Year 8 Autumn Term – 9I: Forces and Motion

Section A: Key Vocabulary

Keyword	Definition
accelerate	To change speed.
balanced forces	When two forces on an object are the same strength, but in opposite directions.
unbalanced forces	When two forces acting in opposite directions on an object are not the same strength. Unbalanced forces change the motion of objects.
drag	Another name for air resistance or water resistance.
deform	Change shape
dissipate	Spread out.
fossil fuel	A fuel formed from the dead remains of organisms over millions of years (e.g. coal, oil or natural gas).
mean speed	The total distance something travels divided by the total time taken is the mean (or average) speed for a journey.
relative speed	The speed of one object compared to another – both objects could be moving.
fulcrum	A point about which something turns. Another name for a pivot.
in equilibrium	In balance.
moment	The turning effect of a force. It is calculated by multiplying the force by the perpendicular distance of the force from the pivot.

Section B: Content

Forces and movement

When an object is pulled along the ground, the force of **friction** between the object and the ground makes it difficult to move. Friction can be reduced using rollers or wheels. In snowy countries, sleds have been used for thousands of years to move heavy loads.

If the forwards force on a moving sled is the same size as the force of friction, the forces on the sled are **balanced**. The sled will continue to move at a constant speed.

C | Forces on a moving boat. Longer arrows represent larger forces.

If the horses pull harder the forces on the sled will be **unbalanced**. The difference between the forward and backwards forces is the **resultant** force. In this case, the resultant force will be acting in a forwards direction and the sled will **accelerate** (get faster). As well as changing the speed, unbalanced forces can also change the direction in which something is moving and its shape.

Forces and movement

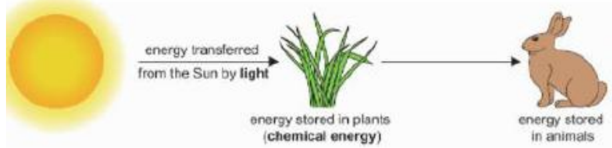
D | The top speed of the ship is when the water resistance is equal to the maximum force from the sails.

Water resistance and **air resistance** are forms of **drag**. Drag forces act to slow down objects moving through **fluids**. The size of the drag force increases as the speed of the object increases, because more of the fluid has to be pushed out of the way each second.

Section C: Content

Energy for movement

The earliest forms of transport often used animals to carry things, or to pull sleds or carts with wheels. The energy needed by humans and animals comes from their food. The energy in the food originally came from the Sun. Today we also directly use energy from the Sun (**solar energy**) to heat water and to produce **electricity**.



Many modern devices use energy transferred by electricity. Electricity cannot be stored, but has to be generated using **renewable resources** such as wind, moving water or solar energy, or from non-renewable resources such as fossil fuels or **nuclear energy**.

Energy is never created or destroyed, but only transferred. This is the **law of conservation of energy**. However energy is not always transferred usefully. The **efficiency** of an energy transfer compares the useful energy transferred to the total energy transferred. Wasted energy is usually transferred to the surroundings by heating, and often by **sound** as well. This energy is **dissipated** (spread out). The greater the efficiency, the less energy is wasted.

Just over 200 years ago, some forms of transport started to use energy stored in coal. Coal is a **fossil fuel**, formed underground over millions of years from the remains of plants. Fossil fuels are a very convenient way of storing large amounts of energy, but they are a **non-renewable resource** because they will run out one day. Today we also use energy stored in oil and natural gas for transport. Energy released by burning fuels can be transferred by **heating** to be used for cooking or keeping our homes warm.

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Section D: Content

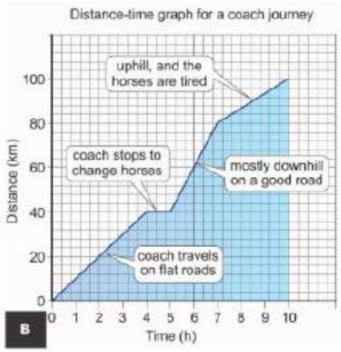
Speed

Speed is a way of saying how far you can travel in a certain time. This time can be a second (s), a minute (m), an hour (h), or even longer.

$$speed = \frac{distance}{time}$$

Many moving objects do not travel at a constant speed. For example, cars can travel faster on motorways than in town, and may have to stop at junctions. The **mean (average) speed** for a journey is the total distance travelled, divided by the total time taken.

Speed

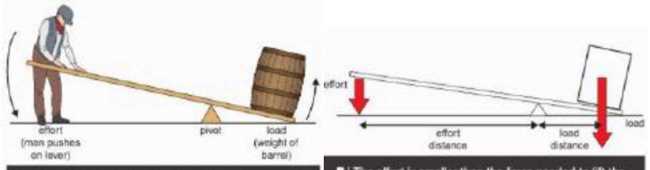


You can show how fast someone travelled during a journey using a **distance–time graph**. This is sometimes called a displacement–time graph. **Displacement** is the distance *in a straight line* between an object and its starting point. Graph B (opposite) shows a journey by coach and horses.

Section E: Content

Turning forces

You can move heavy objects using a **lever**. A lever is a long bar that turns around a **pivot** or **fulcrum**. When you push down on one side you are applying an **effort** and the object on the other end moves up. This object is called the **load**. The longer the lever, the easier it is to move the load.



A | The effort force moves further than the load.

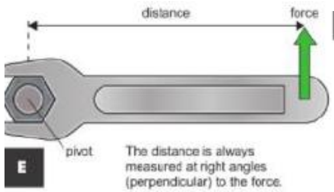
B | The effort is smaller than the force needed to lift the weight of the load directly.

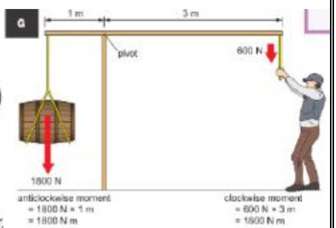
Some levers can act as **distance multipliers** instead. In this case a large effort force moves a small distance, and the load you are moving moves a greater distance.

Turning forces

The spanner in diagram E is being used to turn the nut. The turning effect of a force is called a **moment**. The size of the moment depends on the size of the force and the distance between the force and the pivot. Moments are measured in units called **newton metres (N m)**.

moment of the force (N m) = force (N) × perpendicular distance from the pivot (m)





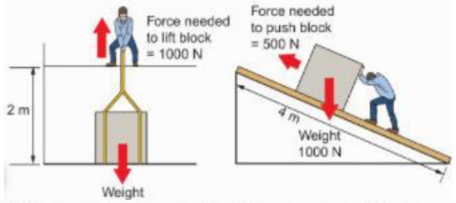
The crane in diagram G is acting as a lever. The crane is balanced, because the clockwise moment is balancing the anticlockwise moment. We say it is **in equilibrium**. If the man in diagram G pulls a little harder, the forces will not be balanced and the barrel will rise.

Section F: Content

Work

In physics, **work** means the amount of energy transferred when a force moves something. Work is measured in joules (J). The formula for calculating work done is:

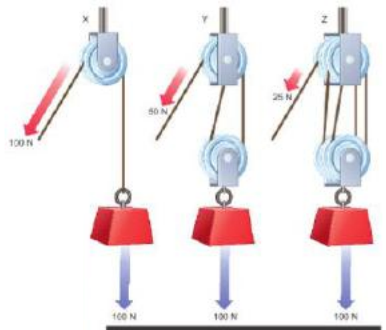
work done (J) = force (N) × distance moved in the direction of the force (m)



Pulleys can also be used to help us to move things. In diagram D, pulley X makes lifting the load easier because we can pull down on the rope instead of lifting the object directly, but it does not change the force needed. Pulley Y halves the force needed to pull the object, but the rope has to be pulled twice as far as for pulley X. Pulley Z reduces the force needed even further.

Conservation of energy

C | Pulleys and levers make it easier to control the sail and to steer.



D | If the rope is pulled for 1 m through pulley X, the weight will be lifted by 1 m and will gain 100 J of gravitational potential energy.

In diagram D, pulley Z allows the weight to be lifted using a force of 25 N, but the rope has to be pulled for 4 m to lift the weight by 1 m. The same is true of all machines – if a smaller force is needed to move something, the force has to move through a greater distance.

You would expect that the same work is done to lift the weight even when the pulley allows you to use a smaller force. However, friction causes a little *more* work to be done when smaller forces are used.