Projectiles

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6D

Question: 6

a

$$R(\longrightarrow)$$

$$u = \frac{s}{t}$$

$$x = Ut\cos\alpha$$

$$t = \frac{x}{U\cos\alpha}$$

$$R(\downarrow)$$

$$s = ut + \frac{1}{2}at^2$$

$$y = U\sin\alpha - \frac{gt^2}{2}$$

$$\begin{aligned} y &= U\sin\alpha\frac{x}{U\cos\alpha} - \frac{gt^2}{2} \\ &= U\sin\alpha\frac{x}{U\cos\alpha} - \frac{g}{2}\frac{x}{U\cos\alpha}^2 \\ &= x\tan\alpha - \frac{gx^2}{2U^2\cos^2\alpha} \\ &= x\tan\alpha - \frac{gx^2}{2U^2}\sec^2\alpha \\ &= x\tan\alpha - \frac{gx^2}{2U^2}\left(1+\tan^2\alpha\right) \end{aligned}$$

b

$$
\begin{aligned}
x &= Ut\cos\alpha \\
&= U\frac{v-u}{a}\cos\alpha \\
&= U\frac{-2U\sin\alpha\cos\alpha}{-9.8} \\
&= \frac{U^2\sin 2\alpha}{9.8} \\
&= \frac{30^2\sin 90}{9.8} \\
&= 91.8m
\end{aligned}
$$

c

$$
\begin{aligned}
t &= \frac{v-u}{a} \\
&= \frac{-2U\sin\alpha}{-9.8} \\
&= 4.3s
\end{aligned}
$$

Question: 7

a

$$
\begin{aligned}
y &= U\sin\alpha\frac{x}{U\cos\alpha} - \frac{gt^2}{2} \\
&= U\sin\alpha\frac{x}{U\cos\alpha} - \frac{g}{2}\frac{x}{U\cos\alpha}^2 \\
&= x\tan\alpha - \frac{gx^2}{2U^2\cos^2\alpha}
\end{aligned}
$$

$$
\begin{aligned}
0.9 &= 9\tan\alpha - \frac{9^2 g}{2U^2\cos^2\alpha} \\
0.9 &= 9\tan\alpha - \frac{81g}{2U^2\cos^2\alpha}
\end{aligned}
$$

b

$$
\begin{aligned}
0.9 &= 9\tan 30 - \frac{81g}{2U^2\cos^2 30} \\
0.9U^2 - 9\tan 30U^2 &= -\frac{81g}{2\cos^2 30} \\
U &= \sqrt{\frac{-\frac{81*-9.8}{2\cos^2 30}}{0.9 - 9\tan 30}} \\
U &= 16.9ms^{-1}
\end{aligned}
$$

Mixed Exercises 6

Question: 6

a

Need to find half of what the total time would be if it hit the ground again.

$$\begin{aligned} t &= \frac{v-u}{a} \div 2 \\ &= \frac{-U\sin\alpha}{-9.8} \\ &= \frac{40\sin 30}{9.8} \\ &= 2.04s \end{aligned}$$

b

$$\begin{aligned} s &= ut - \frac{1}{2}at^2 \\ 15.1 &= 40t\sin 30 - \frac{1}{2}9.8t^2 \\ t &= 3.0816, 1 \\ t &= 3.082s \end{aligned}$$

c

$$\begin{aligned} R(\longrightarrow) & \\ u &= 40\cos 30 \\ &= 20\sqrt{3} = 34.64 \\ R(\downarrow) & \\ s &= vt - \frac{1}{2}at^2 \\ vt &= \frac{1}{2}at^2 - s \\ v &= \frac{1}{2}at + \frac{s}{t} \\ &= \frac{1}{2} * -9.81 * 3.082 + \frac{15.1}{3.082} \\ &= -10.244 = -10.2 \end{aligned}$$

$$\begin{aligned} V &= \sqrt{\left(20\sqrt{3}\right)^2 + -10.244^2} \\ &= 36.1ms^{-1} \end{aligned}$$

Question: 7

a

$$
\begin{aligned}
s_y &= ut + \frac{1}{2}at^2 \\
-0.2 &= 0t - \frac{1}{2} * 10 * t^2 \\
0.04 &= t^2 t \qquad\qquad\qquad\qquad\qquad\qquad = 0.2s
\end{aligned}
$$

$$
\begin{aligned}
s_x &= ut + \frac{1}{2}at^2 \\
&= 0.2 * 10 \\
&= 2m
\end{aligned}
$$

b

$$
\begin{aligned}
y &= x\tan\alpha - \frac{gx^2}{2U^2}\left(1 + \tan^2\alpha\right) \\
0 &= 2\tan\alpha + \frac{10 * 2^2}{2 * 10^2}\left(1 + \tan^2\alpha\right) \\
0 &= \frac{1}{5}\tan^2\alpha + 2\tan\alpha + \frac{1}{5} \\
\tan\alpha &= -5 \pm 2\sqrt{6} = -0.101, -5.898 \\
\alpha &= \text{??? Near to } \pi\text{, so throwing back and up?}
\end{aligned}
$$