Edinburgh Napier UNIVERSITY

Physics-Based Animation (SET09119)

Tutorial 06 - Energy, Work & Power

1 Question

Assuming the mass of $1m^3$ of water is $1000kg$. Find the work done in giving $1m^3$ of water a velocity of $8ms^{-1}$.

$$\begin{aligned}\text{change K.E.} &= \frac{1}{2}mv^2 \\ &= \frac{1}{2}(1000)(8) \\ &= 32000J \\ &= 32kJ\end{aligned}$$

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2 Question

Find the work done in raising a body of mass $50kg$ a distance of $8m$ into a space craft stationary on the surface of the moon. (Take the moon's gravity to be $1.65ms^{-2}$).

$f = ma = (50)(1.65) = 82.5N$

$$\begin{aligned}\text{work done} &= (force)(distance) \\ &= (82.5)(8) \\ &= 660J\end{aligned}$$

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3 Question

A frog of mass $40kg$ slides down a slide inclined at 60^0 to the horizon. The frog starts from rest and there is a constant frictional resistance of $60N$. What velocity will the frog pass the point $10m$ from his starting point (2 decimal places)? (gravity is $9.8ms^{-2}$).

Gravitational force has to be split into the horizontal and vertical components acting on the slope (i.e., f=ma).
horizontal (to the surface):

$$\begin{aligned} f &= (40)(9.8)(sin(60^0)) - 60 \\ &= (339.48) - (60) \\ &= 279.48N \end{aligned}$$

Remember, change in K.E. = (force)(distance) = $\frac{1}{2}mv^2$

$$fd = (279.48)(10) = \frac{1}{2}mv^2$$

solve for v

$$\begin{aligned} v &= \sqrt{\frac{2fd}{m}} \\ &= 11.82ms^{-1}(2.d.p) \end{aligned}$$

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4 Question

A bullet of mass 10 grammes, velocity $600ms^{-1}$, enters $2.4m$ into the protective sandbags before coming to a rest. What is the resisting force of the sandbags (assumed constant)?

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force multiplied by distance is the change in kinetic energy (i.e., $fd = \frac{1}{2}mv^2$)

note - 10g is 0.01kg

$$(F)(2.4) = \frac{1}{2}(0.01)(600^2)$$

solve for F

$$F = 750N$$

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5 Question

A body of mass $20kg$ slides down a smooth plane inclined at 30^0 to the horizon. Initially it is at rest. What is the speed when it has travelled $5m$ down the plane? (gravity is $9.8ms^{-2}$).

The force along the plane f = (m)(a)sin(angle) = (20)(9.8)sin(30^0) = (20)(9.8)(0.5) = 98 N.

$$
\begin{aligned}
fd &= \frac{1}{2}mv^2 \\
v &= \sqrt{\frac{2fd}{m}} \\
&= \sqrt{49} \\
&= 7ms^{-1}
\end{aligned}
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6 Question

A crane raises a $5000kg$ steel girder at $0.4ms^{-1}$. Assuming that work is not lost in driving the crane, what is the power of the crane's engine? (gravity is 9.8)

The formula for power:

$$Power = \frac{Work}{time}$$

and

$$work = (force)(distance)$$

Hence:

$$power = \frac{(force)(distance)}{time} = (force)\frac{distance}{time} = (force)(velocity)$$

$$
\begin{aligned}
f &= ma \\
&= (5000)(9.8) \\
power &= (5000)(9.8)(0.4) \\
&= 19600W \\
&= 19.6kW
\end{aligned}
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