Isaac Physics | Linking Concepts 1.

Gravitational potential and kinetic energy

Please note: these solutions are not endorsed by Isaac Physics!

If you want to improve your understanding of the underlying physics then **you** have to work through the questions in the Linking Concepts book from Isaac Physics. There are answers in the back of the book for Question 1 and you can check your other answers by entering them at **isaacphysics.org**. This is just an example of how to work through a chapter.

Objects rising and falling exchange stores of gravitational potential and kinetic energy.

Example context: We can calculate the speed of objects after they have fallen. We can also work out the height to which a projected object rises. The analysis is particularly useful when balls bounce.

Quantities:				
	h_0	starting height (m)	v_0	starting speed (m s^{-1})
	h_1	final height (m)	v_1	final speed (m s^{-1})
	m	mass (kg)	g	gravitational field strength (N kg^{-1})
	E_K	kinetic energy (J)	E_{GP}	gravitational potential energy (J)
	η	efficiency (no unit)	E_T	total energy (J)

Equations: $E_K = ½\, m\, v^2$ $\quad E_{GP} = m\, g\, h$ $\quad E_T = E_K + E_{GP}$ $\quad E_{T,after} = \eta\, E_{T,before}$

1.1 In the absence of air resistance, use the above equations to derive expressions for:

a. the speed v_1 at the ground if an object was dropped from h_0.

b. the speed v_1 at a height h_1 if an object had speed v_0 at h_0.

c. the greatest height h_1 for an object projected up from the ground with speed v_0.

d. the greatest height h_1 for an object projected up from a height h_0 with speed v_0.

e. the greatest height h_1 above a hard surface reached by an object dropped from a height h_0 if the efficiency of the bounce is η.

f. the speed v_1 just after a bounce from a hard surface if the speed just before was v_0 (if the efficiency of the bounce is η).

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1.2 An 800 kg pumpkin falls from 3.4 m. Calculate its speed just before striking the ground.

1.3 A 60 g tennis ball is hit upwards at 27 m s^{-1}. How high will it rise?

1.4 A 60 g tennis ball is hit upwards at 27 m s^{-1} from a 25 m rooftop. How fast will it be travelling when it passes the rooftop on the way down?

1.5 A 3.1 kg brick falls from scaffolding on a building site. A worker 3.5 m above the ground sees it fall past at 6.5 m s^{-1}. What is its kinetic energy just before striking the ground?

1.6 At what speed will a 4.2 kg lump of clay hit a potter's wheel if it is thrown downwards at 1.1 m s^{-1} from a height 40 cm above the wheel?

1.7 A worker at ground level throws a 2.2 kg drinks bottle upwards to a thirsty colleague 3.2 m above the ground. It just reaches him, but he fails to catch it, and it falls into an excavated trench 1.6 m below ground level.

a. At what speed did the worker need to throw the bottle if she threw it from the waist, 1.0 m above the ground?

b. How fast was it moving when it struck the base of the trench?

1.8 A 5.2 g ball is dropped from 90 cm onto a surface and bounces to a maximum height of 41 cm. Calculate the efficiency, η.

1.9 How fast would the ball, in question 1.8 above, rebound if it struck the surface at 2.5 m s^{-1}?

1.10 How high would a ball bounce if it struck an η = 0.75 surface at 13 m s^{-1}?