Name: ______________________________

Date: ______________________________

Cornell University
Prison Education Program

Conceptual Physics
Class 7 Questions
March 23, 2018

Practice Questions for First Partial Test

1. What is an ideology? What are scientific theories?

2. Some philosophers assert that there is no difference between science and myth, and that modern science fills the same role as ancient myth, with no difference in its methods. What do you think? In what ways are modern science and ancient mythology similar and/or different?

3. Convert the following to centimeters (cm). Some useful conversion factors: 1 mile = 1.6 km, 1 light-year = 9×10^{15} m.

   (a) 15 m

   (b) 10 miles

   (c) 2 light-years

4. You are an astronaut on Mars, passing the time by juggling. You are taking advantage of the fact that the acceleration due to gravity on the surface of Mars is only about 4 m/s^2, which allows you to have slower reaction times. You throw a ball straight upwards at 8 m/s.

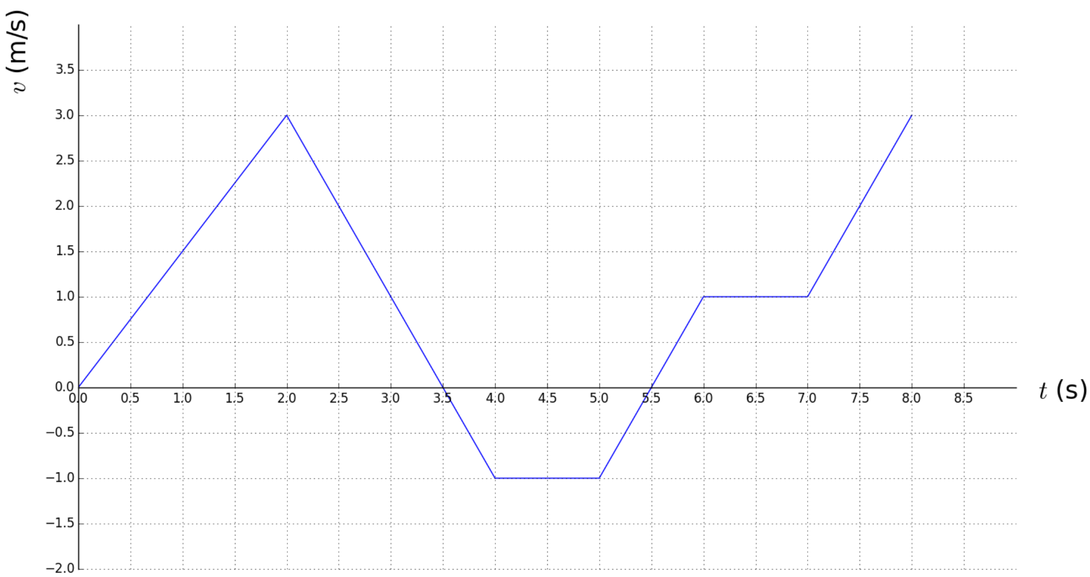
   (a) Draw a sketch of the problem.

   (b) How long does the ball take to reach the top of its trajectory?

   (c) How high does the ball go?

   (d) How long does the ball take to land back in your hand, from the moment you threw it?

5. The following velocity *vs.* time plot describes the random motion of someone running back and forth on a sidewalk. Let the positive direction indicate East, and negative direction be West.



(a) When were they moving fastest?

(b) What was their greatest velocity?

(c) When were they not moving?

(d) When was their acceleration zero?

(e) When was their acceleration negative?

6. Despite a very strong wind, a tennis player manages to hit a tennis ball with her racquet so that the ball passes over the net and lands in her opponent's court. Consider the following forces:

    1. A downward force of gravity
    2. A force by the "hit"
    3. A force exerted by the air

    Which of the above forces is (are) acting on the tennis ball after it has left contact with the racquet and before it touches the ground?

    A. 1 only

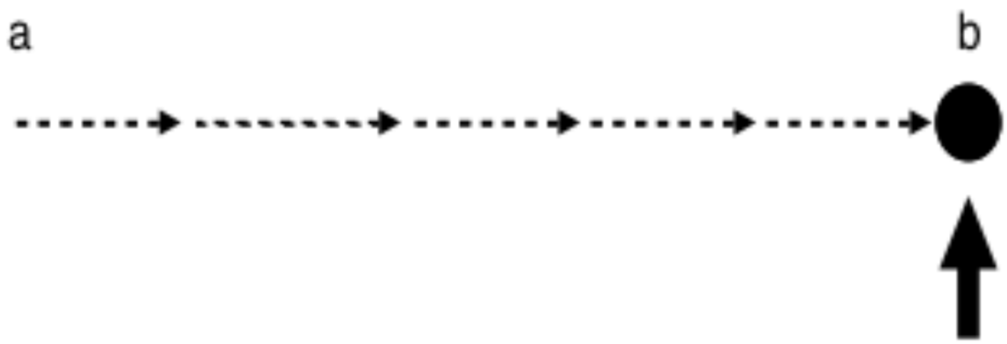
    B. 1 and 2

    C. 1 and 3

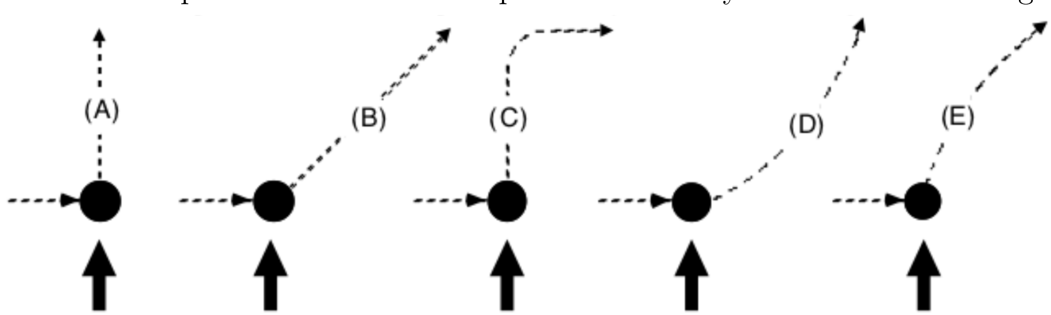
    D. 2 and 3

    E. 1, 2, and 3

7. The figure depicts a hockey puck sliding with a constant speed v_0 from point a to point b on a frictionless horizontal surface. Forces exerted by the air are negligible. You are looking down on the puck. When the puck reaches point b, it receives a swift horizontal kick in the direction of the heavy print arrow.



    (a) Which of the paths below would the puck most closely follow after receiving the kick?



(b) Along the frictionless path you have chosen above, the speed of the puck after receiving the kick:

A. is constant.

B. continuously increases.

C. continuously decreases.

D. increases for a while and decreases thereafter.

E. is constant for a while and decreases thereafter.

(c) Along the frictionless path you have chosen above, the main force(s) acting on the puck after receiving the kick is (are):

A. a downward force of gravity.

B. a downward force of gravity, and a horizontal force in the direction of motion.

C. a downward force of gravity, an upward force exerted by the surface, and a horizontal force in the direction of motion.

D. a downward force of gravity and an upward force exerted by the surface.

E. none. (No forces act on the puck.)

8. You are hiking on a glacier and come across a crevasse. It is too narrow for you to see the bottom, but you want to know how deep it is, so you drop a rock straight down ($v_0 = 0$ m/s) and listen for a splash, which you hear 2.0 s later. (For simplicity, assume the acceleration due to gravity is 10 m/s^2 downwards.)

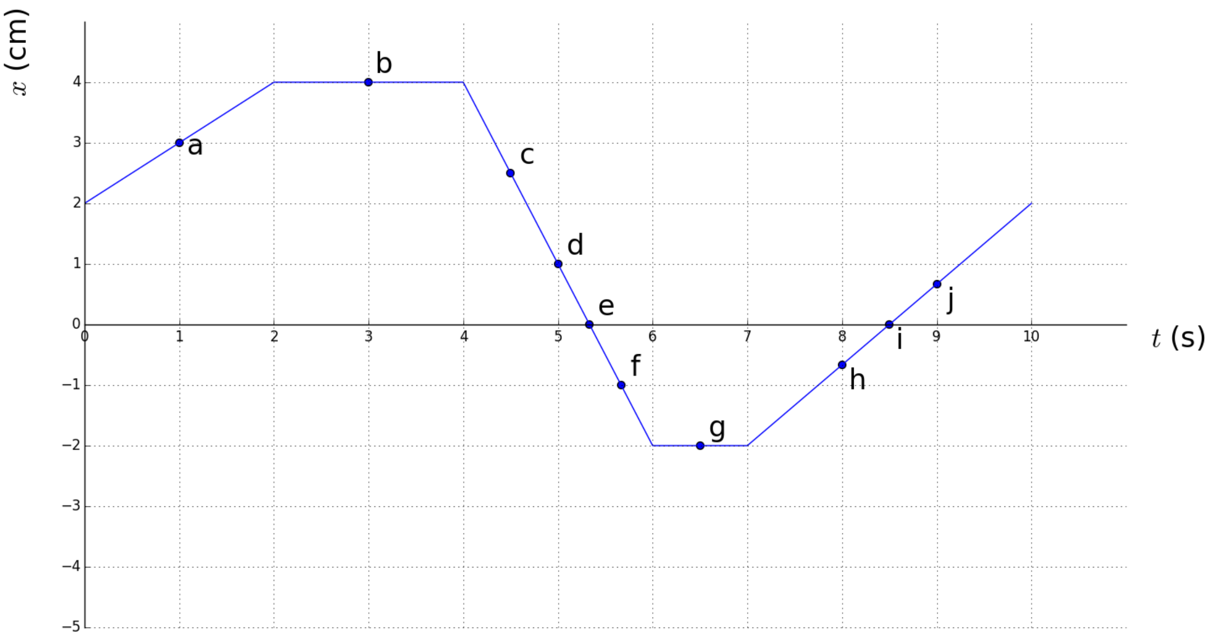
(a) Draw a sketch of the problem.

(b) What was the rock's velocity when it hit the bottom?

(c) What was the rock's average velocity during the fall?

(d) How deep is the crevasse?

9. The following position *vs.* time plot describes the motion of a toy train being pushed along a straight track, where $x = 0$ is the center of the track and points to the right are positive. For questions that ask you to list points, **refer only to the labeled points.**



(a) At which point(s) is the train not moving?

(b) At which point(s) is the train moving fastest?

(c) At which point(s) is the train farthest to the left?

(d) At which point(s) is the train *moving* to the left?

(e) At which point(s) does the train experience zero acceleration?

(f) What is the train's displacement from $t = 0$ to $t = 10$ s?

10. A boy throws a steel ball straight up. Consider the motion of the ball only after it has left the boy's hand but before it touches the ground, and assume that forces exerted by the air are negligible. For these conditions, the force(s) acting on the ball is (are):

    A. a downward force of gravity along with a steadily decreasing upward force.

    B. a steadily decreasing upward force from the moment it leaves the boy's hand until it reaches its highest point; on the way down there is a steadily increasing downward force of gravity as the object gets closer to the earth.

    C. an almost constant downward force of gravity along with an upward force that steadily decreases until the ball reaches its highest point; on the way down there is only a constant downward force of gravity.

    D. an almost constant downward force of gravity only.

    E. none of the above. The ball falls back to the ground because of its natural tendency to rest on the surface of the earth.

11. A woman exerts a constant horizontal force on a large box. As a result, the box moves across a horizontal floor at a constant speed v_0.

    The constant horizontal force applied by the woman:

    A. has the same magnitude as the weight of the box.

    B. is greater than the weight of the box.

    C. has the same magnitude as the total force which resists the motion of the box.

    D. is greater than the total force which resists the motion of the box.

    E. is greater than either the weight of the box or the total force which resists its motion.

12. If the woman in the previous question doubles the constant horizontal force that she exerts on the box to push it on the same horizontal floor, the box then moves:

    A. with a constant speed that is double the speed v_0 in the previous question.

    B. with a constant speed that is greater than the speed v_0 in the previous question, but not necessarily twice as great.

    C. for a while with a speed that is constant and greater than the speed v_0 in the previous question, then with a speed that increases thereafter.

    D. for a while with an increasing speed, then with a constant speed thereafter.

    E. with a continuously increasing speed.

13. If the woman in question 11 suddenly stops applying a horizontal force to the box, then the box will:

    A. immediately come to a stop.

    B. continue moving at a constant speed for a while and then slow to a stop.

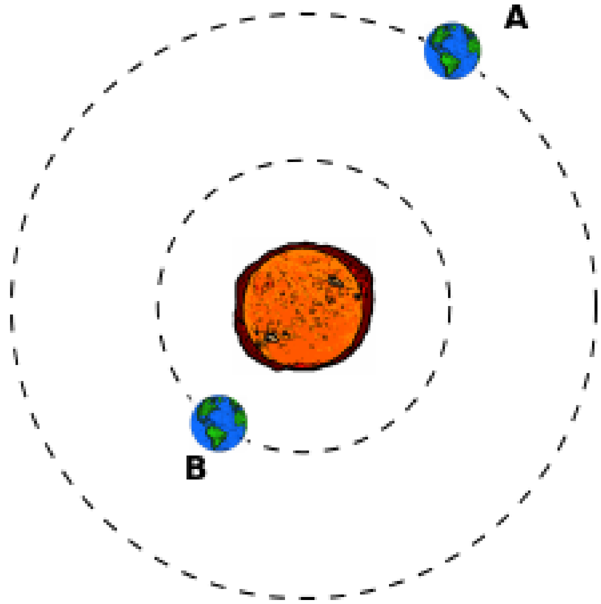
    C. immediately start slowing to a stop.

    D. continue at a constant speed.

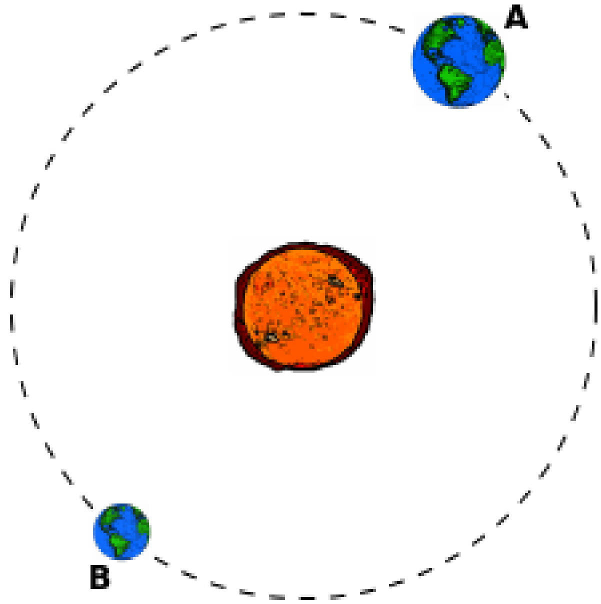
    E. increase its speed for a while and then start slowing to a stop.

14. Consider 2 planets, planet A and planet B, orbiting a distant star. The following 3 scenarios have the two planets located at different distances and with varying masses, and will ask you to compare the gravitational forces experienced by them.

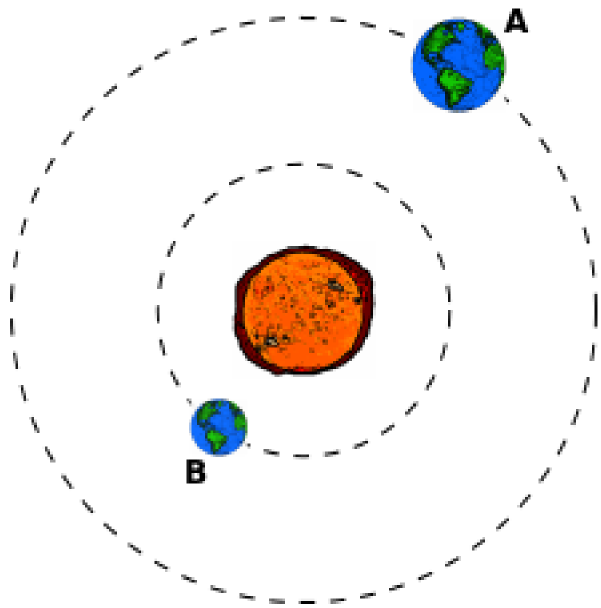
    (a) Planet A and planet B are identical, and orbit the star at different distances. Planet A is **twice as far away** from the star as planet B. Which, if any, experiences the greater gravitational attraction to the star? Why?



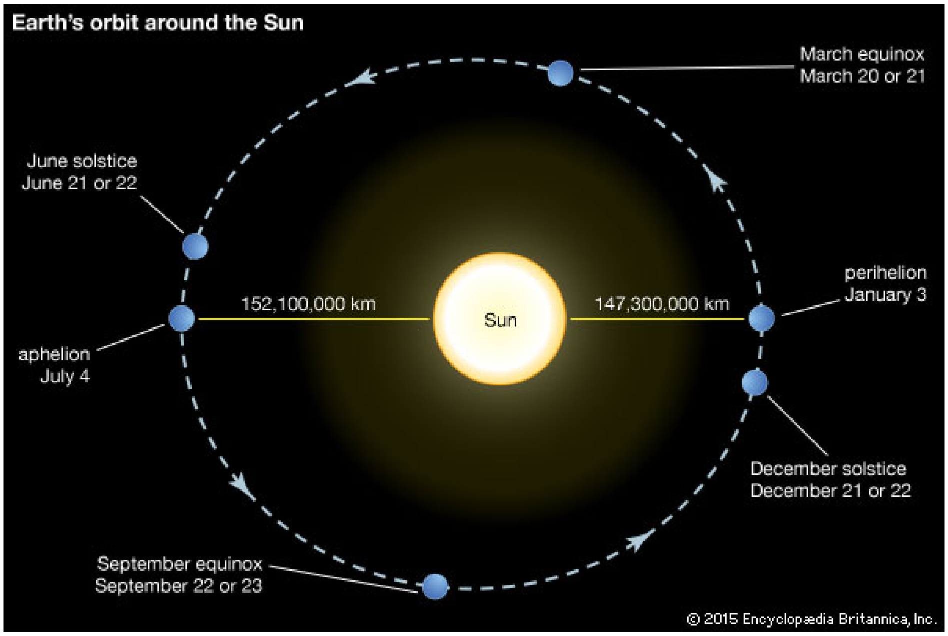
(b) Planet A has **twice the mass** of planet B, and they are orbiting at the same distance from the star. Which, if any, experiences the greater gravitational attraction to the star? Why?



(c) Planet A is located **twice as far away** as planet B, but *also* has **twice the mass** as planet B. Which, if any, experiences the greater gravitational attraction to the star? Why?



15. The Earth's orbit around the Sun is not perfectly circular. Below is a (highly exaggerated) schematic of the Earth's elliptical orbit. Assume that energy is conserved in the Earth+Sun system.



(a) When is the Earth moving the fastest around the Sun? When is it moving the slowest?

(b) When does the Sun do positive work on the Earth? Negative work? Zero work?

16. You are an astronaut looking for a new planet that reminds you of home.

(a) You find a planet with three times the mass of Earth's and the same radius. How would the gravitational force on you on the surface of the planet compare to the gravitational force on you on the surface of the Earth?

(b) You find a planet with the same mass as Earth and one half the radius. How would the gravitational force on you on the surface of the planet compare to the gravitational force on you on the surface of the Earth?

(c) You find a planet with four times the mass of Earth and twice the radius. How would the gravitational force on you on the surface of the planet compare to the gravitational force on you on the surface of the Earth?

17. Explain, using the properties of the electrostatic (Coulomb) force and the strong nuclear force, why all of the heaviest elements (elements with the most protons and neutrons in the nucleus) are unstable. Feel free to draw diagrams that help your explanation.

18. You are attempting to move a 20-kg cardboard box across a room and then upstairs. For each stage, describe the **change** in the box's energy, and say whether **you** did positive, negative, or zero work on the box. (For this problem, you can ignore the effects of air resistance but friction between the box and the floor is **not** negligible.)

(a) You apply a horizontal force to the box as you accelerate from rest to 1 m/s in 1 s.

(b) You push the box at a constant velocity of 1 m/s for 5 s.

(c) You stop pushing the box and allow it to come to rest in 1 s.

(d) You lift the box to a height of 1 m.

(e) Holding the box at a constant height, you accelerate from rest to 1 m/s in 2 s.

(f) You carry the box up a 3 meter flight of stairs at a constant speed of 1 m/s.

(g) You continue to carry the box at a constant height and a constant velocity of 1 m/s for 5 s.

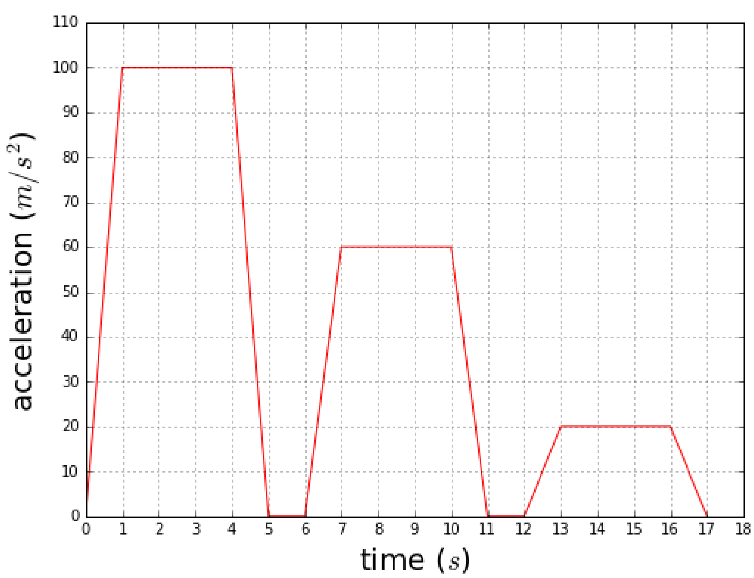
(h) Holding the box at a constant height, you slow to a stop in 1 s.

19. What is the difference between **displacement** and **distance**? Describe a situation in which an object travels a nonzero distance, yet experiences zero displacement.

20. What is the difference between **speed** and **velocity**? Describe a situation in which an object's speed is constant, but its velocity is changing.

21. *Particle accelerators*, as the name implies, are used to accelerate particles. These are used in a variety of experiments, such as colliders which smash particles together to better understand fundamental physics.

    Particles are not always accelerated at a constant rate, but rather experience "acceleration bursts". The graph below shows the acceleration of a particle, as a function of time. There are 3 different "acceleration bursts", (1) from 0 s to 5 s, (2) from 6 s to 11 s, and (3) 12 s to 17 s.



    (a) During which burst (1, 2 or 3) does the particle experience the **greatest change in velocity**? Please explain your answer.

(b) Describe the particle's motion from t=5 s to t=6 s.

(c) Assuming the particle begins at rest, when does the particle have the **greatest velocity**? What is this maximum velocity?

22. Cars are designed with "crumple zones", to reduce the impact of a collision on passengers. A person driving in winter skids on ice and collides their vehicle head on with a post. If they were initially traveling at 10 m/s, and during the crash the front compartment of their car crumples 1 m to absorb some of the impact, then:

    (a) What is the acceleration experienced by the driver in units of m/s^2? (**assume constant acceleration**)

    (b) What is the acceleration experienced by the driver in units of $g = -10\ m/s^2$?

    (c) In order for the driver to experience an acceleration of 1.8 g, what would their initial velocity need to be, assuming the car still crumpled by 1 m?

23. Two objects, each with mass m and a positive charge q, are pushed towards each other with some velocity. The following 2 images show the two as they approach each other. Image 1 represents their initial locations, where they are a distance $2r$ apart. Image 2 shows their final positions, where they are a smaller distance r apart. Use these images to answer the following questions.

(a) Is it possible to tell how the electric force between them changes? If so, does it increase, decrease or stay the same?

(b) Is it possible to tell how the electric potential energy changes? If so, does it increase, decrease or stay the same?

(c) Is it possible to tell how the gravitational force between them changes? If so, does it increase, decrease or stay the same?

(d) Is it possible to tell how the gravitational potential energy changes? If so, does it increase, decrease or stay the same?