Chapter: 01

Physical Quantities and Measurement

Exercise MCQs

1. **The number of base unit is SI is:**

   Ⓐ 3 Ⓑ 6 Ⓒ 7 Ⓓ 9

2. **Which one of the following unit is not a derived unit?**

   Ⓐ Pascal Ⓑ Kilogram Ⓒ Newton Ⓓ Watt

3. **Amount of a substance in terms of numbers is measured in:**

   Ⓐ Gram Ⓑ Kilogram Ⓒ Newton Ⓓ Mole

4. **An interval of 200μs is equivalent to:**

   Ⓐ 0.2 s Ⓑ 0.02 s Ⓒ 2×10^{-4} s Ⓓ 2×10^{-6} s

5. **Which one of the following is the smallest quantity?**

   Ⓐ 0.01g Ⓑ 2mg Ⓒ 3mg Ⓓ 5000ng

6. **Which instrument is most suitable to measure the internal diameter of a test tube?**

   Ⓐ Metre Rule Ⓑ Vernier Calipers Ⓒ Measuring Tap Ⓓ Screw Gauge

7. **A student claimed the diameter of a wire as 1.032cm using Vernier Calipers. Unto what extent do you agree with it?**

   Ⓐ 1cm Ⓑ 1.0cm Ⓒ 1.03cm Ⓓ 11.032cm

8. **A measuring cylinder is used to measure.**

   Ⓐ Mass Ⓑ Area Ⓒ Volume Ⓓ Level of a liquid

9. **A student noted the thickness of a glass sheet using a screw gauge. On the main scale, it reads 3 divisions while the 8th division on the circular scale coincides with the index line. Its thickness is.**

   Ⓐ 3.8cm Ⓑ 3.08mm Ⓒ 3.8mm Ⓓ 3.08cm

10. Significant figures in an expression are:

Ⓐ All the digits

Ⓑ All the accurately known digits

Ⓒ All the accurately known digits and the first doubtful digit

Ⓓ All the accurately known and the doubtful digits

Answer Key:

1	Ⓒ	**6**	Ⓑ
2	Ⓑ	**7**	Ⓒ
3	Ⓓ	**8**	Ⓒ
4	Ⓒ	**9**	Ⓑ
5	Ⓓ	**10**	Ⓒ

Short Questions

1. What is the difference between base quantities and derived quantities? Give three examples in each case.

Ans: The difference between base quantities and derived quantities is:

Base Quantities	Derived Quantities
Base quantities are the quantities on the basis of which other quantities are derived. **Example:** Length, mass, time, electric current, temperature, intensity of light, and amount of substance.	The quantities that are expressed in terms of base quantities are called derived quantities. **Example:** Volume, speed, force, work, energy, power, and electric charge.

2. Pick out the base units in the following:
Joule, Newton, Kilogram, Hertz, Mole, Ampere, Metre, Kelvin, Coulomb, and Watt.

Ans: **Base Units:**

Kilogram, mole, ampere, metre and kelvin and the base units.

3. Estimate your age in seconds.

Ans: My age is 17 years old. So,

1 year = 365 days

1 day = 24 hours

1 hour = 60 minutes

1 minute = 60 seconds

Total seconds in one year = $365 \times 24 \times 60 \times 60$ = 31536000 seconds

Total seconds in 17 years = 17×31536000

My age is seconds = 536112000 seconds.

4. Find the base quantities involved in each of the following derived quantities.

Speed Volume Force Work

Ans: **Speed:** Derived from "Length and time".

Volume: Derived from "Length".

Force: Derived from "Mass, length and time".

Work: Derived from "Mass, length and time".

5. What role Si units have played in the development of science?

Ans: Si units have brought consistency and uniformity in calculation and results. SI units are very helpful to exchange scientific and technical information at the international level.

6. What is meant by Vernier constant?

Ans: The least count of Vernier calipers is known as Vernier constant.

Vernier Constant: It is ratio between smallest readings on main scale to the total divisionon Vernier scale.

OR

The difference between one small division on the main scale and one Vernier scale division.

Formula:

$$\text{Vernier constant} = \frac{\text{Smallest reading on main scale}}{\text{Total No.of divisions on vernier scale}}$$

7. Why is the use of zero error necessary in a measuring instrument?

Ans: Zero error is necessary in measuring instrument to obtain an extreme correct value.

8. What do you understand by the zero error of a measuring instrument?

Ans: When zero of Vernier scale does not coincide with zero of main scale, then instrumenthas "zero error".

9. What is a stopwatch? What is the least count of a mechanical stopwatch you haveused in the laboratories?

Ans: Stopwatch:

"Stopwatch is a device used to measure the time interval of an event".

Least count:

Mechanical stopwatches have least count up to 0.1 second.

10. What is meant by significant figures of a measurement?

Ans: Significant figures:

"All the accurately known digits and the first doubtful digit in anexpression are called significant figures".

Significant figures reflect the precision of a measure value of a physical quantity.

11. Why do we need to measure extremely small interval of times?

Ans: We need to measure extremely small interval of times to calculate the time intervals of natural and artificial events. As in nature and also in physics, there are so many phenomenon's which vary with respect to the small intervals of time.

12. How is precision related the significant figures in a measured quantity?

Ans: An improvement in the quality of measurement by using better instrument increases the significant figures in the measured results. The significant figures are all accurately known digits and the one estimated digit.

Important Conversion

- 1MW = 10^6 W
- 1kg = 10^3 g
- 1 Milligram = 10^{-3} g
- 1 Micro gram = 10^{-6} g
- 1 Nano gram = 10^{-9} g
- 1 Pico gram = 10^{-12} g

- 1 day = 24 hours
- 1 hour = 60 minutes
- 1 minute = 60 seconds
- 1 day = 24 ×60 ×60
- 1 day = 86400 seconds

Important Formulas

- Least count of Screw Gauge = $\dfrac{\text{Pitch}}{\text{No. of division on circular scale}}$
- Least count of Vernier Caliper = $\dfrac{\text{Smallest reading within main scale}}{\text{Number of divisions within vernier scale}}$
- Least count of Vernier caliper = 0.1 mm or 0.01 cm
- Least count of Screw Gauge = 0.01 mm or 0.001 cm
- Area = Length × Width

Numerical

1. Express the following quantities using prefixes.

(a) 5000 g (b) 2000000 W (c) 52×10^{-10} kg (d) 225×10^{-8} S

Ans: Solution:

(a) 5000 g

$5000\ g = 5 \times 10^3\ g$ $(\because\ 10^3\ g = 1\ kg)$

$5000\ g = 5\ kg$

(b) 2000000 W

$2000000\ W = 2 \times 10^6\ W$ $(\because\ 10^6\ W = 1\ MW)$

$2000000\ W = 2\ MW$

(c) 52×10^{-10} kg

$52 \times 10^{-10}\ kg = 52 \times 10^{-10} \times 10^3\ g$ $(\because\ 1\ kg = 10^3\ g)$

$52 \times 10^{-10}\ kg = 52 \times 10^{-7}\ g$

$52 \times 10^{-10}\ kg = 5.2 \times 10^1 \times 10^{-7}\ g$

$52 \times 10^{-10}\ kg = 5.2 \times 10^{-6}\ g$ $(\because\ 10^{-6}\ g = 1\ \mu g)$

$52 \times 10^{-10}\ kg = 5.2\ \mu g$

(d) 225×10^{-8} s

$225 \times 10^{-8}\ s = 2.25 \times 10^2 \times 10^{-8}\ s$

52×10^{-10} kg $= 2.25 \times 10^{-6}$ s $(\therefore\ 10^{-6}\,s = 1\ \mu s)$

52×10^{-10} kg $= 2.25\ \mu s$

2. How do their prefixes micro, nano and pico relate to each other?

Ans: Solution:

As

micro $= 10^{-6}$, nano $= 10^{-9}$, pico $= 10^{-12}$

So,

1000 nano $=$ 1000×10^{-9}

1000 nano $=$ $10^{3} \times 10^{-9}$

1000 nano $=$ 10^{-6}

1000 nano = 1 micro

As,

1000 pico $=$ 1000×10^{-12}

1000 pico $=$ $10^{3} \times 10^{-12}$

1000 pico $=$ 10^{-9}

1000 pico = 1 nano

3. You hair grow at the rate of 1 mm per day. Find their growth rate in nms^{-1}.

Ans: Solution:

Length of hair $= 1mm = 1 \times 10^{-3}$ m

Time $= 24$ hours $= 86400$ seconds

To Find:

Growth rate per day = ?

Formula:

$$\text{Growth rate per day} = \frac{\text{Lenth of hair}}{\text{Time}}$$

Solution:

Putting the values, we have

$$\text{Growth rate per day} = \frac{1 \times 10^{-3}\ \text{m}}{876400\ \text{sec}}$$

Growth rate per day = 1.157×10^{-8} ms^{-1}

Growth rate per day = 11.57×10^{-9} ms^{-1}

Growth rate per day = 11.57 nms^{-1} ($\therefore$ 1 n = 10^{-9})

Result:

The growth rate per day of human hair is 11.57 nms^{-1}.

4. Rewrite the following in standard form.

(a) 1168×10^{-27} (b) 32×10^{5} (c) 725×10^{-5} kg (d) 0.02×10^{-8}

Ans: Solution:

(a) 1168×10^{-27}

$1168 \times 10^{-27} = 1.168 \times 10^{3} \times 10^{-27}$

$1168 \times 10^{-27} = 1.168 \times 10^{3-27}$

$1168 \times 10^{-27} = 1.168 \times 10^{-24}$

(b) 32×10^{5}

$32 \times 10^{5} = 3.2 \times 10^{1} \times 10^{5}$

$32 \times 10^{5} = 3.2 \times 10^{1+5}$

$32 \times 10^{5} = 3.2 \times 10^{6}$

(c) 725×10^{-5} kg

725×10^{-5} kg $= 7.25 \times 10^{2} \times 10^{-5}$ kg

725×10^{-5} kg $= 7.25 \times 10^{2-5}$ kg

725×10^{-5} kg $= 7.25 \times 10^{-3}$ kg ($\therefore$ 1 kg = 10^{3} g)

725×10^{-5} kg $= 7.25 \times 10^{-3} \times 10^{3}$ g

725×10^{-5} kg $= 7.25 \times 10^{-3+3}$ g ($\therefore$ $10^{-3+3} = 10^{0} = 1$)

725×10^{-5} kg $= 7.25$ g

5. Write the following quantities in standard form.

(a) 6400 km (b) 380000 km (c) 300000000 ms^{-1} (d) No. of second in a day

Ans: Solution:

(a) 6400 km

6400 km = 6.4×10^{3} km

(b) 380000 km

380000 km = 3.8×10^{5} km

(c) 380000 km

$300000000\ ms^{-1} = 3 \times 10^8\ ms^{-1}$

(d) No. of second in a day

No. of second in a day = $24 \times 60 \times 60$ s

No. of second in a day = 86400 s

No. of second in a day = 8.64×10^4 s

6. One closing the jaws of Vernier caliper, zero the Vernier scale is on the right to its main scale such that 4th division of its Vernier scale coincides with one of the main scale division. Find its zero error and zero correction.

Ans: Solution:

Vernier division coinciding with main scale = 4th division

Least count = 0.01 cm

Vernier scale reading = 4×0.01

Vernier scale reading = 0.04 cm

Since zero of Vernier scale is on the right side of zero of the main scale, so, instrument has measured more than actual reading. It is positive zero error and correction should be negative.

Zero error = +0.04 cm

Zero correction = −0.04 cm

7. A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5mm. What is the least count?

Ans: Given data:

Number of divisions on circular scale = 50 divisions

Pitch of screw gauge = 0.5 mm

To Find:

Least count = ?

Solutions:

$$\text{Least Count} = \frac{\text{Pitch}}{\text{No. of division on circular scale}}$$

$$\text{Least Count} = \frac{0.5\ \text{mm}}{50}$$

Least Count = 0.01 mm $\quad (\because\ 1\ \text{cm} = 10\ \text{mm})$

Least Count = 0.001 cm

8. Which of the following quantities have three significant figures?

(a) 3.0066 m (b) 0.00309 kg (c) 5.05×10^{-27} kg (d) 301.0 s

Ans: Solution:

(a)	**3.0066 m**	has 5 significant digits.
(b)	**0.00309 kg**	has 3 significant digits.
(c)	**5.05×10^{-27} g**	has 3 significant digits.
(d)	**301.0 s**	has 4 significant digits.

So, values in part (b) and (c) have three significant figures.

9. What are the significant figures in the following measurements?

(a) 1.009 m (b) 0.00450 kg (c) 1.66×10^{-27} kg (d) 2001 s

Ans: Solution:

(a)	**1.009 m**	has 4 significant digits.
(b)	**0.00450 kg**	has 3 significant digits.
(c)	**1.66×10^{-27} kg**	has 3 significant digits.
(d)	**2001 s**	has 4 significant digits.

10. A chocolate wrapper is 6.7cm long and 5.4 cm wide. Calculate its area up to reasonable number of significant figures.

Ans: Given data:

Length of wrapper = 6.7 cm

Width of wrapper = 5.4 cm

Required:

Area of wrapper = ?

Solutions:

Area = Length × Width

Area = 6.7 cm × 5.4 cm

Area = 36.18 cm^2

According to the principle of reasonable numbers of significant figures.

Area = 36 cm^2 (after rounding)