ex: 1

The moon revolves about the earth, making a complete revolution in (27.3 days). Assume that the orbit is circular and has a radius of (239.000 miles). What is the magnitude of the acc^{n} of the moon toward the earth?

Sol.

$r = 239000 \text{ miles} = 3.85 \times 10^{8} \text{ meter}$

The time for one complete revolution called The period is $T = 27.3 \text{ days} = 2.36 \times 10^{6} \text{ sec}$

The speed of the moon is therefore

$$v = \frac{2\pi r}{T} = \frac{2 \times 3.14 \times 3.85 \times 10^{8}}{2.36 \times 10^{6}} = 1020 \text{ m/s}$$

$$\therefore a = \frac{v^{2}}{r} = \frac{(1020)^{2}}{3.85 \times 10^{8}} = 0.00273 \text{ m/sec}^{2}$$

ex: 2

Calculate the speed of an artificial earth Satellite, assuming that it is traveling at an altitude h of (140 miles) above the surface of the earth where ($g = 30 \text{ ft/sec}^{2}$). The radius of earth R is (3960 mile

كل جسم حر ذاك سطح الارض ل ستلايت له تعجيل ارضي g يجعله يتابع
مركته الدائرية لهذا فالتعجيل المركزي هو g

Sol.

we have 1 mile = 5280 ft

$$a = \frac{v^2}{r}$$

$$g = \frac{v^2}{R+h} \quad ; v^2 = (R+h)g$$

$$v = \sqrt{(R+h)g}$$

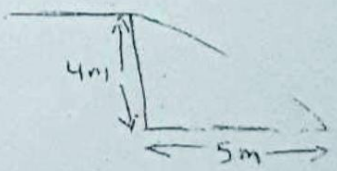
$$V = \sqrt{(3960+140)(5280)\ ft\ (30)\ \frac{ft}{sec^2}}$$

$$V = 2.55 \times 10^4\ ft/sec$$

Ex: 3

A ball rolls off the edge of a horizontal table top 4.0 ft high. If it strikes the floor at a point 5.0 m horizontally away from the edge of the table, what was its speed at the instant it left the table?

كرة تتدحرج على سطح منضدة افقية ارتفاعها 4.0m وتصطدم بالارض على بعد 5.0 m عن حافة المنضدة.



Sol.

$$v_{0x} = v_0 \quad ; v_{0y} = 0$$

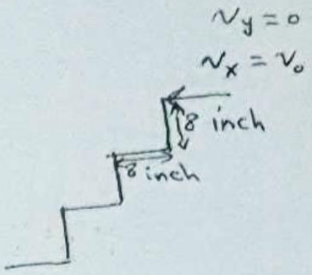
$$y = v_{0y}\,t + \frac{1}{2}gt^2$$

$$4 = 0 + \left(\frac{1}{2}\right)(10)t^2 \Rightarrow t^2 = \frac{4}{5} \longrightarrow t = 0.89\ sec$$

$$x = v_{0x}\,t \quad ; v_0 = \frac{x}{t} = \frac{5}{0.89} = 5.61\ m/sec$$

Y.4

A ball rolls off the top of a stair way with a horizontal velocity of magnitude 5 ft/sec. The steps are (8.0 inch) high and (8.0 inch) wide. which step will the ball hit first?



Sol.

$$x = v_0 t$$

$$y = v_{0y} t + \frac{1}{2} g t^2$$

$$y = 0 + \frac{1}{2} g t^2$$

at any step?

$$x = y$$

$$v_0 t = \frac{1}{2} g t^2 \Rightarrow 5 = \frac{32}{2} t \Rightarrow t = \frac{5}{16} \text{ sec}$$

The displacement in the x-direction

$$x = v_0 t = (5)\left(\frac{5}{16}\right) = \frac{25}{16} = 1.562 \text{ ft}$$

$$y = \frac{1}{2} g t^2 = \left(\frac{1}{2}\right)\left(\frac{32}{16}\right)\left(\frac{5}{16}\right)^2 = \frac{25}{16} = 1.562 \text{ ft}$$

$$= 18.75 \text{ inch}$$

عدد الدرج = المسافة الكلية / ارتفاع الدرجة = $\frac{18.75}{8} = 2.34$ inch

∴ it hit 3rd step.

ex: 5

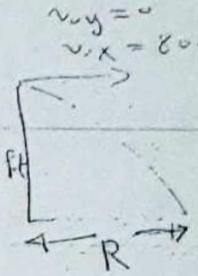
A shell is fired horizontally from a powerful gun Located 144 ft above a horizontal plane with a muzzle speed of (800 ft/sec).

(a) How long dose the shell remain in the air?

(b) what is its rang?

(c) what is the magnitude of the vertical component of its velocity as it strikes the target?

Sol:



(a) $y = v_{0y}t + \frac{1}{2}gt^2$

$144 = 0 + (\frac{1}{2})(32)(t^2)$

$t^2 = \frac{144}{16} \Rightarrow t = \frac{12}{4} = 3$ sec.

(b) $x = v_{0x}t = (800)(3) = 2400$ ft

(c) $v_y = v_{0y} + gt$

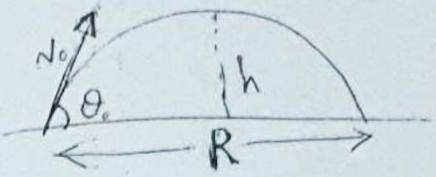
$= 0 + (32)(3)$

$= 96$ ft/sec

ex:6

Find the angle of projection at which the horizontal range and the maximum height of a projectile are equal.

Sol.



$$R = h$$

$$\frac{v_0^2}{-g}\sin 2\theta_0 = \frac{v_0^2 \sin^2\theta_0}{+2g}$$

$$2(\sin 2\theta_0) = \sin^2\theta_0$$

$$2(2\sin\theta_0\cos\theta_0) = \sin^2\theta_0$$

$$4\cos\theta_0 = \sin\theta_0$$

$$4 = \tan\theta_0 \Longrightarrow \theta_0 = \tan^{-1}4 = 76^\circ$$

ex:7

For elevations (angles of projection) which exceed or fall short of 45° by equal amounts, the ranges are equal . prove this statement

اثبت ان $R_1 = R_2$ عندما تكون الزاوية تزيد او تقل بنفس الكمية عن (45°)

Sol.

when $\theta_0 = 45^\circ - \theta$; $R = R_1$

$$R_1 = \frac{v_0^2 \sin 2\theta}{-g} = \frac{v_0^2 \sin 2(45-\theta)}{-g}$$

$$R_1 = \frac{v_0^2 \sin(90-2\theta)}{-g}$$

$$R_1 = \frac{-v_0^2 \cos 2\theta}{g}$$

when $\theta_0 = 45+\theta$; $R = R_2$

$$R_2 = \frac{v_0^2 \sin 2(45+\theta)}{-g} = \frac{v_0^2 \sin(90+2\theta)}{-g}$$

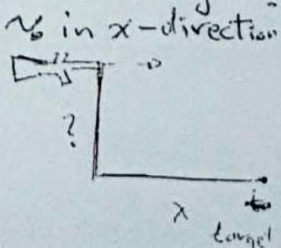
$$R_2 = \frac{-v_0^2 \cos 2\theta}{g}$$

$$\therefore \boxed{R_1 = R_2}$$

ex:8

A rifle with a muzzle velocity of 1500 ft/sec shoots a bullet at a small target 150 ft away. How high above the target must the gun be aimed so that the bullet will hit the target?

Sol.



$$x = v_0 t$$

$$150 = 1500\, t$$

$$t = \frac{150}{1500} = \frac{1}{10} = 0.1 \text{ sec}$$

$$y = v_{0y} t + \frac{1}{2} g t^2 \Rightarrow y = 0 + \left(\frac{1}{2}\right)(32)(0.1)^2 = 0.16 \text{ ft}$$

ex: 9

A magnetic field will deflect a charged particle perpendicular to its direction of motion. An electron experiences a radial acc$^{n.}$ of $(3.0\times10^{14}\ m/s^2)$ in one such field. what is its speed if the radius of its curved path is (0.15 meter)?

Sol.

مجال مغناطيسي فكر جسيمة مشحونة عموديا على اتجاه الحركة، التعجيل المركزي للالكترون $3\times10^{14}\ m/s^2$ في هذا المجال. ما هي سرعته اذا علمت ان نصف قطر المنحني $0.15m$

$$a_R = 3.0\times10^{14}\ m/sec^2$$

$$R = 0.15\ m$$

$$a_R = \frac{v^2}{R} \Longrightarrow v^2 = a_R R = (3.0\times10^{14})(0.15)$$

$$v = \sqrt{(3\times10^{14})(0.15)} = 6.7\times10^{6}\ m/sec$$

ex: 10

In Bohr's model of the hydrogen atom an electron revolves around a proton in a circular orbit of radius $(5.28\times10^{-11}$ meter) with a speed of $(2.18\times10^{6}\ m/sec)$ what is the acc$^{n.}$ of the electron in the hydrogen atom?

المطلوب تعجيل الالكترون في ذرة بور، الالكترون يدور حول نواة نصف قطرها $(5.28\times10^{-11}\ m)$ وسرعة $(2.18\times10^{6}\ m/s)$

Sol.

$R = 5.28 \times 10^{-11}$ m

$v = 2.18 \times 10^{6}$ m/s

$$a_R = \frac{v^2}{R} = \frac{(2.18 \times 10^6)^2}{5.28 \times 10^{-11}} = \frac{4.75 \times 10^{12}}{5.28 \times 10^{-11}}$$

$$\boxed{a_R = 0.9 \times 10^{23} \text{ m/sec}^2}$$

ex: 11

Find the magnitude of the centripetal acc. of a particle on the tip of a fan blade (0.3 meter) in diameter rotating at (1200 rev./min.

revolution = rev.

Sol.

$$R = \frac{\text{diameter}}{2} = \frac{0.3}{2} = 0.15 \text{ m}$$

radius of the fan

$2\pi r$ = الدورة الواحدة تعني محيط الدائرة

$$a_R = \frac{v^2}{R}$$

$$v = \frac{2\pi r \times 1200}{60} = \frac{(2)(3.14)(0.15)(1200)}{60}$$

$v = 18.84$ m/sec

$$\therefore a_R = \frac{(18.84)^2}{0.15} = 2366.3 \text{ m/sec}^2$$

ex: 12

The earth revolves about the Sun in a nearly circular orbit with a nearly constant speed of (30 Km/sec). what is the acc^{n}. of the earth toward the Sun?

Sol.

$$v = \frac{2\pi r}{T} = \frac{\text{محيط الدائرة (المسافة)}}{\text{الزمن لدورة واحدة}}$$

$$r = \frac{vT}{2\pi} = \frac{(30\times10^{3})(360)(24)(3600)}{2(3.14)}$$

$$r = 1.48\times10^{11}\ m$$

$$\therefore a = \frac{v^{2}}{r} = \frac{(30\times10^{3})}{(1.48\times10^{11})} = 6.08\times10^{-3}\ m/sec$$