# Newton's Nightmare 2016

**Objective:** To work with a team of three students to solve a series of space-related problems.

## **Competition:**

1.) Several space-related questions and problems will be given to a team of up to three students which they must answer in a period of approximately 15 minutes.

2.) A high school may enter a team in each division, Grades 8-9, Physics I and Physics II. All students in AP Physics or enrolled in their second physics course must compete in Physics II.

3.) Only correct answers will score points. No partial credit will be given except in case of a tie.

4.) The level of the questions will vary for Elem/Middle and High School divisions.

Grades 5-7 Grade 5 will be scored in a category different from grades 6-7.

\*Grades 8-9 (Matter and Energy)

Grades 9-12 Physics I or IB Primary Level (1st year of high school physics) Grades 9-12 Physics II: AP Physics C or IB Secondary Level (2nd year of high school physics) \*Note: Ninth graders compete with Grades 9-12 if they are enrolled in a Physics Course, and compete with Grades 8-9 if enrolled in Matter and Energy or any other science course.

5.) Students should bring NON-PROGRAMMABLE AND NON-GRAPHING calculators and any formulas they wish. (No printed materials will be allowed.)6) The questions and problems will be from the following topics:

- gravity, falling bodies
- Kepler's Laws
- satellites and orbiting bodies
- the solar system
- the Universal Law of Gravity
- Newton's Laws

Judging: The judges will score the teams' responses and total the points earned by the team.

## Sample questions: Elem/Middle grades 5-7 If a ball is dropped from a tall building, what is it's velocity after 4 seconds? Use 10 m/s/s for acceleration of gravity.

A planet is orbiting the a sun the fastest when it is:

a) nearest the sunb) farthest from the sunc) between its nearest and farthest locations

grades 8-9

What is the average orbital velocity of a satellite orbiting the Earth at an average distance of 8000 km from the center of the Earth? Earth mass =  $6.4 \times 10^{24} \text{ kg}$ 

What would be the speed of an 80 kg free-floating astronaut after throwing a 10 kg container at 3 m/s, if he was originally at rest?

What is her acceleration and force if the throw lasts 0.5 seconds?

What is the weight of a 60 kg rock on a planet that has a radius of 4000 km and a mass of  $2 \ge 10^{22}$  kg?

## **High School Physics I**

1) The Earth orbits the Sun at a distance R. Object X orbits the Sun at a distance 4R. How long, in terms of

Earth years, does it take for object X to complete one orbit?

a. 0.5 yearb. 1 yearc. 2 yearsd. 4 yearse. 8 years

2) Two masses,  $M_1$  and  $M_2$ , are separated by a distance D. There is a force of gravitational attraction between them of magnitude  $F_G$ . If  $M_1$  is doubled,  $M_2$  is halved, and D is halved; how does the new gravitational force compare to the original force  $F_G$ ?

 $\begin{array}{l} a. \ 0.25 \ F_{G} \\ b. \ 0.5 \ F_{G} \\ c. \ FG \\ d. \ 2 \ F_{G} \\ e. \ 4 \ F_{G} \end{array}$ 

#### **High School Physics II**

1) Two planets are made from the same material but have different radii  $r_1$  and  $r_2$ . The ratio of the free-fall accelerations,  $g_1$  and  $g_2$ , caused by gravity near each planet's surface is

a. 
$$g_1/g_2 = r_1/r_2$$
  
b.  $g_1/g_2 = r_2/r_1$   
c.  $g_1/g_2 = (r_1/r_2)^2$   
d.  $g_1/g_2 = (r_2/r_1)^2$ 

2) Two satellites orbit well outside the atmosphere at distances  $r_1$  and  $r_2$  from the center of the Earth. The ratio  $v_1/v_2$  of the tangential speeds of the two satellites is

a. 
$$r_2/r_1$$
  
b.  $(r_2/r_1)^2$   
c.  $(r_2/r_1)^{1/2}$   
d.  $r_1/r_2$   
e.  $(r_1/r_2)^2$ 

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#### website:

http://www.montgomeryschoolsmd.org/schools/woottonhs/academics/finalfront/finalfront.aspx