Class 11 Physics · Chapter 1: Units and Measurement

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

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1. A student adds the masses 18.62 g, 3.1 g and 0.457 g and reports the total as 22.18 g. Which statement about his result is correct? [1]

(a) It should be 22.177 g, since no digit of the sum may be dropped.
(b) It should be 22 g, since 3.1 g has only two significant figures.
(c) It should be 22.2 g, since 3.1 g has only one decimal place.
(d) It is correct, since two of the three masses have two or more decimal places.

Answer: (c) The arithmetic sum is 22.177 g. In addition the result keeps as many decimal places as the least precise term, 3.1 g with one decimal place, so the total is 22.2 g. The significant-figure rule of (b) is the rule for multiplication and division, not for addition.

2. Which one of the following readings has exactly three significant figures? [1]

(a) 0.00203 s
(b) 0.04050 kg
(c) 3.070 m
(d) 2.300×10^3 g

Answer: (a) 0.00203 s: the leading zeros only place the decimal point, so 2, 0, 3 count: three. 0.04050 kg has four (4, 0, 5 and the trailing zero after the decimal point); 3.070 m has four; 2.300×10^3 g has four, since every zero in the base number of scientific notation is significant.

3. A rectangular plot is measured as 12.6 m long and 4.2 m wide. A student multiplies the two and reports the area as 52.92 m^2. How many of the digits he has written are not justified by the measurements? [1]

(a) 1
(b) 3
(c) 2
(d) none

Answer: (c) In multiplication the result keeps as many significant figures as the factor with the fewest: 4.2 m has two. So 52.92 m^2 must be reported as 53 m^2, and the last two digits written, 9 and 2, are not justified.

4. The length of a road is written as 3600 m, without a decimal point and not in scientific notation. By NCERT's rules, the number of significant figures in it is [1]

(a) 4
(b) 3
(c) 1
(d) 2

Answer: (d) In a number without a decimal point the trailing zeros are not significant, so only 3 and 6 count: two significant figures.

5. By the convention for dropping a final digit 5, the number 6.375 rounded off to three significant figures is [1]

(a) 6.37
(b) 6.38
(c) 6.40
(d) 6.3

Answer: (b) The digit dropped is 5 and the preceding digit, 7, is odd, so it is raised by 1: 6.38. (Had the preceding digit been even, the 5 would simply be dropped.)

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6. Using the method of dimensions, find how many dynes make one newton. [2]

Force has dimensions $[M\ L\ T^{-2}]$, so a = 1, b = 1, c = −2. $n_2 = n_1\,[M_1/M_2]^1\,[L_1/L_2]^1\,[T_1/T_2]^{-2} = 1 \times (1\text{ kg}/1\text{ g}) \times (1\text{ m}/1\text{ cm}) \times 1 = 1000 \times 100 = 10^5$. So 1 N = 10^5 dyne.

- dimensions $[M\ L\ T^{-2}]$ and the conversion formula set up (1)
- 1 N = 10^5 dyne (1)

7. In the revised SI, each base unit is defined by fixing the numerical value of a constant of nature. [2] Name the constant used to define (a) the metre and (b) the kilogram, and give the unit in which each fixed value is expressed.

(a) The metre: the speed of light in vacuum c, fixed at 299792458 in m s^{-1}. (b) The kilogram: the Planck constant h, fixed at $6.62607015 \times 10^{-34}$ in J s (= kg m^2 s^{-1}).

- metre: speed of light c, in m s^{-1} (1)
- kilogram: Planck constant h, in J s or kg m^2 s^{-1} (1)

8. Name the SI base units of (a) amount of substance and (b) luminous intensity, with their symbols. [2] Why must the elementary entities be stated whenever the mole is used?

(a) mole, mol; (b) candela, cd. One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities, and these may be atoms, molecules, ions, electrons or other particles; a mole of hydrogen atoms is not the same amount of matter as a mole of hydrogen molecules, so the entity must be named.

- mole (mol) and candela (cd) (1)
- the entities may be atoms, molecules, ions etc., so the count is meaningless unless they are specified (1)

9. A surveyor measures a distance to the nearest metre and writes it as 7200 m. (a) Why is this way of [3] writing it ambiguous? (b) Write it in scientific notation so that its precision is clear. (c) Write it in kilometres, keeping the same precision.

(a) In a number without a decimal point the trailing zeros are not significant, so 7200 m reads as two significant figures, though the surveyor's reading has four. (b) 7.200×10^3 m: zeros in the base number are significant, so four figures are shown. (c) 7.200 km; a change of units does not change the number of significant figures.

- trailing zeros without a decimal point read as not significant (1)
- 7.200×10^3 m (1)
- 7.200 km (1)

10. Young's modulus of steel is 2.0×10^{11} N m^{-2}; it has the dimensions of stress. Asked to express it in [3] dyne cm^{-2} using $n_2 = n_1[M_1/M_2]^a[L_1/L_2]^b[T_1/T_2]^c$, Arjun writes 2.0×10^{12} dyne cm^{-2} and Kabir writes 2.0×10^{16} dyne cm^{-2}. (a) Write the values of a, b and c. (b) Decide which answer is right, showing the working. (c) Identify the error that gives the other answer.

(a) Stress, and so the modulus, has dimensions $[M\ L^{-1}\ T^{-2}]$: a = 1, b = −1, c = −2. (b) M_1/M_2 = 1 kg/1 g = 1000; L_1/L_2 = 1 m/1 cm = 100; T_1/T_2 = 1. $n_2 = 2.0 \times 10^{11} \times 1000 \times (100)^{-1} = 2.0 \times 10^{12}$ dyne cm^{-2}: Arjun is right. (c) $2.0 \times 10^{11} \times 1000 \times 100 = 2.0 \times 10^{16}$: Kabir took b = +1, the power of L in force, and forgot the area in the denominator, which makes the power of L −1.

- a = 1, b = −1, c = −2 (1)
- $2.0 \times 10^{11} \times 1000 \times (100)^{-1} = 2.0 \times 10^{12}$ dyne cm^{-2}; Arjun right (1)
- Kabir used b = +1 (ignored the m^{-2} of area) (1)

11. Find the dimensional formula of (a) impulse (force × time), (b) torque (force × perpendicular [3] distance) and (c) pressure (force/area). For each, name one other quantity with the same dimensions.

(a) $[M\ L\ T^{-2}][T] = [M\ L\ T^{-1}]$, the same as linear momentum. (b) $[M\ L\ T^{-2}][L] = [M\ L^2\ T^{-2}]$, the same as work or energy. (c) $[M\ L\ T^{-2}]/[L^2] = [M\ L^{-1}\ T^{-2}]$, the same as stress or modulus of elasticity.

- impulse $[M\ L\ T^{-1}]$, momentum (1)
- torque $[M\ L^2\ T^{-2}]$, work or energy (1)
- pressure $[M\ L^{-1}\ T^{-2}]$, stress or modulus (1)