Exercises - Energy, work and power

In the following questions, assume acceleration due to gravity to be 10 m/s^2.

E_k = **Kinetic** energy (J) $\boxed{E_k = \frac{mv^2}{2}}$

E_p = Gravitational **potential** energy (J) $\boxed{E_p = m\ g\ h}$

E_m = **total mechanical** energy and is the sum of both energies: $\boxed{E_m = E_K + E_p}$

1. At what height does a body of 500 kg need to be in order for it to have 200 joules of Ep?

2. Calculate the mass of a ball if it moves with a velocity of 72 km/h and its kinetic energy is 1000J.

3. A steel ball has a mass of 1500 g. How much work have we done if we raise it 4m?

If we let it fall, what velocity will it have when it reaches the ground? What is its E_m at the instant it hits the ground?

4. How many m^3 of pure water is there in a water-tower situated at 10 m above the ground if its E_p is 200 KJ?

Power (P) is the speed with which work is produced, i.e., work per unit of time.

$\boxed{P = \frac{W}{t}}$ The SI unit of power is the **watt (W)** $\boxed{1\ W = 1\ J/s}$

5. Calculate the work done by a crane when it lifts an iron bar of 1.5 tonnes to a height of 3 m above the ground.

How much power, in watts, has the motor if it took 2 minutes to lift the bar?

Work (W) is a measure of the mechanical energy transferred from one body to another when a force is exerted to produce displacement.

$\boxed{W = F \cdot s}$ Energy is needed to do work.
The SI unit of both energy and work is the **joule (J)**; $\boxed{1\ J = 1\ N \cdot m}$

6. Catrina took two minutes to carry a bucket, containing 5 litres of water, from the well to her home 50 m away. If the empty bucket had a weight of 4 N, what was the rate of work done?

7. What force does a 1.5MW motor of a pump have if it fills a container with water 10 m above the ground in one and a half minutes?

How many m^3 of water does the deposit contain?

8. I let a ball of 200 g fall from a roof. It takes 1.75 s to reach the floor. Determine:
a) the mechanical energy it has when it hits the floor,

b) the E_p and the velocity the ball has when it is one metre from the roof.

9. Calculate the work done by a car with a mass of half a tonne if it takes 10 s to accelerate from 0 to 90 km/h. We do not take the force of friction with the ground and the air into account.

10. Calculate the muscular power, in watts, realised by an athlete in a 100 m race if he reaches the finishing line with a velocity of 72 km/h. He took 10 s to complete the race, and his mass is 65 kg. We do not take the force of friction with the ground and the air into account.

11. The work done when lifting a ball of iron with a mass of 10 000 g was 125 J. Calculate:
a) the velocity with which the ball reaches the floor if it is dropped,

b) the height from which it is dropped

c) the mechanic energy of the ball when it hits the floor.

12. A force of 100 N is applied to stop a car of 4 tonnes in 10 seconds. Calculate:
a) the power developed over this time
b) the kinetic energy the car had three seconds before coming to a full stop.

13. I let a marble of 20 g fall. In this instant, its potential energy is 100J. What is its velocity, in km/h as it reaches the floor?

14. Calculate the power in kW developed by a truck when it lifts a gold bar of 40 cm^3 4 m up in the air.

The bar later falls. What potential energy does it have the instant it has a velocity of 3,6 km/h? The density of gold = 19,3 g/ cm^3.

15. An object of 400 g has a velocity of 18 km/h. We apply a 0.8 N force in the same direction as it movenment, for 6 seconds. Determine the space covered by the object and the kinetic energy it has when 6s have passed. We do not take the force of friction into account.