

# 1.1 Measurements in Physics

## Question Paper

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

**Time allowed:** 20  
**Score:** /10  
**Percentage:** /100

### Question 1

The frictional force  $F$  on a sphere falling through a fluid is given by the formula:

$$F = 6 \pi a \eta v$$

In this equation,  $a$  is the radius of the sphere,  $\eta$  is a constant relating to the fluid and  $v$  is the velocity of the sphere.

What are the units of  $\eta$ ?

- A.  $\text{kg m s}^{-1}$
- B.  $\text{kg m}^{-1} \text{s}^{-1}$
- C.  $\text{kg m s}^{-3}$
- D.  $\text{kg m}^{-3} \text{s}^{-3}$

[1 mark]

### Question 2

The speed  $v$  of a liquid leaving a tube depends on the change in pressure  $\Delta P$  and the density  $\rho$  of the liquid. The speed is given by the equation:

$$v = k \left( \frac{\Delta P}{\rho} \right)^n$$

In this equation,  $k$  is a constant that has no units.

What is the value of  $n$ ?

- A.  $\frac{1}{2}$
- B. 1
- C.  $\frac{3}{2}$
- D. 2

[1 mark]

### Question 3

Which estimate is realistic?

- A. The kinetic energy of a bus travelling on an motor way is 30 000 J
- B. The power of a domestic light is 300 W
- C. The temperature of a hot oven is 300 K
- D. The volume of air in a car tyre is 0.03 m<sup>3</sup>

[1 mark]

### Question 4

The theory of gas flow through small diameter tubes at low pressures is an important consideration of high vacuum techniques.

One equation used in this theory is:

$$Q = \frac{kr^3(p_1 - p_2)}{L} \sqrt{\frac{M}{RT}}$$

Where  $k$  is a unitless constant,  $r$  is the radius of the tube,  $p_1$  and  $p_2$  are the pressures at each end of the tube,  $L$  is the length of the tube,  $M$  is the molar mass of the gas,  $R$  is the molar gas constant and  $T$  is the thermodynamic temperature of the gas.

What are the base units of  $Q$ ?

- A. kg s<sup>-1</sup>
- B. kg m s<sup>-1</sup>
- C. kg mol<sup>-1</sup>
- D. kg m s<sup>-2</sup>

[1 mark]

### Question 5

What is the correct value for the Gravitational constant?

- A.  $6.67 \times 10^{-3} \text{ nN m}^2 \text{ kg}^{-2}$
- B.  $6.67 \times 10^5 \text{ N mm}^2 \text{ kg}^{-2}$
- C.  $6.67 \times 10^{-20} \text{ kN mm}^2 \text{ kg}^{-2}$
- D.  $6.67 \times 10^{-17} \text{ N km}^2 \text{ kg}^{-2}$

[1 mark]

### Question 6

A boy jumps from a wall 5 m high. What is an estimate of the change in momentum of the boy when he lands without rebounding?

- A.  $4 \times 10^0 \text{ kg m s}^{-1}$
- B.  $4 \times 10^1 \text{ kg m s}^{-1}$
- C.  $4 \times 10^2 \text{ kg m s}^{-1}$
- D.  $4 \times 10^3 \text{ kg m s}^{-1}$

[1 mark]

### Question 7

When a constant braking force is applied to a vehicle moving at speed  $v$ , the distance  $d$  moved by the vehicle as it comes to rest is given by the expression:

$$d = kv^2$$

In this equation,  $k$  is a constant.

When  $d$  is measured in metres and  $v$  is measured in metres per second, the constant has a value of  $k_1$ .

What is the value of the constant when the distance is measured in metres, and the speed is measured in kilometres per hour?

- A.  $\frac{k_1}{12.96}$
- B.  $\frac{k_1}{3.6}$
- C.  $3.6k_1$
- D.  $12.96k_1$

[1 mark]

### Question 8

What is the unit for the gas constant in fundamental SI units?

- A.  $\text{kg m s}^{-2} \text{K mol}^{-1}$
- B.  $\text{kg m}^2 \text{s}^{-2} \text{K}^{-1} \text{mol}^{-1}$
- C.  $\text{kg}^2 \text{m}^2 \text{s}^{-1} \text{K}^{-1} \text{mol}$
- D.  $\text{kg m}^2 \text{s}^{-2} \text{mol}^{-1}$

[1 mark]

### Question 9

Which of the following gives the correct unit for  $\frac{g^3}{G}$ ?

- A.  $\text{kg s}^{-4}$
- B.  $\text{kg}^{-1} \text{s}^{-4}$
- C.  $\text{kg m}^3 \text{s}^{-4}$
- D.  $\text{kg s}^{-8}$

[1 mark]

### Question 10

The drag coefficient  $C_d$  is a number with no units. It is used to compare the drag on different cars at different speeds. It is given by the equation

$$C_d = \frac{2F}{\rho v^n A}$$

$F$  is the drag force on the car,  $\rho$  is the density of the air,  $A$  is the cross-sectional area of the car and  $v$  is the speed of the car.

What is the value of  $n$ ?

- A. 1
- B. 2
- C. 3
- D. 4

[1 mark]



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