NTSC 395
FIRST HOUR EXAM
SOLUTIONS

1. $\text{Density} = \frac{\text{mass}}{\text{volume}}$

This question had the highest correct response rate on the exam (although the class percentage was not quite 100 %).

2. Most everyone remembered the activity we did the first night of the class. The idea is that if you want to determine the density of an object, you need to measure its mass and its volume, then divide the two results to derive the density. The first step most of you indicated was to take successive readings of the mass of your object (or class of objects) to produce a statistically significant measure of mass. Then, to determine the volume, you measure the amount of water displaced by the object. This requires you to record the height of water in a graduated cylinder before placing the object into the water, and then measure the height of the water in the graduated cylinder after it has been displaced by the object. The volume of the object is the volume of water displaced, which will be the difference in the pre and post immersion levels of the water in the graduated cylinder. Full credit required you to state how you would find the volume; merely stating "find the volume" is too vague.

3. The executive summary of RAGS contains four major areas of recommendations. They are :

• 10, 000 teachers for 10, 000, 000 million minds : improving the quality of teaching in K - 12 science and math

• Increasing research in the US

• Attracting the best and brightest to science and math in higher ed

• Incentives for Innovations

RAGS goes into detail into each of these four. I looked through your answers to see how many of these four major recommendations you referred to (it was not necessary to use the language above, any indication of improving quality of K - 12 teaching, for instance satisfied the first bullet point) and gave you 5 pts for each reference to one of these four major recommendations. Therefore, you received full credit if you could cite 3 of the 4 major recommendations of RAGS.

4. The question tells you an object slides 4 m in 2 s. You know two equations to find the average speed :

$$\text{average speed} = \frac{\text{final speed} + \text{initial speed}}{2}$$

and

$$\text{average speed} = \frac{\text{dist}}{\text{time}}$$

While you know the initial speed is zero (object starts from rest), you do not know the final speed (yet) so cannot use the first forumlation above. You do know both distance and speed, and can find :

avg speed = 4 meters / 2 sec = 2 m / s

Once you know the average speed, you can use the first equation above to find the final speed :

$$\text{avg speed} = \frac{\text{final speed} + \text{initial speed}}{2}$$

Since the initial speed is zero, this equation becomes :

avg speed = final speed / 2 or final speed = 2 * average speed

final speed = 2 * 2 m / s = 4 m / s

You have two ways of finding the acceleration. You could use the definition of acceleration :

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time}} = \frac{\text{final speed} - \text{initial speed}}{\text{time}} = \frac{4\text{ m/s} - 0\text{ m/s}}{2\text{ s}} = 2\text{ m}/\text{s}^2$$

You could also use the distance equation to find acceleration :

$\text{dist} = 1/2\, a\, t^2$

Since you know that the object traveled 4 m in 2 s while it was accelerating, you can solve for a :

$4\text{ m} = 1/2\, a\, (2\text{ s})^2$

$a = 8\text{ m}/4\text{ s}^2 = 2\text{ m}/\text{s}^2$

As you expect, the two methods produce the same value for acceleration.

5. The question asks to design an activity that will determine whether an object has uniform acceleration down a ramp, or if the value of the acceleration varies on its way down the ramp. The way to do this is to set the ramp at one angle, and measure the time it takes for an object to slide to the bottom. Use this data to determine average acceleration using the equations developed above (shown in question 4). Now, with the ramp at the same angle, start the object from a different distance, and measure the time to the bottom; use these data to determine acceleration. Rinse, lather, repeat. If the accelerations determined for each starting point are the same (within error of measurement), then you can conclude the acceleration is the same at all points down the ramp.

The most common incorrect answer was to vary the angle of the ramp; this will definitely give us different values of acceleration since the component of gravity acting down the plane will increase as the angle of the ramp increases. Therefore changing the angle of the ramp will not help us investigate the problem as pose.

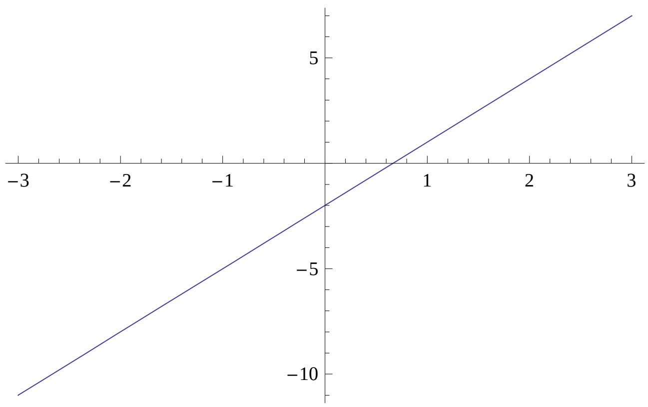
6. a) Plot y = 3 x - 2 :

Making the data table :

If $x = 0$, $y = 3(0) - 2 = -2$
If $x = 1$, $y = 3(1) - 2 = 1$
If $x = 2$, $y = 3(2) - 2 = 4$
If $x = -1$, $y = 3(-1) - 2 = -5$

And the graph looks like :

Out[63]=



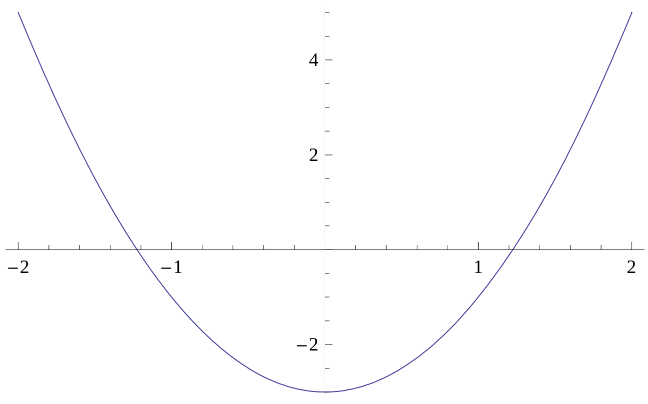
b) Plot $2x^2 - 3$:

If x=0, $y = 2(0)^2 - 3 = -3$
If x=1, $y = 2(1)^2 - 3 = -1$
If x=2, $y = 2(2)^2 - 3 = 5$
If x=-1, $y = 2(-1)^2 - 3 = -1$
If x=-2, $y = 2(-2)^2 - 3 = +5$

In computing these values, many students forgot that squaring a negative number produces a positive number. And the graph looks like:

In[64]:=
```
Plot[2 x^2 - 3, {x, -2, 2}]
```

Out[64]=



Statistics :

All 24 members of the class took the test. The scores were distributed according to:

- 11 scores between 90-100
- 3 scores between 80-89
- 3 scores between 70-79
- 4 scores between 60-69
- 3 scores below 60

Class average = 81
Class median = 89
Standard deviation = 20
Range=68