Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

Material
For this paper you must have:

- a ruler
- a calculator
- the Physics Equations Sheet (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 2 should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.
A laser emits light waves in the visible region of the electromagnetic spectrum.

1 (a) What type of wave are all electromagnetic waves? [1 mark]

_____________________________________________________________________________________

1 (b) The light from a laser has a wavelength of $6.5 \times 10^{-7}$ m

The speed of light is $3.0 \times 10^{8}$ m/s

Calculate the frequency of the light from the laser.

Give your answer to 2 significant figures.

Use the correct equation from the Physics Equations Sheet. [3 marks]

_____________________________________________________________________________________

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_____________________________________________________________________________________

Frequency = ___________________________ Hz

1 (c) What is the approximate range of wavelengths of the electromagnetic spectrum?

Tick (✓) one box. [1 mark]

<table>
<thead>
<tr>
<th>Range of wavelengths in metres</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-10}$ to $10^{8}$</td>
<td></td>
</tr>
<tr>
<td>$10^{-8}$ to $10^{6}$</td>
<td></td>
</tr>
<tr>
<td>$10^{-15}$ to $10^{4}$</td>
<td></td>
</tr>
</tbody>
</table>
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Solar panels use energy from the Sun to heat water.

Two different designs of solar panel are shown in **Figure 1**.

Both designs have the same water flow rate.

**Figure 1**

**Design A**
- White, shiny surface
- Black metal pipe
- Insulation
- 20 °C water in
- 40 °C water out

**Design B**
- Dark, matt surface
- White plastic pipe
- 20 °C water in
- 30 °C water out

Explain why **Design A** is better than **Design B** at heating water.  

[6 marks]
A student investigated how the output voltage of a model wind turbine was affected by the number of turbine blades. The equipment he used is shown in Figure 2.

Figure 2

Suggest two factors, other than the number of turbine blades, that will affect the output voltage of the model wind turbine.

1. 
2. 

Some of the student’s results are shown in Figure 3.
3 (b) (i) Plot the remaining results in Figure 3 using the data in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Number of turbine blades</th>
<th>Output Voltage in volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.39</td>
</tr>
<tr>
<td>7</td>
<td>0.50</td>
</tr>
<tr>
<td>8</td>
<td>0.56</td>
</tr>
</tbody>
</table>

3 (b) (ii) The output voltage for 6 turbine blades is lower than expected. The low value was caused by a measurement error.

State the name of this type of measurement error.

3 (b) (iii) What two conclusions can be made from the student’s results as the number of blades is increased from 1 to 4?

1  ___________________________________________________________________________________
2  ___________________________________________________________________________________

3 (c) Commercial wind turbines can be manufactured with a number of blades between 2 and 8.

Suggest two factors that manufacturers would need to consider when designing and constructing commercial wind turbines.

1  ___________________________________________________________________________________
2  ___________________________________________________________________________________
A radar gun can be used to measure the speed of a car. Microwaves are emitted by the radar gun and reflected by the car, as shown in Figure 4.

**Figure 4**

Microwaves emitted by the radar gun

Microwaves reflected by the car

Radar gun

Car

4 (a) The microwaves reflected by the moving car have a different frequency from the microwaves emitted by the radar gun.

What is the name of the effect causing this change in frequency? [1 mark]

4 (b) The data in Table 2 are measurements taken from three different cars on the same piece of road.

**Table 2**

<table>
<thead>
<tr>
<th>Car</th>
<th>Frequency of emitted microwaves in kHz</th>
<th>Frequency of reflected microwaves in kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27 000 000</td>
<td>27 000 002</td>
</tr>
<tr>
<td>B</td>
<td>27 000 000</td>
<td>27 000 000</td>
</tr>
<tr>
<td>C</td>
<td>27 000 000</td>
<td>26 999 997</td>
</tr>
</tbody>
</table>
4 (b) (i) State which car in Table 2 is moving towards the radar gun. Give a reason for your answer. [2 marks]

Car

Reason

4 (b) (ii) State which car in Table 2 is moving the fastest. Give a reason for your answer. [2 marks]

Car

Reason

Turn over for the next question
5 Figure 5 shows an outdoor pizza oven.

Figure 5

Curved surface
White surface
High specific heat capacity material
Low U-value material

5 (a) A solid biofuel is used to heat the oven.

Name one solid biofuel. [1 mark]

____________________________________________________________________________________

5 (b) The pizza oven is made of concrete. The mass of the concrete is 250 kg

Calculate the temperature increase when $8.36 \times 10^7$ J of energy are transferred to the concrete.

Concrete has a specific heat capacity of $880 \text{ J/kg} \cdot ^\circ\text{C}$

Use the correct equation from the Physics Equations Sheet. [2 marks]

____________________________________________________________________________________
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Temperature increase = ___________ °C
5 (c) The pizza oven is designed to stay hot for at least two hours.

Describe how each of the four labelled design features helps to ensure that the pizza oven stays hot for at least two hours.

[4 marks]

White surface ____________________________________________________________
______________________________________________________________________

Curved surface _________________________________________________________
______________________________________________________________________

High specific heat capacity material ______________________________________
______________________________________________________________________

Low U-value material ___________________________________________________
______________________________________________________________________

Turn over for the next question
Figure 6 shows a mobile phone battery being charged using solar cells.

The useful power output of the solar cells is 2.5 W

**Figure 6**

The efficiency of the solar cells is 40%.

Calculate the total power input to the solar cells.

Use the correct equation from the Physics Equations Sheet.  

\[ \text{Total power input} = \text{_________________ W} \]

The mobile phone battery can store 36 kJ of energy and was initially uncharged.

Calculate the minimum time, in hours, it would take to fully charge the mobile phone battery using these solar cells.

Use the correct equation from the Physics Equations Sheet.  

\[ \text{Time} = \text{______________ hours} \]
6 (c) Explain why the power output of the solar cells may be lower than 2.5 W [2 marks]

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6 (d) Explain why the time taken to recharge this mobile phone battery using these solar cells depends on whether the phone is switched on or off. [2 marks]

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Turn over for the next question
Figure 7 shows how the National Grid connects power stations to consumers.

7 (a) Explain the role of the two transformers, J and K, in the power transmission process and the reasons for their use.

[4 marks]
7 (b) In a pumped storage power station, water flows from a high level reservoir to a low level reservoir turning turbines and generating electricity.

Pumped storage power stations do not supply electricity to the National Grid at all times of the day.

Figure 8 shows a pumped storage power station.

7 (b) (i) Explain how pumped storage power stations store energy for later use.

[4 marks]

7 (b) (ii) Explain why pumped storage power stations are able to meet sudden large demands for electricity.

[2 marks]
8 Figure 9 shows a drink chiller in use.

The cold drink chiller is inserted into a warm bottle of drink, so the temperature of the drink decreases.

8 (a) Explain how a convection current is formed in the drink in the bottle. [4 marks]

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8 (b) As the chiller warms, the drink cools.

State how the rate of energy transfer from the drink to the chiller changes as the chiller warms.

Give a reason for your answer. [2 marks]

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8 (c) As the drink bottle cools down, water vapour in the air condenses on the outside of the bottle.

Explain why. [3 marks]

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END OF QUESTIONS
There are no questions printed on this page