INSTRUCTIONS: Write your NAME and your SECTION (01: 8:30/Eskildsen, 02: 3:00/Tang) on the front of the blue exam booklet. The exam is closed book, and in addition to the equation compendium only pens/pencils and a calculator (no stored equations or programs and no graphing) may be used.

The distributed compendium must be returned at the end of the exam. Please do not write in it.

For problems II-V you must write the complete solution in your blue book. No credit (full or partial) will be given for an answer without supporting work. Draw a diagram when possible, circle or box your final answers, and cross out parts which you do not want us to consider.

I. Multiple Choice Questions (4 points each)

Read each question carefully. Write the *single* correct answer in the grid on the first page inside your blue book. No explanation is required, and no partial credit will be given.

MC1. If K has dimensions ML^2/T^2, the k in $K = kmv^2$ must

    A) have the dimensions ML/T^2.
    B) have the dimensions M.
    C) have the dimensions L/T^2.
    D) have the dimensions L^2/T^2.
   E) be dimensionless.

    Here M is mass, L is length and T is time.

MC2. The graph on the right is a plot of position versus time for a moving object during a particular time interval. Which of the following statements is correct?

    A) The speed of the object is constant.
    B) The speed of the object is negative.
    C) The acceleration of the object is zero.
    D) The acceleration of the object is positive.
   E) The acceleration of the object is negative.
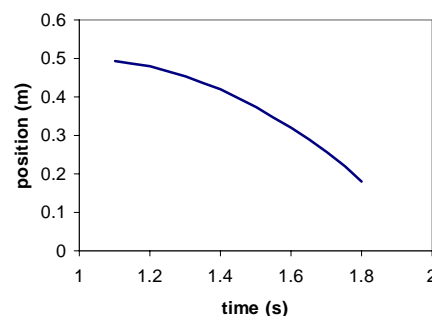
MC3. Ball A is released from rest and rolls down an incline while ball B rolls horizontally at constant speed. In the picture, the positions of balls A and B are marked at each second and the corresponding time stamps are shown near the positions. At which moment does ball A have the same speed as ball B?
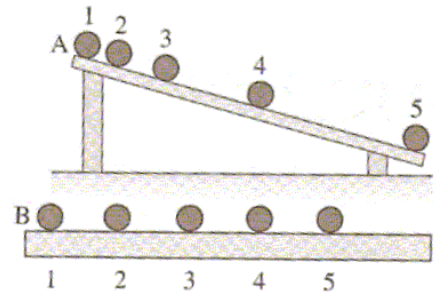
A) 1 s
B) 2 s
C) 3 s
D) 4 s
E) 5 s

MC4. A river is 80 m wide with a current of 0.8 m/s. A boat heads directly across a river, traveling at 1.6 m/s relative to the water (i.e. is it oriented as shown in the figure). How long does it take the boat to cross this river?
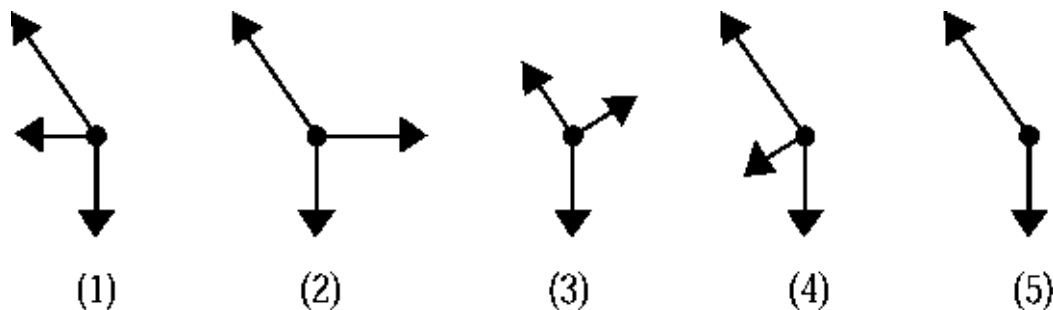
0.8 m/s
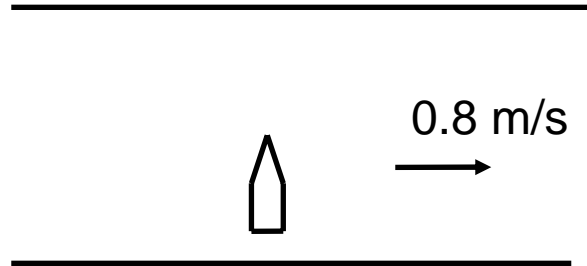
A) 50.0 s
B) 57.7 s
C) 100 s
D) 150 s
E) None of the above.

MC5. Which of the following free-body diagrams represents the car going downhill without acceleration?

A) 1
B) 2
C) 3
D) 4
E) 5
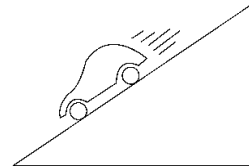
(1)   (2)   (3)   (4)   (5)

Problems (20 points each)

II.   The one-dimensional motion of a particle is plotted in the figure below.

   a) What is the average acceleration in the intervals AB, BC and CE? (6 pts)
   b) Find the displacement from the origin ($t = 0$) at the instant E. (10 pts)
   c) At what time is the particle traveling most slowly? (4 pts)
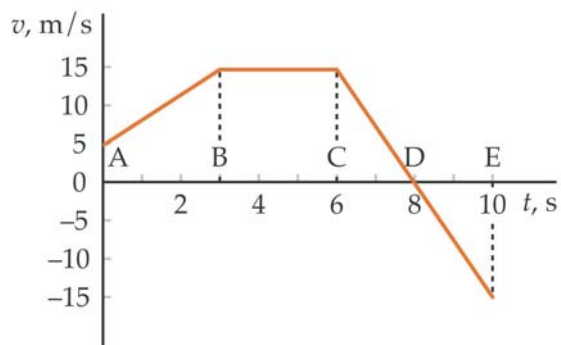
III.   A girl throws a ball at a height of 2 m above ground with an initial speed of $10\sqrt{2}$ m/s at an angle of 45 degrees with respect to horizontal.

   a) Define a reference frame for the problem and indicate the origin of the *x*- and *y*-axis. Find the *x* and *y* components of the initial velocity. (4 pts))
   b) Find the range of the ball when it hits the ground. (8 pts)

   A 5m high vertical wall stands 4 m away from the girl.

   c) Will the ball pass the wall? Why? (8 pts)
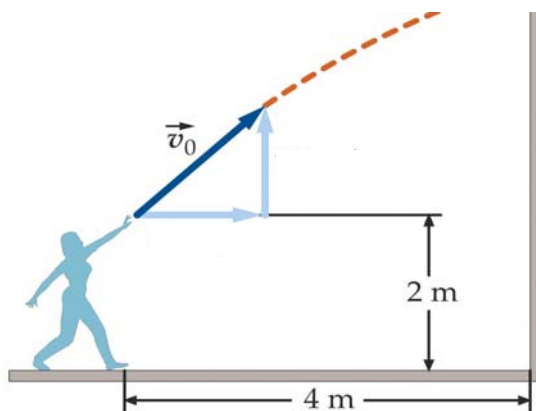
IV.   Block A has a mass of 1 kg and block B has a mass of 2 kg. They
      are being accelerated vertically upward with an acceleration of 1
      m/s^2. Assume the mass of the rope is negligible.

      a) Draw the free body diagrams for both block A and B. (6 pts)
      b) Find the magnitude of the tension T_2. (7 pts)
      c) Find the magnitude of the tension T_1. (7 pts)
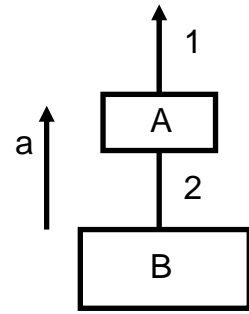
V.   The system in the figure is in static equilibrium.

      a) Draw free-body diagrams for the 6-kg block, the block with
          unknown mass (m), and the intersection between T_1, T_2 and
          T_3. (5 pts)
      b) Find the tensions T_1, T_2 and T_3. (9 pts)
      c) Find the mass m. (6 pts)