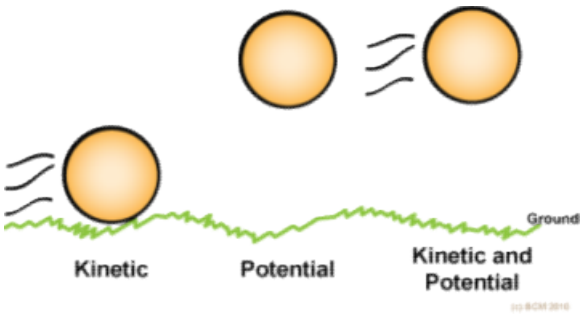
Name: Class:

Total Possible Marks: 20

Kinetic and Potential Energy



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1. Anything that is moving has energy in its kinetic energy store. Energy is transferred to this store when an object speeds up and is transferred away from the store when an object slows down. The energy in the kinetic energy store depends on the object's mass and speed.

   The equation for kinetic energy is:

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

   Where 'm' is the mass in kilograms, and 'v' is the velocity in metres per second.

___ 1 a) A motor vehicle with a mass of 1250 kg is moving at 22 m/s. Calculate the kinetic energy in its kinetic energy store.

___ 1 b) A motorcycle holds 1.17×10^4 J in its kinetic energy store. The motorcycle is moving along at 12 m/s, what is the mass of the motorcycle in kilograms?

___ 1 c) The motorcycle in part (b) picks up the pillion passenger with a mass of 42 kg. The rider continues his journey and accelerates up to a constant speed of, once again, 12 m/s. Given this new information, calculate the new kinetic energy in the kinetic energy store.

___ 10

2. A science student has a mass of 85 kg. He runs up some stairs carrying a 10 kg box. The staircase is 10 m high and it takes him 7 seconds to reach the top.

___ 2 a) How much energy has been transferred to the gravitational potential energy store of the student and the box when he reaches the top of the stairs?

___ 2 b) What is the power output of the student as he runs up the stairs?

___ 2 c) At the top of the stairs, the student walks along the corridor still carrying the box. Calculate the students velocity if the total energy in the kinetic energy store of the student and the box is 153.9 J. State your answer in metres per second.

___ 4 d) The student then stops and drops the box from a height of 1.25 m. Calculate the speed at which it hits the ground, stating any assumptions you may make. State your answer in metres per second to 2 significant figures

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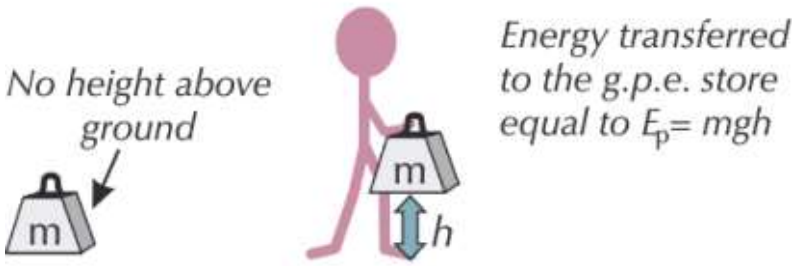

Lifting an object in a gravitational field requires work, this causes a transfer of energy into the objects gravitational potential energy store (sometimes simply referred to as potential energy or PE). The amount of energy transferred depends on the mass of the object, the distance through which it is lifted and the gravitational field force it is experiencing. On earth the gravitational field forces approximately 9.81 N per kilogram.

The formula to calculate gravitational potential energy is:

$$GPE\ (PE) = m \times g \times h$$

Where 'm' is the mass in kilograms, 'g' is the gravitational field strength in newtons per kilogram and 'h' is the height in metres.

___ 1 a) A 50 kg mass is slowly raised through a height of 6 m, find the energy transferred to its gravitational potential energy stored. The gravitational field strength should be taken as 9.8 N per kilogram.

___ 1 b) A flea of mass 1.0×10^{-3} g jumps vertically from the ground. The gravitational field strength is 9.8 N per kilogram. At the top of the jump the flea has gained 1.96×10^{-6} J of energy in its gravitational potential energy store. How high has the flea jumped?

___ 2

4. A communications engineer with a mass of 125 kg stands at the top of the Eiffel Tower, making some repairs to the transmitters.

   The Eiffel Tower stands at a height of 300 m but including the transmitters this rises to 324 m.

___ 1 a) What is the gravitational potential energy stored in the man's GPE store? Take the gravitational field strength to be 9.81 N per kilogram.

___ 1 b) When the engineer climbs down from the transmitters back to the 300 m point, how much gravitational potential energy has he lost (if any)

2 5. Another energy store similar to gravitational potential energy is elastic potential energy. Stretching or squashing object for example a spring or a rubber ball can transfer elastic potential energy to the objects elastic potential energy store. The energy stored can be found using the equation:

$$E = 1/2\ ke^2$$

Where E is the elastic potential energy in Joules, 'e' is the extension in metres and 'k' is the spring constant in Newtons per metre

1 a) A spring with a spring constant of 40 N per metre is stretched from its normal length of 8 cm to a stretched length of 23 cm. Calculate the energy transferred to its elastic potential energy store.

1 b) A spring is stretched by 60 cm, which transfers 18 J of energy to the springs elastic potential energy store. What is the value of the spring constant?

1

6. A construction worker is laying bricks at the top of a 200 m tall block of flats. Each brick weighs approximately 1.2 kg. As the worker goes to pick up a brick he accidentally knocks it, and it falls to the ground. Taking the value of 'g' to be 9.81 N per kilogram, calculate the speed at which the brick hits the ground.