# 1.1 Measurements in Physics

## Question Paper

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|---|---|
| Course | DP IB Physics |
| Section | 1. Measurement & Uncertainties |
| Topic | 1.1 Measurements in Physics |
| Difficulty | Hard |

**Time allowed:** 60

**Score:** /47

**Percentage:** /100



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## Question 1a

A simple pendulum oscillates in simple harmonic motion. It can be assumed that there are no energy losses in the system.

(a)
Prove dimensionally that the work-energy principle applies for this system.

[2]

**[2 marks]**

## Question 1b

(b)
Complete the following table by giving the SI base units. Then estimate the order of magnitude for each of the physical quantities.

[4]

| Physical Quantity | SI Base Unit | Order of Magnitude |
|---|---|---|
| Acceleration of freefall Earth ($g$) | $m\,s^{-2}$ | |
| Stephan-Boltzmann constant ($\sigma$) | | $10^{-7}$ |
| Speed of a $\beta$ particle | | |
| Specific heat capacity of water (c) | | |

**[4 marks]**



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## Question 1c

The density, $\rho$, and pressure, $p$, of a gas are related by the expression:

$$x = \sqrt{\frac{\gamma p}{\rho}}$$

where $x$ and $\gamma$ are constants.

(c)
Given that the constant $\gamma$ is dimensionless

(i)

Determine the unit of $x$.

[1]

(ii)
Suggest what quantity is being represented by the symbol $x$.

[1]

**[2 marks]**

## Question 2a

(a)
Identify the quantity with the SI base units of $m^3\,kg^{-1}\,s^{-2}$.

[3]

**[3 marks]**



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## Question 2b

(b)
Convert the following measurements to the appropriate unit, and express to an appropriate number of significant figures.

90 000 GW = _____ mW

45.1 hF = _____ fF

0.60 pm = _____ km

214 minutes = _____ ms

[4]

**[4 marks]**

## Question 2c

A sheet of silver has a thickness of 0.671 µm. A silver atom has a radius of 172 pm.

(c)
Estimate the number of layers of atoms in this sheet to the nearest thousand.

[2]

**[2 marks]**

## Question 3a

(a)
Identify the variable that has the SI base units kg $m^2$ $s^{-3}$ $A^{-2}$.

[3]



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**[3 marks]**

## Question 3b

(b)
Explain why potential difference is not defined as current × resistance.

[2]

**[2 marks]**

## Question 3c

(c)
Convert 0.01 kWh into PeV.

[3]

**[3 marks]**



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## Question 4a

Tensile stress ($\sigma$) is defined as the *force applied per unit cross-sectional area* on a material. The tensile strength is the maximum amount of tensile stress a material can be subjected to before fracturing, meaning that it is equivalent to the tensile stress at the breaking point.

The humerus bone is approximately cylindrical and has a tensile strength of 0.17 GPa and a diameter of 20 mm.

(a)
Calculate the maximum force on the humerus bone before it fractures.

[4]

**[4 marks]**

## Question 4b

The femur bone is the strongest bone in the body. It has a tensile strength of 0.135 kN $mm^{-2}$.

(b)
Calculate the tensile strength of the femur bone in GPa.

[4]

**[4 marks]**



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## Question 4c

(c)
Calculate the number of cubic millimetres ($mm^3$) in 23 $km^3$.

[2]

**[2 marks]**

## Question 5a

(a)
Estimate the time it takes light to cross the nucleus of a hydrogen atom.

[2]

**[2 marks]**

## Question 5b

(b)
Estimate the order of magnitude with an appropriate SI unit and correct prefix for the following quantities.

(i) Mass of an aeroplane.

[1]

(ii) Current through an LED.

[1]

(iii) Time between two heartbeats.

[1]

**[3 marks]**



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## Question 5c

1 u is the atomic mass unit and a common unit used in nuclear physics.

(c)
Show that its value in kg is approximately equal to the mass of a proton in kg.

[3]

**[3 marks]**

## Question 5d

The cross-sectional area of nuclei are commonly measured in the units *barn*, which are represented by the symbol *b*. 1 barn = 100 $fm^2$

(d)
Calculate the value of a nano barn (nb) in $m^2$.

[4]

**[4 marks]**



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