Name____

Physics 110 Quiz #2, April 9, 2021

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. A ball is thrown from ground level $18m$ below a window and is seen to pass upwards past the window with a speed of $14\frac{m}{s}$. What was the initial launch speed of the ball?

$$v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \to v_{iy} = \sqrt{v_{fy}^2 + 2g\Delta y} = \sqrt{\left(14\frac{m}{s}\right)^2 + 2 \times 9.8\frac{m}{s^2} \times 18m} = 23.4\frac{m}{s}$$

2. What was the maximum height reached by the ball above the ground?

$$v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \to 0 = v_{iy}^2 - 2g\Delta y \to y_f = \frac{v_{iy}^2}{2g} = \frac{\left(14\frac{m}{s}\right)^2}{2 \times 9.8\frac{m}{s^2}} = 28m$$

3. How long does it take the ball to reach ground level again?

Time to rise to maximum height from the ground:

$$v_{fy} = v_{iy} + a_y t \to 0 = v_{iy} - gt \to t_{rise} = \frac{v_{iy}}{g} = \frac{14\frac{m}{s}}{9.8\frac{m}{s^2}} = 2.4s$$

Time to fall from maximum height to the ground

$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 \to t_{fall} = \sqrt{\frac{2y_f}{g}} = \sqrt{\frac{2 \times 28m}{9.8\frac{m}{s^2}}} = 2.4s$$

Time of flight is the sum of these two times or, $t = t_{rise} + t_{fall} = 2.4s + 2.4s = 4.8s$

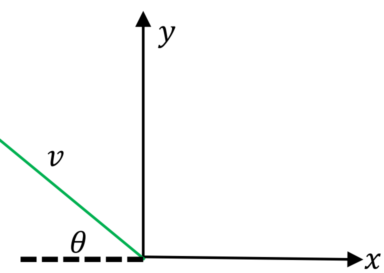
4. At what time(s) is the ball at a height of $y = 12m$ above the ground?

$$y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \rightarrow 12m = 23.4\frac{m}{s}t - \frac{1}{2}\left(9.8\frac{m}{s^2}\right)t^2$$

$$0 = -4.9t^2 - 23.4t - 12 \rightarrow t = \frac{23.4 \pm \sqrt{(-23.4)^2 - (4 \times -4.9 \times -12)}}{2(-4.9)}$$

$$t = \begin{cases} 0.59s \ \ (on\ the\ way\ up) \\ 4.19s \ \ (on\ the\ way\ down) \end{cases}$$

5. Suppose that the ball was launched at an angle of θ, measured with respect to the ground for $0^0 < \theta < 90^0$ at a speed v as shown on the right. The components of the ball's velocity are given by which of the following?



a. $v_x = v\cos\theta$ & $v_y = v\sin\theta$.
b. $v_x = -v\cos\theta$ & $v_y = v\sin\theta$.
c. $v_x = v\cos\theta$ & $v_y = -v\sin\theta$.
d. $v_x = -v\cos\theta$ & $v_y = -v\sin\theta$.
e. None of the above give the correct components of the final velocity of the ball.

Physics 110 Formulas

Motion

$\Delta x = x_f - x_i$ $\quad v_{avg} = \frac{\Delta x}{\Delta t}$ $\quad a_{avg} = \frac{\Delta v}{\Delta t}$

Equations of Motion

displacement: $\begin{cases} x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 \\ y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \end{cases}$

velocity: $\begin{cases} v_{fx} = v_{ix} + a_x t \\ v_{fy} = v_{iy} + a_y t \end{cases}$

time-independent: $\begin{cases} v_{fx}^2 = v_{ix}^2 + 2a_x Dx \\ v_{fy}^2 = v_{iy}^2 + 2a_y Dy \end{cases}$

Uniform Circular Motion

$F_r = ma_r = m\frac{v^2}{r}; \quad a_r = \frac{v^2}{r}$

$v = \frac{2pr}{T}$

$F_G = G\frac{m_1 m_2}{r^2}$

Geometry /Algebra

Circles *Triangles* *Spheres*

$C = 2pr$ $\quad A = \frac{1}{2}bh$ $\quad A = 4pr^2$

$A = pr^2$ $\quad V = \frac{4}{3}pr^3$

Quadratic equation : $ax^2 + bx + c = 0$,

whose solutions are given by : $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

magnitude of a vector: $v = |\vec{v}| = \sqrt{v_x^{\;2} + v_y^{\;2}}$

direction of a vector: $\phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Useful Constants

$g = 9.8\,{}^{m}/{}_{s^2}$ $\quad G = 6.67´\ 10^{-11}\,{}^{Nm^2}/{}_{kg^2}$

$N_A = 6.02´\ 10^{23}\,{}^{atoms}/{}_{mole}$ $\quad k_B = 1.38´\ 10^{-23}\,{}^{J}/{}_{K}$

$s = 5.67´\ 10^{-8}\,{}^{W}/{}_{m^2K^4}$ $\quad v_{sound} = 343\,{}^{m}/{}_{s}$

Linear Momentum/Forces

$\vec{p} = m\vec{v}$

$\vec{p}_f = \vec{p}_i + \vec{F}Dt$

$\vec{F} = m\vec{a}$

$\vec{F}_s = -k\vec{x}$

$F_f = mF_N$

Work/Energy

$K_t = \frac{1}{2}mv^2$

$K_r = \frac{1}{2}Iw^2$

$U_g = mgh$

$U_S = \frac{1}{2}kx^2$

$W_T = FdCos\,q = DE_T$

$W_R = tq = DE_R$

$W_{net} = W_R + W_T = DE_R + DE_T$

$DE_R + DE_T + DU_g + DU_S = 0$

$DE_R + DE_T + DU_g + DU_S = -DE_{diss}$

Heat

$T_C = \frac{5}{9}[T_F - 32]$

$T_F = \frac{9}{5}T_C + 32$

$L_{new} = L_{old}(1 + aDT)$

$A_{new} = A_{old}(1 + 2aDT)$

$V_{new} = V_{old}(1 + bDT) : b = 3a$

$PV = Nk_BT$

$\frac{3}{2}k_BT = \frac{1}{2}mv^2$

$DQ = mcDT$

$P_C = \frac{DQ}{Dt} = \frac{kA}{L}DT$

$P_R = \frac{DQ}{DT} = esADT^4$

$DU = DQ - DW$

Rotational Motion

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$\omega^2{}_f = \omega^2{}_i + 2\alpha\Delta\theta$

$\tau = I\alpha = rF$

$L = I\omega$

$L_f = L_i + \tau\Delta t$

$\Delta s = r\Delta\theta : v = r\omega : a_t = r\alpha$

$a_r = r\omega^2$

Sound

$v = fl = (331 + 0.6T)\,\frac{m}{s}$

$b = 10\log\frac{I}{I_0}; \quad I_o = 1´\ 10^{-12}\,\frac{W}{m^2}$

$f_n = nf_1 = n\frac{v}{2L}; \quad f_n = nf_1 = n\frac{v}{4L}$

Fluids

$\rho = \frac{M}{V}$

$P = \frac{F}{A}$

$P_d = P_0 + \rho gd$

$F_B = \rho gV$

$A_1v_1 = A_2v_2$

$\rho_1A_1v_1 = \rho_2A_2v_2$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho gh_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho gh_2$

Simple Harmonic Motion/Waves

$w = 2pf = \frac{2p}{T}$

$T_S = 2p\sqrt{\frac{m}{k}}$

$T_P = 2p\sqrt{\frac{l}{g}}$

$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$

$x(t) = A\sin\left(\frac{2pt}{T}\right)$

$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2pt}{T}\right)$

$a(t) = -A\frac{k}{m}\sin\left(\frac{2pt}{T}\right)$

$v = fl = \sqrt{\frac{F_T}{m}}$

$f_n = nf_1 = n\frac{v}{2L}$

$I = 2p^2f^2rvA^2$