                                                                                                                  |                    |
|                 | evaluation of $v$ (1)<br>( $v =$ ) 7.4 (m/s) | accept values that round to 7.3 (m/s) or 7.4 (m/s)                                                                                                                                                                                                               |                    |
|                 |                                              | accept answer of 7 (one sig. fig.)<br><br>award 2 marks for an answer that rounds to 54 (m/s)<br><br>if no other mark scored, allow 1 mark for an answer that rounds to 0.23 (m/s) (use of mass in g)<br><br>award full marks for correct answer without working |                    |

| Question number | Answer                     | Additional guidance                                                                                 | Mark               |
|-----------------|----------------------------|-----------------------------------------------------------------------------------------------------|--------------------|
| <b>2(c i)</b>   | thermal (energy/store) (1) | energy dissipated<br><br>energy wasted<br><br>energy lost<br><br>energy transferred to surroundings | <b>1<br/>AO2.1</b> |

| Question number | Answer     | Additional guidance | Mark                     |
|-----------------|------------|---------------------|--------------------------|
| <b>2 (cii)</b>  | 30 (J) (1) | accept -30 (J)      | <b>1</b><br><b>AO2.1</b> |
|                 |            |                     |                          |

| Question number | Answer                                                  | Additional guidance                                                                                                                                                                                                                        | Mark                     |
|-----------------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>2 (ciii)</b> | substitution (1)<br>$\frac{950}{980} \times 100$<br>980 |                                                                                                                                                                                                                                            | <b>2</b><br><b>AO2.1</b> |
|                 | evaluation (1)<br>0.97 OR 97%                           | <p>allow answers that round to 0.97 or 97% for 2 marks</p> <p>allow 1 mark for answers that round to 97 or 0.97%</p> <p>allow 1 mark for answers of 0.96 or 96% (truncated)</p> <p>award full marks for correct answer without working</p> |                          |

**Total Question 2 = 9 marks**

| Question number | Answer                                                                                               | Additional guidance                                                                                                                                                                                                                | Mark         |
|-----------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 6(a)(i)         | rearrangement (1)<br>$h = \frac{\Delta GPE}{m \times g}$<br>evaluation (1)<br>$(h) = 56 \text{ (m)}$ | $h = \frac{39\,000}{70 \times 10}$<br><br>allow numbers that round to 56 (m) e.g. 55.71<br>allow numbers that round to 57 (m) e.g. 56.85 (use of $g=9.8 \text{ N/kg}$ )<br><br>award full marks for correct answer without working | (2)<br>AO3.2 |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                      | Mark         |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 6(a)(ii)        | selection of $v^2 - u^2 = 2 \times a \times x$ (1)<br><br>rearrangement (1)<br>$a = \frac{v^2 - u^2}{2 \times x}$<br><br>evaluation (1)<br>$1.8 \text{ (m/s}^2\text{)}$<br><br>ALTERNATIVE METHOD<br><br>calculation of time = 14.814 using<br>time = distance / average speed (1)<br><br>substitution (1)<br>$a (=v-u) / t = \frac{27(-0)}{14.814}$<br><br>evaluation (1)<br>$1.8 \text{ (m/s}^2\text{)}$ | $27^2 - 0^2 = 2 \times a \times 200$<br>allow<br>$27^2 - 0^2 = 2 \times a \times \text{their (a)(i)}$<br><br>$a = \frac{27^2 - 0^2}{2 \times 200}$<br>allow $a = \frac{27^2 - 0^2}{2 \times \text{their (a)(i)}}$<br><br>no ecf for evaluation<br><br>allow numbers that round<br><b>down</b> to $1.8 \text{ (m/s}^2\text{)}$ e.g.<br>1.8225<br><br>award full marks for correct answer without working. | (3)<br>AO3.2 |

| Question number  | Answer                                                                                                                                          | Additional guidance                                                                                                                                                                                  | Mark                        |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>6(a)(iii)</b> | <p>An explanation linking</p> <p>(measure) GPE at top/start and KE at bottom/end (1)</p> <p>energy (at top) subtract energy (at bottom) (1)</p> | <p>allow subtraction of any energies</p> <p>allow difference for subtraction</p> <p>award 2 marks for GPE at top subtract KE at bottom</p> <p>allow for 2 marks<br/>39 000 – 25 515<br/>OR 13485</p> | <b>(2)</b><br><b>A03.3a</b> |

| Question number | Answer                                                                                       | Additional guidance                                                                                                                                       | Mark                       |
|-----------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| <b>6(b)(i)</b>  | <p>Any <b>one</b> from:</p> <p>direction is changing (1)</p> <p>velocity is a vector (1)</p> | <p>allow velocity has magnitude and direction</p> <p>ignore acceleration</p> <p>ignore reference to centripetal force</p> <p>ignore speed is changing</p> | <b>(1)</b><br><b>A02.1</b> |

| Question number | Answer                                                                                                                             | Additional guidance                                          | Mark                       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------|
| <b>6(b)(ii)</b> | <p>tangent drawn to curve (at 2.5 s) (1)</p> <p>evaluation of gradient (1)</p> <p>(gradient = ) <math>6.0 \pm 1.0</math> (m/s)</p> | <p>accept hypotenuse of triangle</p> <p>dependent on MP1</p> | <b>(2)</b><br><b>A03.2</b> |

**Total for Question 6 = 10 marks**



| Question Number | Answer                                                                                                            | Additional guidance                                                                                                                                | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>8(a)</b>     | <p>a description to include:</p> <p>use a thermometer (1)</p> <p>measure temperature at regular intervals (1)</p> | <p>temp. sensor</p> <p>datalogger</p> <p>it must be clear that it is a number of readings – not just 2</p> <p>eg measure temperature over time</p> | <p><b>(2)</b></p> <p>AO 1 2</p> |

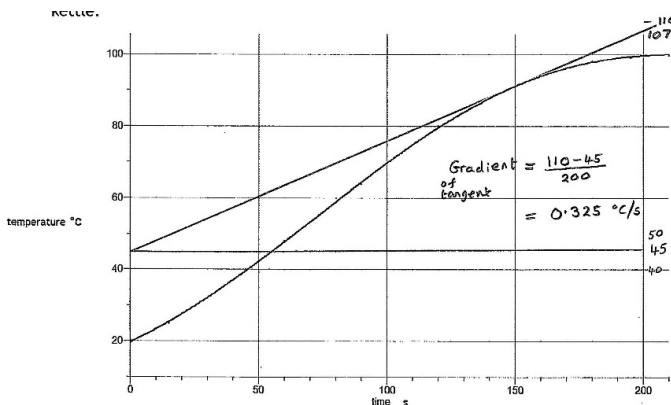
| Question Number: | Answer                                                                                                       | Additional guidance                                                                                           | Mark                                            |
|------------------|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| <b>8(b)</b>      | <p>a description to include:</p> <p>intensity reaches a peak value (1)</p> <p>additional information (1)</p> | <p>other peaks</p> <p>irregular curve</p> <p>non-linear</p> <p>most of radiation outside visible spectrum</p> | <p><b>(2)</b></p> <p>AO 3 1a</p> <p>AO 3 1b</p> |

| Question Number | Answer                                                                                                                                                                                                                                                         | Additional guidance                                                                                                                | Mark                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| 8(c)(i)         | <p>tangent drawn between 20 and 40 ms (1)</p> <p>selection of suitable values and substitution from their tangent (1)</p> <p>e.g. <math>130 \div 60</math></p> <p>evaluation (1)</p> <p>2.0</p> <p>unit (1)</p> <p><math>^{\circ}\text{C}/\text{ms}</math></p> | <p>range 1.8-2.5</p> <p>2000 <math>^{\circ}\text{C}/\text{s}</math></p> <p>award full marks for correct answer with no working</p> | <p><b>(4)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                                                                                                           | Mark                                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 8(c)(ii)        | <p>an explanation linking:</p> <p>the temp rises because the (rate of) energy supplied is greater than the (rate of) energy being radiated. (1)</p> <p>at constant temperature the lamp radiates energy at the same <b>rate</b> at which it is being supplied (2)</p> | <p>accept 'absorbed/in' for supplied.</p> <p>energy in greater than energy out</p> <p>lamp radiates more as temperature increases</p> <p>lamp radiates at the same <b>power</b> at which it is being supplied for 2 marks</p> <p><b>power</b> out = <b>power</b> in</p> <p>award 1 mark for at constant temperature the energy supplied = energy radiated</p> | <p><b>(3)</b></p> <p>AO 3 2a</p> <p>AO 3 2b</p> |

**(Total for Question 8 = 11 marks)**



| Question number | Answer                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                    | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------|
| 8 (a)           |  <p>drawing tangent attempt (1)</p> <p>correct data points from graph (1)</p> <p>60,60 and 150,92</p> <p>evaluation (1)</p> <p><math>0.33 \pm 0.07</math> (<math>^{\circ}\text{C} / \text{s}</math>)</p> | <p>accept other data from the graph</p> <p>award full marks for the correct answer without working</p> | (3)  |

| Question number | Answer                                                                                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                                                                            | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 8 (b)           | rearrangement and substitution (1)<br><br>energy supplied = $\frac{\text{useful energy}}{\text{efficiency}}$<br><br>$= \frac{3.3 \times 10^5}{0.91}$<br><br>evaluation (1)<br><br>$3.6 \times 10^5 \text{ (J)}$ | <br><br><br><br><br><br><br><br><br><br><br>$(3.626 \times 10^5)$<br>number that rounds to<br>$3.6 \times 10^5 \text{ (J)}$<br><br>3600 or 3626 scores 1<br>mark<br><br>award full marks for the<br>correct answer without<br>working<br><br>no marks for 91% of<br>$3.3 \times 10^5 = 3.0 \times 10^5$<br>(J) | (2)  |

| Question number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Mark          |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 8 * (c)         | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO1 1 (6 marks)</b></p> <p><u>Arguments for using nuclear power</u></p> <ul style="list-style-type: none"> <li>• we are running out of fossil fuels SO the use of nuclear can play its part where we have previously used fossil fuels</li> <li>• no carbon emissions SO does not contribute towards global warming, rise in sea-levels etc.</li> <li>• low running costs SO a good economical alternative to other power sources</li> <li>• with reprocessing can last hundreds of years</li> <li>• large power output compared with wind farms / solar etc.</li> </ul> <p><u>Arguments against using nuclear power</u></p> <ul style="list-style-type: none"> <li>• expensive to set up and decommission SO the use of other sources could be more economical</li> <li>• nuclear disasters possible SO there could be a loss of life / contamination of an area</li> <li>• nuclear toxic waste lasts a long time</li> <li>• waste storage issues – contamination of ground water</li> <li>• terrorism / bomb making</li> </ul> | <b>(6)Exp</b> |

| Level   | Mark | Descriptor                                                                                                                                                                                                                                                         |
|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | <ul style="list-style-type: none"> <li>• No rewardable material.</li> </ul>                                                                                                                                                                                        |
| Level 1 | 1-2  | <ul style="list-style-type: none"> <li>• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li> <li>• Presents an explanation with some structure and coherence. (AO1)</li> </ul> |
| Level 2 | 3-4  | <ul style="list-style-type: none"> <li>• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li> </ul>                                |



|         |     |                                                                                                                                                                                                                                                                                                                      |
|---------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |     | <ul style="list-style-type: none"> <li>Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)</li> </ul>                                                                                                                                                                    |
| Level 3 | 5-6 | <ul style="list-style-type: none"> <li>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li> <li>Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)</li> </ul> |

### **SUMMARY, for guidance**

| Level   | Mark | Additional Guidance                                                                                                                                                                                                                              | General additional guidance – the decision within levels<br><br>e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level. |
|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | No rewardable material.                                                                                                                                                                                                                          |                                                                                                                                                                                                                           |
| Level 1 | 1–2  | <u>Additional guidance</u><br><br>Unbalanced incomplete argument Elements of physics present isolated knowledge for or against                                                                                                                   | <u>Possible candidate responses</u><br><br>no CO <sub>2</sub> emissions<br><br>high cost                                                                                                                                  |
| Level 2 | 3–4  | <u>Additional guidance</u><br><br>Argument linked with evidence, but not entirely coherent or balanced<br>Uses evidence for <b>or</b> against but lacks balance / focus / with logical connections made on one side and statement from the other | <u>Possible candidate responses</u><br><br>no CO <sub>2</sub> emissions so no contribution to global warming<br>large power output compared with wind farms                                                               |
| Level 3 | 5–6  | <u>Additional guidance</u><br><br>Developed detailed arguments, including use of evidence, advanced both for <b>and</b> against the use of nuclear power                                                                                         | <u>Possible candidate responses</u><br><br>no CO <sub>2</sub> emissions so no contribution to global warming<br>large power output compared with wind farms<br><br>nuclear toxic waste lasts a long time                  |



|                  |                                                                                                                                          |                                                                                                                                                    |                          |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>10(a)(ii)</b> | <p>recall and substitution (1)</p> <p>(%) efficiency = <math>\frac{2.2 \times 100}{6.2}</math></p> <p>evaluation (1)</p> <p>0.35 (1)</p> | <p>allow numbers that round to 0.35 e.g. 0.3548</p> <p>accept 35(%) for full marks</p> <p>award full marks for correct answer without working.</p> | <b>(2)</b><br><b>AO2</b> |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

|                   | <b>Answer</b>                                                                                                                                                                                                                                                                               | <b>Additional guidance</b> | <b>Mark</b>              |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------|
| <b>10(a)(iii)</b> | <p><b>One</b> from:</p> <p>air (has to be) moving on the other side of the blades (1)</p> <p>not all of the air hits the blade (1)</p> <p>friction within the turbine/generator (1)</p> <p>some energy (always) transferred to thermal (1)</p> <p>it is fitted with a speed limiter (1)</p> |                            | <b>(1)</b><br><b>AO3</b> |

| Question number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Mark               |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 10 *(b)         | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO1 1 (6 marks)</b></p> <p><b>fission</b></p> <ul style="list-style-type: none"> <li>• (heavy) nucleus split</li> <li>• by a neutron</li> <li>• releases 2 daughter nuclei + more neutrons + energy</li> <li>• starts chain reaction</li> </ul> <p style="padding-left: 40px;"><b>advantages</b></p> <ul style="list-style-type: none"> <li>• already in use</li> </ul> <p style="padding-left: 40px;"><b>disadvantages</b></p> <ul style="list-style-type: none"> <li>• waste is radioactive</li> <li>• hard to dispose of</li> <li>• risk of accident</li> </ul> <p><b>fusion</b></p> <ul style="list-style-type: none"> <li>• (light) nuclei joined</li> <li>• at high energy/temperature/pressure/particle density</li> <li>• releases (eg) helium + energy</li> </ul> <p style="padding-left: 40px;"><b>advantages</b></p> <ul style="list-style-type: none"> <li>• no harmful waste products</li> </ul> <p style="padding-left: 40px;"><b>disadvantages</b></p> <ul style="list-style-type: none"> <li>• not achieved yet (on a practicable scale)</li> <li>• difficulty in achieving high energy/temperature/pressure/particle density</li> </ul> | <b>(6)<br/>AO1</b> |

| Level   | Mark | Descriptor                                                                                                                                                                                                                                                                                                                                 |
|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | <ul style="list-style-type: none"> <li>No rewardable material.</li> </ul>                                                                                                                                                                                                                                                                  |
| Level 1 | 1-2  | <ul style="list-style-type: none"> <li>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li> <li>Presents an explanation with some structure and coherence. (AO1)</li> </ul>                                                                             |
| Level 2 | 3-4  | <ul style="list-style-type: none"> <li>Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li> <li>Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)</li> </ul> |
| Level 3 | 5-6  | <ul style="list-style-type: none"> <li>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li> <li>Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)</li> </ul>                       |

| Level   | Mark | Additional Guidance                                                                                                               | General additional guidance – the decision within levels                                                                                                                                                        |
|---------|------|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | No rewardable material.                                                                                                           | e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.                                                       |
| Level 1 | 1–2  | <u>Additional guidance</u><br>isolated facts                                                                                      | <u>Possible candidate responses</u><br>fission involves a nucleus being split by a neutron                                                                                                                      |
| Level 2 | 3–4  | <u>Additional guidance</u><br>simple comparison of fission and fusion                                                             | <u>Possible candidate responses</u><br>fission involves a nucleus being split by a neutron whereas fusion requires combining two light nuclei.                                                                  |
| Level 3 | 5–6  | <u>Additional guidance</u><br>detailed comparison of fission and fusion and one advantage or one difficulty compared to the other | <u>Possible candidate responses</u><br>Fission involves nuclei split by a neutron. Fusion involves combining two light nuclei. The waste from fission is radioactive. Practicable fusion has not been achieved. |

(Total for Question 10 = 11 marks)



| Question Number | Answer                                                                                                                                                                                                                                  | Mark                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 7(a)            | <p><b>B</b> natural gas <b>is the only correct answer</b></p> <p>A geothermal is not a non-renewable source of energy</p> <p>C tidal is not a non-renewable source of energy</p> <p>D solar is not a non-renewable source of energy</p> | <p><b>(1)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                | Additional guidance                                                                                                                               | Mark                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 7(b)            | <p>an explanation linking:</p> <p>increased use of renewables/decrease use of nonrenewables (1)</p> <p>reason (1)</p> | <p>accept "them" as renewable</p> <p>accept reason why renewables are beneficial</p> <p>accept reason why non-renewable(s) are not beneficial</p> | <p><b>(2)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                                                                                 | Additional Guidance                                                                                                                                                                                                    | Mark                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| 7(c)(i)         | <p>recall (1)</p> <p><math>(\Delta PE) = mgh</math></p> <p>substitution and rearrangement (1)</p> <p><math>h = \frac{1300}{7 \times 10}</math></p> <p>evaluation (1)</p> <p>19 (m)</p> | <p><math>1300 = 7 \times 10 \times h</math></p> <p>work done = force x distance</p> <p>accept answers that round up to 19 (m)<br/>(e.g. 18.57 (m) )</p> <p>award full marks for the correct answer with no working</p> | <p><b>(3)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                                            | Additional guidance                                                                                                                                            | Mark                           |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>7(c)(ii)</b> | recall (1)<br>$KE = \frac{1}{2} m v^2$<br>substitution and rearrangement (1)<br>$v = \sqrt{(2 \times 1100 \div 8)}$<br>evaluation (1)<br>17 (m/s) | $v^2 = \frac{2 \times 1100}{8}$<br><br>accept answers that round up to 17 (m/s) (e.g. 16.58 (m/s) )<br>award full marks for the correct answer with no working | <b>(3)</b><br>AO 1 1<br>AO 2 1 |

| Question Number | Answer                                                                                                                                        | Additional guidance                                                                                                                          | Mark                 |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>7(d)</b>     | reading energies from graph (1)<br>5.2 and 3.9 (kJ)<br><br>substitution (1)<br>e.g. $\frac{1.3 \times (100)}{5.2}$<br>evaluation (1)<br>25(%) | accept<br>5.0 to 5.4<br>and<br>3.7 to 4.1<br><br>0.18 to 0.32<br><br>18 to 32 (%)<br>award full marks for the correct answer with no working | <b>(3)</b><br>AO 2 1 |

**(Total for Question 7 = 12 marks)**