

How to use this worksheet. Thirty-one questions, about 35 minutes, with the answer key at the end. A **ratio of two like quantities** is always dimensionless. With exp, sin or log, fix the dimensions of the argument first. Percentage errors are always **added**.

Formula sheet

Force $[MLT^{-2}]$ | **Work** $[ML^2T^{-2}]$ | **Power** $[ML^2T^{-3}]$ | **Pressure** $[ML^{-1}T^{-2}]$

Momentum and impulse $[MLT^{-1}]$ | **Moment of inertia** $[ML^2]$ | **Surface tension** $[MT^{-2}]$

Dimensionless: refractive index, strain, angle, relative density, coefficient of friction

For $X = a^p b^q / c^r$: percentage error = $p\Delta a + q\Delta b + r\Delta c$, always added

Section A · Level 1 — Base units, dimensional formulas and consistency

Ten questions. None should take more than twenty seconds.

- The number of base quantities in the SI system is:
(1) 3 (2) 5 (3) 7 (4) 9
- The dimensional formula of force is:
(1) $[MLT^{-1}]$ (2) $[MLT^{-2}]$ (3) $[ML^2T^{-2}]$ (4) $[ML^{-1}T^{-2}]$
- The dimensional formula of work is:
(1) $[MLT^{-2}]$ (2) $[ML^2T^{-2}]$ (3) $[ML^2T^{-3}]$ (4) $[MLT^{-1}]$
- The dimensional formula of power is:
(1) $[ML^2T^{-2}]$ (2) $[ML^2T^{-3}]$ (3) $[MLT^{-3}]$ (4) $[ML^2T^{-1}]$
- The dimensional formula of pressure is:
(1) $[MLT^{-2}]$ (2) $[ML^{-1}T^{-2}]$ (3) $[ML^2T^{-2}]$ (4) $[MT^{-2}]$
- Which of the following is dimensionless?
(1) Force (2) Strain (3) Momentum (4) Density
- The dimensional formula of momentum is:
(1) $[MLT^{-1}]$ (2) $[MLT^{-2}]$ (3) $[ML^2T^{-1}]$ (4) $[MT^{-1}]$
- For an equation to be dimensionally correct:
(1) All terms must be numbers (2) Every term must have the same dimensions (3) It must contain no constants
(4) It must be linear
- The argument of an exponential, sine or logarithm must always be:
(1) A length (2) A time (3) Dimensionless (4) Negative
- A dimensionally correct equation is:
(1) Always physically correct (2) Not necessarily physically correct (3) Always wrong (4) Never useful

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Significant figures, derived dimensions and errors

Ten questions. Percentage errors are always added, never subtracted.

- The number of significant figures in 0.00340 is:
(1) 2 (2) 3 (3) 5 (4) 6
- The dimensional formula of moment of inertia is:
(1) $[ML]$ (2) $[ML^2]$ (3) $[ML^2T^{-2}]$ (4) $[MLT^{-2}]$

13. The dimensional formula of surface tension is:

- (1) $[MT^{-2}]$ (2) $[MLT^{-2}]$ (3) $[ML^{-1}T^{-2}]$ (4) $[ML^2T^{-2}]$

14. If $X = a^2b$ and the percentage errors in a and b are 2% and 3%, the percentage error in X is:

- (1) 5% (2) 7% (3) 8% (4) 12%

15. If $X = a / b$ and the percentage errors in a and b are 3% and 4%, the percentage error in X is:

- (1) 1% (2) 7% (3) 12% (4) 0.75%

16. The dimensional formula of frequency is:

- (1) $[T]$ (2) $[T^{-1}]$ (3) $[LT^{-1}]$ (4) $[MT^{-1}]$

17. Which pair has the same dimensions?

- (1) Work and power (2) Force and momentum (3) Work and torque (4) Pressure and force

18. The dimensional formula of gravitational constant G is:

- (1) $[M^{-1}L^3T^{-2}]$ (2) $[MLT^{-2}]$ (3) $[ML^3T^{-2}]$ (4) $[M^{-1}LT^{-2}]$

19. Light year is a unit of:

- (1) Time (2) Distance (3) Speed (4) Brightness

20. The least count of a measuring instrument is:

- (1) Its largest reading (2) The smallest quantity it can measure reliably (3) Its average error (4) Its total range

Working space — Questions 11 to 20 Write the formula before you substitute.

Section C · Level 3 — Types of error and the limits of the method

Seven questions. Ask what dimensional analysis can and cannot tell you.

21. Systematic errors can be reduced by:

- (1) Taking more readings (2) Improving the instrument and the technique (3) Averaging (4) Nothing at all

22. Random errors can be reduced by:

- (1) Calibrating the instrument (2) Taking many readings and averaging (3) Changing the observer (4) They cannot be reduced

23. Which of the following has the same dimensions as impulse?

- (1) Force (2) Momentum (3) Energy (4) Power

24. In the equation $v = u + at$, the term at must have the dimensions of:

- (1) Acceleration (2) Velocity (3) Distance (4) Time

25. The dimensional formula of the coefficient of friction is:

- (1) $[MLT^{-2}]$ (2) $[M^0L^0T^0]$ (3) $[MT^{-2}]$ (4) $[L]$

26. A quantity that has dimensions but no units would be:

- (1) Common (2) Impossible (3) Called a constant (4) Dimensionless

27. The dimensional method cannot determine:

- (1) Whether an equation is dimensionally consistent (2) A dimensionless constant such as $\frac{1}{2}$ or 2π (3) The dimensions of a derived quantity (4) The unit of a quantity

Working space — Questions 21 to 27

Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Four questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently checked.

28. Which of the following are dimensionless quantities? (i) Refractive index (ii) Moment of inertia (iii) Strain (iv) Surface tension **[PYQ 2023 · Morning]**

(1) (i) and (iii) (2) (ii) and (iv) (3) (ii) and (iii) (4) (i) and (ii)

29. The dimensions of thermal conductivity are: **[PYQ 2023 · Morning]**

(1) $[MLT^{-2}K]$ (2) $[MLT^{-3}K^{-1}]$ (3) $[MLT^{-3}K]$ (4) $[ML^2T^{-2}K^{-1}]$

30. In the equation $x(t) = A \exp(-Bt)$, where $x(t)$ and t represent displacement and time, the dimensions of A and B respectively must be: **[PYQ 2023 · Evening]**

(1) $[L^{-1}]$ and $[T^{-1}]$ (2) $[L]$ and $[T^{-1}]$ (3) $[L^{-1}]$ and $[T]$ (4) $[L]$ and $[T]$

31. The distance travelled by a car is given by $x(t) = A + Bt + Ct^2$. The dimensions of A , B and C respectively are:

[PYQ 2023 · Evening]

(1) $[L^{-1}]$, $[L^2T^{-1}]$ and $[L^{-1}T^{-2}]$ (2) $[L]$, $[L^{-1}T^{-1}]$ and $[L^{-1}T^{-2}]$ (3) $[L]$, $[LT^{-1}]$ and $[LT^{-2}]$ (4) $[L]$, $[L^2T^{-1}]$ and $[L^{-1}T^{-2}]$

Working space — Questions 28 to 31

Write the formula before you substitute.

Answer key

Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.

1. (3)	8. (2)	15. (2)	22. (2)	29. (2)
2. (2)	9. (3)	16. (2)	23. (2)	30. (2)
3. (2)	10. (2)	17. (3)	24. (2)	31. (3)
4. (2)	11. (2)	18. (1)	25. (2)	
5. (2)	12. (2)	19. (2)	26. (2)	
6. (2)	13. (1)	20. (2)	27. (2)	
7. (1)	14. (2)	21. (2)	28. (1)	

Stuck on any of these? Bring them to a live class.

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