READ THE FOLLOWING DIRECTIONS CAREFULLY

1. You MUST use this answer booklet when responding to the questions. For each question, write your answer in the space provided and return the answer booklet at the end of the examination.

2. ALL WORKING MUST BE SHOWN in this booklet, since marks will be awarded for correct steps in calculations.

3. Attempt ALL questions.

4. The use of non-programmable calculators is allowed.

5. Mathematical tables are provided.
1. You are to spend no more than $\frac{1}{2}$ hour on this question.

The time for 20 oscillations of a simple pendulum was measured as its length, $l$, was varied. The results are tabulated below.

<table>
<thead>
<tr>
<th>Time for 20 oscillations $t/s$</th>
<th>18.8</th>
<th>24.4</th>
<th>31.0</th>
<th>36.4</th>
<th>40.0</th>
<th>43.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length $l/m$</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Period $T/s$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sqrt{\frac{l}{g} \ m^{1/2}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1**

(a) (i) Complete Table 1 above. **(4 marks)**

(ii) Explain why it is better to measure twenty timed oscillations instead of one oscillation. **(1 mark)**

(b) Use the data in the table to plot a graph of $\sqrt{T}$ against $l$. **(9 marks)**

(c) Find the slope, $S$, of your graph. **(5 marks)**

(d) Given that $\frac{\sqrt{g}}{6.28} = S$, where $g$ is the acceleration due to gravity, find $g$. **(2 marks)**

01238020/F/JANUARY 2004
(e) The mass of the bob is 130 g and the length of the pendulum is 1.2 m. The maximum vertical displacement of the bob above its equilibrium position is 1.8 cm.

(i) Calculate its potential energy at this point.

(3 marks)

(ii) a) On the diagram of a simple pendulum shown in Figure 1, indicate, by drawing arrows, the forces acting on the bob.

(2 marks)

\[ \text{Figure 1} \]

b) Name the forces by labelling them on the diagram in Figure 1.

(2 marks)

(f) Find the value of the forces on the bob when it is in the equilibrium position.

(3 marks)

Total 31 marks
Solar radiation at the earth’s surface consists mainly of electromagnetic waves in the wavelength range 0.3 μm to 3.0 μm. Name the THREE types of electromagnetic radiation whose wavelengths lie within this range.

__________________________________________________________

(3 marks)

(b) Name ONE type of electromagnetic radiation whose wavelength is

(i) less than 0.3 μm ____________________________________________

(1 mark )

(ii) greater than 3.0 μm. _________________________________________

(1 mark )

(c) Name ONE property which these three types of radiation have in common.

__________________________________________________________

(1 mark )

(d) Calculate the frequency of electromagnetic radiation of wavelength 1.5 μm.

__________________________________________________________

__________________________________________________________

(Velocity of electromagnetic waves in vacuum = 3 x 10^8 m/s)

(3 marks)

(e) A monochromatic (single wavelength) beam of light enters a glass block whose refractive index is 1.5.

Calculate the velocity of light in the block.

__________________________________________________________

__________________________________________________________

__________________________________________________________

(3 marks)

Total 12 marks
3. (a) (i) Draw a circuit diagram showing two resistors $R_1$ and $R_2$ in series with a battery.

(1 mark)

(ii) Write down an expression for the equivalent resistance of this combination.

(1 mark)

(b) (i) Draw a circuit diagram showing two resistors $R_1$ and $R_2$ in parallel with a battery.

(1 mark)

(ii) Write down an expression for the equivalent resistance of this combination.

(1 mark)
(c) (i) A set of Christmas lights, consisting of 100 identical bulbs rated at 1.0 W arranged in series, is connected to the 110 V mains. Calculate the voltage across EACH bulb.

(2 marks)

(ii) If all the bulbs are ON at the same time, calculate the current through EACH bulb.

(4 marks)

(iii) Calculate the resistance of one of these bulbs.

(3 marks)
(d) A bimetallic strip may be used to make the lights switch on and off repeatedly. A schematic of such an arrangement is shown in Figure 2.

![Diagram of bimetallic strip and Christmas lights](image)

Figure 2

(i) Identify the components labelled A, B, C and D.

A

B

C

D

(4 marks)

(ii) Name TWO metals that could be used to make a bimetallic strip.

(2 marks)

Total 19 marks

4. (a) State Newton's Third Law of Motion.

(2 marks)
(b) Define the moment of a force and state its SI unit.

(3 marks)

(c) Figure 3 shows a wheeled suitcase, of weight \( W \), supported in the stationary position shown by applying a vertical force \( Y \) at the towing handle.

![Diagram of a wheeled suitcase with forces](image)

Figure 3

The mass of the suitcase is 25 kg. By taking moments about the wheel, calculate the magnitude of the force \( Y \).

(6 marks)
(d) An additional horizontal force \( X \) is applied at the towing handle so that the suitcase begins to move in a horizontal direction.

Deduce the relationship between the force \( X \) and the horizontal frictional force at the point of contact with the ground when the suitcase

(i) is moving at constant speed

(1 mark )

(ii) is accelerating.

(1 mark )

Total 13 marks

5. (a) Define specific heat capacity and state the relationship between heat capacity and specific heat capacity.

(3 marks)

(b) 1.5 kg of water initially at 19\(^\circ\) C is heated to 45\(^\circ\) C. Calculate the amount of heat energy supplied to the water.

(4 marks)

(Specific heat capacity of water = 4200 J kg\(^{-1}\) \(^\circ\)C\(^{-1}\))
(c) Define specific latent heat of vaporisation.


(2 marks)

(d) An electric kettle rated at 2.5 kW contains 1.4 kg of water. The kettle is switched on and brings the water to boil. Calculate the time taken to convert the entire amount of water in the kettle to steam after it begins to boil.


(Specific latent heat of vaporisation = 2.26 x 10^6 J/kg)

(6 marks)

Total 15 marks

END OF TEST