REVIEW SHEET: Methods and Tools of Physics

1. Read chapter 1.
2. *Terms to know*: order of magnitude estimate, significant figures, fundamental units, derived units, factor-label method, uncertainty estimate, range, parallax, accuracy, precision, random uncertainty, systematic error, literature value, independent variable, dependent variable, control variables, general equation, experimental equation, mathematical model, graph straightening (linearizing)

3. Be able to make order of magnitude estimations.
   a) How big is a proton? 10^{-15} m
   b) How big is an atom? 10^{-10} m

4. State the seven fundamental units in the SI system.
   length, temperature, time, mass, electric current, amount, luminous intensity

5. Know how to report the answers to calculations with the correct number of sig. figures.
   a. What is the addition/subtraction rule?
      perform the operation and then round your answer to the same decimal place as the value w/ the smallest decimal places
   b. What is the multiplication/division rule?
      perform the operation and round your answer to match with the value having the lowest number of sig figs.
   c. Report the answers to the correct number of significant digits:
      i) (3.24 kg) / (5.8 m^3) ii) 29.783 cm – 14.1 cm
      0.56 kg/m^3 15.7 cm

6. Identify some reasons why any measurement is uncertain.
   human error, mistake reading the instrument, not using standardized measurements.

7. If multiple trials of a measurement are taken, how should the experimental value and its uncertainty be reported?
   take the average of the three measurements to find the experimental value and take ½ of the range to find the uncertainty.

8. What is the difference between accuracy and precision? Give an example.
   Accuracy means you are close to the accepted value while precision means that the values aren't necessary close to the accepted value but rather close to a set of data collected in the same way. For example, throwing a dart and hitting the target really close, you are precise and accurate.

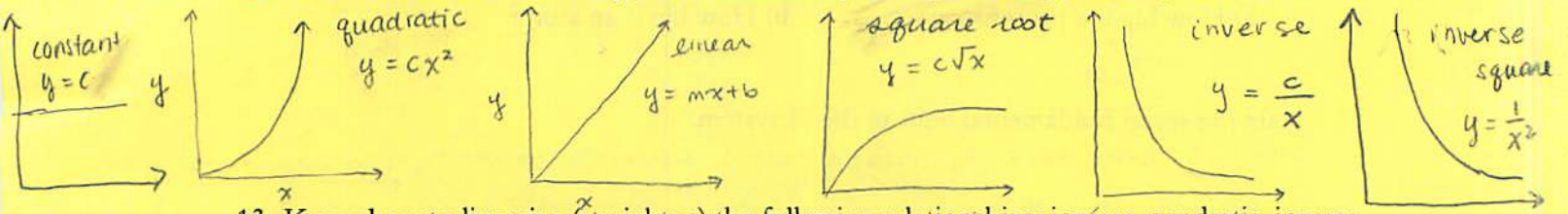
9. a. What is the difference between random uncertainty and a systematic error?
      systematic error - predicted uncertainty caused by a particular instrument or experimental technique
      random uncertainty - uncertainty produced by unknown variations in the experimental situation.
   b. Which can be fixed? Which can only be reduced but never eliminated?
      systematic can be fixed; random can be reduced but not eliminated.
   c. Which affects the accuracy of the results?
      systematic uncertainty, an accurate experiment has low systematic error.
   d. Which affects the precision of the results?
      random uncertainty
   e. Suggest a way to reduce random uncertainties.
      repeated trials

Name:_____ Per:____

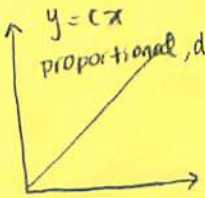
10. How can you determine if a literature value agrees with experimental results or not?
if the value falls under the range of uncertainty.

11. a) Be able to graph data properly and draw a best-fit line or curve.
1.b) Be able to calculate the slope of a line. What is the formula for the slope of a line?
$\frac{y_1 - y_2}{x_1 - x_2}$ = slope
2.c) Be able to write the general and experimental equation of the line or curve.

12. Sketch the most common types of relationships and give their general equations.



13. Know how to linearize (straighten) the following relationships: inverse, quadratic, inverse quadratic, and square root. What transformed variables must be plotted in each case to straighten the graph? change the horizontal axis:

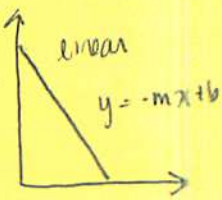


inverse : $x \rightarrow x^{-1}$

quadratic $x \rightarrow x^2$

inverse quadratic : $x \rightarrow \frac{1}{x^2}$

square root : $x \rightarrow \sqrt{x}$



14. Five students were given a stopwatch and asked to time Asher walking across the classroom. Their data are given in the chart.

15. What value should be reported as the time it took to cross the room? the average
$\frac{6.5s + 8.2s + 5.8s + 6.3s + 7.0s}{5} = 6.8s$

16. What is the range of this data?
$8.2s - 5.8s = 2.4s$

17. How should the time be reported with its uncertainty?
$6.8s \pm \frac{1}{2}(2.4)s \rightarrow 6.8s \pm 1.2s$

Student #	Time (s)
1	6.5
2	8.2
3	5.8
4	6.3
5	7.0

18. Jack Indabocks and his lab group reported an experimental value for the density of a metal block as 23 g/cm^3 ± 4 g/cm^3. They looked up the literature value and found it was listed as 29 g/cm^3. Do their results agree with the literature value? Why or why not?
No because 29g/cm^3 is above the uncertainty.

19. How many significant digits are in the following numbers:
a. 54.020 5 b. 0.00490 3 c. 3070 3 d. 3070. 3

20. Convert: a. 38 g = .038 kg b. 4.7 km = 4.7×10^{-15} pm

See other sheet for my work

c. 0.055 m = 5.5×10^4 µm d. 65 mph = 29 m/s

d. 27 m/s = 97 km/hr e. 14 cm^3 = 1.4×10^{-5} m^3

Answers: 5. c) i) 0.56 kg/m^3 ii) 15.7 cm 14. a) 6.8 s b)2.4 s c) 6.8 s ± 1.2 s (mean ±1/2 range)
16. a) 5 b) 3 c) 3 d) 4 17. a) 0.038 kg b) 4.7×10^{15} pm c) 5.5×10^4 µm d) 29 m/s e) 97 km/hr f) 1.4×10^{-5} m^3

20. a) $38\,g\left(\frac{10^{-3}\,kg}{1\,g}\right) = \boxed{0.038\,kg}$

b) $4.7\,km\left(\frac{10^{-15}\,pm}{1\,km}\right) = \boxed{4.7\times10^{-15}\,pm}$

c) $0.055\,m\left(\frac{10^{6}\,\mu m}{1\,m}\right) = \boxed{5.5\times10^{4}\,\mu m}$

d) $\frac{65\,mile}{hr}\left(\frac{1\,hr}{3600\,s}\right)\left(\frac{1609.3\,m}{1\,mile}\right) = \boxed{29\,m/s}$

e) $\frac{27\,m}{s}\left(\frac{10^{-3}\,km}{1\,m}\right)\left(\frac{1\,s}{2.78\times10^{-4}\,hr}\right) = 97.2 \rightarrow \boxed{97\,km/hr}$

f) $14\,cm^3\left(\frac{10^{-2}\,m}{1\,cm}\right)\left(\frac{10^{-2}\,m}{1\,cm}\right)\left(\frac{10^{-2}\,m}{1\,cm}\right) = \boxed{1.4\times10^{-5}\,m^3}$