Physics Grade 9 — Chapter 1

Physical Quantities and Measurement · Tests from supplied DeepSeek notes PDF

Chapter Test 1 — Foundation and Understanding

Instructions:
Section A: 15 MCQs (1 mark each)
Section B: 5 Short Questions (2 marks each)
Section C: 2 Long Questions (5 marks each)
Section D: 3 Numerical Problems (3 marks each)
Total: 40 marks
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. The branch of science that deals with the study of matter, energy, and their interaction is called:
A. Chemistry
B. Biology
C. Physics
D. Geology
Correct Answer: C. Physics
Explanation: Physics is defined as the study of matter, energy, and their mutual interaction.
MCQ 2. Which of the following is a physical quantity?
A. Taste of an apple
B. Mass of a book
C. Feeling of happiness
D. Color of a flower
Correct Answer: B. Mass of a book
Explanation: Physical quantities can be measured and expressed with a number and a unit; mass is measurable.
MCQ 3. The SI base unit of length is the:
A. Centimetre
B. Metre
C. Kilometre
D. Millimetre
Correct Answer: B. Metre
Explanation: The metre (m) is one of the seven SI base units and is the base unit for length.
MCQ 4. Which of the following is a scalar quantity?
A. Velocity
B. Force
C. Mass
D. Displacement
Correct Answer: C. Mass
Explanation: Mass has magnitude only and no direction, making it a scalar quantity.
MCQ 5. The least count of a standard metre rule is:
A. 1 cm
B. 1 mm
C. 0.1 mm
D. 0.01 mm
Correct Answer: B. 1 mm

Explanation: A standard metre rule has 1000 small divisions called millimetres, giving a least count of 1 mm.

MCQ 6. The number of base units in the SI system is:

A. 3

B. 5

C. 7

D. 9

Correct Answer: C. 7

Explanation: The SI system is built on seven base units.

MCQ 7. Which of the following is a derived unit?

A. Metre (m)

B. Kilogram (kg)

C. Second (s)

D. Newton (N)

Correct Answer: D. Newton (N)

Explanation: The newton is a derived unit for force; metre, kilogram, and second are base units.

MCQ 8. The prefix "kilo" represents the power of ten:

A.

B.

C.

D.

Correct Answer: B.

Explanation: The prefix kilo (k) represents a multiplier of (1000).

MCQ 9. A quantity that requires both magnitude and direction for its complete description is a:

A. Scalar quantity

B. Vector quantity

C. Base quantity

D. Derived quantity

Correct Answer: B. Vector quantity

Explanation: Vector quantities require both magnitude and direction.

MCQ 10. The instrument used to measure the internal and external diameter of a hollow cylinder is a:

A. Metre rule

B. Vernier caliper

C. Screw gauge

D. Measuring tape

Correct Answer: B. Vernier caliper

Explanation: The vernier caliper can measure external and internal dimensions of a hollow cylinder.

102

103

106

109

103

103

MCQ 11. The SI unit of mass is the:

A. Gram

B. Kilogram

C. Newton

D. Pound

Correct Answer: B. Kilogram
Explanation: The kilogram (kg) is the SI base unit of mass.
MCQ 12. Which of the following is a non-physical quantity?
A. Temperature
B. Density
C. Color
D. Time
Correct Answer: C. Color
Explanation: Color cannot be measured with a standard unit; it is a non-physical quantity.
MCQ 13. The number has how many significant figures?
A. 1
B. 2
C. 3
D. 4
Correct Answer: B. 2
Explanation: The leading zeros are not significant; the significant figures are 2 and 9.
MCQ 14. The instrument used to measure the volume of a liquid is a:
A. Physical balance
B. Measuring cylinder
C. Vernier caliper
D. Stopwatch
Correct Answer: B. Measuring cylinder
Explanation: A measuring cylinder is used to measure the volume of liquids.
0.0029
MCQ 15. Which of the following is a vector quantity?
A. Distance
B. Speed
C. Time
D. Displacement
Correct Answer: D. Displacement
Explanation: Displacement has both magnitude and direction, making it a vector quantity.
Section B — Short Questions (5 × 2 = 10 marks)
Q1. Define physical quantities and give two examples.
Answer:
Physical quantities are those quantities which can be measured and expressed in terms of a standard unit. They have a numerical magnitude and a unit. For example, length is a physical quantity because it can be measured in metres (e.g., 5 m). Mass is another physical quantity measured in kilograms (e.g., 10 kg). Non-physical quantities, such as taste or color, cannot be measured with a standard unit and are therefore not physical quantities.
Q2. What is the difference between base quantities and derived quantities? Give one example of each.
Answer:
Base quantities are the fundamental, independent quantities that cannot be defined in terms of other quantities. They form the foundation of the measurement system. Examples include mass, length, and time. Derived quantities are formed by multiplying or dividing base quantities. They depend on base quantities for their definition. For example, area is a derived quantity obtained by multiplying two lengths (length × width). Similarly, speed is derived by dividing distance by time. This distinction is important because all physical quantities can be expressed in terms of the seven base quantities.

Q3. Why is the SI system important in science?
Answer:
The SI system (International System of Units) is important because it provides a globally standardized set of units for measurement. This ensures that measurements are understood and can be reproduced accurately anywhere in the world. Without a common system, scientists and engineers in different countries would use different units, causing confusion and errors in communication. The SI system is built on seven base units and provides a coherent framework for all physical quantities. It facilitates international collaboration, trade, and technological development by ensuring that a measurement made in one country is identical to the same measurement made in another.
Q4. What is meant by the least count of a measuring instrument?
Answer:
The least count of a measuring instrument is the minimum value that can be measured on its scale. It represents the smallest division that the instrument can read accurately. For example, a standard metre rule has a least count of 1 mm because its smallest division is 1 mm. A vernier caliper typically has a least count of 0.1 mm, and a screw gauge has a least count of 0.01 mm. The least count determines the precision of the instrument; a smaller least count means the instrument can measure smaller differences. All measurements taken with an instrument are limited to its least count.
Q5. Differentiate between scalars and vectors with examples.
Answer:
Scalar quantities are physical quantities that are completely described by their magnitude (size) and a unit. They do not require a direction. Examples include mass, time, distance, and speed. For instance, saying "the mass is 5 kg" completely describes the mass. Vector quantities, on the other hand, require both magnitude and direction for a complete description. Examples include displacement, velocity, force, and acceleration. For instance, saying "the force is 10 N to the right" is necessary; just "10 N" is incomplete. Scalars follow ordinary algebra, while vectors follow vector algebra.
Section C — Long Questions (2 × 5 = 10 marks)
Q1. Describe the construction and working of a vernier caliper. How is its least count calculated?
Answer:
Introduction: A vernier caliper is a precision measuring instrument used to measure lengths smaller than 1 mm. It can measure the thickness, diameter, or width of an object, as well as the internal and external diameter of a hollow cylinder.
Construction: A vernier caliper has two scales. The main scale is a fixed scale with markings, usually of 1 mm each, and it has a fixed jaw on its left end. The vernier scale is a sliding scale that moves over the main scale. It has markings that are a fraction of the size of the markings on the main scale. The instrument also has outside jaws for measuring external dimensions, inside jaws for measuring internal dimensions, a retainer to lock the sliding scale, and a depth probe for measuring depth.

Working: To take a measurement, the jaws are closed on the object. The main scale reading is taken just before the zero of the vernier scale. Then, the division on the vernier scale that coincides exactly with any division on the main scale is found. This coinciding division number is multiplied by the least count. The result is added to the main scale reading to get the final measurement.
Least Count Calculation: The least count (vernier constant) is the minimum length that can be measured accurately with the instrument. It is calculated by dividing the value of the smallest division on the main scale by the total number of divisions on the vernier scale. For example, if the smallest main scale division is 1 mm and the vernier scale has 10 divisions, then the least count is .

Conclusion: The vernier caliper is a valuable instrument for precise measurements. Its least count of 0.1 mm allows it to measure lengths that a metre rule cannot measure accurately.

Q2. What are the rules for writing significant figures? Explain with examples.

Answer:

Introduction: Significant figures are all the accurately known digits in a measurement plus the first doubtful digit. They indicate the precision of a measurement.

Rules for Writing Significant Figures:

1. All digits reported as a direct result of a measurement are significant. Every digit recorded from an instrument is significant.
2. Non-zero digits (1 to 9) are always significant. For example, the number 23.457 has 5 significant figures.
3. Zeros that follow a non-zero digit to indicate place value are not significant. For example, in "29,000 spectators," the digits 2 and 9 are significant, but the zeros are not. To avoid confusion, such numbers should be written in scientific notation:
(3 significant figures) or (4 significant figures).
4. Zeros after a decimal point that come before non-zero digits are not significant. They serve only as placeholders. For example, 0.0029 has two significant figures (2 and 9). Zeros after a non-zero digit in a decimal indicate a measurement, so they are significant. For example, 0.00290 has three significant figures.
5. Zeros between two significant figures are significant. For example, 100.8 has four significant figures.

Examples:

: 4 significant figures (1, 0, 0, 8).
: 3 significant figures (5, 8, 0).
: 4 significant figures (2, 1, 0, 0).
1 mm/10=0.1 mm
2.90×
104 2.900×104
100.8 s
0.00580 km
210.0 g

Conclusion: Following these rules ensures that measurements are reported with the correct precision and that the number of significant figures accurately reflects the reliability of the measurement.

Section D — Numerical Problems (3 × 3 = 9 marks)

Q1. Convert into m/s.

Solution:

Given:

Speed =

Required:

Speed in m/s

Formula:

Substitution:

Calculation:

Final Answer:

Verification: . Correct.

Q2. A cube has a side length of 5 cm and a mass of 500 g. Find its density.

Solution:

Given:

Mass

Side length

Required:
Density
Formula:
160 km/h
160 km/h
1 km/h= =3600 s1000 m
 m/s185
160 km/h=160× m/s18
5
160× =18
5
=18
800 44.44 m/s
160 km/h=44.44 m/s
44.44× =518 44.44×3.6=160 km/h
m=500 g
s=5 cm
ρ=?
Volume of a cube:
Substitution:
Calculation:
Final Answer:
Verification: . Correct.
Q3. Express in scientific notation.
Solution:
Given:
Number =
Required:
Scientific notation
Formula:
Scientific notation: , where .
Substitution:
Move the decimal point 4 places to the right to get 4.5. Since we moved right, the exponent is .
Calculation:
Final Answer:
Verification: . Correct.
ρ=
V
m
V=s3
V=(5 cm) =3 125 cm3
ρ=
125 cm3
500 g
ρ=4 g/cm3
ρ=4 g/cm3
4×125=500 g
0.00045
0.00045
M×10n 1≤M<10
−4

0.00045=4.5×10−4
4.5×10 =−4 4.5×0.0001=0.00045
0.00045=4.5×10−4
4.5×10 =−4 0.00045

Answer Key and Detailed Solutions — Test 1

MCQ Answers

1. C
2. B
3. B
4. C
5. B
6. C
7. D
8. B
9. B
10. B
11. B
12. C
13. B
14. B
15. D

Short Answers

(Provided above in Section B.)

Long Answers

(Provided above in Section C.)

Numerical Solutions

(Provided above in Section D.)

Chapter Test 2 — Understanding and Application

Board: FBISE
Class: 9
Subject: Physics
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. Which of the following is the correct scientific notation for 0.00045?
A.
B.
C.
D.
Correct Answer: C.
Explanation: The decimal is moved 4 places to the right to obtain a mantissa of 4.5, giving an exponent of -4.
4.5×104
45×10−5
4.5×10−4
0.45×10−3
4.5×10−4

MCQ 2. A body moves 3 km East and then 4 km North. What is the magnitude of its total displacement?
A. 7 km
B. 5 km
C. 1 km
D. 12 km
Correct Answer: B. 5 km
Explanation: Displacement is the straight-line distance from start to finish; using the Pythagorean theorem, .
MCQ 3. A length is measured as 20.14 cm using a vernier caliper. The least count of the instrument is:
A. 0.1 cm
B. 0.01 cm
C. 1 cm
D. 0.001 cm
Correct Answer: B. 0.01 cm
Explanation: The reading has two decimal places, with the last digit uncertain, indicating a least count of 0.01 cm.
MCQ 4. Which of the following is NOT a base quantity in the SI system?
A. Mass
B. Length
C. Force
D. Time
Correct Answer: C. Force
Explanation: Force is a derived quantity, while mass, length, and time are base quantities.
MCQ 5. If the pitch of a screw gauge is 0.5 mm and the circular scale has 50 divisions, the least count is:
A. 0.5 mm
B. 0.1 mm
=3 +42 2 5 km

C. 0.01 mm
D. 0.001 mm
Correct Answer: C. 0.01 mm

Explanation: Least count = Pitch / Total circular divisions = .
MCQ 6. A scalar quantity is completely described by:
A. Its direction only
B. Its numerical magnitude and unit only
C. Both magnitude and direction
D. Its shape and size
Correct Answer: B. Its numerical magnitude and unit only
Explanation: A scalar has magnitude and a unit but no direction.
MCQ 7. The prefix "micro" represents which power of ten?
A.
B.
C.
D.
Correct Answer: B.
Explanation: The prefix micro () represents .
MCQ 8. Which of the following is a source of systematic error?
A. Fluctuations in temperature
B. Human reaction time
C. A mis-calibrated instrument
D. Random variations in measurement
Correct Answer: C. A mis-calibrated instrument
Explanation: Systematic errors are consistent and occur in one direction; a mis-calibrated instrument is a source of instrumental systematic error.
MCQ 9. The number has how many significant figures?
A. 2
B. 3
0.5 mm/50=0.01 mm
10−3
10−6
10−9
106
10−6
μ 10−6
100.8 s
C. 4
D. 5
Correct Answer: C. 4
Explanation: All four digits (1, 0, 0, 8) are significant because zeros between non-zero digits are significant.
MCQ 10. A vector is graphically represented by:
A. A circle
B. A square
C. An arrow
D. A dot
Correct Answer: C. An arrow
Explanation: A vector is represented by an arrow whose length indicates magnitude and whose head indicates direction.
MCQ 11. When rounding off to two decimal places, the answer is:
A. 3.87
B. 3.88
C. 3.90
D. 3.80

Correct Answer: B. 3.88
Explanation: The digit to be dropped is 6, which is greater than 5, so the previous digit (7) is increased by 1, giving 3.88.
MCQ 12. Which of the following is an example of a derived quantity?
A. Length
B. Mass
C. Area
D. Time
Correct Answer: C. Area
Explanation: Area is obtained by multiplying two lengths, so it is a derived quantity.
MCQ 13. The density of a material is 5 g/cm³. In SI units, this is:
3.876

A. 5 kg/m³
B. 500 kg/m³
C. 5000 kg/m³
D. 50,000 kg/m³
Correct Answer: C. 5000 kg/m³
Explanation: , so .
MCQ 14. A physical balance measures:
A. Weight
B. Mass
C. Volume
D. Density
Correct Answer: B. Mass
Explanation: A physical balance measures mass by comparison with standard weights.
MCQ 15. The number written in scientific notation with three significant figures is:
A.
B.
C.
D.
Correct Answer: B.
Explanation: To show three significant figures, the trailing zero must be included:
.
Section B — Short Questions (5 × 2 = 10 marks)
Q1. Explain why a scalar quantity can be added using ordinary algebra, while a vector quantity cannot.
Answer:
A scalar quantity has only magnitude and no direction, so its addition depends solely on numerical values. For example, if you add 5 kg of mass to 3 kg of mass, the total is simply 8 kg; the direction is irrelevant. A vector quantity, however, has both magnitude and direction. Adding vectors requires accounting for direction, because two vectors of equal magnitude but opposite directions can cancel out (e.g., 5 N to the right and 5 N to the left give a net force of zero). Therefore, vectors must be added using vector algebra
1 g/cm=3 1000 kg/m3 5 g/cm=3 5000 kg/m3
29,000
2.9×104
2.90×104
2.900×104
0.29×105
2.90×104
2.90×104

(e.g., the head-to-tail rule), which considers both magnitude and direction. This is why ordinary arithmetic cannot be used for vectors unless they act along the same line.

Q2. Why is it important to use the correct number of significant figures when reporting a measurement?

Answer:

Using the correct number of significant figures is important because it communicates the precision of a measurement. If you report too many digits, you suggest a level of accuracy that the instrument does not have, which is misleading. For example, reporting a length as 25.432 cm when the instrument can only measure to the nearest millimetre (0.1 cm) falsely implies precision to the thousandth of a centimetre. Conversely, reporting too few digits loses useful information. Significant figures also ensure that calculations reflect the precision of the original measurements. In scientific work, consistent use of significant figures allows others to interpret and compare data reliably and to know how much trust to place in the reported values.

Q3. Distinguish between systematic and random errors, giving one example of each.

Answer:

Systematic errors are consistent, repeatable errors that tend to occur in one direction (either always positive or always negative). They are caused by faulty instruments, imperfect experimental techniques, or personal bias. For example, a mis-calibrated balance that always reads 0.5 g too high will produce systematically high readings. Random errors, on the other hand, are unpredictable and occur irregularly due to fluctuations in experimental conditions, instrument imperfections, or human reaction time. For example, when using a stopwatch, human reaction time may cause the recorded time to be sometimes slightly higher and sometimes slightly lower. Systematic errors affect accuracy and can be corrected by calibration, while random errors affect precision and can be reduced by taking multiple measurements and averaging.

Q4. Describe the displacement method for finding the volume of an irregularly shaped solid.

Answer:

The displacement method measures the volume of an irregularly shaped solid by submerging it in water in a measuring cylinder. First, the mass of the object is measured using a balance. Then, water is added to the measuring cylinder and the initial volume is recorded. The object is tied with a thin thread and gently lowered into the water until it is completely submerged. The water level rises, and the final volume is recorded. The volume of the object is the difference between the final and initial volumes ( ). Finally, the density is calculated by dividing the mass by the volume. This method $V = V - f$ V i works because a submerged object displaces a volume of water equal to its own volume. It is suitable for objects that sink and do not dissolve or absorb water.

Q5. Explain why the least count of a screw gauge is smaller than that of a vernier caliper.

Answer:

The least count is the smallest measurement an instrument can make, and it depends on the instrument's design. A vernier caliper uses a main scale (typically 1 mm divisions) and a sliding vernier scale. Its least count is calculated by dividing the smallest main scale division by the number of vernier divisions. A typical vernier caliper with 10 vernier divisions has a least count of 0.1 mm. A screw gauge, however, uses a rotating circular scale (thimble) over a linear scale. The pitch (distance moved per rotation) is divided by the number of circular scale divisions. A typical screw gauge with a pitch of 0.5 mm and 50 circular divisions has a least count of 0.01 mm. Because the circular scale allows finer subdivision of the pitch, the screw gauge has a smaller least count and is therefore more precise.

Section C — Long Questions (2 × 5 = 10 marks)

Q1. Explain the rules for rounding off numbers and significant figures. Illustrate with examples.

Answer:

Introduction: Rounding off is the process of approximating a number to a simpler value while maintaining an appropriate level of accuracy. Significant figures indicate which digits in a measurement are reliable.

Rules for Rounding Off:

1. Whole Numbers: When rounding off a whole number, look at the digit to the right of the place you want to round to. If that digit is less than 5, leave the digit unchanged (round down). If it is 5 or greater, add 1 to the digit (round up). Any digits after the rounded digit become zero.

Example: Round 7,847 to three significant figures. The digit to be dropped is 7, which is greater than 5, so the previous digit (4) is increased to 5, giving 7,850.

2. Decimal Numbers: When rounding off a decimal, find the digit you want to round and look at the digit to its right. If that digit is less than 5, drop it and all digits to its right (round down). If it is 5 or greater, add 1 to the digit and drop the rest (round up).

Example: Round 3.876 to two decimal places. The digit to be dropped is 6, which is greater than 5, so the previous digit (7) is increased to 8, giving 3.88.

Example: Round 657.873 to two decimal places. The digit to be dropped is 3, which is less than 5, so the previous digit (7) remains unchanged, giving 657.87.

Importance of Significant Figures: Significant figures are all the accurately known digits plus the first doubtful digit. They communicate the precision of a measurement. When performing calculations, the result should not have more significant figures than the least precise measurement used. For example, ; since 2.5 has two significant figures, the result is rounded to 8.6.

Conclusion: Rounding off and significant figures ensure that numbers are reported honestly and consistently, reflecting the precision of the instruments used.

Q2. Describe the construction and working of a screw gauge. How is its least count calculated?

Answer:

Introduction: A screw gauge is a precision measuring instrument used to measure lengths even smaller than those possible with a vernier caliper, such as the diameter of a thin wire.

Construction: A screw gauge consists of a U-shaped frame with a fixed measuring face called the anvil and a movable measuring face called the spindle. The spindle is connected to a rotating part called the thimble, which has a circular scale. The sleeve is the fixed part with a linear (main) scale and a datum line. A ratchet mechanism ensures consistent pressure during measurement.

Working: To take a measurement, the object is placed between the anvil and the spindle. The thimble is rotated using the ratchet until the object is gently held. The main scale reading is taken on the sleeve. Then, the circular scale division that aligns with the datum line is noted. This division number is multiplied by the least count and added to the main scale reading to get the total measurement.

Least Count Calculation: The least count is the minimum length that can be measured accurately. It is calculated by dividing the pitch by the total number of divisions on the circular scale.

For example, if the pitch is 0.5 mm and the circular scale has 50 divisions, the least count is .

Conclusion: The screw gauge's small least count (typically 0.01 mm) makes it one of the most precise simple measuring instruments available for small dimensions.

Section D — Numerical Problems (3 × 3 = 9 marks)

Q1. A car travels a distance of 100 km in 2 hours. Calculate its average speed in km/h and m/s.

2.5×3.42=8.55

Least Count=

Total circular divisions

Pitch

0.5/50=0.01 mm

Solution:

Given:

Distance

Time

Required:

Average speed in km/h and m/s

Formula:

Substitution:

Conversion to m/s:

Final Answer:

Verification: . Correct.

Q2. The mass of a metal block is 200 g and its volume is 50 cm³. Calculate its density in g/cm³ and kg/m³.

Solution:

Given:

Mass

Volume

Required:

Density in g/cm³ and kg/m³

Formula:

Substitution:

Conversion to kg/m³:

s=100 km

t=2 h

V =ave

t

s

V =ave

=2 h

100 km 50 km/h

50 km/h=50× =3600 s1000 m 50× =185 13.89 m/s

V =ave 50 km/h=13.89 m/s

13.89×3.6=50 km/h

m=200 g

V=50 cm3

ρ

ρ=

Vm

ρ= =50 cm3

200 g 4 g/cm3

Final Answer:

Verification: . Correct.

Q3. A body moves 6 km West and then 8 km North. Find the magnitude of its displacement.

Solution:
Given:
Displacement West
Displacement North
Required:
Magnitude of total displacement
Formula:
Using the Pythagorean theorem:
Substitution:
Calculation:
Final Answer:
Verification: . Correct.

Answer Key and Detailed Solutions — Test 2
MCQ Answers
1. C
2. B
3. B
4. C
4 g/cm=3 4×1000=4000 kg/m3
ρ=4 g/cm=3 4000 kg/m3
4×1000=4000 kg/m3
=6 km
=8 km
R= (6) +(8)2 2
R= =36+64 100
R=10 km
Displacement=10 km
6 +2 8 =2 36+64=100=102

5. C
6. B
7. B
8. C
9. C
10. C
11. B
12. C
13. C
14. B
15. B
Short Answers
(Provided above in Section B.)
Long Answers
(Provided above in Section C.)
Numerical Solutions
(Provided above in Section D.)

Chapter Test 3 — Application, Reasoning, and Exam Preparation

Board: FBISE
Class: 9
Subject: Physics
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. A student measures the length of a pencil five times and obtains: 12.1 cm, 12.2 cm, 12.0 cm, 12.1 cm, 12.1 cm. The precision of the measurements is best described as:
A. Low precision and low accuracy
B. High precision and high accuracy
C. High precision but accuracy cannot be determined from the given data
D. Low precision but high accuracy
Correct Answer: C. High precision but accuracy cannot be determined from the given data
Explanation: The measurements are close to each other (high precision), but the true value is not given, so accuracy cannot be determined.
MCQ 2. A rectangular block has dimensions 5.0 cm × 3.0 cm × 2.0 cm and a mass of 60 g. The density of the material is:
A. 2 g/cm³
B. 4 g/cm³
C. 6 g/cm³
D. 10 g/cm³
Correct Answer: A. 2 g/cm³
Explanation: Volume = . Density = .
MCQ 3. A body moves 4 km North, then 3 km East, then 4 km South. The magnitude of its total displacement is:
A. 11 km
B. 5 km
5.0×3.0×2.0=30 cm3 60/30=2 g/cm3
C. 3 km
D. 7 km
Correct Answer: C. 3 km
Explanation: The North and South displacements cancel (4 km - 4 km = 0). The net displacement is 3 km East. Magnitude = 3 km.
MCQ 4. The number has how many significant figures, and what is its value in metres in scientific notation?
A. 3 sig figs,
B. 3 sig figs,
C. 4 sig figs,
D. 5 sig figs,
Correct Answer: A. 3 sig figs,
Explanation: The significant figures are 5, 8, and the final 0 (3 sig figs).
.
MCQ 5. A vernier caliper has a main scale division of 0.5 mm. The vernier scale has 25 divisions. The least count is:
A. 0.5 mm
B. 0.1 mm
C. 0.02 mm
D. 0.05 mm
Correct Answer: C. 0.02 mm
Explanation: Least count = Smallest main scale division / Total vernier divisions = .
MCQ 6. A student measures the mass of an object as using a balance with a least count of . The percentage uncertainty in the measurement is:

A. 0.1%
B. 1%
C. 2%
D. 10%
Correct Answer: C. 2%
Explanation: Percentage uncertainty =
.
0.00580 km
5.80×10 m0
5.80×10 m1
5.80×10 m0
5.80×10 m1
5.80×10 m0
0.00580 km=
5.80 m=5.80×10 m0
0.5 mm/25=0.02 mm
5.0 g
0.1 g
(least count/measured value)×100%=
(0.1/5.0)×100%=2%

MCQ 7. Which of the following statements about scalars and vectors is correct?
A. Scalars can be added using vector algebra.
B. Vectors can be added using ordinary algebra.
C. Scalars follow ordinary algebra, while vectors follow vector algebra.
D. Vectors have magnitude only, while scalars have both magnitude and direction.
Correct Answer: C. Scalars follow ordinary algebra, while vectors follow vector algebra.
Explanation: Scalars are added using ordinary arithmetic, while vectors require vector addition because direction matters.
MCQ 8. A screw gauge has a zero error of +0.02 mm. A reading of 3.50 mm is obtained. The corrected reading is:
A. 3.48 mm
B. 3.50 mm
C. 3.52 mm
D. 3.54 mm
Correct Answer: A. 3.48 mm
Explanation: For a positive zero error, the correction is negative. Corrected reading = observed reading - zero error = .
MCQ 9. The result of the calculation should be reported with the correct number of significant figures as:
A. 8.55
B. 8.6
C. 8.550
D. 9
Correct Answer: B. 8.6
Explanation: has 2 significant figures, and has 3 significant figures. The result should have 2 significant figures. , which rounds to 8.6.
MCQ 10. A body moves 6 km West, then 8 km North. The angle of the displacement vector with the West direction is:
A.
B.
3.50−0.02=3.48 mm
2.5×3.42

2.5 3.42
2.5×3.42=8.55
tan (8/6)−1
tan (6/8)−1
C.
D.
Correct Answer: A.
Explanation: The displacement vector has components: West = 6 km, North = 8 km. The angle with the West direction is given by , so
.
MCQ 11. Which of the following statements about systematic and random errors is correct?
A. Systematic errors can be reduced by taking multiple measurements and averaging.
B. Random errors can be eliminated by calibrating the instrument.
C. Systematic errors affect precision, while random errors affect accuracy.
D. Random errors can be reduced by taking multiple measurements and averaging.
Correct Answer: D. Random errors can be reduced by taking multiple measurements and averaging.
Explanation: Random errors are unpredictable and can be reduced by averaging multiple measurements. Systematic errors require calibration or improved technique to reduce.
MCQ 12. The density of a substance is . The volume of a 54 g sample is:
A.
B.
C.
D.
Correct Answer: B.
Explanation: Volume = mass / density = .
MCQ 13. Which of the following measurements has the highest precision?
A.
B.
C.
D.
Correct Answer: D.
Explanation: Precision is indicated by the number of significant figures. has 5 significant figures, indicating the highest precision.
sin (8/6)−1
cos (6/8)−1
tan (8/6)−1
θ tanθ=North/West=8/6 θ=
tan (8/6)−1
2.7 g/cm3
10 cm3
20 cm3
30 cm3
40 cm3
20 cm3
54 g/2.7 g/cm=3 20 cm3
2.5 cm
2.50 cm
2.500 cm
2.5000 cm
2.5000 cm

2.5000 cm

MCQ 14. A body moves 10 m East, then 10 m West, then 5 m East. The total distance traveled and the magnitude of displacement are:

A. and

B. and

C. and

D. and

Correct Answer: A. and

Explanation: Total distance = . Displacement =

East. Magnitude = 5 m.

MCQ 15. A student uses a metre rule to measure the length of a wire and records 25.3 cm. The number of significant figures in this measurement is:

A. 1

B. 2

C. 3

D. 4

Correct Answer: C. 3

Explanation: All three digits (2, 5, 3) are significant. The last digit (3) is the estimated (uncertain) digit, and the first two are certain.

Section B — Short Questions (5 × 2 = 10 marks)

Q1. Explain why the density of a substance is a characteristic property and does not depend on the size of the object.

Answer:

Density is defined as mass per unit volume ( ). It is a characteristic property because it depends on the nature of the material and how closely its particles are packed, not on the amount of the substance. For example, a small piece of iron and a large iron block have the same density because the ratio of mass to volume remains constant for the same material. If you double the volume of a substance, its mass also doubles, so the density remains unchanged. This is why density can be used to identify materials. Only changes in temperature or pressure (for gases) can alter the density of a given material.

Q2. A student claims that a measurement of 25.4 cm is more precise than a measurement of 25.40 cm. Is the student correct? Explain.

25 m 5 m

5 m 25 m

25 m 25 m

5 m 5 m

25 m 5 m

10+10+5=25 m 10−10+5=5 m

ρ=m/V

Answer:

The student is not correct. Precision is indicated by the number of significant figures in a measurement. The measurement 25.40 cm has four significant figures, while 25.4 cm has only three. The extra zero in 25.40 cm indicates that the measurement was made with an instrument capable of reading to the hundredth of a centimetre (0.01 cm), whereas 25.4 cm only indicates precision to the tenth of a centimetre (0.1 cm). Therefore, 25.40 cm is more precise because it provides more information about the measurement's resolution. The trailing zero after the decimal point is significant and should not be dropped.

Q3. Two forces of 5 N and 12 N act on an object. What is the minimum and maximum possible magnitude of their resultant?

Answer:

The resultant of two vectors depends on the angle between them. The maximum magnitude occurs when the forces act in the same direction (angle = 0°), giving . The minimum magnitude occurs when the forces act in opposite directions (angle = 180°), giving . For any other angle, the resultant lies between these two extremes. This illustrates that vectors cannot be added by simple arithmetic; their directions must be considered. The actual resultant can be found using the parallelogram law or by resolving components.

Q4. Explain why random errors cannot be completely eliminated, but systematic errors can be corrected.

Answer:

Random errors are unpredictable and uncontrollable fluctuations that occur due to factors like human reaction time, small variations in experimental conditions, or instrument noise. Since they occur in random directions (sometimes positive, sometimes negative), they cannot be completely eliminated. However, their effect can be minimized by taking multiple measurements and calculating the mean, which averages out the fluctuations. Systematic errors, on the other hand, are consistent and occur in one direction (always positive or always negative). They arise from identifiable causes such as instrument mis-calibration or faulty technique. Because they are predictable, systematic errors can be detected and corrected, for example, by calibrating the instrument or applying a correction factor.

Q5. A student measures the volume of a stone using a measuring cylinder. The initial water level is 30 mL and the final level is 45 mL. The mass of the stone is 60 g. Calculate the density of the stone and explain whether the stone will float or sink in water (density of water = 1 g/cm³).

R =max 5+12=17 N

R =min □12−5□=7 N

Answer:

The volume of the stone is the difference between the final and initial water levels: . The density of the stone is . Since the density of the stone (4 g/cm³) is greater than the density of water (1 g/cm³), the stone will sink in water. An object floats if its density is less than the fluid's density and sinks if it is greater. This is why stones sink in water while lighter materials like wood float.

Section C — Long Questions (2 × 5 = 10 marks)

Q1. A student is asked to measure the thickness of a single sheet of paper using a metre rule, a vernier caliper, and a screw gauge. Explain which instrument would give the most accurate result and why. Include a discussion of least count and precision.

Answer:

Introduction: The thickness of a single sheet of paper is very small (typically about 0.1 mm or less). To measure it accurately, the instrument must have a very small least count. The choice of instrument depends on the precision required.

Metre Rule: A standard metre rule has a least count of 1 mm. It cannot measure a thickness smaller than 1 mm directly. A single sheet of paper is much thinner than 1 mm, so the metre rule would give an unreliable or zero reading. It is unsuitable for this measurement.

Vernier Caliper: A vernier caliper typically has a least count of 0.1 mm. While it is more precise than a metre rule, a single sheet of paper is still thinner than 0.1 mm in many cases. The vernier caliper might give a rough estimate but would not be accurate enough for a precise measurement.

Screw Gauge: A screw gauge typically has a least count of 0.01 mm. This makes it the most suitable instrument for measuring the thickness of a single sheet of paper. Its small least count allows it to detect very small changes in thickness. The ratchet ensures

consistent pressure, preventing compression of the paper.
Precision and Least Count: The least count determines the precision of an instrument. A smaller least count means higher precision. The screw gauge's least count of 0.01 mm is 100 times smaller than the metre rule's least count of 1 mm, allowing much more precise measurements. The vernier caliper's least count of 0.1 mm is intermediate.
Conclusion: The screw gauge is the most accurate instrument for measuring the thickness of a single sheet of paper because of its very small least count (0.01 mm). The metre rule and vernier caliper are not precise enough for this measurement.
Q2. Describe the steps involved in measuring the density of an irregularly shaped solid using the displacement method. Also, explain the precautions that should be taken to
V=
45−30=15 mL=15 cm3 ρ=m/V=60/15=
4 g/cm3
ensure accurate results.
Answer:
Introduction: The displacement method is used to find the density of irregularly shaped solids whose volume cannot be calculated using geometric formulas.
Steps:
1. Measure the mass: Use a balance to measure the mass of the irregular solid accurately.
2. Measure initial volume: Fill a measuring cylinder with enough water to completely submerge the object. Record the initial volume ().
3. Submerge the object: Tie a thin thread to the object and gently lower it into the water until it is completely submerged.
4. Measure final volume: Record the new water level as the final volume ().
5. Calculate volume: The volume of the object is .
6. Calculate density: Use the formula to calculate the density.
Precautions:
1. Read the meniscus correctly: Always read the bottom of the meniscus at eye level to avoid parallax error.
2. Remove air bubbles: Tap the cylinder gently to remove any air bubbles clinging to the object, as they would increase the volume reading.
3. Use a thin thread: A thick thread displaces extra water, leading to an overestimation of the object's volume.
4. Dry the object before weighing: If the object is wet, its mass will be too high. Dry it first.
5. Ensure complete submergence: The object must be fully submerged to displace a volume equal to its own volume.
6. Choose an appropriate cylinder: The cylinder should be large enough to submerge the object but small enough to provide precise volume readings.
Conclusion: The displacement method is a reliable technique for measuring the density of irregular solids when performed carefully with proper precautions. It relies on the principle that a submerged object displaces a volume of fluid equal to its own volume.
Section D — Numerical Problems (3 × 3 = 9 marks)
Q1. A student measures the length of a rod as 25.4 cm using a metre rule (least count 0.1 cm) and as 25.42 cm using a vernier caliper (least count 0.01 cm). Calculate the percentage uncertainty in each measurement and determine which measurement is more precise.
V
i
V
f

$V = V - f V$
i
$\rho = m/V$

Solution:
Given:
Measurement 1: (least count =)
Measurement 2: (least count =)
Required:
Percentage uncertainty in each measurement and comparison of precision
Formula:
Calculation for Measurement 1:
Calculation for Measurement 2:
Comparison:
The percentage uncertainty in the vernier caliper measurement (0.0394%) is much smaller than that in the metre rule measurement (0.394%). This means the vernier caliper measurement is more precise.
Final Answer:
Metre rule: uncertainty
Vernier caliper: uncertainty
The vernier caliper measurement is more precise.
Verification: A smaller percentage uncertainty indicates higher precision, which is consistent with the smaller least count of the vernier caliper.
Q2. A body moves 10 km East, then 10 km North, then 10 km West. Find the magnitude of its total displacement and the total distance traveled.
Solution:
Given:
Displacement 1: 10 km East
Displacement 2: 10 km North
Displacement 3: 10 km West
25.4 cm 0.1 cm
25.42 cm 0.01 cm
Percentage uncertainty= ×Measured value
Least count 100%
Percentage uncertainty= ×25.40.1 100%=0.394%
Percentage uncertainty= ×25.420.01 100%=0.0394%
0.394%
0.0394%

Required:
Magnitude of total displacement and total distance
Total Distance:
Total Displacement:
The East and West displacements cancel each other: .
The net displacement is 10 km North.
Magnitude of Displacement:
Final Answer:
Total distance =
Magnitude of displacement =
Verification: The East and West displacements are equal and opposite, so they cancel. The only remaining displacement is 10 km North.
Q3. The mass of an irregularly shaped stone is 80 g. When it is lowered into a measuring cylinder, the water level rises from 20 mL to 40 mL. Calculate the volume and density of the stone. Will the stone float or sink in water (density of water = 1 g/cm³)?

Solution:
Given:
Mass
Initial volume
Final volume
Required:
Volume and density of the stone; whether it floats or sinks
Volume:
Density:
Float or Sink:
Since the density of the stone ( ) is greater than the density of water ( ),
the stone will sink.
Distance=10+10+10=30 km
10 km East−10 km West=0
Displacement=10 km North
30 km
10 km
m=80 g
V =i 20 mL
V =f 40 mL
V=V −f V =i 40−20=20 mL=20 cm3
ρ= =V
m
=20 cm3
80 g 4 g/cm3
4 g/cm3 1 g/cm3

Final Answer:
Volume =
Density =
The stone will sink in water.
Verification: . Correct. Density greater than water means sinking.

Answer Key and Detailed Solutions — Test 3
MCQ Answers
1. C
2. A
3. C
4. A
5. C
6. C
7. C
8. A
9. B
10. A
11. D
12. B
13. D
14. A
15. C

Short Answers
(Provided above in Section B.)
Long Answers
(Provided above in Section C.)

Numerical Solutions
(Provided above in Section D.)