2018-2019 Term 2

PHYS1001 Essential Physics

Assignment 1

Due date: 29th Jan, 2019 by 6:00 pm

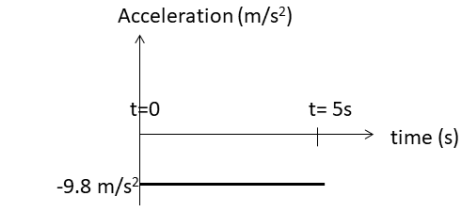
(Please leave your homework in the box with the label "PHYS 1001" outside room 213 in Science Centre North Block)

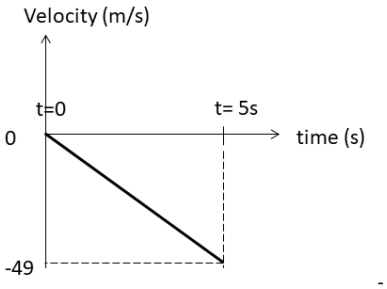
Use $g = 9.8\ \mathrm{m/s^2}$ in your calculation.

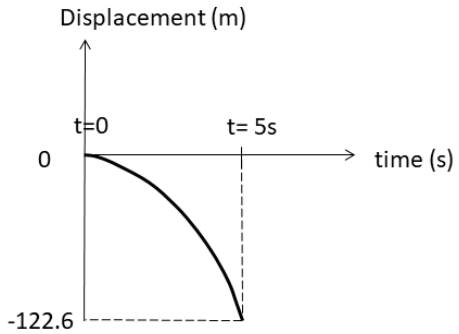
1. A car initially moves with a velocity of 70 km/h. When the car brake is applied, the car decelerates at 4 m/s^2. Calculate the distance travelled by the car before it stops.
   Answer:
   $$u = 70\frac{\mathrm{km}}{\mathrm{h}} = \frac{70(1000)}{3600} = 19.4\frac{\mathrm{m}}{\mathrm{s}}, \qquad a = -4, v = 0\ , s = ?$$
   $$v^2 = u^2 + 2as$$
   $$0^2 = (19.4)^2 + 2(-4)s$$
   $$s = 47.3\ \mathrm{m}$$

2. An object undergoes a uniform acceleration motion for 2s. The displacement of the object is 10m. The acceleration of the object is 1 ms^{-2}. What is the initial speed of the object?
   Answer:
   $$v = ?\ , a = 1\ \mathrm{m\ s^{-2}}, u = ?\ , s = 10\ \mathrm{m}\ , t = 2\ \mathrm{s}$$
   $$s = ut + \frac{1}{2}at^2$$
   $$10 = 2u + 2$$
   $$u = 4\ \mathrm{m\ s^{-1}}$$

3. A ball with mass 1 kg starts from rest and falls under the influence of gravity. Ignore the effect of air resistance in this question.
   (a) Draw three graphs, one for the acceleration, one for the velocity and one for the displacement of the ball as a function of time from *t*=0 to *t*=5s. Please take downward as negative.
   (b) How would you modify the above graphs if the ball has a mass 2 kg instead of 1 kg?
   Answer:
   (a)







(b) The graphs remain the same as before.

4. A ball is thrown vertical upwards with a certain initial velocity. When the ball is at a height 0.4 m above the starting point, the velocity is 3 m/s. Calculate the velocity of the ball when it is at a location 0.4 m below the starting point.

Answer:

The ball passes through the point 0.4 m above the starting point twice.

$v = 3$ m/s, $= -9.8$ m/s^2, $u =?$, $s = 0.4$ m

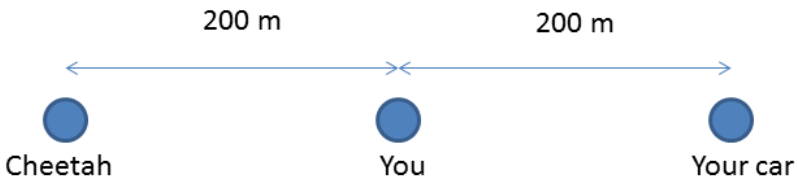
$$v^2 = u^2 + 2as$$
$$3^2 = u^2 + 2(-9.8)(0.4)$$
$$u = 4.10 \text{ m/s}$$

To find the velocity of the ball when it is ,

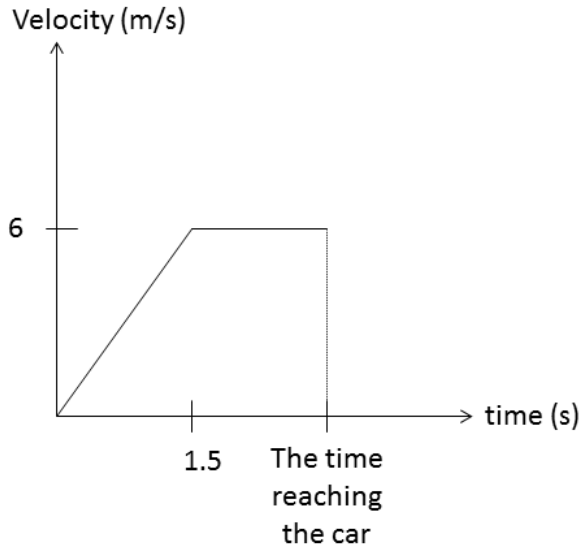
$$v = ?, a = -9.8 \text{ m s}^{-2}, u = 4.1 \text{ m s}^{-1}, s = -0.4 \text{ m},$$
$$v^2 = u^2 + 2as$$
$$v^2 = (4.10)^2 + 2(-9.8)(-0.4)$$
$$v = 4.97 \text{ m s}^{-1}$$

5. (a) A cheetah is the fastest running land animal with a speed of 109.4 km/h. How far does a cheetah reach in 10s?

(b) Suppose your car is 400 m away from a cheetah and you are standing at the mid-point between your car and the cheetah. You know that the cheetah has seen you and you start running towards the car.



(I) Your velocity-time graph is shown below. Calculate the acceleration in the first 1.5 s. (10%)



(II) How long does it take you to reach the car? (10%)

(III) Assume the cheetah runs at a constant velocity of 109.4 km/h. How long does the cheetah take to reach the car? Can you escape the tragic fate of being eaten by the cheetah? (10%)

Answer:

(a)

$$109.4\frac{\text{km}}{\text{h}} = 109.4 \times \frac{1000\text{ m}}{3600\text{ s}} = 30.4\text{ m/s}$$

In 10 seconds, the cheetah has traveled $30.4 \times 10 = 304$ m.

(b)(I) The velocity increases from 0 to 6 m/s in 1.5 seconds. The acceleration is

$$a = \frac{6-0}{1.5} = 4\text{ m s}^{-2}$$

(II) Area under the v-t graph =displacement. Let t be the time when I reach the car:

Area of trapezium = displacement

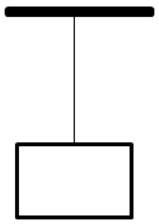
$$\left(\frac{(t-1.5)+t}{2}\right)(6)=200$$

$$t=34.1\ s$$

(IV) From (a), the cheetah runs at $30.4\ \mathrm{m/s}$.
Total displacement =400 m
Time required=400/30.4=13.16 s

The cheetah reaches the car earlier than I do. There is a high chance I will be eaten!

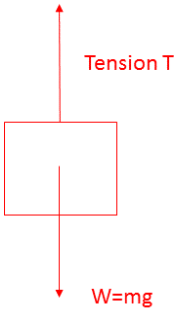
6. A block of mass 10 kg is attached to a string as shown below: The block remains at rest



(a) Draw a force diagram for the block.
(b) Determine the magnitude of all forces in the force diagram in (a).
(c) Now the string is cut, again draw a force diagram for the block. What happens to the block?

Answer:

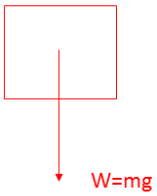
(a)



(b) The block is at rest. According to Newton's first law, the net force on the block is zero.

$$T=W$$
$$\Rightarrow T=mg=(10)(9.8)=98\ \mathrm{N}$$

(c)



There is a net force acting on the block. The net force is *mg*. According to Newton's second law, the net force is equal to the acceleration times the mass which means that the acceleration is *g* (downward).