# AP/Honors Exam Practice 1

**Full Name, Period, AP/Honors:**

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

## 1 Multiple Choice

1. You have two balls with different density, but the same mass. Which of these will be different if the balls are dropped off of a very high building in the presence of air resistance? The balls have not hit the ground after 10 seconds. **Select two answers.**

   A. The instantaneous acceleration of the balls after 10 seconds

   B. The gravitational force on the balls

   C. The terminal velocity of the balls

   D. The instantaneous acceleration when the balls are first released.

2. Two identical blocks are given the same initial speed down frictionless ramps with different angles and different heights. Block one's ramp has $\theta_1, h_1$, and block two's has $\theta_2, h_2$. What will be the difference in the objects kinetic energies when the last block reaches the bottom of the ramp? The times it takes each block to reach the bottom are $t_1$ and $t_2$ respectively.

   A. $KE_2 - KE_1 = (mg\sin\theta_1 - mg\sin\theta_2)(t_1^2 - t_2^2)$

   B. $KE_2 - KE_1 = (mg\sin\theta_2)t_2^2 - (mg\sin\theta_1)t_1^2$

   C. $KE_2 - KE_1 = mg(h_2 - h_1)$

   D. $KE_2 - KE_1 = \frac{1}{2}m(g\sin\theta_2)t_2^2 - \frac{1}{2}m(g\sin\theta_1)t_1^2$

3. (AP) We have two systems (1 and 2) that each consist of identical bullets and wooden cubes. The cubes are much more massive than the bullets. The cubes have the same friction coefficient with the surface they reside on. In all collisions, the bullets stay embedded in the cubes. If the bullet in system 2 has twice as much kinetic energy, how far will cube 2 go compared to cube 1?

   A. The same distance

   B. $\sqrt{2}$ times as far

   C. 2 times as far

   D. 4 times as far

4. Two teams are playing tug of war. Team A is winning. Which of these must be true? Neglect the mass of the rope.

   A. The average force that team A applied to the rope is larger than team B.

   B. The total mass of team A is greater than team B.

   C. The average frictional force on team A from the ground is larger than for team B.

   D. The magnitude of the acceleration of team A is greater than team B.

5. A block is slid down a ramp with friction that is at an angle of theta from the horizontal. No force acts except gravity. Which of these represents a condition under which the block would speed up as it went down the ramp?

   A. $\tan\theta > \mu_k$

   B. $\cot\theta > \mu_k$

   C. $v < g\mu_k$

   D. $\cos\theta < \mu_k$

6. A large truck crashes into a small car on ice (ie no friction during the collision, also ignore air resistance). The vehicles do not stick together, but they are damaged during the collision. $\vec{j}$ represents impulse, $W$ is work $\vec{v}$ is velocity, $KE$ is kinetic energy. $\vec{p}_{cm}$ is momentum of the center of mass.

   (a) Which of these statements will be true immediately after the collision? **Select all that apply.**

   A. $\vec{j}_t = -\vec{j}_c$

   B. $\Delta KE_c = -\Delta KE_t$

   C. $\Delta\vec{v}_c = -\Delta\vec{v}_t$

   D. $W_c = -W_t$

   E. $\Delta\vec{p}_{cm} = 0$

   (b) Once the cars have come to a complete stop using their brakes, which of these will definitely be true? Assume that the car and truck are not a part of the Earth. **Select all that apply.**

   A. The change in the Earth's momentum is exactly 0.

   B. The momentum of the center of mass of the cars is unchanged.

   C. The Earth's translational kinetic energy has decreased.

   D. The Earth's rotational kinetic energy has increased.

   E. None of the above.

7. Jupiter orbits the sun. When Jupiter is at it's furthest point from the sun, what is the direction of the sun's acceleration? Ignore the influence of other planets and stars, and take the reference frame that is static relative to the Jupiter-Sun system.

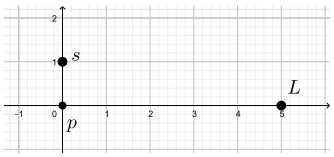
   A. The acceleration is 0.

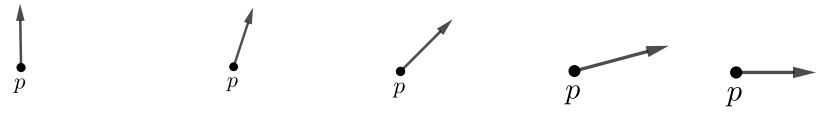
   B. Directly away from Jupiter.

   C. Directly toward Jupiter.

   D. None of the above.

8. Imagine that there is a system that consists of a very large star $L$ and a small star $s$ that is 1/25 the mass of the large star. If the stars are aligned as shown below, which will most closely give the direction of the force on the planet $p$?




(a) (b) (c) (d) (e)

9. A student has measurements of an objects momentum and kinetic energy at various times. Which of the following should the student plot so that the slope gives the object's mass? Answers are in the form $y$ vs $x$.

   A. $KE$ vs $p$

   B. $p$ vs $KE$

   C. $\frac{p^2}{2}$ vs $KE$

   D. $\sqrt{2KE}$ vs $p$

10. (AP) An object with speed $v$ collides perfectly inelastically with an object of the same mass that was initially at rest. The mass then moves onto a surface with coefficient of friction $\mu_k$.

    (a) How far does the object slide before stopping?

    A. $\frac{v^2}{2g\mu_k}$

    B. $\frac{v^2}{8g\mu_k}$

    C. $\frac{2v^2}{g\mu_k}$

    D. The answer cannot be determined.

    (b) How long does the object take to stop?

    A. $\frac{v^2}{2g^2\mu_k}$

    B. $\frac{v}{g}\mu_k$

    C. $\frac{v}{2g\mu_k}$

    D. The answer cannot be determined.

11. Can two satellites both have geostationary circular orbits at different distances from the surface of Earth?

    A. Yes, if the satellites are at different latitudes.

    B. Yes, if the satellites have different linear speeds.

    C. No, only one stable orbital radius exists for a given angular speed

    D. No, only certain orbital radii allow circular orbits

12. A piece of clay with momentum $\vec{p}$ collides with the tip of a rod of length $l$ that is floating in space and sticks to it. The rod is initially motionless. The mass of the clay is small compared to the mass of the rod. After the collision what will the momentum and angular momentum of the rod be?

    A. $(\vec{p}, \frac{\vec{l}\times\vec{p}}{2})$

    B. $(-\vec{p}, -\frac{\vec{l}\times\vec{p}}{2})$

    C. $(0, \vec{l}\times\vec{p})$

    D. $(0, 0)$

13. You have a pendulum on earth that is a length $l$ and has a period of exactly 1 second. You go to a planet where the gravity is 2g. How long of a pendulum do you need to have a period of 1 second?

    A. $\sqrt{2}l$

    B. $2l$

    C. $\frac{l}{\sqrt{2}}$

    D. $\frac{l}{2}$

## 2 Short answer

14. A student creates a pendulum with string length $L$ in an airless room and starts it at some angle $\theta_0$ from the vertical.

    (a) (AP) In terms of any combination of $m$, $g$, $L$ and $\theta_0$, what will be the pendulum's maximum speed $v_{max}$?

    (b) A ball of clay that is the same mass as the pendulum but has $\vec{p}_b = 4\vec{p}_p$ strikes the pendulum exactly at its lowest point and the two objects move upward together. How high $h_{max}$ (height, not angle!) will the pendulum go now compared to how high it went before $h_{old}$? Justify your answer.

    (c) (AP) The clay is removed and the pendulum (now called pendulum A) is reset to $\theta_0$ and released while in an elevator. Just as pendulum A reaches its lowest point, the elevator begins to (suddenly) accelerate upwards. Once the elevator is already accelerating, another pendulum (pendulum B) is released from angle $\theta_0$ in the elevator. Which pendulum will now reach a higher height, or will they reach the same height? Explain your answer.

15. For this problem, consider the Earth. The Earth rotates, but that rotation is fairly slow. We want to explain the effects that would occur if we sped it up.

    (a) Explain (without equations) why the rocks on Earth's surface would eventually be flung off the surface if we increased the rotational speed of the Earth enough.

    (b) (AP) Find the approximate maximum rotational speed (aka angular speed $\omega$) of the Earth before this would start to happen in terms of the radius of the Earth $R_E$ and the surface gravity of Earth $g$.

    (c) If we doubled the radius of Earth (keeping density constant), would the maximum rotational speed we found before increase, decrease, or stay the same? Explain your answer.