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, \( g = 10 \text{ m/s}^2 \).

<table>
<thead>
<tr>
<th>Forces</th>
<th>( W = mg )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>( \rho = \frac{m}{V} )</td>
</tr>
<tr>
<td>Pressure</td>
<td>( P = \frac{F}{A} ) ( P = h \rho g )</td>
</tr>
<tr>
<td>Moments</td>
<td>Moment = Force x perpendicular distance</td>
</tr>
<tr>
<td>Others</td>
<td>Area of rectangle/square: ( L \times B )</td>
</tr>
<tr>
<td></td>
<td>Volume of cuboid/cube: ( L \times B \times H )</td>
</tr>
</tbody>
</table>

For examiner’s use:

<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>
SECTION A
This section carries 40 marks.

1. This question is about mass and forces.

a) State whether the correct answer is mass or weight. The first one is done for you.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>It is measured in kilograms.</td>
</tr>
<tr>
<td>ii</td>
<td>Depends on the force of gravity.</td>
</tr>
<tr>
<td>iii</td>
<td>It is a vector quantity.</td>
</tr>
<tr>
<td>iv</td>
<td>It is the amount of matter in an object.</td>
</tr>
</tbody>
</table>

b) A man tries to move a wooden box by pulling it as shown in Figure 1:

i) Draw on Figure 1:
   - an arrow to show the direction in which friction acts. Label it with a letter ‘F’. [1]
   - an arrow to show the reaction of the ground on the box. Label it with a letter ‘R’. [1]

ii) Underline the correct answer:
   If a heavy object is placed inside the box, the friction between the ground and the box (decreases, remains the same, increases). [1]

iii) Given that the box has a mass of 10 kg while the object inside has a mass of 16 kg, calculate the total weight in N.

__________________________________________________________________________________
______________________________________________
______________________________________________

i) It is measured in kilograms.
ii) Depends on the force of gravity.
iii) It is a vector quantity.
iv) It is the amount of matter in an object.
2. This question is about pressure in liquids.

Four divers are diving as shown in Figure 2.

![Figure 2]

a) Which diver experiences the greatest water pressure? Why?
__________________________________________________________________________________  [2]

b) Which divers experience the same water pressure? Why?
__________________________________________________________________________________  [2]

c) Diver C is at a depth of 5 m. Given that the density of water is 1025 kg/m³, calculate the water pressure acting at that depth.
__________________________________________________________________________________  [2]

d) The atmospheric pressure is 101 kPa. Change this value to Pa.
__________________________________________________________________________________  [1]

e) Calculate the total pressure acting on diver C.
__________________________________________________________________________________  [1]
3. **This question is about density.**

Nicole needs to find the density of a pebble she found on the beach.

a) State the name of the apparatus she uses to find its mass.
_____________________________________________________________________________ [1]

Then she fills the instrument in Figure 3 with water and gently immerses the pebble.

![Figure 3](image)

b) Name the instrument she uses to find the volume of the pebble.
_____________________________________________________________________________ [1]

c) Calculate the **volume** of the pebble.
_____________________________________________________________________________ [1]

d) Given that the pebble has a mass of 24 g, calculate its **density**.
_____________________________________________________________________________ [2]

e) State **two** precautions she takes while measuring the volume.
_____________________________________________________________________________ [2]

f) Explain why the pebble sinks in water.
_____________________________________________________________________________ [1]
4. This question is about hydraulic machines.

The hydraulic jack shown in Figure 4 is an example of a hydraulic machine.

a) State the advantage of using hydraulic machines.
__________________________________________________________________________________

__________________________________________________________________________________ [1]

A force \( F \) applied at piston L just balances the weight of an object placed on piston K.

b) Calculate the \textbf{pressure} exerted on piston K. Give your answer in N/cm\(^2\).
__________________________________________________________________________________ [1]

c) What is the value of the pressure exerted throughout the liquid?
__________________________________________________________________________________ [1]

d) Calculate the value of force \( F \).
__________________________________________________________________________________ [2]

e) The area of piston K is increased while everything else is unchanged. Would a smaller or larger force \( F \) be required to lift the object?
__________________________________________________________________________________ [1]

f) Why are liquids and not gases used in hydraulic machines?
__________________________________________________________________________________ [1]

g) Give another example of a hydraulic machine.
__________________________________________________________________________________ [1]
5. This question is about stretching springs.

a) Elisa was carrying out an experiment to prove Hooke’s law. She was provided with a spring, a stand with a clamp, a number of weights, a hanger, a pointer and a metre ruler. Draw and label the missing apparatus in Figure 5.

![Figure 5](image)

b) She obtains the results shown below.

![Graph](image)

i) Explain why the spring obeys Hooke’s law.

__________________________________________________________________________________

__________________________________________________________________________________

ii) Before adding weights, the spring was 16 mm long. Work out the **total length** of the spring when the load added was 3 N.

__________________________________________________________________________________

__________________________________________________________________________________

iii) Elisa repeats the experiment with a **stiffer** spring. Sketch on the same axes the graph she obtains.
SECTION B

This section carries 45 marks.

6. a) The principle of moments states that when a system is in _______________, the total anti-clockwise and the total clockwise moments are ________________. [2]

b) A box is placed on a wooden bar which is pivoted at its midpoint as shown in Figure 6. It is moved several times away from the pivot. Each time the force in the spring changes as shown in the table.

```
<table>
<thead>
<tr>
<th>Distance d₁ (cm)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force in spring (N)</td>
<td>0</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>
```

i) Plot a graph of Force in the spring (N) on y-axis against distance d₁ (cm) on x-axis. [5]

ii) When the box is placed 7.5 cm from the pivot, the force in the spring = __________ N [1]

c) The uniform wooden bar in Figure 7 is balanced and pivoted at its midpoint.

```
20 N  10 N  36 N
```

i) Show through calculation that the total anti-clockwise moments are equal to 9 Nm. [3]

ii) What is the value of the total clockwise moment? Why? [2]

iii) Calculate the total downward force acting on the wooden bar. [1]

iv) **Underline the correct answer:**

The reaction at the pivot is (smaller than, equal to, greater than) the answer in c(iii). [1]
7. a) A sealed glass container has the dimensions shown below. It is filled with air.

![Container Diagram]

i) **Complete:** The gas particles move at high __________ and ________________ with the inside walls [2]

ii) Calculate the **volume** of air inside the container in cm³.

[Calculation]

Figure 8

iii) Given that mass of air inside the container is 0.066 g, calculate its density.

[Calculation]

iv) Some of the air particles are removed from the container. Does the pressure increase, remain the same or decrease? Explain.

[v) The air inside is heated. The size of the container does not change. Does the pressure increase, remain the same or decrease? Explain.

[Calculation]

b) Nigel needs to find the **density** of apple juice.

Write down the steps (2, 3, 4 and 5) which he needs to follow.

The first one is done for you.

i) **Complete:**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>He uses a top pan balance to find the mass of an empty beaker.</td>
</tr>
<tr>
<td>2</td>
<td>He uses the formula Density = mass/volume to find the density.</td>
</tr>
<tr>
<td>3</td>
<td>He works out the difference in mass to find the mass of the apple juice.</td>
</tr>
<tr>
<td>4</td>
<td>He pours some apple juice into a measuring cylinder to find its volume.</td>
</tr>
<tr>
<td>5</td>
<td>He pours the apple juice in the beaker and finds the total mass.</td>
</tr>
</tbody>
</table>

ii) **Underline the correct answer:**

If the volume of apple juice is doubled, the density (remains the same, is doubled, is halved). [1]
8. a) Complete: Pressure is the ________________ per unit _________________.  [2]

b) The table in Figure 9 has a weight of 80 N. Each of its four legs in contact with the floor has an area of 5 cm$^2$.

![Figure 9]

i) Calculate the total area (in cm$^2$) in contact with the floor.

______________________________________________ [2]

ii) Calculate the total pressure (in N/cm$^2$) acting on the floor.

______________________________________________ [2]

iii) A fish bowl is placed on the table. Does the pressure decrease, remain the same or increase? Explain

______________________________________________ [2]


c) Complete:
Stiletto heeled shoes have a very ____________ area of contact and so the pressure that is exerted on the floor is ________________. As a result the wooden floor can be ________________.

On the other hand snow shoes have a very ____________ area of contact and so the pressure that is exerted on the snow is ________________.

It is easier to cut wood using a sharp saw. The saw exerts a large pressure and so a ________________ force is required to cut it.

We say that pressure and area of contact are ________________ proportional.  [7]