Contents

Topical Cheat Sheets

Chapter 1: Measurements			
1.	**Addition**	$P = aX + bY$	$\Delta P = \lvert a\rvert \Delta X + \lvert b\rvert \Delta Y$
2.	**Subtraction**	$P = aX - bY$	$\Delta P = \lvert a\rvert \Delta X + \lvert b\rvert \Delta Y$
3.	**Product**	$P = aX \times Y$	$\frac{\Delta P}{P} = \frac{\Delta X}{X} + \frac{\Delta Y}{Y}$
4.	**Division**	$P = a\frac{X}{Y}$	$\frac{\Delta P}{P} = \frac{\Delta X}{X} + \frac{\Delta Y}{Y}$
5.	**Product with powers**	$P = aX^m \times Y^n$	$\frac{\Delta P}{P} = \lvert m\rvert\frac{\Delta X}{X} + \lvert n\rvert\frac{\Delta Y}{Y}$
6.	**Quotient with powers**	$P = a\frac{X^m}{Y^n}$	$\frac{\Delta P}{P} = \lvert m\rvert\frac{\Delta X}{X} + \lvert n\rvert\frac{\Delta Y}{Y}$
7.	**Numerical Substitution** *(for complicated functions)* e.g. logarithms, trignometic functions	$P = \frac{(P_{max} + P_{min})}{2} \pm \frac{(P_{max} - P_{min})}{2}$	
8.	**Change in Vectors**	$\overrightarrow{\Delta v} = \vec{v_f} - \vec{v_i} = \vec{v_f} + \left(-\vec{v_i}\right)$ * use head-to-tail method	

Chapter 2: Kinematics		
1.	**4 Equations of Motion**	$v = u + at$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$ $s = \frac{(u+v)t}{2}$

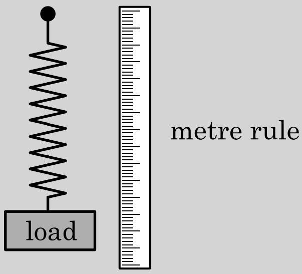
30. What is the difference between Errors and Uncertainties?

Errors can be both bi-directional and uni-directional whereas uncertainties can only be bi-directional. Errors can be added or subtracted, but uncertainties can only be added.

31. Consider four physical quantities A, B, C and D. They are related by A = BC + D. It is given that A = 1.30 and D = 1.28. By considering the significant figures available, explain why A–D can be unreliable.

A–D = 0.02 and the uncertainty of (A–D) can be 0.02. Hence, the percentage uncertainty is 100%. So, it is unreliable.

32. The spring constant of a spring may be determined by finding the extension of the spring and the load applied using the apparatus shown in the figure below. If the extension of the spring is of the order of a few millimeters, comment on the reliability of the measurements.



The uncertainty involved when using a metre rule is ±1 mm. Hence, a large percentage uncertainty will result and the measurements will be reliable only to a small extent.

Scalar and Vectors

33. Define scalar quantities.

Scalar quantities are physical quantities that have magnitude only.

Important Note(s)!

- It can be added algebraically.

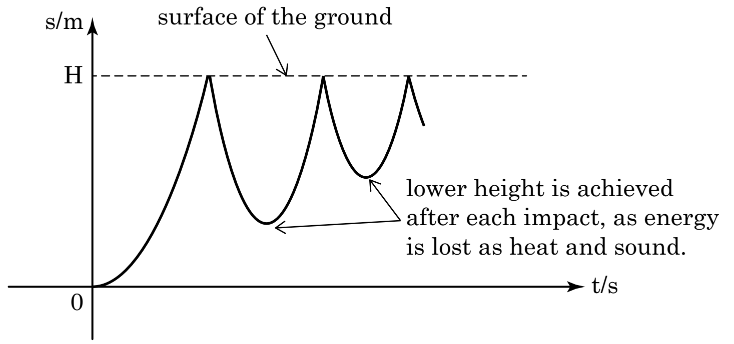
34. Define vector quantities.

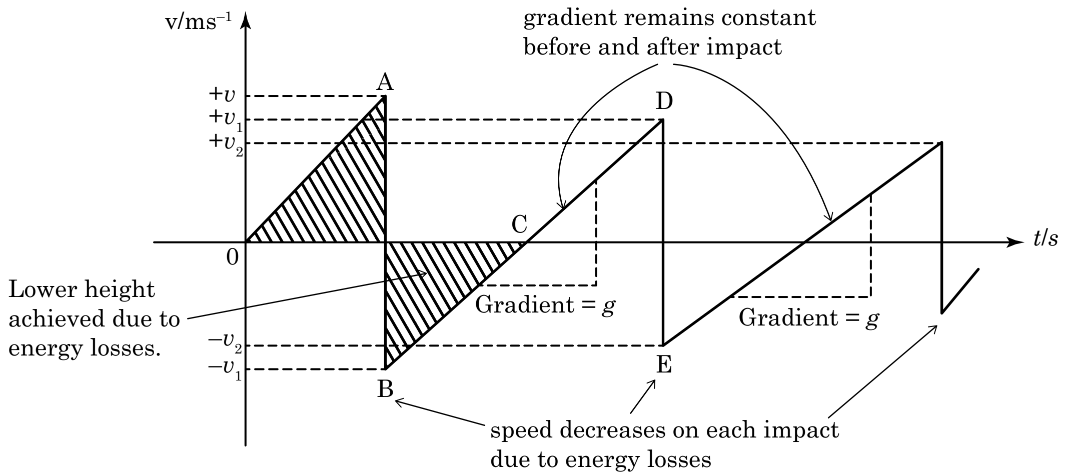
Vector quantities are physical quantities that have both magnitude and direction.

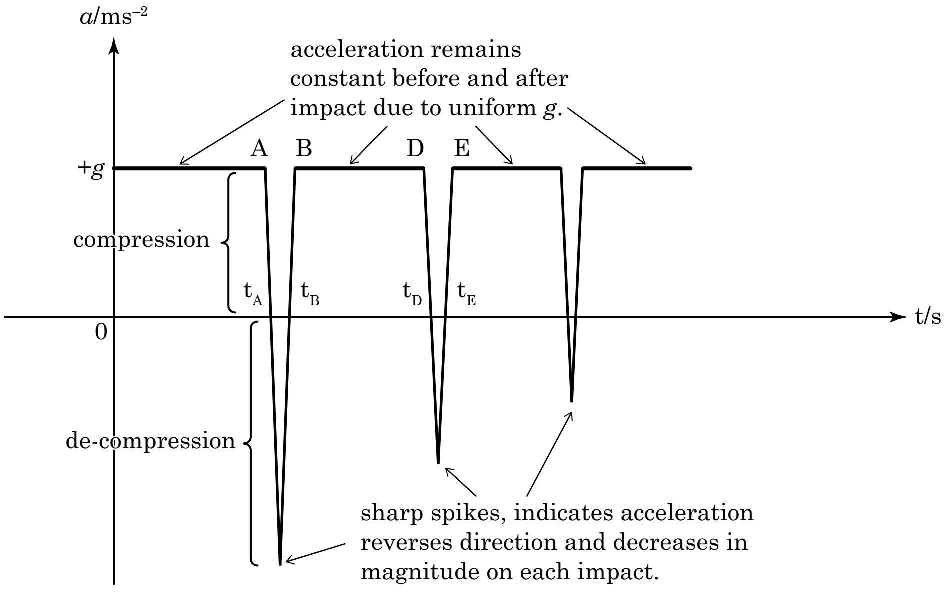
Important Note(s)!

- It cannot be added algebraically, but rather by vector addition.
- **Vectors can be added by:**
  1. Head to Tail method
  2. Parallelogram Law
  3. Vector Resolution

32. An elastic ball is dropped from a certain height above the ground. Assume no air resistance, but energy is lost as heat and sound. Taking *downwards to be positive*, sketch the *s-t*, *v-t* and *a-t* graphs.





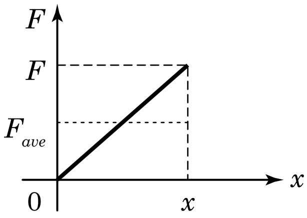


12. Derive the formula for elastic potential energy $EPE = \frac{1}{2}kx^2$.

Elastic potential energy, EPE, is the product of average force, F_{ave}, and extension, x. Since, $EPE = F_{ave}x$, by Hooke's law, where extension is directly proportional to applied force, $EPE = F_{ave}x = \frac{F}{2}x = \frac{kx}{2}x = \frac{1}{2}kx^2$.

Important Note(s)!

- From Hooke's Law,



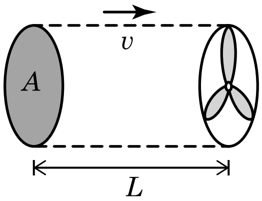
where $F_{ave} = \frac{0+F}{2} = \frac{F}{2}$

13. A wind generator has blades of length r. Air of density ρ and speed v is incident normally on the plane of the rotating blades.

(a) Show that the kinetic energy E of the wind incident normally per unit time on the plane of the rotating blades is given by

$$E = \frac{1}{2}\pi r^2 v^3 \rho$$

(b) Suggest one problem associated with high wind speeds on such a generator.



(a) Mass of air per unit time entering generator blades $= \frac{m}{t} = \frac{\rho v}{t} = \frac{\rho AL}{t} = \frac{\rho\pi r^2 L}{t} = \rho\pi r^2 v$, as $\frac{L}{t} = v$

As kinetic energy $= \frac{1}{2}mv^2$,

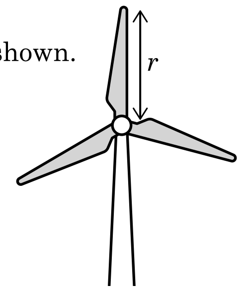
$$\therefore \frac{KE}{\text{time}} = \frac{1}{2}\left(\frac{m}{t}\right)v^2 = \frac{1}{2}\left(\rho\pi r^2 v\right)\left(v^2\right)$$

$$= \frac{1}{2}\pi r^2 \rho v^3 \quad \textbf{(shown)}$$

(b) High speeds cause immense stresses in the blades.

Important Note(s)!

- A wind generator is as shown.

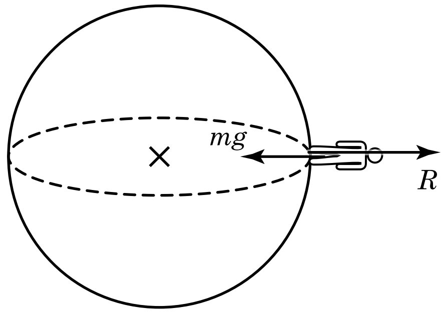


12. Explain why gravitational field strength, *g*, at the poles is greater than that at the equator.

- Part of the gravitational force at the equator is used to provide for the centripetal force for circular motion.

Important Note(s)!

- $mg - R = \frac{mv^2}{r}$, where R, is the registered weight on the scale (weighing scale reading).



- The poles are closer to the centre and thus have a stronger gravitational field strength.

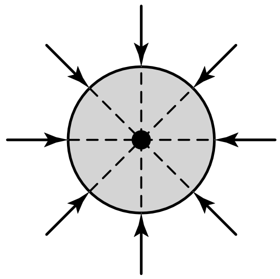
Important Note(s)!

- The earth is flattened at the poles and bulges at the equatorial region. So $g \propto \frac{1}{r^2}$.

13. Why the gravitational field lines due to the Earth can be considered to be equivalent to that of a point mass placed at the centre of the Earth?

The gravitational field lines are radial, perpendicular to the surface and directed radially inwards, towards the centre of the Earth, which is similar to the field pattern due to a small point or test mass.

Important Note(s)!



14. Why is the 'g' near the surface of the Earth approximately uniform?

Gravitational field lines are radially pointing inwards towards the centre of a mass. The field lines end perpendicular on the mass. Near the earth's surface, the field lines are approximately parallel to each other and approximately equally spaced apart. The gravitational field strength refers to the number of gravitational field lines passing through unit area. Hence, only near the earth's surface, the acceleration of free-fall (gravitational field strength)is approximately a constant.

Important Note(s)!

- $|g| = \frac{\text{Number of gravitational field lines}}{\text{Perpendicular Area}}$.