

# Homework 5

SABIC: Physics

Due April 14, 2016

## Reading:

Review chapters 1 and 4.

## Problem 1: practice with errors

- (a) A race car travels around a circular track of radius  $130 \pm 3\text{m}$ . A radar gun measures its velocity at  $98 \pm 5\text{m/s}$ . (i) How long does it take for the car to travel around the track? (ii) What is the acceleration of the car? Give answers including standard error.
- (b) A group of 10 physics students climb to the top of a 20m tower and drop stones. Using a stopwatch, each student times how long it takes for their stones to fall. The results are shown in the table below:

Stone Drop	
Student	Measured time (s)
Ali	2.508
Ben	2.619
Carlina	2.590
Dan	2.425
Emily	2.426
Francis	2.367
Gia	2.463
Hassan	2.426
Injit	2.627
Julia	2.388

- (i) What is the average time? What is the standard deviation from the average? (ii) The students use these numbers to calculate the strength of gravity. What do they get (include error). Is there systematic error? What might have caused it?

## Problem 2: Unit vectors

- (a) As was done in class for the unit vector  $\hat{r}$ , show that for a particle moving counterclockwise about a point with position  $r(t)$ , the change  $\delta\hat{\theta}$  over a short time  $\delta t$  is given by

$$\Delta\hat{\theta} = \Delta\theta\hat{r}.$$

## Problem 3: Kepler's laws

- (a) Haley's comet orbits the sun with a period of 75 years. (i) What is the semi-major axis of the orbit? (ii) The eccentricity  $\epsilon = f/a$  of Haley's orbit is 0.967, where  $f = \sqrt{a^2 - b^2}$  is the distance from the center of the orbit to the focus. What is the average speed of the orbit? (iii) At what distance is the comet from the sun when its instantaneous speed matches the average speed? (iv) The comet moves fastest when it's closest to the sun. Using Kepler's second law

$$r^2 \frac{d\theta}{dt} = r \frac{dv_{\perp}}{dt} = \text{constant}, \tag{1}$$

what speed is the comet moving at that time?