

CLASS 9 • CHEMISTRY

Empirical Data **Collection** & Analysis

Chapter 12 — Exercise Solutions

✓ Solved MCQs

💡 Explained

Short Answers

Descriptive

Investigative



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How to read this solution: In every MCQ, the correct option is highlighted in green with a ✓ tick, and a clear explanation is given below it. All other questions are answered step by step.

1

Tick (✓) the Correct Answer

10 Multiple-Choice Questions

(i) Which of the following pairs of quantities may be measured in the same unit?

A Heat and temperature

B Temperature and area

C Heat and work



D Length and work

 Explanation

Heat and work are both forms of energy. In the SI system, both are measured in Joules (J). Temperature is measured in Kelvin, area in square metres, and length in metres. Therefore, they cannot share the same unit.

(ii) In which unit we usually measure the energy present in the food?

- A Kilojoules
- B Megajoules
- C Calorie**
- D Joule

 Explanation

While the SI unit of energy is the Joule (and kilojoules are often printed on food labels), the “Calorie” (specifically the kilocalorie, often denoted as Cal) is the traditional and most commonly used unit to express the energy content of food in daily life and nutrition.

(iii) What prefix is used for 10^{-12} ?

- A Mega
- B Pico**
- C Giga
- D Tessa

 Explanation

The SI prefix “Pico” (symbol: p) represents a factor of 10^{-12} . Mega is 10^6 , Giga is 10^9 , and “Tessa” appears to be a typo in the textbook for “Tera,” which represents 10^{12} .

(iv) In SI unit of pressure is expressed in:

- A Newton per metre
- B Newton per metre square
- C Joule
- D Pascal**



 Explanation

The SI unit of pressure is the Pascal (Pa). While it is mathematically equivalent to a Newton per square metre (N/m^2), the standard named SI unit for pressure is the Pascal.

(v) Which symbol is used for kilogram in SI units?

- A K
- B k
- C Kgm
- D kg**



 Explanation

The correct symbol for the kilogram is “kg” (k for kilo, g for gram). “K” represents Kelvin, “k” is the prefix for kilo, and “Kgm” is an incorrect notation.

(vi) What does a mole represent?

A Number



B Mass

C Volume

D Length

 Explanation

A mole is the SI unit for the amount of substance. It represents a specific, fixed number of particles (Avogadro's number, approximately 6.022×10^{23}), much like a "dozen" represents the number 12.

(vii) Which unit of volume should usually be used in Chemistry?

A Millilitre

B Litre

C Cubic centimetre



D Cubic metre

 Explanation

In chemistry, the cubic centimetre (cm^3) is highly preferred because it perfectly equates to a millilitre (mL). This makes measuring small volumes of liquids in laboratory glassware (like burettes and pipettes) very convenient. The SI unit, cubic metre (m^3), is too large for everyday lab work.

(viii) Express 0.000840 in scientific notation:

A 8.40×10^{-3}

B 840×10^{-6}

C 8.40×10^{-4} ✓

D 84.0×10^{-5}

 Explanation

To convert to scientific notation, move the decimal point to the right until only one non-zero digit remains to its left. Moving from 0.000840 to 8.40 requires moving the decimal 4 places to the right. Because we moved it right, the exponent is negative. Result: 8.40×10^{-4} .

(ix) In SI units prefix nano means:

A 10^{-9} ✓

B 10^{-8}

C 10^{-11}

D 10^{-12}

 Explanation

The SI prefix “nano” (symbol: n) denotes a factor of 10^{-9} (one billionth).

(x) **65°C is equivalent to:**

A 208 K

B 338 K



C 403 K

D 300 K

 Explanation

To convert Celsius to Kelvin, use the formula: $K = ^\circ C + 273.15$ (often simplified to 273 in standard school problems). $65 + 273 = 338 \text{ K}$.

2

Questions for Short Answers

8 Short Questions

i.

What is consistency of results?

✓ **Answer**

Consistency of results refers to the degree to which repeated measurements of the same quantity, taken under identical conditions, yield similar or identical values. It is heavily related to the precision of an experiment.

ii. Why SI units are user friendly?**✓ Answer**

SI units are user-friendly because they are based on the decimal system (powers of 10). This makes conversions between units (like multiplying or dividing by 10, 100, or 1000) extremely simple. They are also universally standardized, meaning they are coherent and logically interconnected.

iii. Define systematic error and random error.**✓ Answer**

- **Systematic error:** A consistent, repeatable error associated with faulty equipment or flawed experimental design, causing measurements to consistently deviate in one specific direction (either always too high or always too low).
- **Random error:** An unpredictable variation in measurements caused by unknown or uncontrollable factors, leading to scattered results around a true value.

iv. What is reason behind a random error?**✓ Answer**

Random errors are caused by unpredictable fluctuations in the experimental environment. These include changes in temperature, humidity, vibrations, or human limitations in reading instruments (such as parallax error while reading a meniscus).

v. Does systematic error affect the accuracy?

✓ **Answer**

Yes, systematic errors directly affect accuracy because they cause all measurements to be consistently off from the true value by a specific, repeatable amount.

vi. Which other systems of measurements are used apart from SI units?

✓ **Answer**

Other systems of measurement include the CGS system (Centimetre-Gram-Second), the FPS system (Foot-Pound-Second), and the MKS system (Metre-Kilogram-Second). *(Note: MKS is essentially the foundation of the modern SI system).*

vii. Define metre.

✓ **Answer**

The metre is the SI base unit of length. It is scientifically defined as the distance light travels in a vacuum in exactly $1/299,792,458$ of a second.

viii. Mention two benefits scientists get by using SI units.

✓ **Answer**

1. Global standardization allows scientists worldwide to easily share, compare, and replicate experimental data without confusion.
2. The decimal-based system drastically simplifies mathematical calculations and unit conversions.

3

Constructed Response Questions

5 Constructed Questions

i. Compare the units in SI system with those in MKS system?

✓ **Answer**

The MKS (Metre-Kilogram-Second) system is the precursor and foundation of the SI system. They share identical base units for length (metre), mass (kilogram), and time (second). However, the SI system is a more comprehensive and globally standardized extension of MKS. SI includes additional base units for other physical quantities, such as the Ampere for electric current, Kelvin for temperature, Mole for the amount of substance, and Candela for luminous intensity.

ii. What are five basic SI units which are used in Chemistry?**✓ Answer**

The five basic SI units heavily used in Chemistry are:

1. Kilogram (kg) for Mass
2. Metre (m) for Length
3. Second (s) for Time
4. Kelvin (K) for Temperature
5. Mole (mol) for Amount of Substance

iii. Explain the three units derived for the basic SI units.**✓ Answer**

Derived units are formed by mathematically combining base SI units. Examples include:

1. **Cubic metre (m^3) for Volume:** Derived by multiplying length three times ($\text{m} \times \text{m} \times \text{m}$).
2. **Newton (N) for Force:** Derived from mass and acceleration ($\text{kg} \cdot \text{m}/\text{s}^2$).
3. **Pascal (Pa) for Pressure:** Derived from force per unit area (N/m^2 or $\text{kg}/(\text{m} \cdot \text{s}^2)$).

iv. Explain why do we prefer to use smaller units of mass and volume in Chemistry?

✓ Answer

In chemistry, we frequently work with microscopic or very small quantities of substances (e.g., milligrams of a reactant, millilitres of a solution). Using smaller units like grams (g), milligrams (mg), millilitres (mL), and cubic centimetres (cm³) provides much better precision, significantly reduces measurement errors, and makes mathematical calculations more manageable than using massive units like kilograms or cubic metres.

v. What difficulties we expect to encounter if we use different units of measurement in daily life.

✓ Answer

Using different units in daily life would cause massive confusion, inefficiency, and danger. In trade, comparing prices (e.g., kilograms vs. pounds) would be difficult. In engineering and medicine, mismatched units (like confusing metres with feet or grams with ounces) could lead to catastrophic structural failures or fatal medical dosage errors. Standardization is critical for safety and global communication.

4

Descriptive Questions

5 Descriptive Questions

i. What are our indigenous units of measurement of mass, volume and length?

✓ Answer

Indigenous units vary by culture, but in the South Asian context, traditional units include:

- **Mass:** Tola, Masha, Ser (used historically for grains and precious metals).
- **Volume:** Payali, Mana (used for measuring grains and liquids).
- **Length:** Gaz, Hath (cubit, based on the length of a forearm), Baalish.

ii. Elaborate the difference between precision and accuracy.

✓ Answer

- **Accuracy** refers to how close a measured value is to the true or accepted value. High accuracy implies low systematic error.
- **Precision** refers to how close multiple measurements are to each other, regardless of whether they are close to the true value. High precision implies low random error.

You can be precise but inaccurate (all shots hit the same wrong spot), or accurate but imprecise (shots are scattered but average out near the bullseye).

iii. How can you avoid systematic errors in your measurements?**✓ Answer**

Systematic errors can be avoided by:

1. Regularly calibrating all measuring instruments against known standards.
2. Using properly functioning and well-maintained equipment.
3. Applying correct mathematical formulas and accounting for known zero errors.
4. Using appropriate techniques to avoid personal errors (e.g., reading a meniscus at eye level to prevent parallax).

iv. How do taking measurements in SI units ensure safety and reliability?**✓ Answer**

SI units provide a universal standard. In fields like medicine, engineering, and aviation, using standardized SI units ensures that critical calculations for drug dosages, structural loads, or fuel quantities are accurate and universally understood by all professionals involved. This prevents dangerous misinterpretations that could lead to accidents, thereby ensuring safety and reliability.

v.

Can a student be both inaccurate and imprecise in his measurements?

✓ **Answer**

Yes. A student can be both inaccurate and imprecise. This occurs when their measurements are far from the true value (inaccurate) and also widely scattered from each other (imprecise). This usually happens due to a combination of faulty equipment (systematic error) and poor technique or fluctuating environmental conditions (random error).

5

Investigative Question

1 Investigative Question

i. **Elaborate the importance of using SI units in space exploration.**

✓ Answer

The importance of using SI units in space exploration is paramount for several reasons:

1. **International Collaboration:** Space missions (like the International Space Station) involve multiple countries. SI units provide a single, universal language for engineering and physics calculations.
2. **Preventing Catastrophes:** Mixing unit systems can be fatal. For example, the Mars Climate Orbiter was lost because one team used metric units while another used imperial units, leading to a trajectory miscalculation.
3. **Precision and Safety:** Calculating rocket trajectories, fuel loads, life-support systems, and re-entry angles requires extreme precision. A standardized system like SI ensures that all calculations are coherent, reliable, and safe.
4. **Data Sharing:** It allows scientists from different nations to seamlessly share, verify, and build upon each other's astronomical and engineering data.

THANK YOU

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