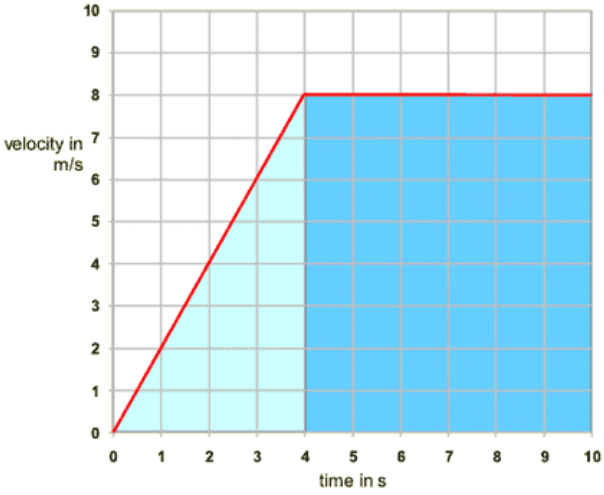
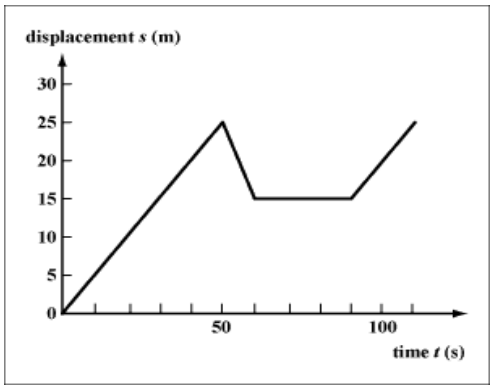
02 Mechanics review questions

Part A: Kinematics:



1. For the graph on the right state:
    a. The instantaneous velocity at t=3seconds
    b. The average velocity during the first 4 seconds
    c. The acceleration during the first 4 seconds
    d. The total distance travelled

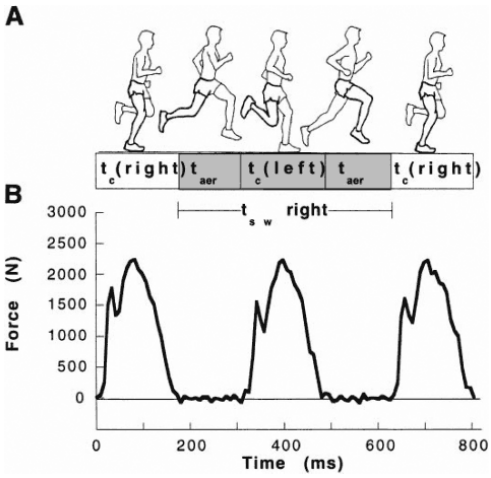


2. Plot a velocity-time graph for the motion represented by the graph on the left.
3. Explain, by considering acceleration why the graph you have drawn for question 5 is a simplification.
4. State what the area under an acceleration-time graph represents.
5. State the condition under which the equation ***s = (u+v)t/2*** is valid.
6. A ball is dropped near the surface of the Earth and if air resistance is negligible it would hit the ground 3 seconds later.
    a) How fast will the ball be travelling when it hits the ground?
    b) How far will the ball have travelled and what is its average speed?
    c) How much time did the ball take to travel the first 9.81 metres?
    d) How fast was the ball travelling after it had fallen 19.62 metres?
7. For the ball in question 6 air resistance is not, in fact negligible.
    a) How will this affect your answers to c) and d)?
    b) Will air resistance change the answer to c) or d) more? Explain.

Part B: Forces and Dynamics

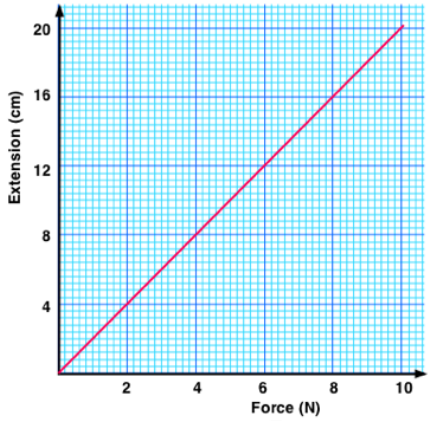
1. A 1kg block is sliding along a table. There is no force pushing it.
    a. Draw a force diagram for the block, labeling the forces and describe its motion.
    b. The block falls off the edge of the table, draw a force diagram for the block now.
    c. The block is caught and during the catch the maximum force on the ball was 30N upwards. Draw the force diagram at this moment and calculate the acceleration.
2. State the conditions of a system that are needed for the law of conservation of linear momentum to apply.
3. A rifle can shoot a 4.20 g bullet at a speed of 965 ms^{-1}. The bullet is fired into a 50.0 kg torso of a dummy wearing a bullet proof vest of 2.5kg. Ignoring friction with what velocity will the bullet, vest and torso be moving after the impact?

4. a) Estimate the (vertical) impulse on the ground exerted by a footfall using the graph on the right.
   b) Estimate the change in vertical velocity during one footfall for a person of mass 70kg.



Part C: Work, Energy and Power

1) A child pulls a sledge by pulling on a rope at an angle of 30^{o} to the horizontal. If the sledge is dragged 30m in this way and the force used is 10N how much work has been done?
2) a) The extension-force graph of a spring is shown opposite. How much work is done stretching it 0.2m?
   b) What type of energy is transferred to the spring?



3) A 1100kg lorry travelling at $24ms^{-1}$ collides with a 600kg car travelling at $19ms^{-1}$ in the same direction.
   a) After the collision the new speed of the car is 23m/s what is the new velocity of the lorry?
   b) Calculate the total amount of kinetic energy before and after the collision.
4) An 80kg skier starts from a velocity of $0.5ms^{-1}$ at the top of a slope 35m high. The average force of friction on the skier is 20N and the slope is 200m long.
   a) How fast is the skier travelling at the bottom of the slope?
   b) If the skier uses a drag lift to get back up the slope how much work does the drag list do if the average frictional force remains 20N?
   c) State the dynamic coefficient of friction for the skiis.
   d) If the static coefficient of static friction is 0.05 what is the maximum value of static friction? Explain why the static friction can be less that this value.

Part D: Projectile motion:

1. A stone is thrown from a hand at a velocity of $24ms^{-1}$ and an elevation of 40^{0} to the horizontal. The stone is 2m above the ground when released. Ignore air resistance.
   a. Calculate the horizontal and vertical components of velocity.
   b. Calculate the time taken for the stone to reach the top of its flight.
   c. Calculate the total flight time for the stone.
   d. Calculate the horizontal distance travelled by the stone.
   e. Calculate the velocity of the stone just before landing.
   f. Sketch the flight path of the stone with arrows drawn to scale to represent the velocity of the stone at the start, high point and landing.
2. A bullet is fired horizontally from a gun at 500ms-1 directly at a cross on a target. If the target is 200m away how far below the cross will the bullet hit?