PHYSICS 131 EXAM 1 12 September 2000

INSTRUCTIONS: Write your name on the front of the blue exam booklet. The exam is closed book, and you may have only a pen/pencil and a calculator (no stored equations or programs and no graphing). Show all of your work in the blue book. For problems II−V, an answer alone is worth very little credit, even if it is correct − so show how you get it.

Suggestions: Draw a diagram when possible, circle or box your final answers, and cross out parts which you do not want us to consider.

In all problems neglect the effects of air resistance.

I. *Multiple Choice Questions* (4 points each). Read each question carefully. Write the SINGLE correct answer in the grid given inside your blue book. No explanation is required, and no partial credit will be given.

Two stones are released from rest at a certain height, the second exactly one second after the first.

1. The difference in their speeds

A. increases. B. decreases. C. stays the same.

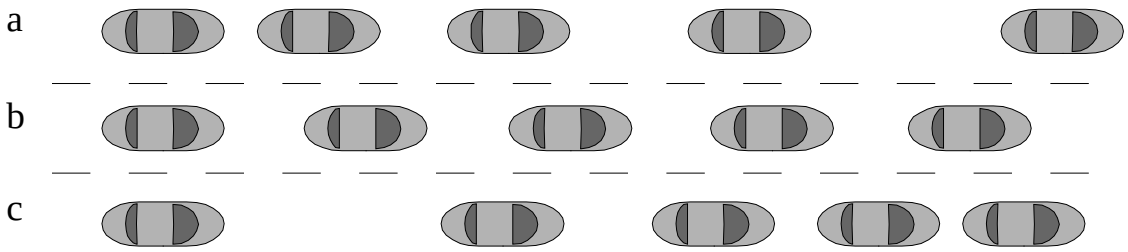
2. Their separation

A. increases. B. decreases C. stays the same.

3. The time interval between the instants at which they hit the ground will be

A. smaller than 1 sec. B. equal to 1 sec. C. larger than 1 sec.

4. The diagram below represents a multiple−exposure photograph of three cars traveling down the Toll Road in heavy pre−game traffic. Each exposure is taken exactly 1 second apart.



Which of the following gives a correct description of the motions shown in the photo?

A. car a accelerates, car b decelerates, car c moves at constant velocity.
B. car a decelerates, car b accelerates, car c moves at constant velocity.
C. car a accelerates, car b moves at constant velocity, car c decelerates.
D. car a moves at constant velocity, car b accelerates, car c decelerates.
E. car a decelerates, car b moves at constant velocity, car c decelerates.

5. A stealth bomber flying at an altitude of 5000 m and a speed of 620 km/hr drops a string of bombs, with each bomb leaving the plane 0.1 seconds after the previous one. How far apart horizontally are the impact craters that the bombs leave on the (flat) earth?

A. 34.4 m B. 17.2 m C. 9.8 m D. 62 m E. 50 m

Problems. (20 points each) Write the complete solutions in your blue book. Remember that no partial credit will be given for an answer with no supporting work.

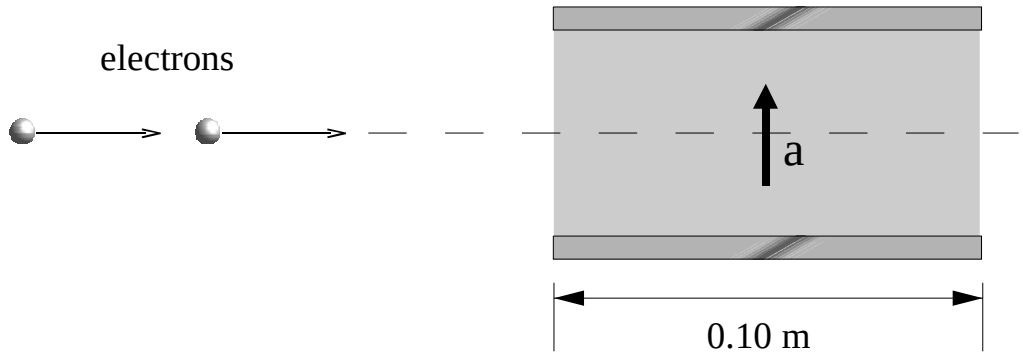
II. As the space shuttle burns up its fuel after takeoff, it gets lighter and lighter and its acceleration gets larger and larger.

(a) Copy the following set of axes into your blue book and sketch the velocity of the space shuttle as a function of time.

(b) Between the moment of lift−off and the time at which it has consumed nearly all of its fuel, is its *average speed* larger than, equal to, or less than **half** of its *final speed*? Explain.

III. Your TV set: A beam of electrons, each with an initial speed of 5.0×10^6 m/s is shot horizontally into a region where each electron experiences an upward acceleration of magnitude 5.0×10^{13} m/s^2. The acceleration is provided by the electric field in a capacitor of length 0.10 m, as drawn below. You can safely neglect gravity here.

(a) How long is each electron in the capacitor?
(b) What is the vertical deflection of each electron from its original horizontal path?



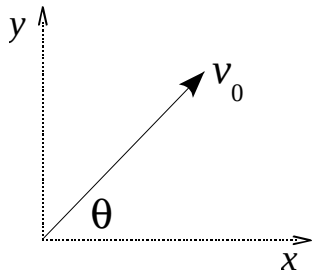
IV. An unlawful hunter is armed with a rifle that can shoot a bullet with muzzle velocity u. He spots a juicy−looking duck flying directly overhead with a velocity v and constant altitude h. For the following questions, assume the hunter fires the rifle when the duck is directly overhead.

(a) If the duck flies away from the hunter on a straight line, at what angle should he aim his rifle to hit the duck?

(b) If the muzzle velocity is 300 m/s, the duck's velocity is 20 km/hr, and the duck's height is 50 m, how long is the bullet in flight before it hits the duck?

(c) Assuming the effect of the bullet on the duck's velocity is negligible (except that the duck is killed), how long before the duck hits the ground?

V. A projectile is launched with speed v_0 at an angle θ from the surface of a planet where a mysterious force creates a constant horizontal acceleration $+a_x$. Also present is the usual gravitational acceleration which just happens to be that of earth (g).



(a) What is the ratio of the time taken for the projectile to reach maximum altitude to the time the projectile is in flight? (Prove your answer either mathematically or using a conceptual argument.)

(b) What is the range of the projectile?