FORM 3 PHYSICS

Name: _________________________   Class: ______________

INFORMATION FOR CANDIDATES
• Where necessary take acceleration due to gravity ‘g’ to be 10 m/s$^2$.
• The use of a calculator is allowed.
• The number of marks for each question is given in brackets [ ] at the end of each question.
• You may find these equations useful:

<table>
<thead>
<tr>
<th>Density</th>
<th>$m = \rho V$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>$P = \rho gh$</td>
</tr>
<tr>
<td>Forces</td>
<td>$W = mg$</td>
</tr>
<tr>
<td>Moments</td>
<td>Moment $= F \times$ perpendicular distance</td>
</tr>
<tr>
<td>Energy</td>
<td>$P.E. = mgh$</td>
</tr>
<tr>
<td>Heat</td>
<td>$\Delta Q = mc \Delta \theta$</td>
</tr>
</tbody>
</table>

INSTRUCTIONS TO CANDIDATES
• Use blue or black ink. Pencil should be used for diagrams only.
• Read each question carefully and make sure that you know what you have to do before writing your answer.
• Answer ALL questions.
• All working must be shown.

For Examiner’s Use Only

<table>
<thead>
<tr>
<th>Question</th>
<th>Max Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
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<td>4</td>
<td>8</td>
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<td>5</td>
<td>8</td>
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<td>6</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Written</td>
<td>85</td>
</tr>
<tr>
<td>Practical</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

This document consists of 10 printed pages.
1. The Maltese islands are almost totally dependent on fossil fuels as a source of energy.
   a) i) Give an example of a fossil fuel. __________________________________________ [1]
      ii) State one advantage of using fossil fuels.
          ________________________________________________________________ [1]
      iii) Why are fossil fuels considered to be non-renewable?
          ______________________________________________________________________ [1]
   b) Wind energy is more environmentally friendly than fossil fuels. State:
      i) one disadvantage of using wind energy,
          ________________________________________________________________ [1] Figure 1
      ii) two other forms of energy that are considered to be renewable.
          ________________________________________________________________ [2]
   c) A wind turbine converts 100 000 J of wind energy into 45 000 J of electrical energy. Calculate its efficiency.
      __________________________________________________________________________ [2]

2. In 1738, Daniel Bernoulli, a Swiss physicist, laid the basis for the kinetic theory of gases. He proposed that gases consist of a large number of particles moving in all directions.
   a) A closed glass container is filled with a gas at room temperature. State whether each of the following quantities increases, decreases or remains the same as the gas cools:
      i) mass of the gas,
          __________________________________________________________________________ [1]
      ii) pressure of the gas,
          __________________________________________________________________________ [1]
      iii) density of the gas,
          __________________________________________________________________________ [1]
      iv) speed of the gas particles,
          __________________________________________________________________________ [1]
      v) internal energy of the gas particles.
          __________________________________________________________________________ [1]
b) A closed container is filled with air. The container has a length of 0.8 m, a breadth of 0.3 m and a height of 0.5 m as shown in Figure 3. Calculate the:

i) volume of air inside the container,

\[ \text{Volume} = l \times b \times h \]

\[ = 0.8 \times 0.3 \times 0.5 \]

\[ = 0.12 \text{ m}^3 \] [1]

ii) mass of air, given that the air density is 1.1 kg/m$^3$.

\[ \text{Mass} = \text{Volume} \times \text{Density} \]

\[ = 0.12 \times 1.1 \]

\[ = 0.132 \text{ kg} \] [1]

c) All the air particles are now removed from the container. This empty space is called a

_____________________. [1]

3. a) Underline the correct answer:

i) Seasons on Earth are caused by a (tilt, spin) in the Earth’s axis. [1]

ii) In winter, regions on Earth receive (less, more) solar energy. [1]

b) Put the following in order of size, smallest first: star, planet, galaxy, solar system.

______________________________________________ [1]

c) Curiosity is a robotic rover that has been active on planet Mars since 2011. It has provided further evidence about the presence of water on Mars in the distant past.

The mass of Curiosity on Earth is 900 kg. Complete the table below.

<table>
<thead>
<tr>
<th></th>
<th>On Earth (g = 10 N/kg)</th>
<th>On Mars (g = 4 N/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of Curiosity (kg)</td>
<td>900</td>
<td></td>
</tr>
</tbody>
</table>
| Weight of Curiosity (N)|                       |                      | [3]

d) Name two benefits of space exploration.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [2]
4. a) Complete:
The principle of ___________________________________________ states that energy can
neither be created nor destroyed but only changed from one form to another. [1]

![Figure 4]

b) Figure 4 shows a ball of mass 0.25 kg being kicked vertically upwards with a speed of
5 m/s.
i) Calculate the kinetic energy of the ball just after being kicked.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________[2]

ii) What is the value of the potential energy of the ball at maximum height? (Assume there
are no energy losses)

_______________________________________________________________________[1]

iii) Calculate the maximum height reached by the ball.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________[2]

c) Complete:
After hitting the ground the kinetic energy of the ball is changed to ______________ and
_______________. [2]
5. a) Malcolm uses a rope to pull a large wooden box as shown in Figure 5.

![Figure 5]

i) Name the force:

- ‘A’ acting between the box and the ground _____________________________ [1]
- ‘B’ acting in the stretched rope ________________________________________ [1]

ii) Draw on Figure 5 the reaction of the ground on the wooden box. [1]

b) Jasmine loads the spring shown in Figure 6 using 1 N weights. She plots a graph of extension (cm) against load (N).

![Figure 6]

i) She measures the extensions of the spring by using a __________________________ [1]

ii) How does she know that the spring obeys Hooke’s law?

_______________________________________________________________________
_______________________________________________________________________ [1]

iii) The original length of the spring is 40 cm. Calculate the new length of the spring when the total load is 6 N. (Assume that the spring continues to obey Hooke’s law).

_______________________________________________________________________
_______________________________________________________________________ [2]

iv) Jasmine performs the same experiment with a similar spring which is stiffer. Draw on the same axes the graph that would result. [1]
SECTION B
Each question carries 15 marks. This section carries 45 marks of the total marks for this paper.

6. This question is about moments.
   a) What is meant by the moment of a force?
   ____________________________________________________________________________ [1]

   b) Amy sets up a metre rule of negligible weight such that it is pivoted at one end and is kept
      horizontally by the pull of a force sensor attached at the other end (Figure 7). She moves the
      block towards the force sensor and records the force exerted by the force sensor to keep the
      ruler horizontal. The data she obtains is given in the table below.

<table>
<thead>
<tr>
<th>Distance of mass from pivot (cm)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force measured by force sensor (N)</td>
<td>2.5</td>
<td>5.0</td>
<td>6.8</td>
<td>10.0</td>
<td>12.5</td>
<td>15.0</td>
<td>17.5</td>
</tr>
</tbody>
</table>

   i) Plot a graph of Force (N) on the y-axis against Distance (cm) on the x-axis. [5]
   ii) One of her readings is incorrect. Circle on your graph the reading that is incorrect. [1]
   iii) The correct value should have been ________ N. [1]
   iv) Given that the weight of the block is 25 N, calculate the clockwise moment when it is placed
       40 cm away from the pivot.
       ____________________________________________________________________________ [1]
   v) State the value of the anti-clockwise moment. Give a reason for your answer.
       ____________________________________________________________________________ [2]

   c) Alex is practising windsurfing as in Figure 8. Suddenly the wind force increases and he leans
      backwards to balance his windsurf.
      i) Calculate the moment produced by the wind force.
      ____________________________________________________________________________ [1]
      ii) What is the moment caused by Alex if he balances his windsurf?
      ____________________________________________________________________________ [1]
      iii) Find the value of the distance ‘d’.
      ____________________________________________________________________________ [2]
7. This question is about density and pressure in liquids.

a) Explain in terms of density why a plastic spoon floats in water while a steel spoon sinks in water.

_______________________________________________________________________________________

_______________________________________________________________________________________ [2]

b) Tim is asked to find the density of a liquid. He is given a beaker filled with liquid, a measuring cylinder and a digital balance. Describe how he carries out this experiment.

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________ [4]

c) Tank A is a large wide tank which is filled with water. Tank A needs to be painted and all the water needs to be transferred into tank B.

i) Will the water pressure at the bottom of tank B be greater than, smaller than or equal to the water pressure at the bottom of tank A? Give a reason for your answer.

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________

_______________________________________________________________________________________ [2]

ii) Tank B has two taps as shown in the diagram. Draw (on Tank B) how water would flow out of each tap when turned on at the same time. [1]


d) On March 26, 2012, film director James Cameron reached the deepest known underwater point on Earth inside a special submersible. The depth of the sea at this point was 10 900 m.

i) Given that the density of sea water is 1050 kg/m$^3$, calculate the water pressure at that depth.

_______________________________________________________________________________________

_______________________________________________________________________________________ [2]
ii) The pilot window has an area of 0.15 m$^2$. Calculate the force due to the water acting on it.

______________________________________________________________________________

[2]

iii) The pressure **inside** the submersible was kept at around 100 kPa. Explain why.

______________________________________________________________________________

[2]

8. **This question is about specific heat capacity.**

a) An iron block and an aluminium block have a mass of 1 kg each.

![Figure 10](image)

**Iron block**  **Aluminium block**

Figure 10

i) Explain why the two metal blocks have the same mass even though the iron block is smaller in size.

______________________________________________________________________________

[1]

ii) Identical heaters are used to heat each block. Calculate the power of the heater if it changes 900 J of electrical energy into heat energy every 20 seconds.

______________________________________________________________________________

[2]

iii) The specific heat capacity of iron is 450 J/kg°C while that of aluminium is 900 J/kg°C. Given that initially the two blocks are at room temperature, which one will reach the higher temperature after being heated for five minutes. Explain.

______________________________________________________________________________

[2]

iv) Name the process by which heat is transferred through each block.

______________________________________________________________________________

[1]

v) A liquid-in-glass thermometer is used to measure the temperature of each block. Name the process through which the liquid inside the thermometer rises when heated.

______________________________________________________________________________

[1]
b) Diana is asked to find the specific heat capacity of water. She is given the following apparatus:

- container
- lid
- heater
- insulating material
- thermometer
- joulemeter (an instrument to measure energy)
- top pan balance
- stirrer

i) In the space below draw a labelled diagram showing the set-up of the apparatus.

```
[3]
```

ii) Write down the equation she has to use.

```
[1]
```

iii) Explain how she measures each of the three quantities in the equation.

```
[3]
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iv) Name one precaution taken during the experiment.

```
[1]
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END OF PAPER