Name: ____

PHYSICS 1050 Test 1
University of Wyoming
25 September 2008

This test is closed-note and closed-book. No written, printed, or recorded material is permitted, with the exception of a formula sheet with no writing on the back and one 3"×5" note card which may bear writing on both sides. Turn both in with your test when you are finished.

Calculators are permitted but computers are not. No collaboration, consultation, or communication with other people (other than the administrator) is allowed by any means, including but not limited to verbal, written, or electronic methods. Sharing of materials, such as calculators, formula sheets, and note cards, is prohibited.

If you have a question about the test, please raise your hand. If that does not get the administrator's attention, he will probably notice if you catch him with a header rope.

Please do not open this test booklet until everyone has received a booklet and the test administrator has indicated for you to begin. While you are waiting, make sure that your name is written clearly at the top of this page and on your note card.

A

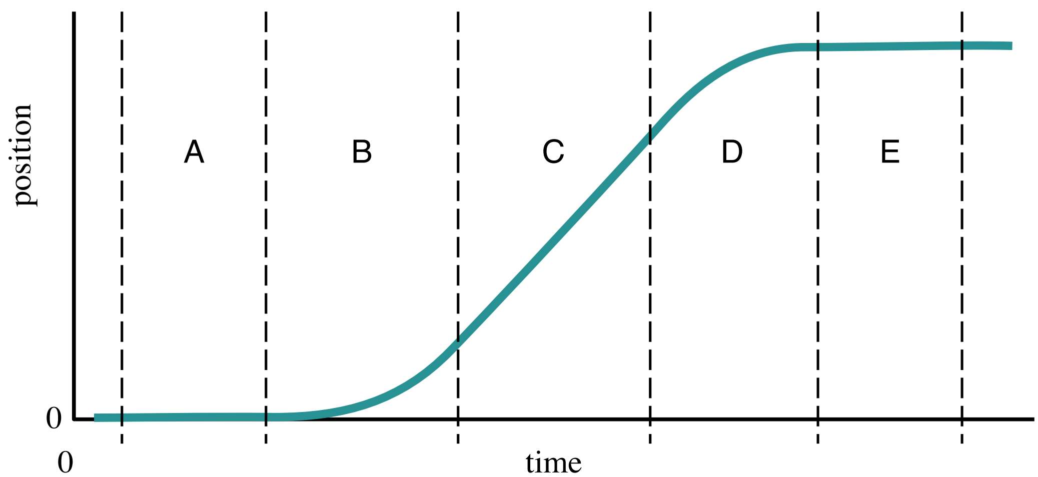
Scenario Problems

Four scenarios, 20 questions, 4 points each.

Please circle the correct answer or answers from the choices given.

Scenario 1: Motion graphs

Below is a graph of the position over time of an Army recruit climbing a rope. The graph's axes are oriented in the usual way, with time increasing to the right (→) and position increasing upward (↑). Five time intervals, A through E, are marked on the graph.



1. Which verbal description below agrees with the graph?

a. The recruit climbs up, stops, and then climbs down.

b. The recruit climbs up, stops, and then climbs up again.

c. The recruit climbs up, climbs down, and then stops.

d. The recruit waits, climbs upward for a little while, and then stops.

e. The recruit waits and then climbs upward at a constant speed.

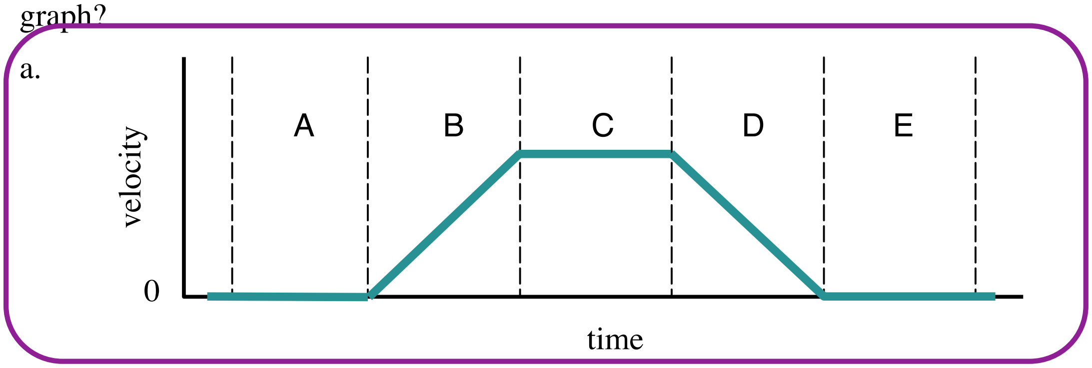
2. Over which interval is the recruit's *average speed* greatest? Circle only one choice.

a. A. b. B. c. C. d. D. e. E.

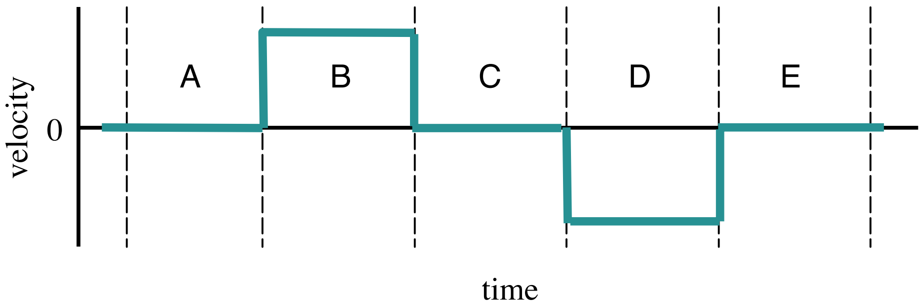
Steepest average slope.

3. Which plot below is a velocity-time graph consistent with the position-time graph?

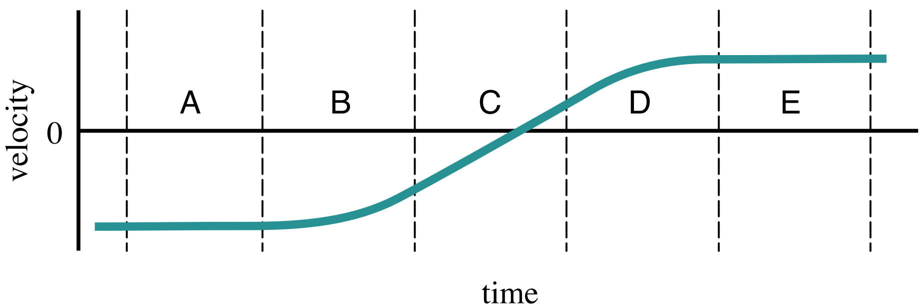
a.



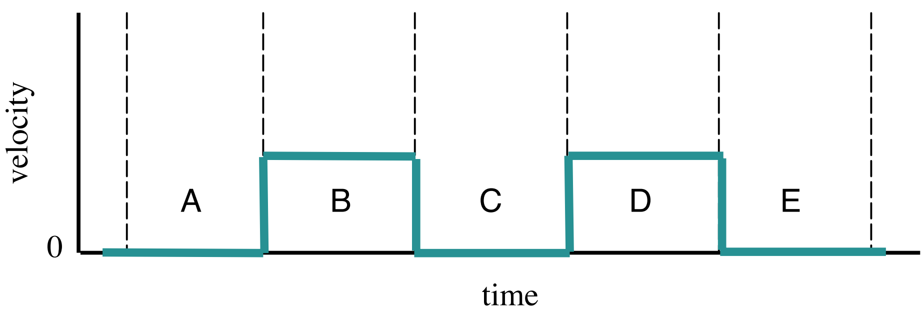
b.



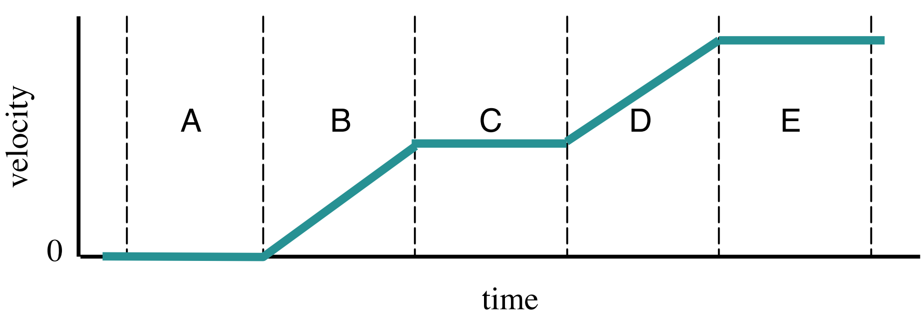
c.



d.



e.



4. During which interval or intervals is the recruit's *velocity* zero? Circle **all** that apply. Scoring is the fraction of correct choices minus the fraction of incorrect choices.

a. A. b. B. c. C. d. D. e. E.

Zero velocity when position-time graph is a horizontal line.

5. During which interval or intervals is the recruit's *kinetic energy* increasing? Circle **all** that apply. Scoring is the fraction of correct choices minus the fraction of incorrect choices.

a. A. b. B. c. C. d. D. e. E.

Kinetic energy increases when speed increases.

6. During which interval or intervals is the recruit's *momentum* positive? Circle **all** that apply. Scoring is the fraction of correct choices minus the fraction of incorrect choices.

a. A. b. B. c. C. d. D. e. E.

Momentum is positive when velocity is positive.

7. During which interval or intervals is the recruit's *acceleration* negative? Circle **all** that apply. Scoring is the fraction of correct choices minus the fraction of incorrect choices.

a. A. b. B. c. C. d. D. e. E.

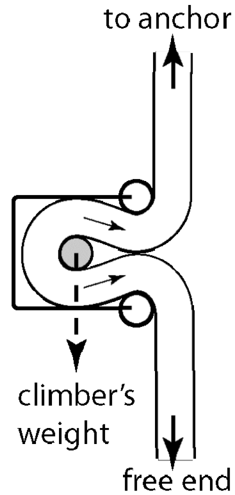
Velocity becoming less positive.

8. During which interval or intervals is the recruit's *velocity* constant? Circle **all** that apply. Scoring is the fraction of correct choices minus the fraction of incorrect choices.

a. A. b. B. c. C. d. D. e. E.

Straight line on position-time plot.

Scenario 2: Rappelling



A climber descends a rope. Her descent is controlled by running the rope through a buckle attached to her harness. The buckle kinks the rope around a post (shaded). To adjust her speed of descent, the climber pulls the free end of the rope taught below the buckle or actively feeds the rope into the buckle.

9. Inside the buckle, the tension of the rope above and below the center post pulls on the post in the directions shown by the small arrows. What is the direction of the *sum* of these forces on the post?

a. Up. ↑
b. Down. ↓
c. Right. →
d. Left. ←
e. Right, upward. ↗
f. Left, upward. ↖
g. Right, downward. ↘
h. Left, downward. ↙

The sum of the two vectors ↗ and ↘ is in the → direction.

10. One of the forces acting on the climber is the force of gravity. What is the *reaction force* that corresponds to it?

a. The upward pull of the rope on the climber.
b. The force of air resistance on the climber.
c. The support force upward on the climber.
d. The gravitational pull of the climber on the Earth.

This must be a force *on the Earth*, not on the climber. This force is gravity. Like all forces, it is *between* two objects.

11. What happens to the force of *friction* against the rope when the climber *increases* the *tension* below the buckle?

a. The force of friction *increases* when tension increases.
b. The force of friction *decreases* when tension increases.
c. The force of friction is *not affected* by the rope tension below the buckle.

The tension increases the normal force pushing the post and rope together. The friction is proportional to the normal force.

12. Under what conditions will the climber *decrease* her *speed* of descent?

a. It will decrease if the friction of the rope against the post is *greater* than her weight.
b. It will decrease if the friction of the rope against the post is *less* than her weight.
c. It will decrease if the friction of the rope against the post is *equal* to her weight.

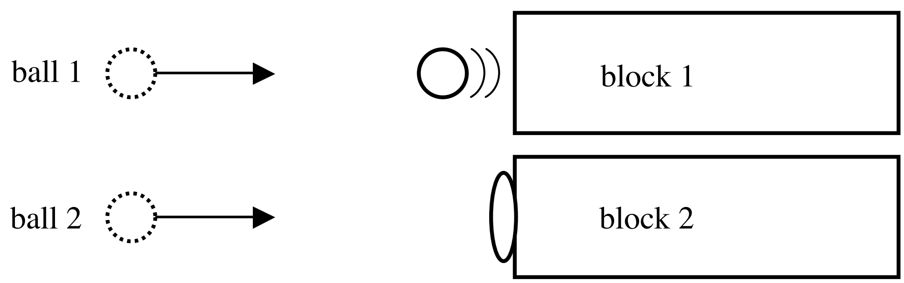
So that the net force is upward, opposing her downward motion.

Scenario 3. Elastic and inelastic collisions

A perfectly elastic ball of mass *m* (ball 1) moves through space at velocity *v* until it collides with a motionless, very massive block (block 1) of mass *M*, where $M > m$. When it collides, the ball rebounds in a perfectly elastic collision. After the collision, the block moves in the direction that ball 1 was initially moving.

Another perfectly *in*elastic ball (ball 2), of the same size, mass *m*, and initial velocity *v* as the elastic ball, collides with another motionless block (block 2) of mass *M*. This ball, however, sticks to the block in a perfectly *in*elastic collision. After the collision, the ball and block move together in the direction that ball 2 was initially moving.

In both cases, the balls and blocks float freely in space and receive no forces other than those of the collision.



13. After the elastic collision, which has the greater magnitude of *momentum*?

a. Ball 1.

b. Block 1.

c. Ball 1 and block 1 have the *same* magnitude of momentum after the collision.

The ball rebounds backwards, but the total momentum of the (ball + block) is still forward. So the block's momentum must exceed the ball's by enough to make the total value still in the forward direction.

14. After the inelastic collision, which has the greater magnitude of *momentum*?

a. Ball 2.

b. Block 2.

c. Ball 2 and block 2 have the *same* magnitude of momentum after the collision.

They have the same velocity, but the block's mass is greater than the ball's.

15. After the collisions, which has the greatest magnitude of *momentum*?

a. Ball 1.

b. Block 1.

c. Ball 2.

d. Block 2.

e. All four objects have the *same* magnitude of momentum after the collision.

Block 1 had more momentum transferred to it than block 2 did.

16. After the inelastic collision, which has the greater *kinetic energy*?

a. Ball 2.

b. Block 2.

c. Ball 2 and block 2 have the *same* kinetic energy after the collision.

They have the same speed, but the block has a much greater mass. The block's kinetic energy 1/2 Mv^2 exceeds the ball's kinetic energy 1/2 mv^2.

17. In which collision was *momentum* conserved? In other words, in which collision was (momentum of ball) + (momentum of block) the same before, during, and after the collision?

a. Momentum was conserved only in the *elastic* collision between ball 1 and block 1.

b. Momentum was conserved only in the *inelastic* collision between ball 2 and block 2.

c. Momentum was conserved in *both* collisions.

d. Momentum was *not* conserved in either collision.

Momentum is always conserved. Unlike energy, momentum does not have any different forms to convert into.

18. In which collision was *kinetic energy* conserved? In other words, in which collision was (kinetic energy of ball) + (kinetic energy of block) the same before, during, and after the collision?

a. Kinetic energy was conserved only in the *elastic* collision between ball 1 and block 1.

b. Kinetic energy was conserved only in the *inelastic* collision between ball 2 and block 2.

c. Kinetic energy was conserved in *both* collisions.

d. Kinetic energy was *not* conserved in either collision.

Kinetic energy is conserved in elastic collisions, but not in inelastic collisions. Energy as a whole is conserved, but the kinetic energy transforms into some other form (here, heat) in an inelastic collision.

19. Which ball had the most *work* done on it during the collision? (The work done is *negative* for both balls, so you need to select the one whose work has the *greatest absolute value*.)

a. Ball 1 had the most work done on it.

b. Ball 2 had the most work done on it.

c. Both balls had exactly the *same* amount of work done on them.

Ball 2's kinetic energy changed the most.

20. Which block has the greatest *speed* after the collision?

a. Block 1 has the greatest speed after the collision.

b. Block 2 has the greatest speed after the collision.

c. Both blocks have exactly the *same* speed after the collision.

Much greater momentum than block 2, but the same mass.

Short answer

2 questions, 10 points each.

Please provide complete answers to each question. Show all work so that partial credit can be assigned.

21. On Earth, any object acted upon only by the force of its own weight (that is, in free fall) falls with an acceleration of $g = 9.8$ m/s^2. Bodies other than the Earth, however, have different gravitational fields. On the planet Mercury, for instance, an object with a mass of 15 kg weighs 56.08 N. What is the acceleration of an object in free-fall on Mercury?

Under a gravitational field all masses accelerate equally.

On Mercury, gravitational force $F = 56.08$ N.

mass $m = 15$ kg

So acceleration $a = F/m = (56.08\text{ N})/(15\text{ kg}) = 3.74\text{ m/s}^2$

(Yes, the units work out. Check them yourself.)

22. Answer one, and only one, of the following questions. You may choose either one you wish. Clearly indicate which one you are answering.

a. Explain the difference between average velocity and instantaneous velocity. Your answer should indicate more than just how they are defined. How are they related, when are they similar, and when are they different?

b. All simple machines employ a trade-off between two quantities. What are those two quantities? What is the relationship between them? What is the fundamental principle of physics that requires this trade-off?

a. Average velocity is $\Delta v/\Delta t$ over some time interval: the distance traveled divided by the time elapsed. Instantaneous velocity is the limit of this expression as Δt gets very small (approaches zero). They will be similar when velocity does not change much, or as Δt gets small.

b. Simple machines trade off force and distance. The side applying or receiving the least force exerts it over the longest distance. The relation between the two is inverse, so that the work, $F\Delta d$, on both sides is the same. this is a consequence of conservation of energy.

Extra credit

23. (5 points) Choose the correct line to complete the following verse of one of the songs presented in lecture.

"Push a little bit
And you will always find there's a push on you.
Direction's opposite"

a. "But with a much bigger magnitude."

b. "And with the opposite magnitude."

c. "And it can have any magnitude."

d. "But with identical magnitude."