AP/Honors Exam Practice 2

Full Name, Period, AP/Honors: **Not graded**

Problems marked with (AP) will be more difficult that than the hardest problems on the honors exam.

1 Multiple Choice

1. A planet orbits a star in a highly elliptical orbit. The star is substantially more massive than the planet, but not so much that the star's movement can be neglected. When the planet reaches the highest speed, what will the star be doing?

   A. The star will have its lowest speed, to conserve kinetic energy.

   B. The star will have its lowest speed, to conserve angular momentum.

   C. The star will have its highest speed, to conserve (linear) momentum.

   D. The star will have its highest speed, because the center of mass must accelerate.

2. You have two systems. The first has 10 disks, the first has mass M_1 and is spinning with angular velocity ω and each subsequent disk has half the thickness of the one before, but is spinning with twice the angular velocity. The other has 10 disks, all with mass M_1 and angular velocity $-\omega$. All disks in both systems are made of the same material and have radius R. What will be the total rotational kinetic energy of the disks once all of the disks from both systems are combined into a single large disk?

   A. 0

   B. $\frac{1}{4}(20M_1R^2\omega^2)$

   C. $\frac{1}{4}M_1R^2\omega^2\left(10+\sum_{i=1}^{10}2^i\right)$

   D. $\frac{1}{4}M_1R^2\omega^2\left(10+\sum_{i=1}^{10}\left(\frac{1}{2}\right)^i\right)$

3. An object is rotating rapidly. Based on this, which of these statements is definitely correct? **Select all that apply.**

   A. The object has momentum.

   B. The object has no momentum

   C. The object has angular momentum.

   D. The object has kinetic energy.

4. Which of these will have a magnitude of g? Neglect air resistance, friction, and other external forces. **Select all that apply**.

   A. The gravitational force on an object per kilogram of mass.

   B. The rate at which the moon is accelerating towards earth.

   C. The power added to an object as it falls.

   D. The acceleration that a dense object will have if dropped from a building.

5. The moon is nearly the same density as mars (both way less than Earth) and it's radius is about half of the radius of mars. The moon's escape speed is about 2.5 $\frac{\text{km}}{\text{s}}$. What is the Martian escape speed?

   A. 1.25 $\frac{\text{km}}{\text{s}}$

   B. 2.5 $\frac{\text{km}}{\text{s}}$

   C. 5 $\frac{\text{km}}{\text{s}}$

   D. 10 $\frac{\text{km}}{\text{s}}$

6. (calculator required!) A dog and a cat are racing each other, but the dog offers to give the cat a head start of $t_1 = 11$ s. The cat moves with a constant velocity of $v_g = 10\ \frac{\text{m}}{\text{s}}$ and once it starts, the dog moves with a constant acceleration of $a_b = 5\ \frac{\text{m}}{\text{s}^2}$. The race ends in a tie.

   (a) About how far away was the point they were racing towards?

   A. 100 m

   B. 200 m

   C. 300 m

   D. 400 m

   (b) Which of these accurately describes their velocities when they arrive at the end? Time begins from when the cat started traveling.

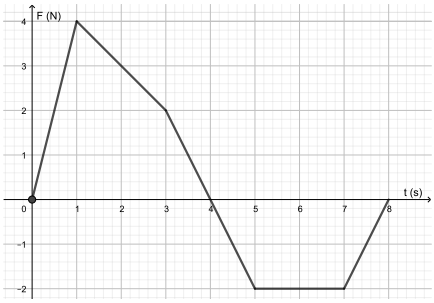
   A. The dog and cat will have the same instantaneous velocity and the same average velocity.

   B. The dog will have a higher average velocity and a higher instantaneous velocity.

   C. The dog will have a higher instantaneous velocity, but the average velocities are the same.

   D. The cat will have a higher average velocity, but the instantaneous velocities are the same.

7. (AP) An object with mass $\frac{1}{3}$ kg experiences time varying force shown in the graph below.



   (a) What will be the object's velocity at time $t = 9$ s?

   A. 0

   B. $3\frac{\text{m}}{\text{s}}$

   C. $9\frac{\text{m}}{\text{s}}$

   D. $57\frac{\text{m}}{\text{s}}$

   (b) Assume that this force is the result of interaction with a single other object. The other object's mass is 1 kg. If we graphed the force on the other object against time over the same time interval, the graph would be...

   A. Identical.

   B. Scaled by $\frac{1}{3}$.

   C. Flipped over the horizontal axis.

   D. Impossible to determine from this graph.

2 Short answer

8. (AP) Identical projectiles with identical velocities are fired at three objects made of different materials and with very different masses. For the lightest object (m_1), the projectile passes through and ends up with a smaller speed than it started with. For the middle object (m_2), the projectile embeds itself inside. For the largest object (m_3), the projectile bounces back with a smaller speed than it started with. Based on the information presented above, rank the final speeds of the objects. If that isn't possible, say so and explain what additional information would be needed. Explain your answer with a coherent paragraph length response.