

Chapter 5:

5.3 Work

Objectives:

1. **Identify** work تعريف الشغل.
2. **Relate** work to Kinetic energy ربط الشغل بالطاقة الحركية.
3. **Solve** problems on work-energy theorem حل مسائل.

Vocabulary



force (noun)

the push or pull on an object with mass



دفع أو سحب جسم كتلته يؤدي إلى تغيير في سرعة الجسم

Vocabulary



gravitational force (noun)

a force that attracts two objects with mass



قوة الجاذبية

Vocabulary



work (noun)

the energy transfer to or from an object due to a net force



الشغل

Vocabulary



work-energy theorem (noun)

states that the change in kinetic energy of an object is equal to the work done by an external net force acting on the object



نظرية الشغل و الطاقة

Recall: Kinetic energy

Previously, you learned that the formula for the kinetic energy of an object is:

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

Handwritten annotations in red: 'J' with an arrow pointing to 'KE', 'kg' with an arrow pointing to 'm', and 'm/s' with an arrow pointing to 'v'.

The mass of an object is usually constant, so, to change the kinetic energy, a change in speed is needed.

Q: What do you call an object that experiencing a change in speed?

A: Accelerating



According to Newton's second law (قانون نيوتن الثاني), and object accelerates when acted upon by a net force.

Work

Definition

Work is the energy transferred to or from an object as the result of the action of a force. Positive work is a transfer of energy to the object, and negative work is a transfer of energy from the object.

التعريف

الشغل هو الطاقة التي تنتقل إلى جسم أو من جسم نتيجة لحركة قوة. يمثل الشغل الموجب انتقال الطاقة إلى الجسم ويمثل الشغل السالب انتقال الطاقة من الجسم.

- If an object's motion changes, work has been done on the object.
- Work can be positive, negative, or zero. الشغل يكون موجب، سالب أو صفر.
- Work is energy, so the unit of work is Joule, J. وحدة القياس (ال جول).

Work

- Work is **positive** when kinetic energy is transferred **to** the object the net force acts on. الشغل موجب عند انتقال الطاقة إلى الجسم.
- Example: the force of gravity الجاذبية does **positive work** on a falling apple, transferring gravitational potential energy into kinetic energy.

$$W_g = +$$




Work

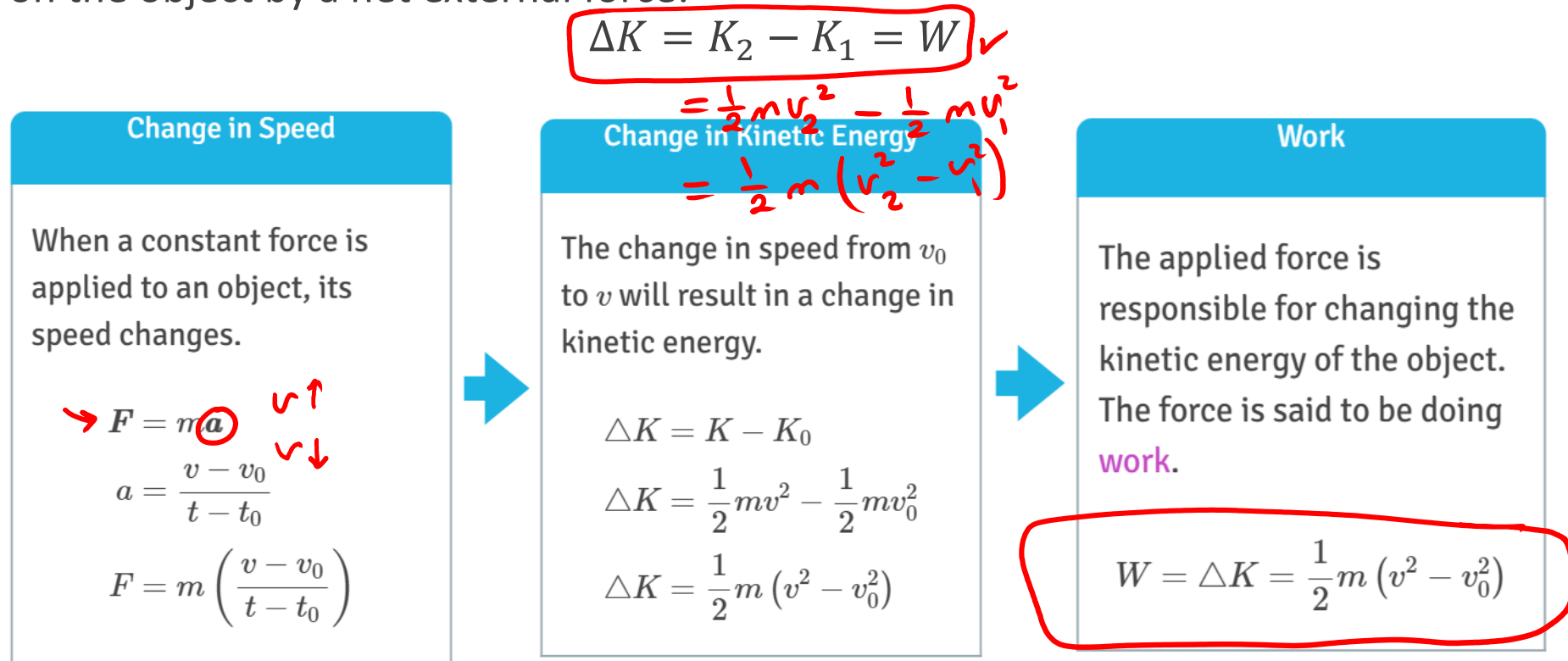
- Work is **negative** when kinetic energy is transferred **from** the object the net force acts on. الشغل سالب عند انتقال الطاقة من الجسم.
- Example: the force of **gravity** الجاذبية ^{$W_g = -$} does **negative work** on an apple that has been thrown upward, transferring kinetic energy into gravitational potential energy.



$$W_{man} = +$$

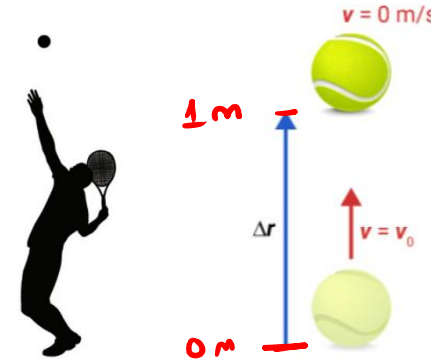
The Work-Kinetic energy Theorem

The work energy theorem states that the change in kinetic energy of an object equals the work done on the object by a net external force:



Activity 1:

A tennis player serves by throwing the tennis ball of mass 60 grams vertically upward with an initial speed of 4.43 m/s.



02:00

The ball reaches its maximum height after moving up 1.0 m, where its speed is 0 m/s. Calculate the work done by the gravitational force while the ball is moving upward.

$$✓ m = \frac{60}{1000} = 0.060 \text{ kg}$$

$$\begin{aligned} W_g &= \Delta K = \frac{1}{2} m (v_2^2 - v_1^2) \\ &= \frac{1}{2} \times 0.060 \times (0^2 - 4.43^2) \\ &= -0.58 \text{ J} \end{aligned}$$

Activity 2:

$$m = \frac{75}{1000} = 0.075 \text{ kg}$$

02:00

↑ A tennis player throws a tennis ball with mass 75 grams vertically upward with an initial speed of 6.0 m/s. What is the change ^{ΔK} in kinetic energy of the ball as it reached the maximum height ^{v_1} , where it momentarily stops?

$$v_2 = 0$$

$$\begin{aligned} W_g = \Delta K &= \frac{1}{2} m (v_2^2 - v_1^2) \\ &= \frac{1}{2} \times 0.075 (0^2 - 6^2) \\ &= -1.35 \text{ J} \end{aligned}$$

02:00

Activity 3:

$$v_1 = 0$$

سرعت

رف

ارتفاع

h

m

A vase of mass 1.40 kg is dropped from a shelf at a height of 2.00 meters above the ground. The speed of the vase increases until it reaches a maximum speed of 6.26 m/s, right before it hits the floor.

v_2

What is the work done by the force of gravity?

$$\begin{aligned} W_g &= \Delta K = \frac{1}{2} m (v_2^2 - v_1^2) \\ &= \frac{1}{2} \times 1.4 \times (6.26^2 - 0^2) \\ &= 27.4 \text{ J} \end{aligned}$$

Activity 4:

02:00

The speed of an object of mass 2kg ^{تزداد} increases from 2 m/s ^{v_1} to 4 m/s ^{v_2} . Find out the total work done on the object during this time interval?

$$\begin{aligned} W &= \Delta K = \frac{1}{2} m(v_2^2 - v_1^2) \\ &= \frac{1}{2} \times 2 \times (4^2 - 2^2) \\ &= 12 \text{ J} \end{aligned}$$

02:00

Activity 5:

What is the ^{عمل}work to be done to ^{زيادة}increase the velocity of a car from 30 ^{v_1} km/h to 60 ^{v_2} km/h, If the mass of the car is 1500 kg? ✓

$$v_1 = 30 \times \frac{1000}{3600} = 8.3 \text{ m/s} \quad \checkmark$$

$$v_2 = 60 \times \frac{1000}{3600} = 16.7 \text{ m/s} \quad \checkmark$$

$$\begin{aligned} W &= \Delta K = \frac{1}{2} m (v_2^2 - v_1^2) \\ &= \frac{1}{2} \times 1500 (16.7^2 - 8.3^2) = 157500 \text{ J} = 157 \text{ kJ} \end{aligned}$$

Thank you

Link for slides in the description

For inquiries:

Telegram: **@Asmaa_Alhameed**

Email: **a.a.alhameed@gmail.com**