Physics – Midterm Exam
Formula Sheet

The Science of Physics

Table 3
Some Prefixes for Powers of 10 Used with Metric Units

Power	Prefix	Abbreviation	Power	Prefix	Abbreviation
10^{-18}	atto-	a	10^{-1}	deci-	d
10^{-15}	femto-	f	10^{1}	deka-	da
10^{-12}	pico-	p	10^{3}	kilo-	k
10^{-9}	nano-	n	10^{6}	mega-	M
10^{-6}	micro-	µ (Greek letter *mu*)	10^{9}	giga-	G
			10^{12}	tera-	T
10^{-3}	milli-	m	10^{15}	peta-	P
10^{-2}	centi-	c	10^{18}	exa-	E

Table 4 Rules for Determining Whether Zeros Are Significant Figures

Rule	Examples
1. Zeros between other nonzero digits are significant.	**a.** 50.3 m has three significant figures. **b.** 3.0025 s has five significant figures.
2. Zeros in front of nonzero digits are not significant.	**a.** 0.892 kg has three significant figures. **b.** 0.0008 ms has one significant figure.
3. Zeros that are at the end of a number and also to the right of the decimal are significant.	**a.** 57.00 g has four significant figures. **b.** 2.000 000 kg has seven significant figures.
4. Zeros at the end of a number but to the left of a decimal are significant if they have been measured or are the first estimated digit; otherwise, they are *not* significant. In this book, they will be treated as *not* significant. (Some books place a bar over a zero at the end of a number to indicate that it is significant. This textbook will use scientific notation for these cases instead.)	**a.** 1000 m may contain from one to four significant figures, depending on the precision of the measurement, but in this book it will be assumed that measurements like this have one significant figure. **b.** 20 m may contain one or two significant figures, but in this book it will be assumed to have one significant figure.

Table 5 Rules for Calculating with Significant Figures

Type of calculation	Rule	Example
addition or subtraction	Given that addition and subtraction take place in columns, round the final answer to the *first column from the left containing an estimated digit.*	97.3 + 5.85 $103.15 \xrightarrow{\text{round off}} 103.2$
multiplication or division	The final answer has the same number of significant figures as the measurement having the *smallest* number of *significant figures.*	123 × 5.35 $658.05 \xrightarrow{\text{round off}} 658$

Table 6 Rules for Rounding in Calculations

What to do	When to do it	Examples
round down	• whenever the digit following the last significant figure is a 0, 1, 2, 3, or 4	30.24 becomes 30.2
	• if the last significant figure is an even number and the next digit is a 5, with no other nonzero digits	32.25 becomes 32.2 32.65000 becomes 32.6
round up	• whenever the digit following the last significant figure is a 6, 7, 8, or 9	22.49 becomes 22.5
	• if the digit following the last significant figure is a 5 followed by a nonzero digit	54.7511 becomes 54.8
	• if the last significant figure is an odd number and the next digit is a 5, with no other nonzero digits	54.75 becomes 54.8 79.3500 becomes 79.4

Rectilinear Kinematics

DISPLACEMENT

$$\Delta x = x_f - x_i$$

displacement = change in position = final position − initial position

AVERAGE VELOCITY

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

$$\text{average velocity} = \frac{\text{change in position}}{\text{change in time}} = \frac{\text{displacement}}{\text{time interval}}$$

AVERAGE ACCELERATION

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

$$\text{average acceleration} = \frac{\text{change in velocity}}{\text{time required for change}}$$

DISPLACEMENT WITH CONSTANT ACCELERATION

$$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$$

$$\text{displacement} = \frac{1}{2}(\text{initial velocity} + \text{final velocity})(\text{time interval})$$

VELOCITY WITH CONSTANT ACCELERATION

$$v_f = v_i + a\Delta t$$

final velocity = initial velocity + (acceleration × time interval)

DISPLACEMENT WITH CONSTANT ACCELERATION

$$\Delta x = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

displacement = (initial velocity × time interval) + $\frac{1}{2}$ acceleration × (time interval)^2

FINAL VELOCITY AFTER ANY DISPLACEMENT

$$v_f^2 = v_i^2 + 2a\Delta x$$

(final velocity)^2 = (initial velocity)^2 + 2(acceleration)(displacement)

Vectors

PYTHAGOREAN THEOREM FOR RIGHT TRIANGLES

$$c^2 = a^2 + b^2$$

(length of hypotenuse)^2 = (length of one leg)^2 + (length of other leg)^2

DEFINITION OF THE TANGENT FUNCTION FOR RIGHT TRIANGLES

$$\tan \theta = \frac{\text{opp}}{\text{adj}} \qquad \text{tangent of angle} = \frac{\text{opposite leg}}{\text{adjacent leg}}$$

DEFINITION OF THE SINE FUNCTION FOR RIGHT TRIANGLES

$$\sin \theta = \frac{\text{opp}}{\text{hyp}} \qquad \text{sine of an angle} = \frac{\text{opposite leg}}{\text{hypotenuse}}$$

DEFINITION OF THE COSINE FUNCTION FOR RIGHT TRIANGLES

$$\cos \theta = \frac{\text{adj}}{\text{hyp}} \qquad \text{cosine of an angle} = \frac{\text{adjacent leg}}{\text{hypotenuse}}$$

The inverse of the tangent function, which is shown below, gives the angle.

$$\theta = \tan^{-1}\left(\frac{\text{opp}}{\text{adj}}\right)$$

Projectile Motion

VERTICAL MOTION OF A PROJECTILE THAT FALLS FROM REST

$$v_{y,f} = a_y \Delta t$$

$$v_{y,f}^2 = 2a_y \Delta y$$

$$\Delta y = \frac{1}{2} a_y (\Delta t)^2$$

HORIZONTAL MOTION OF A PROJECTILE

$$v_x = v_{x,i} = \text{constant}$$

$$\Delta x = v_x \Delta t$$

PROJECTILES LAUNCHED AT AN ANGLE

$$v_x = v_{x,i} = v_i \cos\theta = \text{constant}$$
$$\Delta x = (v_i \cos\theta)\Delta t$$
$$v_{y,f} = v_i \sin\theta + a_y \Delta t$$
$$v_{y,f}^2 = v_i^2 (\sin\theta)^2 + 2a_y \Delta y$$
$$\Delta y = (v_i \sin\theta)\Delta t + \tfrac{1}{2}a_y(\Delta t)^2$$

Range

$$d = \frac{v_i^2(sin\ 2\theta)}{9.8}$$

Maximum Height

$$h = \frac{[v_i(\sin\theta)]^2}{19.6}$$

Time of Flight

$$t = \frac{2\ v_i(sin\ \theta)}{9.8}$$