Answer ALL questions in the spaces provided on the exam paper. All working must be shown. The use of a calculator is allowed. Where necessary take the acceleration due to gravity, g to be 10 m/s².

<table>
<thead>
<tr>
<th>Forces &amp; Motion</th>
<th>( W = mg )</th>
<th>( F = ma )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( v = u + at )</td>
<td>( s = ut + \frac{1}{2} at^2 )</td>
</tr>
<tr>
<td></td>
<td>( s = \frac{(u+v)t}{2} )</td>
<td>( v^2 = u^2 + 2as )</td>
</tr>
</tbody>
</table>

\[ \text{Average speed} = \frac{\text{Total distance}}{\text{Total time}} \]

\[ \text{Area of trapezium} = \frac{1}{2} h(a+b) \]

<table>
<thead>
<tr>
<th>Waves</th>
<th>( v = f \lambda )</th>
<th>( f = \frac{1}{T} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( m = \frac{\text{image distance}}{\text{object distance}} )</td>
<td>( m = \frac{\text{height of image}}{\text{height of object}} )</td>
</tr>
<tr>
<td></td>
<td>( \eta = \frac{\text{real depth}}{\text{apparent depth}} )</td>
<td>( \eta = \frac{\text{speed of light (air)}}{\text{speed of light (medium)}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum mark</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td>Actual mark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Theory</th>
<th>Total Practical</th>
<th>Final Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Mark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Mark</td>
<td>85</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>
1. The diagram below shows a displacement-time graph of a water wave.

\[
\begin{array}{c}
\text{Displacement in cm} \\
\hline
-10 & -5 & 0 & 5 & 10 \\
\hline
0.1 & 0.2 & 0.3 & 0.4 & 0.5 & 0.6 \\
\hline
\end{array}
\]

a) Is this wave a transverse or a longitudinal wave?
______________________________________________________________________ [1]

b) On the graph mark a crest with a letter C and a trough with a letter T [2]

c) From the graph answer the following questions:
   i. Find the amplitude of the wave _____________________ [1]
   ii. Find the time of one wave _____________________ [1]

d) In order to find the frequency of a wave we use the formula:

\[
f = \frac{1}{T}
\]

i. Find the frequency of the wave above: _________________________ [1]

ii. The wavelength of the above wave is 0.2 metres. Hence find the velocity of the wave.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
[2]
2a. **Fill in** the following empty spaces in the diagram below to complete the electromagnetic spectrum.

<table>
<thead>
<tr>
<th>Gamma-Rays</th>
<th>Ultraviolet</th>
<th>Visible Light</th>
<th>Infra-Red</th>
<th>Radio-Waves</th>
</tr>
</thead>
</table>

From the above diagram:

b. Name **two** types of waves that can be used for communications.

__________________________________________________________________[1]

c. Name **one** type of wave that can be used to treat cancer.

__________________________________________________________________[1]

d. Name **one** use of Infra-Red rays.

__________________________________________________________________[1]

e. Name a common **property** for all the waves of the electromagnetic spectrum .

__________________________________________________________________[1]

f. Why it is advisable to cover exposed skin with a suitable cream if you stay outdoors in summer on a sunny day?

__________________________________________________________________

__________________________________________________________________[2]

3. The lens of a projector is used to put an image on a screen.
a. Draw two rays on the diagram to show how the image is produced. [2]

b. Is this image:
   i) Magnified or diminished? ________________________ [1]
   ii) Upright or inverted? ________________________ [1]

c. Calculate the magnification of the lens.
   ____________________________________________
   ____________________________________________ [2]

d. Describe two changes which occur to the image when the object is moves very close to the lens
   ____________________________________________ [2]

4. John looks at a stationary object on the bottom of a swimming pool as shown in the diagram below.

   observer

   a. The object appears to be closer to the water surface. This effect is caused by _________________. [1]

   b. On the diagram above:
      i. draw the ray of light as it emerges from under the water, [1]
      ii. mark the angle of incidence (i) and the angle of refraction (r). [2]
c. If the pool is 2m deep and the object appears to be only 1.5m below the water surface, calculate the refractive index of water.

_____________________________________________________________________
_____________________________________________________________________

[2]

d. Given that the speed of light in air is 300,000,000m/s, calculate the speed of light in water.

_____________________________________________________________________
_____________________________________________________________________

[2]

5. A ray of light hits side AB of an isosceles right-angled glass prism. The critical angle for glass is 42°.

![Diagram of a ray of light hitting an isosceles right-angled prism]

a. Explain why the ray of light passes straight through and is not deviated when entering the glass block at side AB.

_____________________________________________________________________
_____________________________________________________________________

[2]

b. Complete the diagram to show the passage of the ray of light as it passes through the prism.

[1]

c. What is the size of the angle of reflection? Explain.

_____________________________________________________________________
_____________________________________________________________________

[2]
d. The diagram shows an optical fibre.

**Complete** using some of the following words.

reflection, refraction, smaller, larger

A ray of light that passes through an optical fibre undergoes total internal _____________. This happens because the angle of incidence of light in glass is ___________ than the critical angle. [2]

e. State one practical application of optical fibres.

_________________________________________________________________[1]

---

**SECTION B**

This section carries 45 marks

6. A ripple tank is used to observe the properties of waves. The diagrams below show reflection and refraction of water waves.

a. **Complete each diagram** to show how waves travel in each situation. [4]

i.  

ii.  

---

Glass block

Reflecting surface
b. A plastic bar is used in the ripple tank to produce straight waves that have a **frequency of 4Hz**.

i. Explain what the words ‘a frequency of 4Hz’ tell you about the waves in the ripple tank.

______________________________________________

_____________________________________

[2]

ii. The **wavelength** of the waves is 0.05m, calculate the **velocity of the waves** in the ripple tanks.

______________________________________________

[2]

iii. **Explain** what happens to the **frequency** and **wavelength** if the motor rotates faster.

______________________________________________

[2]

c. Two students placed two barriers in the ripple tank leaving a gap in between. **Describe**:

i. what happens to each of the following as the waves pass through the gap:

- frequency: _________________ [1]
- wavelength: _________________ [1]
- shape: _________________ [1]

ii. what will happen if the **gap was made much larger**?

______________________________________________

[2]
7. A racing car was driven to test a new engine. The engineer moved with a low velocity on a straight track to check the engine’s performance.

The velocity of a car during the first part of a lap was measured and is shown in the table below.

<table>
<thead>
<tr>
<th>Velocity/ m/s</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>12</th>
<th>12</th>
<th>6</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time/ s</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

a. Plot a graph of velocity (y-axis) against time (x-axis) on the graph paper provided. [4]

b. What is the highest velocity reached by the car? 
________________________________________________________________________[1]

c. With what velocity did the car travel during the 3rd second?
________________________________________________________________________[2]

d. Describe the motion of the car during;

i. the 8th to the 12th second: ______________________________ [1]

ii. the 12th to the 14th second: ______________________________ [1]

iii. the 16th to the 18th second: ______________________________ [1]

e. Calculate the acceleration of the car for the first 8 seconds.
________________________________________________________________________
________________________________________________________________________[2]

f. Calculate the total distance covered by the car.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________[3]
8 a. Nathan and Jane use a data logger to measure the speed of sound in air. The diagram shows the experimental setup.

i. Describe how Nathan and Jane can use the setup above to measure the speed of sound in air.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ [4]

ii. Give two precautions they should take during the experiment.
________________________________________________________________________
________________________________________________________________________ [2]

b. Ultrasounds are sounds that have a high frequency.

A fishing boat is using a sonar device which works by ultrasounds. A short pulse is sent and received back after 0.6s.

i. Calculate the distance travelled by the pulse in 0.6s, if the speed of sound in water is 1500m/s.
________________________________________________________________________
________________________________________________________________________ [2]

ii. What is the depth of the sea at that point.
________________________________________________________________________ [1]
c. Ultrasounds can also be used to obtain information about the internal structure of the body. A wave is transmitted into the body, where it is reflected at the boundaries between different types of tissue.

<table>
<thead>
<tr>
<th>Medium</th>
<th>Ultrasound Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle</td>
<td>1590</td>
</tr>
<tr>
<td>Soft tissue</td>
<td>1540</td>
</tr>
</tbody>
</table>

i. A wave with a frequency of $1.5 \times 10^5$ Hz is transmitted through muscle. Calculate the **wavelength** of the wave.

_______________________________________________________________________
_______________________________________________________________________ [2]

ii. **Explain** why ultrasounds travel faster in the muscle?

_______________________________________________________________________ [2]

iii. **Name one other wave** which can be used to obtain information about the internal structure of the body.

_______________________________________________________________________ [1]

iv. **Explain** why this wave is **not used** with unborn babies.

_______________________________________________________________________ [1]