

Three types of motion:

- **Linear motion** – the straight line or curved progression of an object as a whole e.g. (straight) skiing straight down a hill (curved) a skier performing a curved turn down the slope.
- **Angular motion** – when an object acts as a radius and moves in a circular path about a fixed point. E.g. the lower leg when kicking a rugby ball.
- **General motion** – A combination of linear and angular motion, e.g. running.

**Inertia:**

The resistance a body has to change in its state of motion.

**Force:**

Is often described as pushes or pulls on a body.

**Mass:**

The quantity of matter that a body contains. The weight of an object is proportional to its mass.

**Centre of mass:**

The point where the mass of an object is concentrated. It is the object's point of balance.

What a force can do:

- \*Change the shape of a body.
- \*Make a moving body change direction.
- \*Make a moving body accelerate.
- \*Make a moving body slow down or stop moving.
- \*Make a body at rest move.

Factors affecting stability:

- \*Position of the centre of mass.
- \*Position of the line of gravity.
- \*Size of the area of support.

**Velocity:** The rate of change of displacement over a unit of time.

Newton's Laws of Motion**1. Law of Inertia**

*'A body continues in a state of rest or uniform velocity unless acted upon by an external force.'*

Example:

**2. Law of Acceleration**

*'The acceleration of an object is directly proportional to the force causing it and is inversely proportional to the mass of the object.'*

Example:

**3. Law of Reaction**

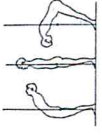
*'For every action there is an equal and opposite reaction.'*

Example:

# Biomechanics



# Activities



## Types Of Motion

**Linear:** When a body moves in a straight or curved line, with all its parts moving the same distance, in the same direction and at the same speed. Eg a bobsleigh run..

**Angular:** When a body or part of a body moves in a circle or part of a circle about a particular point called axis of rotation. Eg the arm in a cricket bowl.

**General:** A combination of linear and angular motion. Eg cyclist leg round the bike and the movement for the bike itself.

## Newton's Laws

- Inertia:** A body continues in a state of rest or uniform velocity unless acted upon by an external force. For example a football is still on the penalty spot until the external force of the football kick is acted upon it.
- Acceleration:** When a force acts on an object, the rate of change of momentum experienced by the object is proportional to the size of the force and takes place in the direction in which the force acts. For example when a cricket ball is thrown it will accelerate faster if there is a larger force acting upon it and will move towards the wickets.
- Reaction:** For every action there is an equal and opposite reaction. For example when a squash ball is hit against the wall, the opposite force will be the rebound off the wall.

## Forces

- Cause a body at rest to move:** When a golf ball is on the ground and then hit it moves.
- Cause a moving body to change direction:** When a hockey ball is hit and bounces off the post it will rebound and change direction.
- Cause a moving body to accelerate:** When a tennis ball is hit in a serve it accelerates.
- Cause a moving body to decelerate:** When a football is kicked and hits the net in the goal it will decelerate.
- Cause a body to change shape:** When a netball hits the ground it slightly changes shape due to the bounce.

## Centre of Mass—the point at which the body is balanced in all directions

**Uniform symmetrical objects:** the centre of mass is found in the exact centre of the object like in a shot put or tennis ball.

**Human body:** the centre of mass is not a fixed point in the body, can even be outside the body, depending on the body position. Men's usually higher than woman's due to most men's mass is concentrated around their upper body but woman's is more round the hips.

As well as this if the person moves it can change their centre of mass. For example they lift their arm up, centre of mass moves up to ensure the body is balanced. In some cases the centre of mass can be outside the body, for example and gymnast doing a pike will have a centre of mass outside the body

**Stability:** is how difficult it is to disturb a body from a balance position—determined by position of centre of mass, the line of gravity and size of athletes area of support.

**Line of gravity:** is a line extending from the centre of mass vertically down to the ground.

Relationship between force and centre of mass:

**Direct force:** to create linear motion the line of force action must pass through the centre of mass

**Eccentric force:** to create angular motion the line of force must pass outside the centre of mass.



## Word search

F R N X G Y T J S Y O W G D V X S A V V  
 U G Y K E C E N T R E O F M A S S E R  
 E B L N J Q Z D W P N S C M T P B W U K  
 T U N S Y M M E T R I C A L M Q I D I D  
 W S E C R O F E D R D O T R O V O I M B  
 L Q C K D I R E C T E I T Z V F M R O U  
 A H R M O Z C G U W N W U Q E Q E T D  
 C Z N N O I T A R E L E C C A H C C I N  
 I S Q H G B F I R H L F H V T P H T O O  
 R P X Y N A R T B Q M E W U Z I A I N I  
 T X R A L V I P V I V M X H B Q N O C T  
 E Y Q G P A Z R J B G S U B R O I N P C  
 M T L R C S J C E E C I R T N E C C E A  
 M I Z Z H R S A N P K C M E Y L S S G E  
 Y L Y L X W D E C E L E R A T E A F H R  
 S I K I D P R U G V U S E P A H S D I W  
 V B A N F A A C C E L E R A T E X G C H  
 U A L E L N Q T C R Z Z D F A H I S B P  
 N T B A Z N E W T O N Z N P O Y O Y E D  
 P S C R F G J I M H L Y T I V A R G O Y

biomechanics motion linear angular general newton  
 inertia acceleration reaction forces move direction  
 accelerate decelerate shape centre of mass direct eccentric  
 stability gravity symmetrical unsymmetrical



## Anagram

- Confess me rat = Glamour oat in =
- Wants owls en = Detaching coiner =
- Overlay fig tin = Coffee or nil =



## Biomechanics: newton's laws

### Law of inertia –

'Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.'

E.g. in football, the ball is in a continuous state of rest until an external force is applied in this case the player's foot, the force causes the ball to exit the state of rest and move.

### Law of acceleration –

'The relationship between an object's mass  $m$ , its acceleration  $a$ , and the applied force  $F$  is  $F = ma$ . Acceleration and force are vectors; in this law the direction of the force vector is the same as the direction of the acceleration vector.'

E.g. in hockey when the ball is hit, the scale of force applied to the ball by the stick will be directly proportional to the force then produced by the ball in terms of both direction and acceleration.

### Law of reaction –

'For every action there is an equal and opposite reaction.'

E.g. in squash when the ball hits the wall and applies a force, the wall then exerts an equal and opposite force which propels the ball back off the wall.

1. Think of a different practical example for each of the laws relating to your given sport.
2. Where possible produce a simplified definition of the three laws.
3. Complete the word search below and the group the words into the three different laws.

L N T T X W J D M G M V Q E U  
A H O T S E D O K Y G B J J N D  
N W X I X E I H D B P G I O B  
O F M C T T R B K X F F E W E  
I F V O C A N Y G Q O J P T K  
T S V A M H R Y O R Y K S G C  
R K E K I O I N H L K F K G F V  
P P Y R B N L T D E L A U Q E E  
O B H U G E Q D U X C E F Y H  
R L K I N R R T B K M Q C Y W T  
P O I N L T T D B M Z V A D Y  
R P R E W I U U G C X Q H N  
E I W A C A M A D K Y W Y D N  
A O P P O S I T E G G O A A Z

ACCELERATION  
EQUAL  
INERTIA  
MOMENTUM  
OPPOSITE  
PROPORTIONAL  
REACTION  
REST  
UNIFORM

## Respiration: external and internal during exercise

### External respiration:

- Skeletal muscles use up more oxygen to provide energy which means a greater amount of carbon dioxide is produced.
- The increased pp of CO<sub>2</sub> causes an increased diffusion gradient meaning a quicker and greater amount of gaseous exchange.
- The higher pp of O<sub>2</sub> in the alveoli and low pp O<sub>2</sub> in capillaries ensures Hb is amount fully saturated.

### Internal respiration:

- A greater oxygen dissociation is required at the working muscles during exercise to provide the necessary oxygen required.
- Four factors have the effect of causing decreased affinity and so increased dissociation of O<sub>2</sub> from Hb in the blood capillaries to the Muscle tissue.

### 4 factors (LEARN):

- Blood and muscle temperature increase.
- PP O<sub>2</sub> in muscle decreases, increasing diffusion gradient.
- PP CO<sub>2</sub> increases, increasing diffusion gradient.
- Bohr effect – increased acidity (lower pH)

E R U S S E R P F O M W H E F  
Y M G W F V H R L E C Q H H K  
D T C G Q D F C G Y W H H E T  
J B I H L T A N D I F I D R D  
T S T U D E A I L V H B I G R  
M E B E I H F J L X O G S Y U  
L D T Y C F O X Z H I B S H M  
B P N X U Z F X R C M N O V E  
Q M E S D Q H A Y K T Z C Z O  
A G I I N Q J T G X G U U I I X  
Q O D H B H U Z N O E H A T Y  
M P A G A S E O U S V N T S P  
X Y R F V H V S Z G F G I T C  
J Y G P E P W B H Y C S O I Y  
C C I U F Y P W N S H D M A L

AFFINITY  
BOHR  
O<sub>2</sub>-FUSION  
DISSOCIATION  
EFFERSY  
EXCHANGE  
GASEOUS  
GRADIENT  
OXYGEN  
PRESSURE

1. The degree to which a substance tends to combine with another.
2. Haemoglobin's oxygen binding affinity (see Oxygen-haemoglobin dissociation curve) is inversely related both to acidity and to the concentration of carbon dioxide.
3. The spreading of something more widely.
4. The action of disconnecting or separating or the state of being disconnected.
5. The strength and vitality required for sustained physical or mental activity.
6. An act of giving one thing and receiving another.
7. Relating to or having the characteristics of a gas.
8. An increase or decrease in the magnitude of a property (e.g. temperature, pressure, or concentration).
9. A colourless and odourless reactive gas.
10. Continuous physical force exerted on or against an object by something in contact with it.

## Oxygen and carbon dioxide transport

Blood consists of 45% blood cells and 55% plasma. It's within these substances that oxygen and carbon dioxide is carried.

### **Oxygen transport:**

97% is transported within haemoglobin in red blood cells as oxyhaemoglobin. Haemoglobin has a high affinity for oxygen, combining with 4 oxygen molecules. It readily gives up oxygen to tissues if oxygen concentration is low.

3% in blood plasma

### **Carbon Dioxide transport:**

70% combines with water within red blood cells as carbonic acid

23% combines with haemoglobin to form carbaminohaemoglobin

7% dissolved in plasma

### **Efficient Transport:**

Prolongs both aerobic and anaerobic activity

Delays the anaerobic threshold

Increases the intensity of the activity

Speeds recovery after activity preventing OBLA

### **Smoking:**

Smoke contains carbon monoxide. Haemoglobin has a higher affinity for carbon monoxide than oxygen and therefore reduces the oxyhaemoglobin association in the blood.

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### Activities:

Discuss and write down which activities will place the greatest demand upon the oxygen transport and explain why.

Complete question 1d OCR AS PE 2009 paper

Fill in the blanks; Blood contains 45% blood cells and \_\_\_\_ plasma. Oxygen transport consists of 2 ways. 97% within \_\_\_\_\_ packed inside \_\_\_\_ \_\_\_\_\_, 3% inside blood \_\_\_\_\_. Carbon dioxide transport is achieved in 3 ways. 70% combines with water to form \_\_\_\_\_, \_\_\_\_% forms carbaminohaemoglobin and 7% dissolved in plasma.

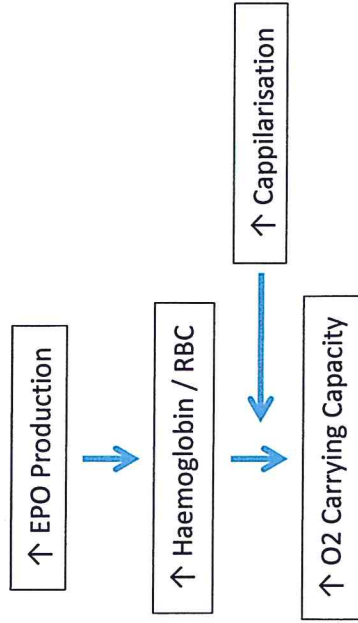


# A L T I T U D E

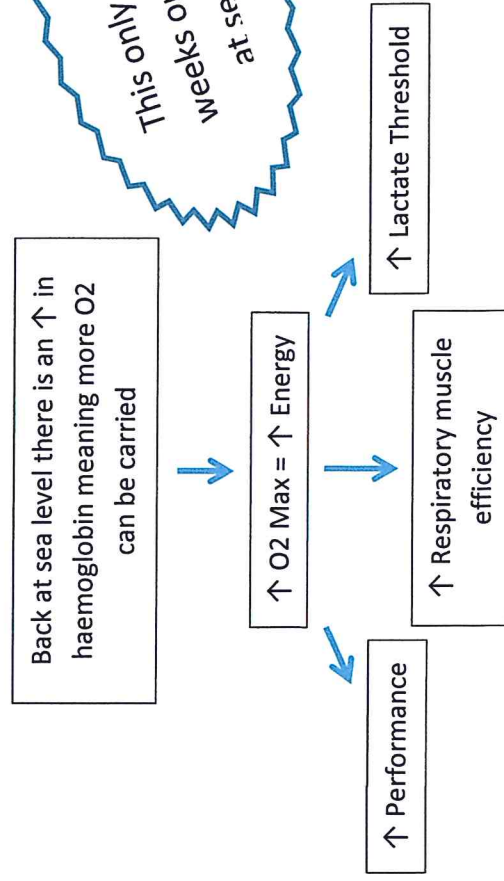
## Short Term Effects

- Lack of O<sub>2</sub> (decrease in the PP of O<sub>2</sub>) in the air
- Decrease in PP O<sub>2</sub> in the lungs/alveoli
- Decrease in the diffusion gradient (alveoli -> blood)
- Decrease in O<sub>2</sub> in the blood
- Decrease in O<sub>2</sub> to the working muscles
- Increase in fatigue / Decrease in performance
- Hypoxic Conditions (without O<sub>2</sub>)

## Adaptations



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## Word search

Q	F	E	F	G	J	U	C	D	G	S	H	U	O	
G	E	P	O	A	R	I	H	V	H	K	R	H	D	
D	Q	S	C	T	H	J	F	S	A	D	E	S	Q	
J	M	H	R	D	Z	B	E	T	E	G	U	K	B	
U	W	D	V	G	U	T	A	B	M	R	X	E	N	
V	I	Y	P	L	A	E	Q	F	O	F	O	E	J	
S	H	E	D	T	R	D	E	R	G	S	E	W	R	
G	B	W	C	P	I	S	E	I	D	L	B	T	O	D
E	F	A	S	S	F	J	E	X	O	Y	E	W	H	
O	L	E	A	B	N	M	N	R	B	C	Y	T	I	
M	R	S	J	I	O	L	E	T	I	J	Y	K	H	
L	P	O	T	I	R	C	H	Y	N	U	I	O	K	

Find 5 key words/points associated with adaptations

