

name:  
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school:  
grade:

ball (in terms of given variables and gravitational acceleration,  $g$ ).

1. what is the length scale of the smallest object you can see with a microscope (roughly)? why?

8. the electric force between two charges  $q_1$  and  $q_2$ , separated by a distance  $r$  is

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

using dimensional analysis, find units for  $\epsilon_0$ .

2. rank the following, in size order:

- the width of a dna polymer
- an e. coli bacterium
- the wavelength of visible light
- the golgi apparatus

3. it's a really hot day and you don't own an air conditioner. (poor you.) you decide to open your refrigerator to cool the room. what happens to the temperature of the room and why?

9. give an example of a function whose derivative is 3 times the original function.

10. give any solution to the following differential equation

$$\frac{d^2 x}{dt^2} = -\omega^2 x$$

4. imagine that you're an astronaut on the moon, a place with (basically) no atmosphere. you're thirsty from your long trip there and decide to have a drink using a straw. will you find yourself refreshed or frustrated? why?

11. evaluate

$$\int_0^1 \frac{x^3}{2} dx$$

5. define temperature (more precisely than "how hot or cold something is").

12. a roulette wheel has 38 equally possible outcomes. if you bet \$1 and lose, you're out \$1; if you win, you're up \$35. how much money to expect to make (or lose) after playing many times?

6. the second law of thermodynamics states that the total entropy of an isolated macroscopic system

- a always decreases
- b never decreases
- c always increases

13. what are you interested (or not interested) in learning in this class?

7. a ball of mass  $m$  is dropped 1 km above the earth and is subject to gravitational forces and a drag force. if the drag force is of the form  $F_{drag} = -bv$ , where  $v$  is the ball's velocity, give an algebraic expression that estimates the terminal velocity of the