Work Done

Stored energy can only be moved from one store to another. We say it is _____ from one store to another. You cannot _____ energy from nothing or _____ it. This is the idea of **Conservation of Energy**.

Mechanical energy transfer happens when there is a _____ that has made the object _____. We say that force does _____ to transfer energy. The amount of **work done** by the force is given by:

$$\begin{array}{ccccc} \text{work done} & = & \text{force} & \times & \text{distance} \\ W & = & F & \times & s \end{array}$$

The work done tells us _____ has been taken from one _____ and moved to another. It is measured in _____ (J).
If there is a _____ in energy, work has been done. The _____ cannot always be seen.

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1 Which of these forces do work? How do you know?

(a) The 2 N weight of a ball on a table.

(b) The force of friction on a box sliding across the floor.

(c) A cook stirring soup.

(d) The force in an elastic band stretched around a stack of letters.

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2 You pick up a ball from the floor with a force of 1 N and put it on a table 1 m high. Complete the sentences.

(a) You have done 1 N × 1 m = ☐ J of work.

(b) You pick up a second ball and place it on a shelf 2 m high. How much work have you done?

$$\begin{array}{ccccc} \text{work done (J)} & = & \text{force (N)} & \times & \text{distance (m)} \\ \square & = & 1 & \times & \square \end{array}$$

Now you pick up 4 balls with a total force of 4 N and put them on the 1 m high table. How much work has been done?

$$\begin{array}{ccccc} \text{work done (J)} & = & \text{force (N)} & \times & \text{distance (m)} \\ \square & = & \square & \times & \square \end{array}$$

3 A ball falls off a shelf onto the ground. The weight of the ball does 4 J of work. Complete the sentences using the words **increases, increased, decreases, gravitational potential energy, kinetic energy, 4 J**.

(a) As the ball falls to the ground, the ball's **kinetic energy** store _____ compared to when it was on the shelf

(b) As the ball falls to the ground, the ball's **gravitational potential energy** store _____ compared to when it was on the shelf.

(c) 4 J have been transferred from the _____ store to the _____ store of the ball. This last store has _____ by _____.

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4 A lorry drives along a flat road at a steady 30 mph. It reaches the bottom of a hill and continues to maintain its speed as it goes up the hill. Complete the sentences using the words **decreases, increases, stays the same**.

(a) The lorry's kinetic energy store _____.

(b) The lorry's gravitational potential energy store _____.

(c) The chemical store of the fuel _____.

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5 A shopper pushes a trolley with a 4 N force for 5 m.

(a) Complete this: The distance the shopper pushes the trolley is [ ] m.

(b) Work out how much work they have done.

work done (J)	=	force (N)	×	distance (m)
	=	4	×	_

(c) How much work will they do if they push the trolley 7 m using an equation.

work done (J)	=	force (N)	×	distance (m)
	=	4	×	_

(d) How much work will the shopper do to push the trolley 12 m?

(e) How much work will the shopper do to push the trolley 12 m with a force of 6 N?

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6 Complete the word equation with the words **work done, distance, force**.

[ ] = [ ] × [ ]

7 A submarine at the surface sinks down to 33 m below the surface of the sea. It is pulled down with a force of $10\,000$ N. How much work was done on the submarine?

work done (J)	=	force (N)	×	distance (m)
	=		×	

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8 Place these in order of increasing amount of work being done:

(a) A crane picking up 3 crates of bricks and moving them up 10 m.

(b) A crane picking up 3 crates of bricks and moving them up 15 m.

(c) A crane picking up 5 crates of bricks and moving them up 15 m.

(d) A crane picking up an empty crate and moving it up 10 m.

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9 The work done to pull 10 bricks up a certain height has been recorded and put in the following table.

Height (m)	1	5	10	15	20
Work done (J)	200	1000		3000	4000

(a) What was the amount of work done needed to reach 10 m?

(b) How much potential energy do the bricks have at a height of 10 m?

(c) What height would be reached after doing $10\,000$ J of work?

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10 Three friends try push a car that has a flat battery. Each friend pushes with a force of 200 N and the car moves forwards 5 m. What is the total amount of work done on the car?

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11 A heavy suitcase weighing 200 N $(20$ kg of mass$)$ has to be lifted on to the storage rack above the seats on a train. This means raising it a height of 2 m.

(a) How much work is done on the suitcase?

(b) As it is so heavy, it is easier to swing it up there. How much extra work is done if you swing it an extra 0.2 m above the top of the rack?

(c) Along a sharp bend in the railway line, the suitcase falls off the rack. How much work is done on the suitcase by gravity as it falls to the floor?