NEW LOWER SECONDARY CURRICULUM PHYSICS TOPIC: FORCES

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PHYSICS
TOPIC : FORCES

Course outline;

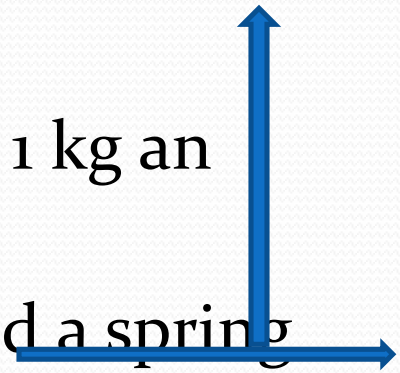
- Definition of force and its S.I. unit
- Meaning and measurement of force
- Types of forces
- Contact and non contact forces
- Force of gravity and weight
- Effects of forces on matter
- Balanced and unbalanced forces
- Effects of balanced and unbalanced forces on motion

continuation

- Resultant forces
- Calculations of resultant forces
- Friction between surfaces
- Relating friction with weight
- Factors which determine the amount of friction
- Advantages and disadvantages of friction
- Intermolecular forces(cohesion and adhesion)
- Surface tension and capillarity.

Introduction

- Force is a pull or a push of an object.
- The S.I. unit of force is newton(N)
- newton is the force which gives a mass of 1 kg an acceleration of 1 m/s^2.
- Instrument used to measure force is called a spring balance.
- Forces are represented by straight lines
- The direction where the arrow points indicates the direction of force.



Types of forces

- Gravitational force
- Electrostatic
- Magnetic
- Friction
- Weight
- Intermolecular forces
- Compression and tension
- Upthrust……etc

Contact and non contact forces

- The different types of forces are above are classified into two:
- A Contact force is a force that acts at the point of contact between objects
- Non-contact forces act between bodies at a distance

Contact forces	Non contact forces
Friction Compression and tension action and reaction viscous drag	Force due to gravity Centripetal Centrifugal magnetic force electrostatic force etc.

GRAVITATIONAL FORCE

- Is the force that pulls an object toward the Centre of the earth.
- When bodies fall under gravity, they have a constant acceleration due to gravity.
- On earth acceleration $g = 10m/s^2$
- The formula of the gravitational force on an object of mass m is given by $F = mg$

Measuring force.

- A body weighs 75N on the earth's surface. Calculate its mass in grams if g= 10 N/kg.

  W=mxg

m=W/g= 75N/10Nkg^{-1}

=7.5kg=7500g

- A man weighs 900N on earth and 150N on the moon. If the earth's gravitational field strength is 10N/kg, determine the moon's gravitational field strength.

Mass on earth= W/g=900N/10Nkg^{-1}

=90kg=mass on the moon

Gravitational field strength on the moon=W/m=150N/90kg

=1.67N/kg

- N.B. mass is constant everywhere while weight varies.
- Gravitational force is also known as weight.

Comparing weight and mass

- Activity 4.1. Copy and complete the table

Mass(g)	Mass(kg)	Weight(N)
90		
	0.1	
		600
	20	
0.0005		

- Weight is related to mass by the formula:
- Weight = mass x acceleration due to gravity (W = mg)

continuation

The value of acceleration due to gravity on earth is 10N/kg.it differs from place

Did you know?

The weights vary from place to place on earths surface. This is because the earth is not a perfect sphere, so different parts of the earth surface are at different distances from the center of the earth. It is also different on different planets.

Weight is very important because it keeps air surrounding the earth. Air is important for life

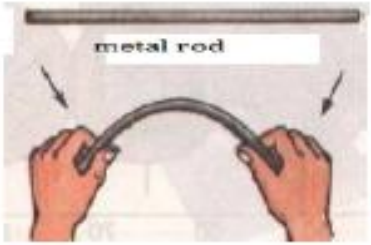
EFFECTS OF FORCE

Forces affect bodies in different ways

- Sets a body into motion.
- Can stop a moving body.
- Can increase or reduce the speed of a moving body.
- Can change the direction of a moving body.
- May deform (change the shape of) a body.

Activity 4.2

- Investigate the effect of force on different pictures



Activity 4.3

Identifying force between charged objects

a)Blow up one of the balloons.

b) Rub the inflated balloon with a piece of wool to charge it with static electricity.

c) Place the balloon near, but not touching, the pieces of tissue paper.

d) Bring the balloon slowly towards the pieces of paper and observe what happens.

e) Blow up the second balloon

continuation

g)Rub both balloons with a piece of wool.

h) Slowly bring the balloons towards each other and observe what happens.

RESULTS

1. What happened when the charged balloon was placed near the pieces of tissue paper?

2. What happened when the two charged balloons were brought near each other?

3. Which kind of effect of force is observed in this activity? Explain your answer.

Balanced and unbalanced forces

- When two forces act on an object the net effect will depend on the size and direction of each of the forces.
- When we place a book on the table, the weight of the book acts down due to gravity, and an equal force acts upwards called reaction. The upward force is due to a push by the table. The forces are equal in size and act in opposite directions. These forces are said to be balanced. The shape or position of the book does not change.

continuation

- The difference between unbalanced forces is called the resultant or net force.
- When a crane raises a container, it must exert an upward force greater than the weight of the container. The forces act in opposite directions but they are not equal in size. These forces are said to be unbalanced.

Unbalanced forces cause changes in the shape, position or speed of an object.

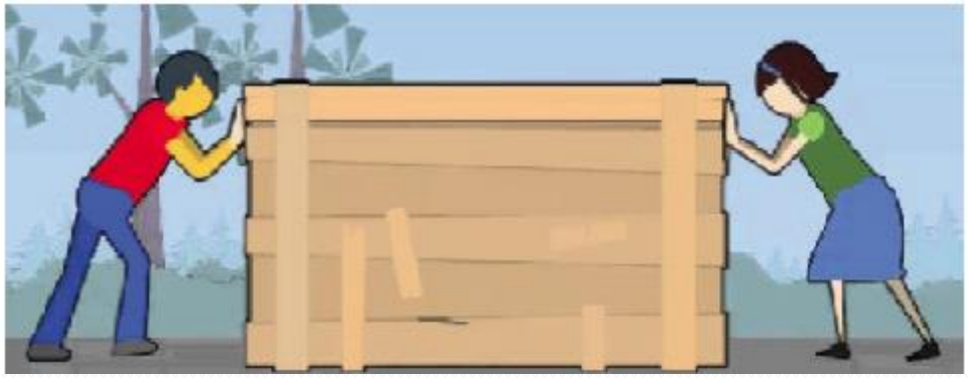
Effects of balanced and unbalanced forces on motion

- When balanced forces are exerted on a stationary object, it does not move. If balanced forces are exerted on a moving object, its speed will remain unchanged.
- When unbalanced forces are exerted on a moving object, it will either move more quickly (accelerates) or less quickly (decelerates) depending on the magnitudes of the resultant force.

Resultant of forces

- A stationary object remains stationary if the sum of the **forces** acting upon it — **resultant force** — is zero.
- It is a single force which has the same effect as the two or more forces acting together at a point.
- When two or more forces act on a body, the total force on the body is called the resultant force.
- In Figure below, if the two children are pushing the box in opposite directions with the same force, the box will not move.

Contin….



- However, suppose there is a tug-of-war and there are two teams pulling each other as shown below. What do you say about the teams?

Which team will move? In which direction will it move? You can try this activity using a rope.

Unbalanced force

Fig. 4.12: Unbalanced forces

Resultant force

- The stronger team is the one that exerts a greater force. The weaker team exerts a smaller force and will move towards the stronger team.
- This means that for two unbalanced forces in opposite directions, the resultant force is in the direction of the larger force. If the forces are acting in the same direction, then the resultant will be in the direction of the forces.
- When two or more forces act on the body in the same direction the resultant force is got by addition

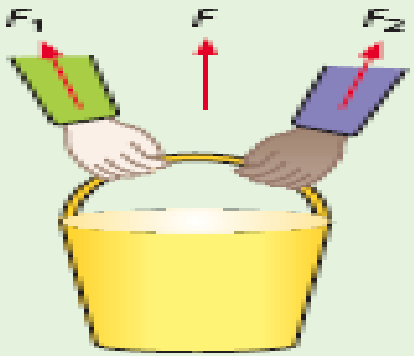
Resultant force

- When two or more forces act in opposite direction, the resultant force is got by subtraction.
- Forces at right angle(perpendicular to each other), When two forces act on a body at right angles, their resultant is obtained using Pythagoras theorem. What is meant by Pythagoras theorem?
- The above information can be summarized using the illustration in the table below

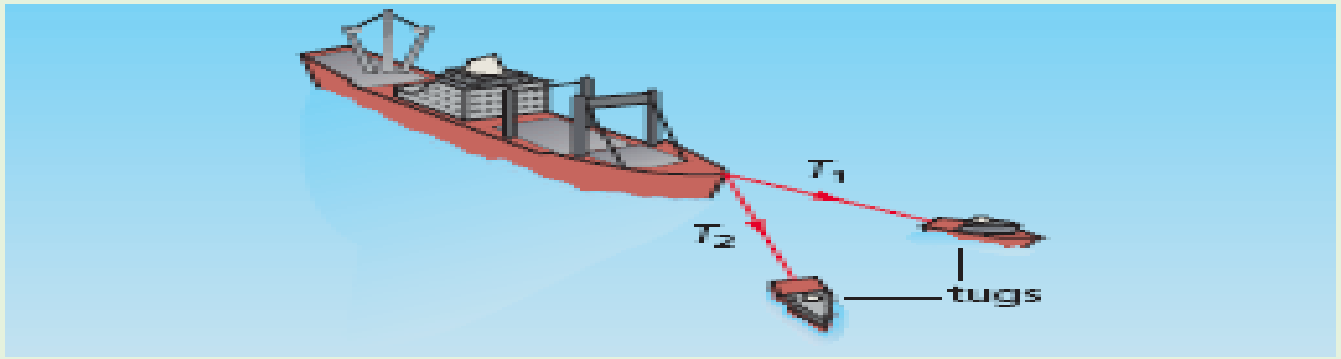
Examples of addition of forces

1 **Two people carrying a heavy bucket.** The weight of the bucket is balanced by the force F, the resultant of F_1 and F_2 (Figure 7.6a).

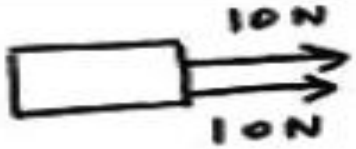
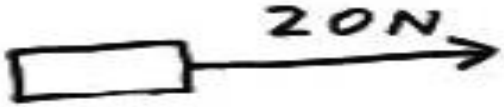
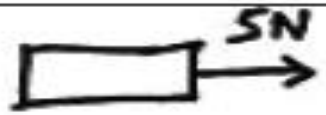
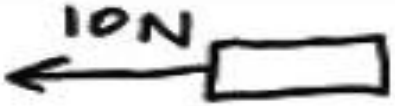
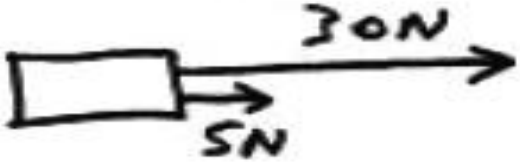
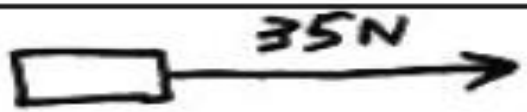
2 **Two tugs pulling a ship.** The resultant of T_1 and T_2 is forwards in direction (Figure 7.6b), and so the ship moves forwards (as long as the resultant is greater than the resistance to motion of the sea and the wind).



a

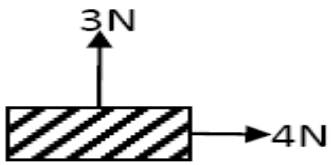


Examples

Original forces	Resultant forces
	
	
	
	
	

Forces at right angles

- Two force of 3N and 4N act on an object as shown. Find single force which can produce the same effect as the two forces above.

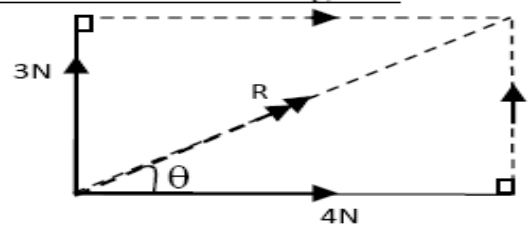


Solution:

$F_H = 4N \rightarrow$

$F_V = 3N \uparrow$

Resultant Vector diagram



Magnitude of the resultant force

Using the Pythogras theorem;

$$(\textbf{Hypotenuse})^2 = (\textbf{Base})^2 + (\textbf{Height})^2$$

$$(R)^2 = (b)^2 + (h)^2$$

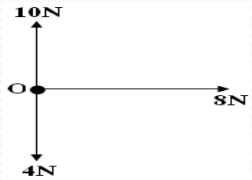
$$R^2 = 4^2 + 3^2$$

$$R^2 = 25$$

$$R = \pm\sqrt{25}$$

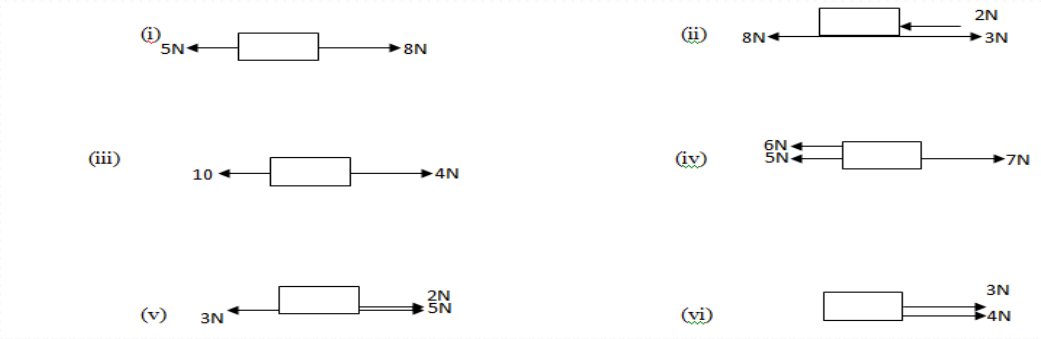
Exercise

1. Forces of 10N, 4 N and 48Nact on a body ***o***,as shown in the diagram below.

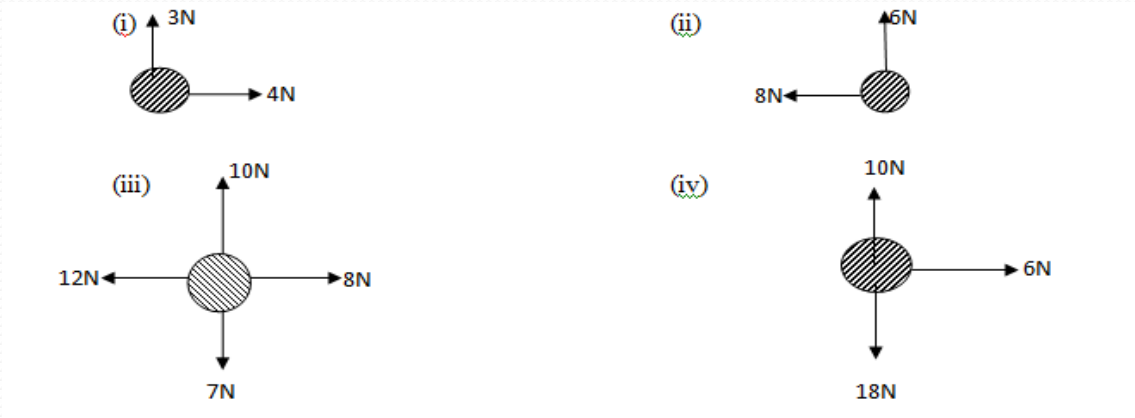


Determine the resultant force and acceleration at ***o*** if its mass of 2 kg is

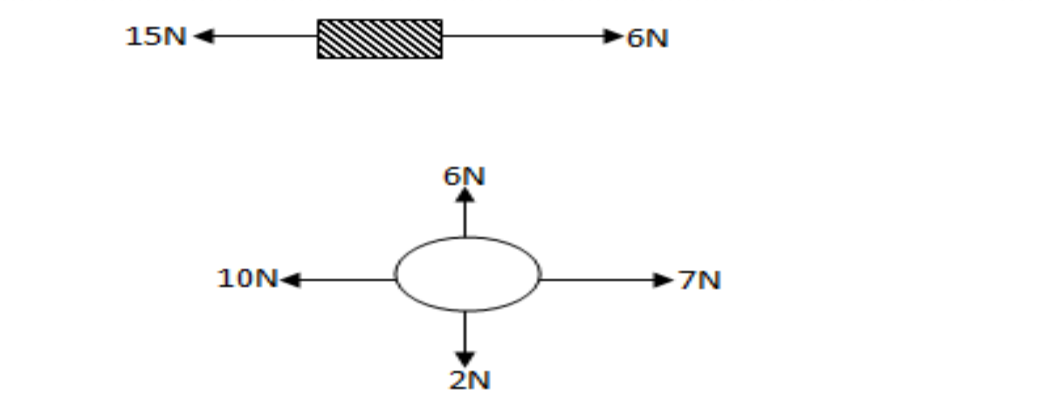
2. (a) Calculate the resultant force of the following system.



(b) Resultant force at right angle.



(c)Find the resultant force, F, and the mass on the body if the acceleration is $3ms^{-2}$



A body of mass 2kg is acted upon by four forces 10N, 2N, 7N and 6N as shown above. Calculate;

(i) Resultant force.

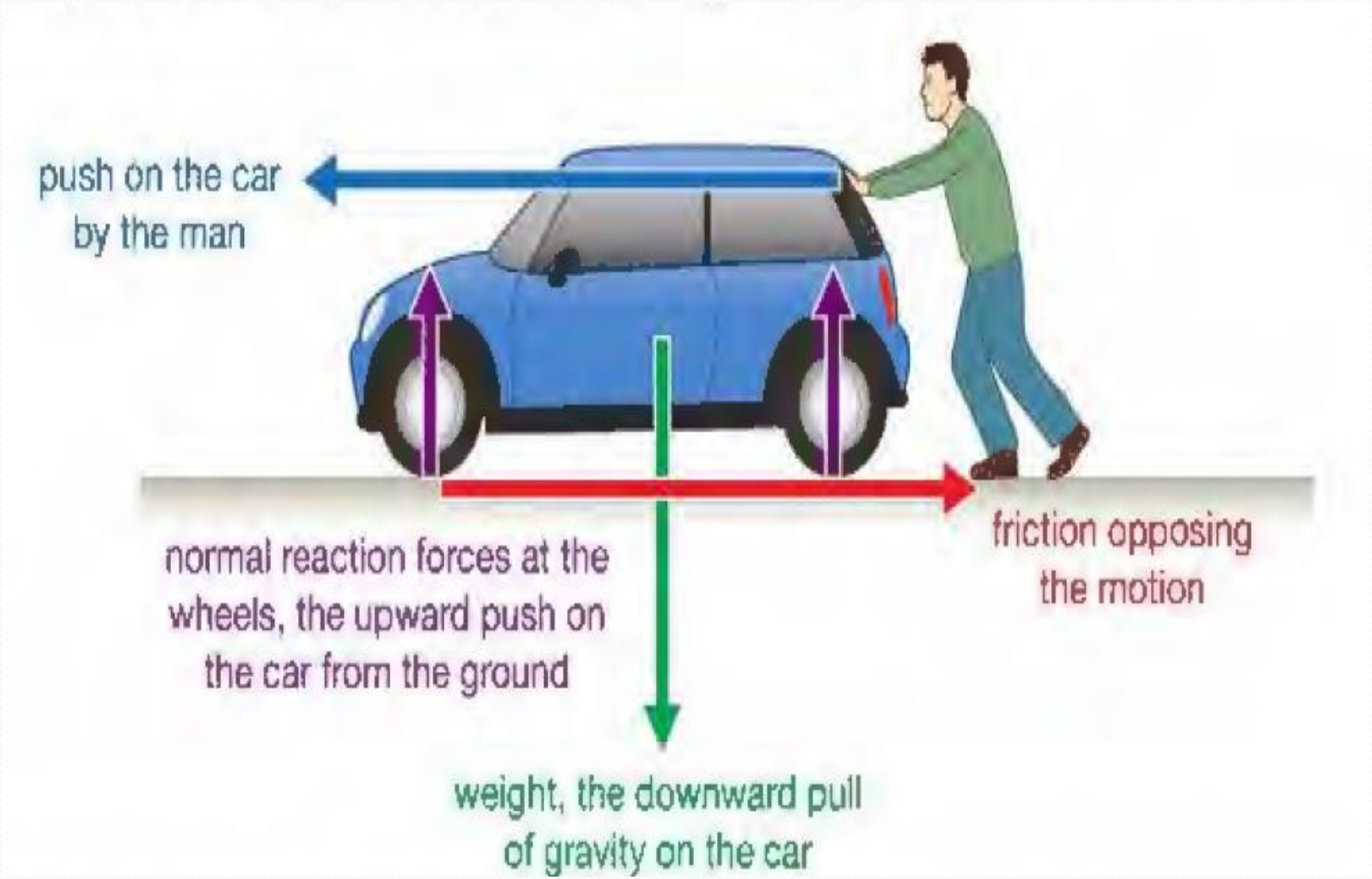
(ii) Acceleration

END

Friction between surfaces

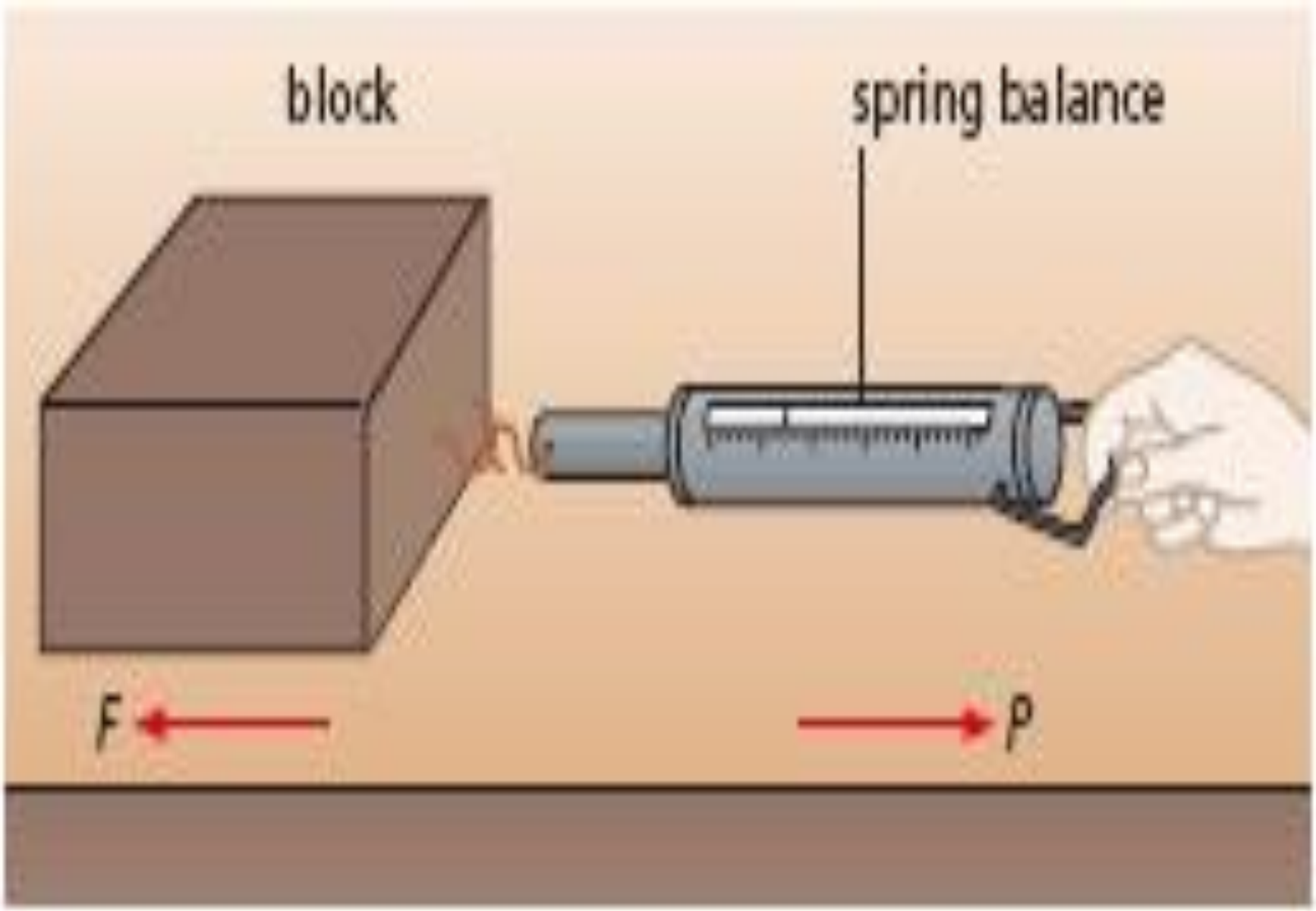
- Friction is a force that acts in the opposite direction to the movement between two surfaces which are in contact. Friction only exists when the two surfaces are moving relative to each other. It does not exist when the surfaces in contact are stationary or moving in the same direction with the same speed.

Demonstrating friction



Activity 4.4 **Relating friction with weight**

- a) Place the wooden block on the table so that one of the largest
- faces is in contact with the smooth table.
- b) Hook the force meter (spring) onto the block.
- c) Keeping the force meter horizontal, gently pull until the wooden block on its smooth surface starts to move.
- d) Write down the force needed to move the wooden block.
- e) Place a 100 g mass onto the wooden block and repeat steps 3 and 4.
- f) Repeat this for different total masses up to 500 g (5 x 100 g) and record your results in the table below.
- g) Repeat the experiment when the block is lying on its rough surface.


block
spring balance
F
P

Mass on the wooden block (g)	Force needed to move the wooden block (N)	
	Smooth surface	Rough surface
0		
100		
200		
300		
400		

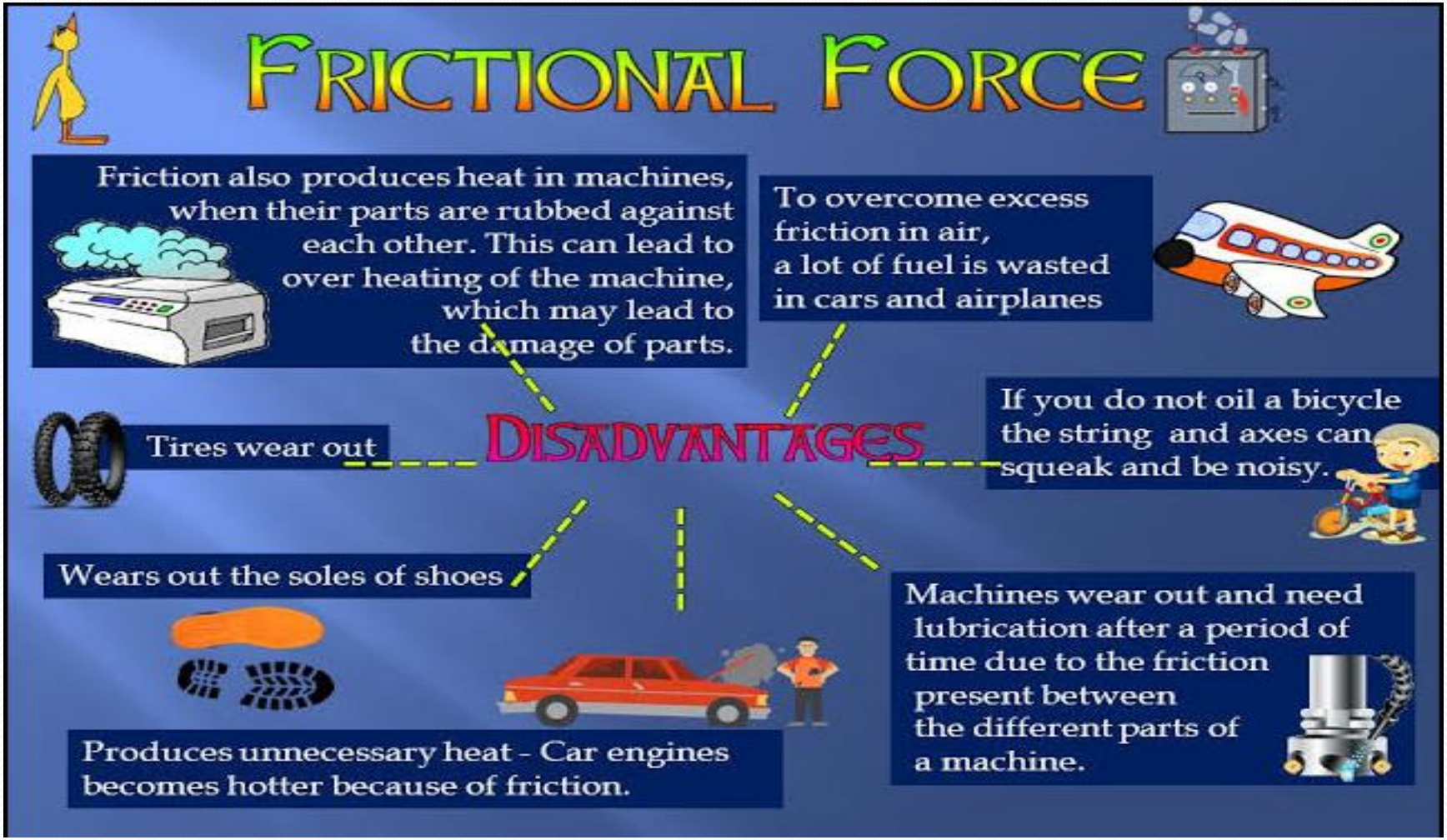
- 1. What is the friction force between the wooden block and the surface of the table at the start of the activity?
- 2. How does the friction force change, if at all, when additional masses are added to the wooden block?
- 3. Which surface has more friction: a smooth surface or a rough surface?

Factors which determine the amount of friction

1. The weight exerted by one surface on the other.
2. The nature of the surfaces.

Methods of reducing or increasing friction between surfaces involves changing one or more of these factors

Advantages and disadvantages of friction



Ways of reducing friction

3. reducing friction

a. lubricants – oil, wax, grease

b. switch from sliding to rolling

c. smooth surface – ex. use sandpaper

Intermolecular forces