

# 1.1 Measurements in Physics

## Question Paper

Course	DPIB Physics
Section	1. Measurement & Uncertainties
Topic	1.1 Measurements in Physics
Difficulty	Medium

**Time allowed:** 80  
**Score:** /64  
**Percentage:** /100

### Question 1a

(a)

Define 1 Farad in fundamental SI units.

[3 marks]

### Question 1b

A parallel plate capacitor of capacitance  $86 \mu\text{F}$  is connected to a  $6.00 \text{ kV}$  power supply.

(b)

Calculate the charge between the plates in mC. Give your answer to an appropriate number of significant figures.

[3 marks]

### Question 1c

(c)

List the following capacitance in increasing magnitude:

$100 \text{ pF}$ ,  $0.1 \mu\text{F}$ ,  $100 \text{ cF}$ ,  $0.01 \text{ fF}$

[4 marks]

### Question 1d

(d)

Estimate the current through a 1700 W kettle connected to a UK mains supply.

[3 marks]

### Question 2a

Pressure at a certain depth in a fluid can be calculated using the value for the density of the fluid, the gravitational field constant  $g$  and the depth within the fluid.

(a)

State the following measurements in standard form:

(i) 20 000 kPa

(ii) 0.18 Gm

(iii) 1.15  $\mu\text{g}$

(iv) 82.6 pN

[4 marks]

### Question 2b

Pressure is measured in pascals.

(b)

Define 1 Pascal in fundamental SI units.

[3 marks]

### Question 2c

Atmospheric pressure on Earth is 101 325 Pa. The Mariana trench at the bottom of the western Pacific Ocean has a pressure of around 110 MPa.

(c)

Calculate how many times larger the pressure in the Mariana trench is than the atmospheric pressure on Earth.

[2 marks]

### Question 2d

Pressure changes with depth, as well as force and area.

(d)

List the following in order of decreasing pressure:

- Atmospheric pressure at the summit of Mount Everest
- Surface pressure on the Moon
- Atmospheric pressure ~ 101 kPa
- Water pressure of an average garden hose
- The Mariana trench ~ 110 MPa

[3 marks]

### Question 3a

An electron microscope is used to analyse the arrangement of atoms and their nuclei on a new design for a special sheet of silver foil. The foil is a new material being added to various components in a military medical aircraft.

(a)

Estimate the orders of magnitude with an appropriate fundamental SI unit and correct prefix for the following quantities

Quantity	Order of magnitude
Mass of an aeroplane	
Radius of a proton	
Current through an LED	
Time between two heart beats	

[4 marks]

### Question 3b

The sheet of silver foil has a thickness of  $0.992 \mu\text{m}$ . A silver atom has a radius of  $172 \text{ pm}$ .

(b)

Approximate how many layers of atoms there are in this sheet.

[3 marks]

### Question 3c

Using the electron microscope, the cross-sectional area of the silver nuclei can be measured accurately in units of 'barn', with symbol b.

$$1 \text{ barn} = 100 \text{ fm}^2$$

(c)

Calculate the value of 1 nb in  $\text{m}^2$

[4 marks]

### Question 3d

Einstein's famous equation Energy (J) = Mass (kg)  $\times$  (Speed of light ( $\text{m s}^{-1}$ ))<sup>2</sup> demonstrates that energy and matter are interchangeable.

$$\text{Atomic mass unit, } 1 \text{ u} = 931.5 \text{ MeV}$$

$$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$$

(d)

Use this equation to show that the value in kg of 1 u of silver in the foil is approximately equal to the mass of a proton in kg.

[4 marks]

**Question 4a**

X-ray pulsars are detected by X-ray telescopes on a satellite in low Earth orbit 2000 km above the surface of the Earth.

(a)

Calculate the number of cubic millimetres ( $\text{mm}^3$ ) in a volume of  $2000 \text{ km}^3$ .

[3 marks]

**Question 4b**

X-rays from a pulsar travel at the speed of light and are detected on Earth with a wavelength of 8.0 nm.

(b)

Calculate the frequency of the X-rays in PHz. Give your answer to an appropriate number of significant figures. .

[4 marks]

**Question 4c**

X-rays from the nearest pulsar PSR J0109-1431 take 8.82 Gs to travel to Earth.

- (c)  
Calculate the number of oscillations of the X-rays from the pulsar to the surface of the Earth. Give your answer to an appropriate number of significant figures.

**[3 marks]****Question 4d**

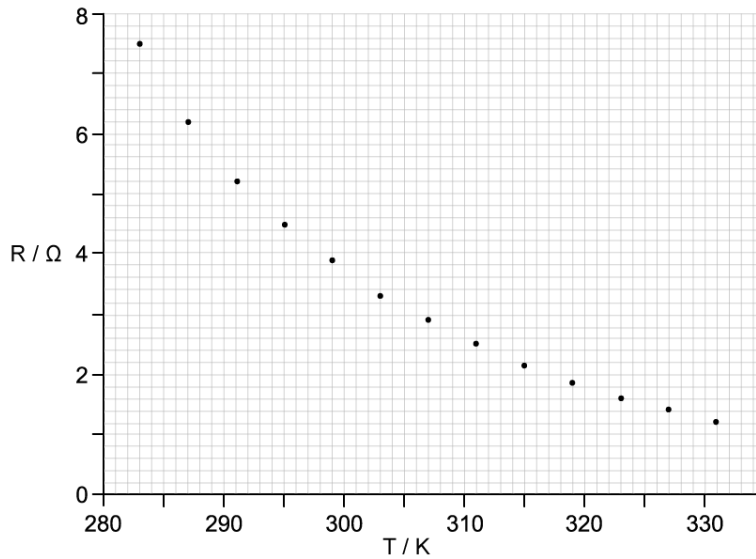
- (d)  
Show the distance from Earth to PSR J0109-1431 is around 280 light years.

**[3 marks]**



**Question 5a**

A student conducts an experiment to study the variation of resistance  $R$  of a negative temperature coefficient (NCT) thermistor with temperature  $T$ . The data from the experiment is shown plotted on the graph.



The electric current through the thermistor for  $T = 283 \text{ K}$  is  $0.0078 \text{ mA}$ .

(a)

What is the units of resistance  $R$  in SI units?

[5 marks]

**Question 5b**

(b)

Convert  $0.0078 \text{ mA}$  to  $\text{A}$  and write in standard form.

[2 marks]

**Question 5c**

(c)

Calculate the ratio  $\frac{R}{T}$  when  $T = 291 \text{ K}$ . Write your answer in fundamental SI units to an appropriate number of significant figures.

**[3 marks]****Question 5d**

(d)

Estimate the resistance of the thermistor at a temperature of  $335 \text{ K}$

**[1 mark]**