Individual Quizbit 8

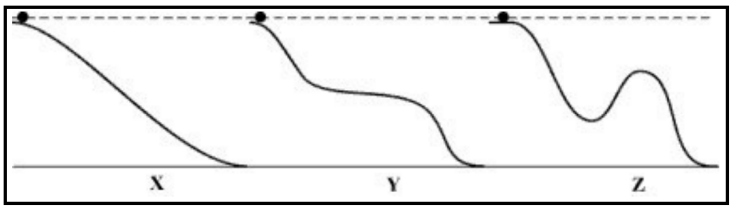
PH201, Fall 2022

You are encouraged to discuss these questions with others, but those conversations need to be only in words. Please do not write down steps for others, draw pictures, show math steps, or consult online resources. Any work shown here should be your own thoughts and not copied from any source. You will be graded on the clarity of how well you communicate your steps and reasoning, not on absolute correctness. Hand write your solutions (paper or tablet) and turn your work into Gradescope.

Problem Statement | In order to familiarize yourself with a common question format of the final exam, this week's Quizbit will be a series of "multiple select" problems. Here are the instructions you will receive on the final exam:

For questions 1 through 3, clearly indicate all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **4 correct answers** in this section and **only the first 4 filled in answers will be graded**. There is no partial credit.

1) A ball can be rolled down one of four different ramps, as shown in the diagram. The final elevation loss of each of the ramps is the same. Neglecting friction, for which ramp will the speed of the ball be the highest at the bottom?



(a) The speed of the ball will be the same for all ramps.

(b) Ramp X

(c) Ramp Y

(d) Ramp Z

2) A Pokémon in your hand is being raised up at a constant velocity. Which of the following statements are false regarding this situation?

(a) The normal force on the Pokémon must be larger than the gravitational force.

(b) The net external impulse acting on the Pokémon is zero.

(c) The normal force does positive work on the Pokémon.

(d) The kinetic energy of the Pokémon increases from one second to the next.

3) A ball is dropped from a cliff and falls freely towards earth. Which of the following statements are true concerning the ball as it falls? Neglect air resistance (aka drag) for this problem.

(a) It will gain an equal amount of momentum during each second.

(b) It will gain an equal amount of kinetic energy during each second.

(c) It will gain an equal amount of speed for each meter through which it falls.

(d) It will gain an equal amount of momentum for each meter through which it falls.

(e) The amount of momentum it gains will be linearly proportional to the amount of potential energy that it loses.

The multiple select questions end now. Answer the following question.

4) Explain your answers to each of questions 1, 2, and 3 using words, diagrams, algebra, etc. Clearly label which part(s) of which question you are explaining. If an explanation explains more than one part, clearly label which parts it explains.

See next page

Reasoning

Q1: Without friction, there is zero energy transferred to thermal energy. The change in gravitational potential energy is the same for all three because the high difference is the same. Thus they gain an equal amount of kinetic energy. Same final kinetic energy, same mass, means they will have the same final speed.

Q2: If the system is traveling at constant speed, than the acceleration and net force must be zero due to Newton's 2nd law. For this system, there is a normal force and gravity, both acting in opposite directions with equal magnitude (they are not 3rd law force pairs). That helps see how (a) is a false statement. Option (d) is also false because with the speed constant, and the mass staying the same, the kinetic energy is a constant.

Q3: Most of the options can be answered by either the impulse-momentum theorem or the work-energy theorem. Momentum changes come from a net force acting over time, while energy changes come from a net force acting over a distance. In free-fall, there is a constant net force due to gravity acting on the object. Option (a) is true because constant force for equal intervals equals a constant change in momentum. The rest of the options are either conflating work/impulse theorems, or refer to a kinematic equation with a non-linear relationship.

Group Quizbit 8

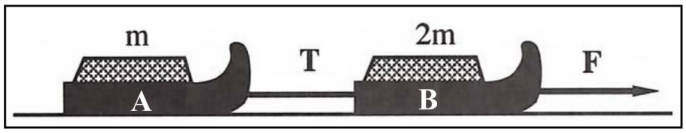
PH201, Fall 2022

You will be working with your group to create a single solution for these questions. You are encouraged to think about the questions beforehand, and discussing with your classmates is encouraged, but do not bring a solution to your group's working session. You are working to develop a shared solution, with the input and problem solving skills of all your group members. You will be graded on both the clarity of how well you communicate your steps and reasoning, and on absolute correctness.

Problem Statement | In order to familiarize yourself with the format of the final exam, this week's Quizbit will be a series of "multiple select" problems. Here are the instructions you will receive for multiple select problems on the final exam:

For questions 1 through 2, clearly indicate all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **8 correct answers** in this section and **only the first 8 filled in answers will be graded**. There is no partial credit.

1) Two sleds (A and B), connected by a rope with tension T, are pulled at a constant speed by a force F, as shown in the figure. Which of the following statements are false?



(a) The work done by T on sled A is half the work F does on B.

(b) The work from friction on B is twice the work from friction on A.

(c) The change in energy of the A+B system is zero.

(d) The net impulse exerted on A is less than on B.

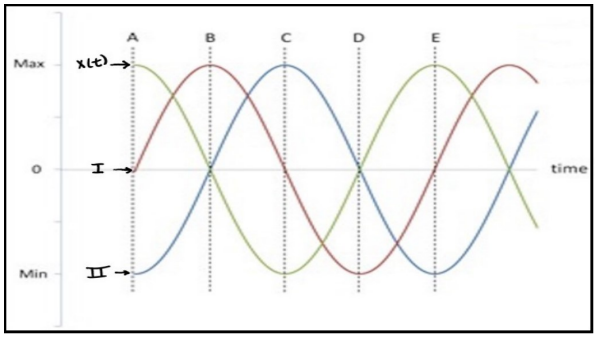
(e) The net impulses exerted on both A and B are zero.

(f) Both A and B experience positive net external work.

(g) Both A and B experience negative net external work.

(h) Both A and B experience zero net external work.

2) The figure shows several plots, one of which labeled as representing the position of a mass on a frictionless surface, connected to a horizontal spring that is oscillating back and forth. The other two plots are numbered I and II. Which of the following statements are true regarding these plots and this situation?



(a) Plot I could represent the mass's velocity as a function of time.

(b) Plot I could represent the mass's acceleration as a function of time.

(c) Plot II could represent the mass's acceleration as a function of time.

(d) The mass has the greatest amount of potential energy at points A, C, and E.

(e) The mass has the greatest amount of kinetic energy at points A, C, and E.

(f) The potential energy of the mass is maximum when its magnitude of acceleration is greatest.

(g) The kinetic energy of the mass is greatest when its position is zero.

The multiple select questions end now. Answer the following question.

3) Explain your answers to the following questions using words, diagrams, algebra, etc.

(a) Question 1 part (a)

(b) Question 1 part (c)

(c) Question 2 part (f)

Reasoning

Q1(a): Assuming the surfaces are the same for both, and thus the same coefficient of friction, with the normal force on B twice that of A, the friction force will be twice as large on B ($2F^f$) than it is on A (F^f). If they are traveling at a constant speed, the tension T, must be equal to the friction force on A ($T=F^f$), consistent with Newton's 2nd Law. If that's true the tension on the right must be equal to 3T (F = 3T). 2 of the T's come from overcoming twice the friction as A, and one comes from the tension T pulling towards the left on mass B. So there is a factor of 3 different in the tensions T and F. Work is force dotted with displacement, and while the relative orientations of the force and displacement are the same for comparing these two force's work, the magnitude differs by a factor of 3. That is why (a) is a false statement, it states a factor of 2 difference.

Q1(c): The energy is increasing for the A+B system because while it's kinetic and potential energies are constant, it's increasing in temperature and thus thermal energy due to the friction while it slides. Essentially the force F is doing positive work on the system, which is not going into kinetic or potential energy, but rather increasing the thermal energy of both the system A + B, and the surface they are sliding on.

Q2(f): Both the spring force ($F=-kx$) and potential energy ($U=kx^2/2$) are maximum when displacement x is maximum. Newton's 2nd law shows that if the spring is the only horizontal force acting on the system, the acceleration will be greatest when the force, and thus displacement is maximum.