AP/Honors HW: Work and Energy

Full Name, Period, AP/Honors: **due: 8/21**

Instructions: For short answer questions, work must be shown to receive credit. Most questions should not require a calculator.

1 Energy... and you're done!

1. An object is thrown from a position $x_1\hat{x} + z_1\hat{z}$ with an initial velocity $v_i\hat{z}$. Is the object able to make it to position $x_1\hat{x} + z_2\hat{z}$?
   A. Yes, if $v_i > \sqrt{2g(z_2 - z_1)}$
   B. Yes, if $v_i < \sqrt{2g(z_2 - z_1)}$
   C. Yes, if $v_i > \sqrt{2g(z_2 - z_1 + x_1)}$
   D. Definitely no

2. An object is thrown upward with speed v_i at some angle θ from a height h_1 above flat ground. Which of these statements about the speed the instant before the ball hits the ground is correct? **Select all that apply.**
   A. The speed will depend on θ
   B. The speed will depend on the height h_1
   C. The speed will depend on the initial speed v_i
   D. The speed will be at its highest value at this point

3. An object is placed on a frictionless inclined plane located on the surface of an unknown planet and released form rest. Which of these are involved in determining its velocity when it reaches the bottom? **There are two correct answers**.
   A. The planet's mass
   B. The object's mass
   C. The angle of the plane
   D. The planet's radius

4. Two objects with the same mass are slid down frictionless inclined planes of the same length, but different inclination angles. Object 1 is slid down ramp 1 with angle θ_1 and object 2 is slid down ramp 2 with angle θ_2. $0 < \theta_1 < \theta_2 < 90°$. Which of the following statements is accurate?
   A. The objects reach the ground at the same time and with the same final velocity.
   B. The objects reach the ground at the same time, but object 2 has higher final velocity.
   C. The objects reach the ground with the same final velocities, but object 1 takes longer.
   D. Object 2 reaches the ground first, and arrives with higher final velocity.

5. The experiment in the previous problem is repeated on ramps that both have with friction coefficient μ_k with the masses. Which of the following statements is accurate?
   A. The objects reach the ground at the same time and with the same final velocity.
   B. The objects reach the ground at the same time, but object 2 has higher final velocity.
   C. The objects reach the ground with the same final velocities, but object 1 takes longer.
   D. Object 2 reaches the ground first, and arrives with higher final velocity.

6. You want to accelerate a box with mass M from a velocity of v_i to a velocity of $2v_i$ on flat ground. How much work do you need to do? You may assume that there is no friction or air resistance, and that your force is applied in the same direction as the velocity.

   A. Mv_i^2

   B. $\frac{3}{2}Mv_i^2$

   C. $2Mv_i^2$

   D. $3Mv_i^2$

7. A wagon (with no internal engine, or power source) travels in a circle along a track with friction (but no air resistance) and arrives back at it's starting point with velocity $v_f < v_i$. Which of these provides a correct answer and explanation for the work done by friction.

   A. The work done by friction is 0 because the displacement is 0

   B. The work done by friction is 0 because the force was perpendicular to the displacement

   C. The work done by friction is negative because the object slowed down

   D. The work done by friction is negative because the object traveled in a circle

8. An object has an initial position of 0 m. A force F_1 is applied to an object at an angle of 45° from $+\hat{\mathrm{x}}$ in the $x - z$ plane. The object's velocity is at an angle of $-180°$ from $+\hat{\mathrm{x}}$. If the object's initial velocity is v_1, find the final velocity after the object reaches a position of $-x_f\hat{\mathrm{x}}$. Assume that the object eventually reaches $-x_f\hat{\mathrm{x}}$ and doesn't come off the ground.

   A. $v_f = \sqrt{v_i^2 + 2\frac{F_1 x_f}{M}}$

   B. $v_f = \sqrt{v_i^2 - 2\frac{F_1 x_f}{M}}$

   C. $v_f = \sqrt{v_i^2 + \sqrt{2}\frac{F_1 x_f}{M}}$

   D. $v_f = \sqrt{v_i^2 - \sqrt{2}\frac{F_1 x_f}{M}}$

9. Write your name on the top of the paper... or don't if you enjoy doing work for no credit.

2 But there's always more

9. A constant force F_1 presses a box M_1 straight against a wall. The mass begins at a height of h_1 with a velocity of 0 and ends at a height $h_2 < h_1$ with a downward velocity of $-v_2\hat{z}$. Find the friction coefficient of the wall. Recall that the frictional force of an object is given by $F_f = F_N \mu_k$ where F_N is the force pushing us against the wall, and μ_k is the friction coefficient. (Don't expect a super clean answer here, it will be difference of a ratio of energies and a ratio of forces.)

10. A ball is rolled down a ramp at the same time as an object is slid down a frictionless ramp. When the objects reach the bottom, they have the same translational speed. If they then roll up ramps that are identical to the ones they rolled down, which makes it further up? Answer first using intuition, then using math.

11. Some experimental types of hybrid cars use a mechanical flywheel to store energy that is then given back to the car. Flywheels are typically made of steel disks that have a radius of about $\frac{1}{2}$ m and mass of about 30 kg. How fast would the disk need to spin to be able to accelerate a 1000 kg car to 5 $\frac{\mathrm{m}}{\mathrm{s}}$