No Brain Too Small ● PHYSICS

Energy

Definitions

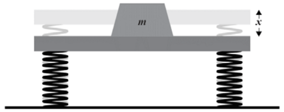
The law of conservation of energy: The total energy of a system remains constant; it is said to be conserved. Energy can neither be created nor destroyed; rather, it can only be transformed or transferred from one form to another.

Equations

Equation	Quantity	Symbol	Unit
$W = Fd$	Work done	W	J
	Force	F	N
	displacement	d	m
$E_k = \frac{1}{2}mv^2$	Kinetic Energy	E_k	J
	mass	m	kg
	velocity	v	m s^{-1}
$\Delta E_p = mg\Delta h$	Potential Energy	E_p	J
	Acceleration due to gravity	g	m s^{-2}
	height	h	m
$E_p = \frac{1}{2}kx^2$	Potential Energy	E_p	J
	Force Constant	k	N m^{-1}
	Extension	x	m
$P = \frac{W}{t}$	Power	P	W
	Work done	W	J
	time	t	s

Questions

THE BRIDGE (2020;3)



Jo and Alex need to cross a bridge.

(a) The bridge has an earthquake-protection system made up of springs. Before being put in place on the bridge, the springs are tested by being loaded with a mass m. When loaded with a mass m the springs compress by a distance x. Explain, in depth, how the size of the mass on the springs needs to change in order to compress the springs a distance 2x from the original length.

(b) Jo and Alex wonder whether a compressed spring from the bridge could accelerate their car once the spring is released, as in the diagram below. They decide to determine the effect of the spring on the car's motion. They estimate that for this spring, a force of 50 000 N would compress the spring length from 6.0 m to 4.2 m. The total mass of the car and occupants is 1600 kg.

(i) Calculate the maximum speed to which this spring could accelerate the car and its occupants if it was compressed to 4.2 m. You should start your answer by first determining the spring constant, k.

(ii) What assumption(s) have you made in this calculation?

Terms

Work: Work is done when a force makes something move or tries to stop it moving. Whenever work is done **energy** is transformed.

Kinetic Energy: The energy an object has because of its movement.

Gravitational Potential Energy: When an object is able to gain kinetic energy in the future on account of its **position**, being raised above ground, it has Gravitational Potential Energy

Elastic Potential Energy: The energy stored in a stretched or compressed spring

Power: The rate of change of energy (or work done) is Power.

Tips

- Memorise the short version of the law of conservation of energy "Energy can neither be created nor destroyed" – it is almost always required

Answers

(a) *F* = k*x,* Double *m* means double the force, which means double *x*, since k is constant.

(b)

$50\,000 = k \times 1.8$

$k = 27\,777.8$

$E = \frac{1}{2}kx^2 = \frac{1}{2} \times 27\,777.8 \times 1.8^2$

$= 45\,000 \text{ J}$

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

$45\,000 \text{ J} = \frac{1}{2} \times 1600 v^2$

$v = 7.5 \text{ m s}^{-1}$

(c) Energy is conserved. Assumes all the energy from the spring is transferred to the car.OR no energy lost to accelerating the spring