A-level Mathematics: Energy

Priority Learning

Revision Sheet

Name: _____ **Date**: _____

Aims of this revision sheet:

- Learning the fundamental principles of energy.
- Learning about energy transfers.
- Learning and memorising the basic equations needed for your course.

Formulae and Definitions

In this section we explore what moments are and how to calculate them.

These are the formulae we will be using in this revision sheet and corresponding worksheet. It is highly recommended you commit them all to memory as most exam boards do not give them in the formula books. It should be no effort memorising them all as by the time you have your exam, you should have practiced enough questions that it becomes second nature to use these equations.

Weight

$$W = mg$$

- Weight is the force of gravity on an object.
- $m \implies$ mass of the particle $\implies$ kg.
- $g \implies$ acceleration due to gravity $\implies$ 9.81ms^{-2}.

Kinetic Energy

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

- Kinetic energy: The energy a particle has due to it moving (having velocity).
- $m \implies$ mass of the particle $\implies$ kg.
- $v \implies$ velocity $\implies$ ms^{-1}.

Gravitational Potential Energy

$$\text{GPE} = mg\Delta h$$

- The energy a particle has due to it's position in a gravitational field.
- $m \implies$ mass of the particle $\implies$ kg.
- $g \implies$ acceleration due to gravity $\implies$ ms^{-2}.
- $\Delta h \implies$ the change in height of the particle $\implies$ m.

Elastic Potential Energy

$$\text{EPE} = \frac{1}{2}kx^2$$

- The energy stored in an elastic object that has been stretched beyond it's natural length.
- $k \implies$ spring constant of the spring $\implies$ Nm.
- $x \implies$ the extension of the spring beyond it's natural length $\implies$ m.

Work Done

Work done is the rate at which energy is transferred. It is given by the equation,

$$\text{W.D.} = F \times d$$

Where F is the net force in the direction of motion and d is the distance moved.

Conservation Of Energy

Energy cannot be created or destroyed, only transferred from one form into another. The total energy in a closed system remains constant.

Example - Basket Ball

A ball of mass 3kg is dropped from 12m, and it lands in a basket 4m above the ground. How fast was the ball going when it entered the basket?

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Example - Basic Spring

1. If a spring has a spring constant of 3N/m, and we put a 5kg mass on the end, it extends 2m.

   (a) How much energy is stored in the spring?

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   (b) The spring snaps and the mass is released. Calculate the initial velocity of the mass.

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Example - Dropping A Ball

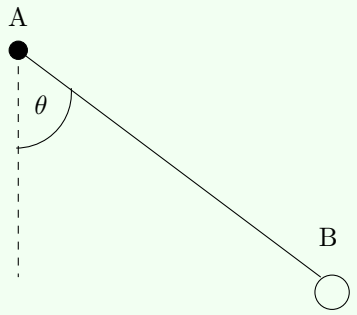
A ball of mass 2kg is dropped from a height of 10m. How fast is it going just before it hits the ground?

Example - Rough Slope

A ball of mass 1kg rolls down a rough slope, 10m long and inclined at 30 degrees to the horizontal. The friction between the ball and the slope is 4N. How fast is it going at the bottom?

Example - Truck On An Incline

A truck of mass 10000kg drives up an incline where for every 20m horizontally the road climbs 1m. The driving force of the truck is 10kN and the friction between the truck and road is a constant force of 3kN. The truck is pulling a car which has one fifth the mass of the truck. The car is being pulled by a towbar, the tension in the towbar is a constant 2kN. The initial speed of the truck is 15ms^{-1}. How far does the truck travel before doubling it's speed.

Example - Pendulum

A ball of mass 2kg is attached to a light inextensible string of length 2.5m fixed at the point A. It is dropped from the point B, as shown in the diagram. The maximum speed of the ball is $v\text{ms}^{-1}$, find the value of v given $\theta = 20$.