Units and Measurement

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The dimensional formula of work is:

(a) $[M^{-1}L^{3}T^{-2}]$ **(b)** $[MLT^{-1}]$

(c) $[M^{0}L^{0}T^{0}]$ (dimensionless) **(d)** $[ML^{2}T^{-2}]$

2. The number of significant figures in 0.83090 is:

(a) 4 **(b)** 6 **(c)** 5 **(d)** 7

3. 20 m/s in km/h is:

(a) 72 km/h **(b)** 200 km/h **(c)** 10 km/h **(d)** 90 km/h

4. $Z = A^2B^2 \div C^2$. The percentage errors in A, B and C are 1%, 3% and 1%. The maximum percentage error in Z is:

(a) 10% **(b)** 20% **(c)** 5% **(d)** 6%

5. The number of base quantities in the SI system is:

(a) 7 **(b)** 9 **(c)** 5 **(d)** 3

6. Which of these equations is dimensionally correct?

(a) v = u + at **(b)** F = mv/r **(c)** $v = \sqrt{(F/m)}$ **(d)** $T = 2\pi\sqrt{(g/l)}$

7. 120 cJ (centijoules) in J is:

(a) 1.2×10^{0} J **(b)** 1.2×10^{1} J **(c)** 1.2×10^{4} J **(d)** 1.2×10^{-3} J

8. Assertion (A): The dimensional formula of angular momentum is $[ML^{2}T^{-1}]$.
Reason (R): The dimensions of a derived quantity come from its defining formula in terms of base quantities.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. Convert (a) 180 km/h into m/s, (b) a density of 6.2 g/cm^3 into kg/m^3.

10. State the number of significant figures in 18.1, 37317, 9648.

11. Five readings of the period of a pendulum are 6.4 s, 6.41 s, 6.41 s, 6.37 s, 6.37 s. Find the mean value, the mean absolute error and the percentage error. (Give answers to 2 decimal places where needed.)

12. A physical quantity is $P = ab^3 \div c^2$. The percentage errors in a, b and c are 4%, 3% and 2%. Find the percentage error in P.

13. Two lengths are (23.3 ± 0.4) cm and (33.8 ± 0.5) cm. Find their sum and difference, with errors.

14. Find the dimensional formula of a in $x = at^2$ (x distance).

15. Check whether the equation $v = \sqrt{(F/m)}$ is dimensionally correct.

16. Convert 73 N into dynes, and 73 J into ergs.

Section C — Word problems — 4 × 4 = 16 marks

17. Use the method of dimensions to find how the period T of a simple pendulum depends on its length l and on g.

18. In a pendulum experiment, l = (87 ± 0.3) cm and T = (2.17 ± 0.01) s. Since $g = 4\pi^2 l/T^2$, find the percentage errors in l and T and the maximum percentage error in g. (2 decimal places.)

19. In a new system of units, the unit of mass is 5 kg, the unit of length is 10 m and the unit of time is 2 s. How many new units of energy make 1 J? ([E] = $[ML^2T^{-2}]$)

20. Six measurements of a length are 32.8, 33.6, 33.8, 32.5, 33.1, 33.8 cm. Find (a) the mean length, (b) the absolute error in each reading, (c) the mean absolute error, (d) the relative error and percentage error. Write the result as length ± error. (2 decimal places.)

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Answer key

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Q	Answer	Working
1	**(d) $[ML^2T^{-2}]$**	—
2	**(c) 5**	leading zeros do not count; zeros between or after digits (after a decimal point) do
3	**(a) 72 km/h**	× 18/5
4	**(a) 10%**	multiply each % error by its power and add
5	**(a) 7**	length, mass, time, electric current, temperature, amount of substance, luminous intensity
6	**(a) v = u + at**	every term is $[LT^{-1}]$
7	**(a) 1.2×10^0 J**	$c = 10^{-2}$
8	**(a) Both A and R are true, and R is the correct explanation of A.**	A is true: angular momentum: $[ML^2T^{-1}]$. R is true and explains A.
9	**(a) 50 m/s; (b) 6,200 kg/m^3**	1 km/h = 5/18 m/s; 1 g/cm^3 = 1000 kg/m^3
10	**18.1: 3; 37317: 5; 9648: 4**	—
11	**Mean 6.392 s; mean absolute error 0.0176 s; percentage error 0.28%**	mean absolute error = average of |reading − mean|
12	**17%**	1 × 4 + 3 × 3 + 2 × 2
13	**Sum (57.1 ± 0.9) cm; difference (10.5 ± 0.9) cm**	absolute errors add for both sum and difference
14	**$[LT^{-2}]$**	rearrange to make a the subject, then put in dimensions
15	**Not correct: √(F/m) has dimensions $[L^{½}T^{-1}]$.**	—
16	**7.3×10^6 dyne; 7.3×10^8 erg**	1 N = 10^5 dyne; 1 J = 10^7 erg
17	**T = k√(l/g), where k is a dimensionless constant (it cannot be found by dimensions)**	write the quantity as a product of powers and equate the powers of M, L and T
18	**%l = 0.34%; %T = 0.46%; %g = 0.34 + 2 × 0.46 = 1.27%**	% error in g = % error in l + 2 × % error in T
19	**1/125 new units (= 0.008)**	$n_2 = n_1 (M_1/M_2)(L_1/L_2)^2(T_1/T_2)^{-2} = 1 \times (1/5)(1/10)^2(2)^2$
20	**(a) 33.27 cm; (b) 0.47, 0.33, 0.53, 0.77, 0.17, 0.53 cm; (c) 0.47 cm; (d) relative 0.014, percentage 1.40%; (33.27 ± 0.47) cm**	—

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