Quiz 2 (motion and Newtons laws)

In this quiz you will get the same questions but with different numbers.

You will not get all 12 questions but will get a random selection of 6 of them. You, therefore, need to understand how to solve them all.

1) A car accelerates from 10 m/s to 15 m/s at a rate of 3.0 m/s^2. How far does it travel while accelerating?
Solution:

$$v^2 = v_o^2 + 2\ a\ \Delta x$$

$$15^2 = 10^2 + 2\ (3)\ \Delta x \Rightarrow \Delta x = 20.8\ m$$

2) A train starts from rest and accelerates uniformly, until it has traveled 5.6 km and acquired a velocity of 22 m/s. The train then moves at a constant velocity of 22 m/s for 420 s. The train then slows down uniformly at 0.10 m/s^2, until it is brought to a halt. The acceleration during the first 5.6 km of travel is closest to:
Solution:

$$v^2 = v_o^2 + 2\ a\ \Delta x$$

$$22^2 = 0^2 + 2\ a\ 5600 \Rightarrow a = 0.043\ m/s^2$$

3) A toy rocket is launched vertically from ground level (y = 0 m), at time t = 0.0 s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 50 m and acquired a velocity of 20 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground. The time interval, during which the rocket engine provides upward acceleration is

Solution:

The question asks for the time the engine provides upwards acceleration. Upwards acceleration is ONLY when the rocket is burning. This is called the burn phase. (After that it is in free fall and has downwards acceleration)

Solution : from the question we only need the information for the upward burn phase

$\Delta y=50m$
$v=20m/s$
$v_o=0$
t is what we want.

$$\Delta y = \frac{v_o + v}{2} t$$

$$50 = \frac{0 + 20}{2} t$$

t = 5 s

4) A racquetball strikes a wall with a speed of 40 m/s and rebounds with a speed of 30 m/s . The collision takes 17 ms. What is the average acceleration of the ball during the collision?

Solution:

(note: ms is milliseconds and not m/s)
The final velocity is a rebound, so it is in the opposite direction to the initial velocity. Thus, we make it negative.

$$v = v_o + a\,t$$

$$-30 = 40 + a\,(17x10^{-3})$$

a = - 4118 m/s^2

5) A projectile is fired at time t = 0.0 s, from point 0 at the edge of a cliff, with initial velocity components of v_{0x} = 40 m/s and v_{0y} = 30 m/s (Fig.3.1). The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 75.0 s.

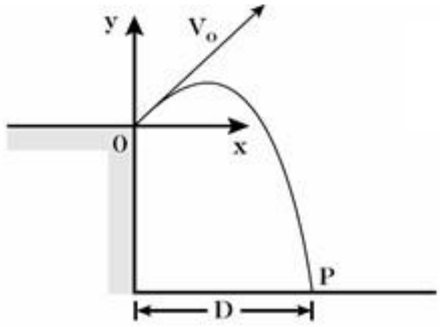


Figure 3.1: Projectile

The magnitude of the velocity at time t = 15.0 is

Solution:

In these questions we are given similar data. We are then asked a particular question. We may not use all the data given.

The question asks for the magnitude of the velocity. For that we need the x and y components first. In free fall the x component is constant as there is no acceleration in the horizontal (x) direction.
We have to work out the y component and then using vectors combine them.

$v_{ox} = v_x = 40$ m/s
$v_{oy} = 30$ m/s
$a = -9.8$ m/s^2
t = 15 s

$$v_y = v_{oy} + a\,t = 30 + \ -9.8\,(15) = \ -117\ m/s$$

so

$$v = \ \sqrt{117^2 + \ 40^2}$$

v = 124 m/s

6) A projectile is fired at time t = 0.0 s, from point 0 at the edge of a cliff, with initial velocity components of v_{0x} = 90 m/s and v_{0y} = 900 m/s The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 225.0 s.
The x-coordinate of the projectile when the y-component of velocity equals 720 m/s upwards is

Solution:

We want the x-**coordinate** (position) when the y **component** (velocity) is 720 m/s
Be careful of the words. Time is the comment factor. When its at a certain position it has a certain component at the same time. So, if we find time with one variable we can use it with the other variables.
In this question we can find t from the velocity component and then use that to find the position.

The time is common on x and y. In y-axis: find t

$$v_y = v_{0y} + a\,t$$
$$720 = 900 + -9.8 \times t$$
$$t = 18.4 \text{ s}$$

In x-axis: no acceleration

$$\Delta x = v_{0x}\, t = 90 \times 18.4 = 1656$$

Question 0.7 A projectile is fired at time t = 0.0 s, from point 0 at the edge of a cliff, with initial velocity components of v_{0x} = 80 m/s and v_{0y} = 800 m/s. The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 200.0 s.
In Figure 3.1, the height H of the cliff is closest to:
Solution:

$$t = 200\ s,\ \ a = -9.8\ m/s^2,\ \ v_{0y} = 800\ m/s$$
$$\Delta y = v_{0y}t + \frac{1}{2}\ a\ t^2\ \ =\ \ -36,000\ m$$

So 36,000 m is the height.

Question 0.8 A projectile is fired at time t = 0.0s, from point 0 at the edge of a cliff, with initial velocity components of v_{0x} = 125 m/s and v_{0y} = 900 m/s. The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 225.0 s. The horizontal distance D is
Solution:

$$\Delta x = v_{0x}\ t = 125 \times 225 = 28100\ m$$

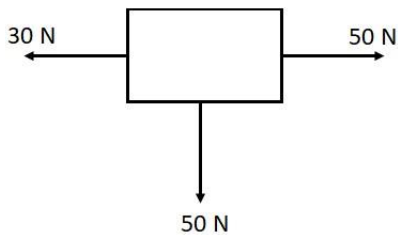
9) What is the mass of an object that experiences a gravitational force of 30 N near Earth's surface?

$$m = \frac{F}{g} = \frac{30}{9.8} = 3.1\ kg$$

10) If I weigh 800 N on Earth and 500 N on the surface of a nearby planet, what is the acceleration due to gravity on that planet?
Solution:
The mass is common

$$m = \frac{F}{g} = \frac{800}{9.8} = \frac{500}{g_p} \Rightarrow g_p = 6.1\ m/s^2$$

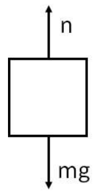
11) An object that weighs 50.0 N is pulled on a horizontal surface by a horizontal pull of 50.0 N to the right. The friction force on this object is 30.0 N to the left. The acceleration of the object is
Solution:



$$\sum F = m\ a$$

$$50 - 30 = \frac{50}{9.8}\ a \Rightarrow a = 3.92\ m/s^2$$

12) A 22 kg box must be slid across the floor. If the coefficient of static friction between the box and floor is 0.14, what is the minimum force needed to start the box moving from rest?
Solution:



$$F = f_s = \mu_s\, n = \mu_s\, m\, g$$

$$= 0.14 \times 22 \times 9.8$$

$$f_s = 30.2\ N$$