JPS Science League: AP Physics I

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Entrance Test

Instruction: There are 25 test questions, 5 bonus questions and 1 thought provoking question in this exam. The 25 questions will determine your placement while the 5 bonus questions will serve as tie breakers. The thought provoking question is just for you to think about after the exam if you enjoy physics. You will be given 50 minutes for this exam. Points will not be taken off for wrong answers so you are encouraged to answer every question. Remember, finish the 25 questions before starting the bonus. Good luck and have fun!

1) a) b) c) d)

2) A major issue in the news is the Trump border wall. Suppose that such a wall were to be build and the wall is $11m$ tall. Kevin is a very curious kid and wants to see at what angle would it take to launch a ball over the wall. Sadly, Kevin isn't very bright and built a cemented down launcher located at $14m$ away from the wall. Furthermore, the launcher can only shoot at an angle of 56 degrees. What is the minimum speed so the ball can just pass over the top of the wall.

   a) b) c) d)

Use the following information for Questions #3 and #4: Kevin got bored one day and accidentally built a 500 m tall building. On top of the building, Kevin added a ramp with an incline of 30 degrees and height of 10 m. The ramp does not extend the entire width of the building such that the end of the ramp is not the edge of the building(the ball has to roll on a flat surface after leaving the ramp). Suppose that all transitions are smooth and all forces of friction are negligible since Kevin is so great at engineering.

3) One day, Kevin stole a bowling ball from the bowling ball team. After being chased to the top of his building, Kevin decided that the only way out was by rolling the bowling ball off the roof. In order to give the bowling ball, which as a mass of 7 kg, enough velocity, Kevin decided to roll the ball off the ramp. After placing the bowling ball at the top of the ramp, what is the velocity of the ball at the bottom of the ramp?

   a) b) c) d)

4) Regardless of your answer to the last problem, assume that velocity at the end of the ramp is 20 $\frac{m}{s}$. Determine the horizontal distance the bowling ball could travel after it leaves the roof.

   a) b) c) d)

5) Suppose there is a ball with a mass of 10 kg. Let the ball be rolling without sliding on a rough surface at 3 $\frac{m}{s}$. You are given the static and kinetic coefficients of friction to be $\mu_s = 0.67$ and $\mu_k = 0.3$. Find the amount of force needed to be exerted at a 30 degree angle to keep the ball moving at a constant velocity.

   a) b) c) d)

6) A really common physics problem given to beginning physics students is called the Atwood machine. This setup is so commmonplace in the world of physics education that even the US Physics Team uses it in some form. An Atwood machine is basically two weights connected by a string draped over a pulley. The pulley in this case is completely massless and frictionless. The mass on the left side is 12.6 kg while the mass on the right side is 3.7 kg. What is the tension on the string connecting the two masses?

   a) b) c) d)

Use the following for Questions #7 and #8: There is a ramp of 45 degrees from the ground and coefficients of friction $\mu_s = 0.62$ and $\mu_k = 0.47$. A box with a mass of 14 kg is placed on the ramp.

7) Elisha can only exert a force horizontal to the ground. Find the amount of force she needs to exert inorder to keep the box in static equilibrium.

   a) b) c) d)

8) If Elisha were to stop pushing the box. Find the acceleration the box would have as it slides down the ramp.

a) b) c) d)

9) When Kevin was writing this test, he kinda got bored and decided to build something. Again, he accidentally built a building but this time it is H m tall. To express his rage at his ability to accidentally build skyscrapers, Kevin decided to roll a ball off the roof at a horizontal velocity of v $\frac{m}{s}$. Kevin chose one of his heaviest balls-weighing at m kg. However, as a aspiring physicist, Kevin wanted to know what was the final velocity of the ball just before it hit the ground. Can you help him figure it out?

a) b) c) d)

10) a) b) c) d)

11) Suppose there are two blocks placed right next to each other. The left block is much bigger than the right block with a mass of 30 kg. The right block has a mass of 14 kg. Let us call the force between the two blocks F_L when a force to the right is exerted on the left block. Let us call the force between the two blocks F_R when a force to the left is exerted on the right block. These two forces are applied seperately. How does F_L and F_R compare?

a) b) c) d)

12) Elisha is putting up some lamps in order to give the test takers some more light. Each lamp is held in place by 2 strings. 1 string attaches to ceiling at an angle of 60 degrees while the second string perpendicularly attaches to the wall. Each lamp has a weight of 5.5 kg. Find the tension in the horizontal string.

a) b) c) d)

Reminder: Remember, finish the 25 actual questions before moving onto the bonus and thought provoking question(TPQ). You will not get any extra time to do these. It is more important for you to place onto the team rather than having tiebreaker points.

Bonus 1) a) b) c) d)

Bonus 2) a) b) c) d)

Bonus 3) a) b) c) d)

Bonus 5) a) b) c) d)

Bonus 6) a) b) c) d)

TPQ: Suppose you have a mass m attached to a spring. Let the spring have an original coefficient of k. Originally, the mass is set into oscillation with an angular velocity of ω and a max amplitude of A_0. Over a course of 10^6 years, aka it takes a long time, the spring constant decays to $\frac{k}{2}$ while the mass is still oscillating. What multiple of the original amplitude A_0 is the new amplitude A_f?