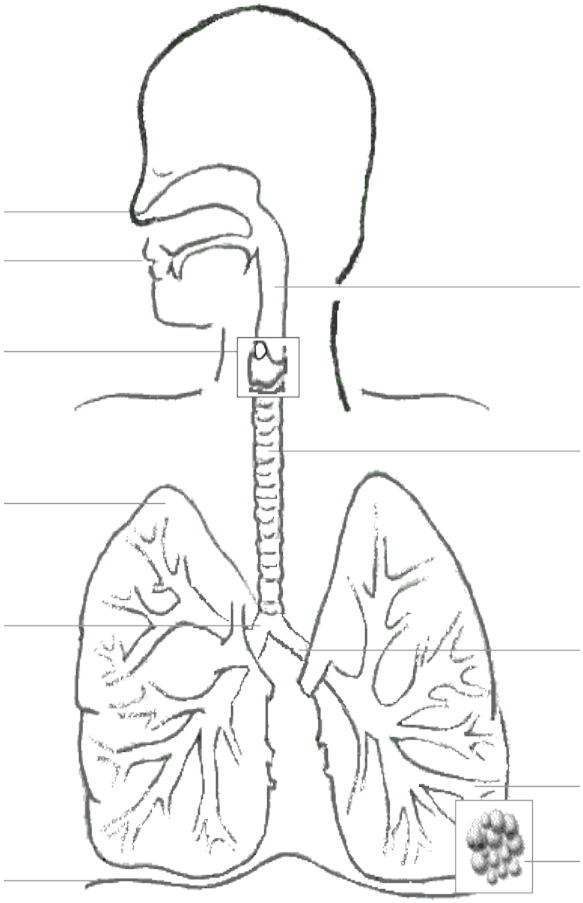
CARDIO-RESPIRATORY EXERCISE PHYSIOLOGY WORKBOOK **Name**:

THE VENTILATORY SYSTEM

Can you label the parts of the ventilatory system below?



Different tissues found within the ventilator system

Complete the table below. Make sure to include key terms and examples.

Structure	**Function**
Smooth muscle	
Cartilage	
Elastic fibres	
Epithelial lining	

Breathing Rate Investigation

Question: What is the effect of exercise on breathing rate?

Hypothesis:
Make a prediction about the effects exercise on breathing rate.
EXPLAIN the reason for your prediction.
Try and include the following terms in your explanation:

aerobic respiration, energy, muscular contraction, ATP, gas exchange, diffusion, glucose, carbon dioxide

Method:

1. **Determine your <u>resting</u> breathing rate**. Sit down and breathe normally. Use a clock or stopwatch to time a 1 minute time period. During this time, count the number of times you inhale. RECORD this information in the table in the <u>data section</u>.

2. Repeat Step 1 two more times. Record your trials. Calculate an mean resting breathing rate.

3. **Determine your breathing rate during exercise.** Run in place for 1 minute. During this time, count the number of times you inhale. RECORD this information in the table in the <u>data section</u>.

4. Repeat Step 3 two more times. Record your trials. Calculate an average breathing rate during exercise.

5. For the last test, **choose an activity** that you can do for one minute (sit-ups, jumping jacks, jump rope, standing on one foot, dance the "twist", touching your toes, etc.). While doing the activity, count the number of times you inhale in one minute. RECORD this information in the <u>data section</u>.

6. Repeat Step 5 two more times. Record your trials. Calculate a mean breathing rate.

Data collection:

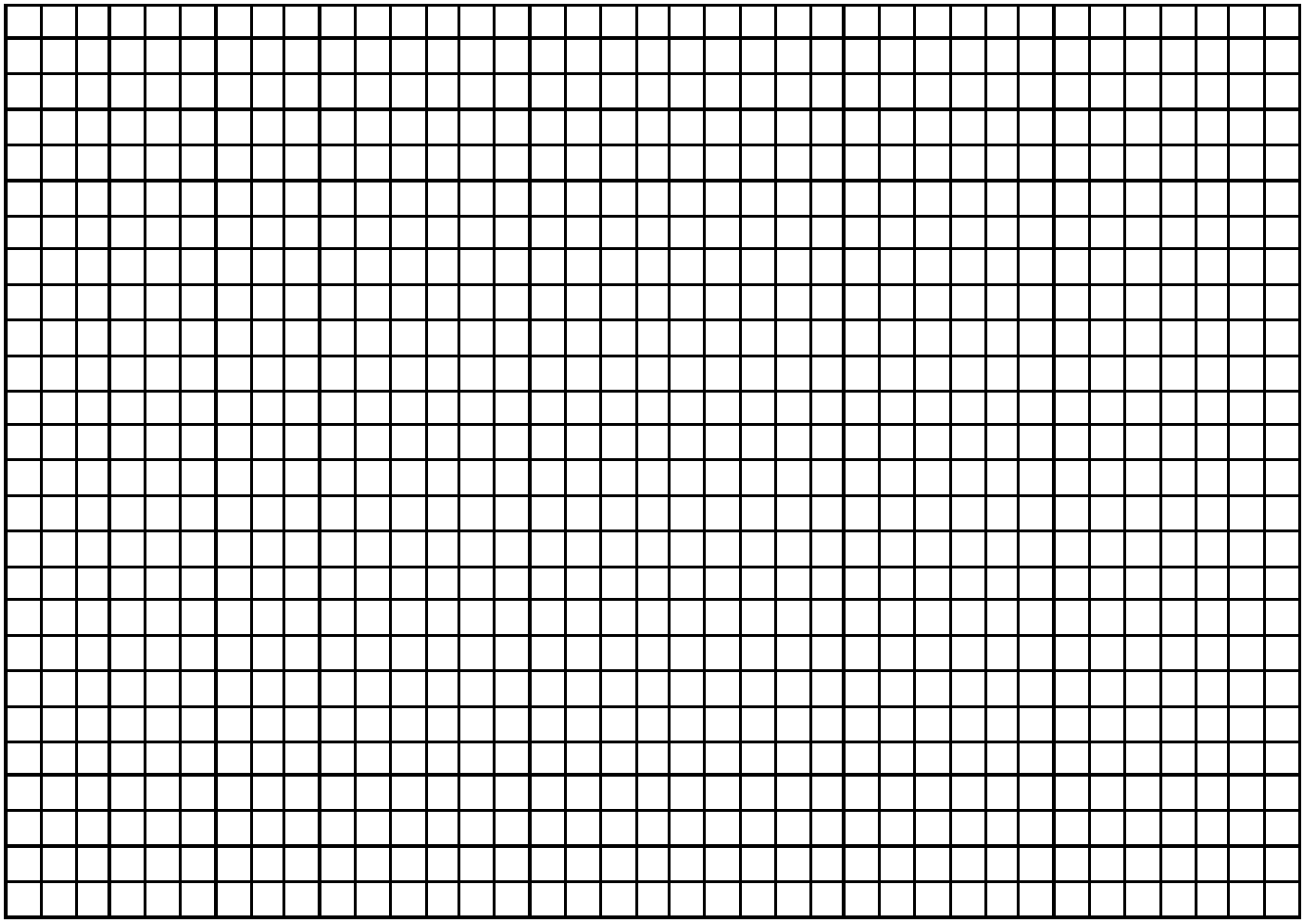
In the table below, record your trials and means. Be sure to use label your data with appropriate labels and title.

Title _____

	Sitting at Rest	Running in Place	(Record your activity here)
Trial 1			
Trial 2			
Trial 3			
Mean			

Bar Graph: Create a bar graph of the **MEANS** from your three activities.

- Give your graph a title
- Include appropriate labels for your x and y axis
- Label your y-axis with an appropriate scale



Analysis

1. What is the relationship between breathing rate and exercise? WHY do you think your data turned out as it did?

2. Did your data support your hypothesis? Were there any surprises? EXPLAIN!

3. What were some controlled variables in your experiment (ie: the variables that did NOT change from trial to trial)

4. What could you do to improve the reliability of your data?

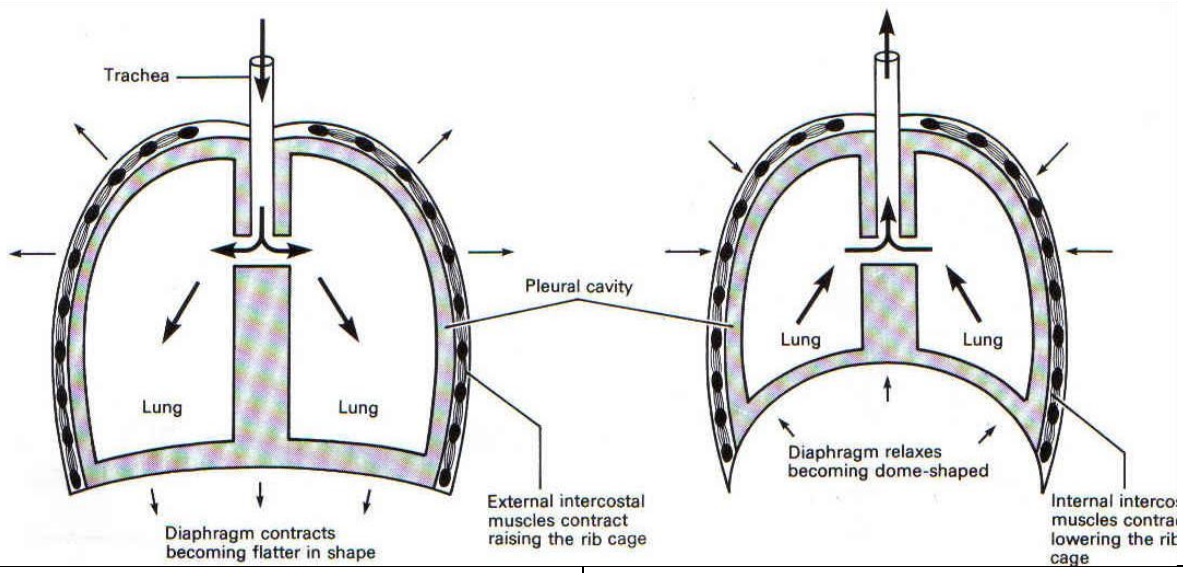
5. <u>Other than exercise</u>, what other factors could possibly affect one's breathing rate? Explain two possible examples.

VENTILATION

Define *Boyle's Law*

Mechanics of ventilation

Use the statements given to annotate the diagram and complete the table

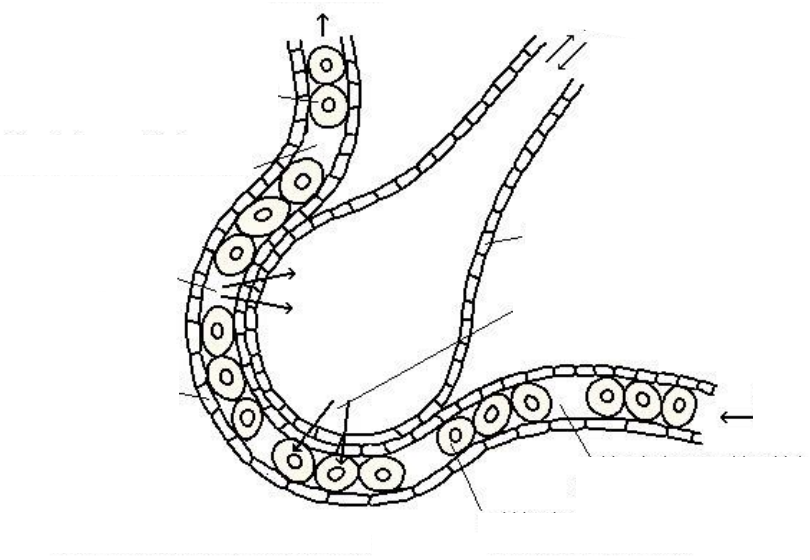


INSPIRATION	EXPIRATION

Summary of ventilation

	Inhaling (Inspiration)	Exhaling (Expiration)
Volume of thorax		
Diaphragm muscle		
Movement of diaphragm		Relaxes and resumes to dome shape
External intercostal muscles		
Rib cage movement		
Pressure in chest cavity	Decreases below atmospheric pressure	
Movement of air		

GAS EXCHANGE



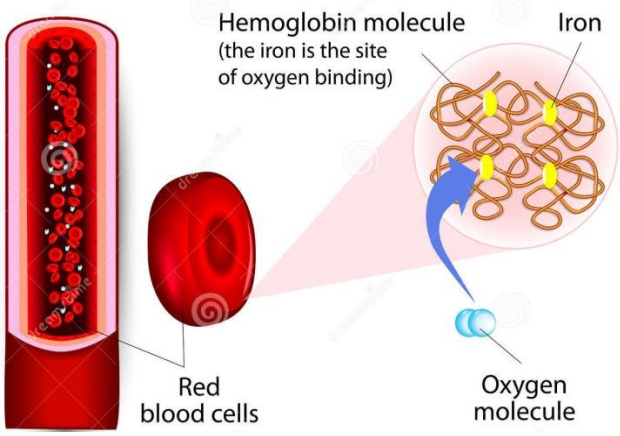
Explain the process of gas exchange at the alveoli
You must use the terms in the word bank.
HINT: Write out a set of bullet points that starts with deoxygenated blood flowing towards the lung and oxygenated blood leaving the lungs

WORD BANK:

oxygenated deoxygenated high concentration low concentration diffusion carbon dioxide oxygen one cell thick short distance

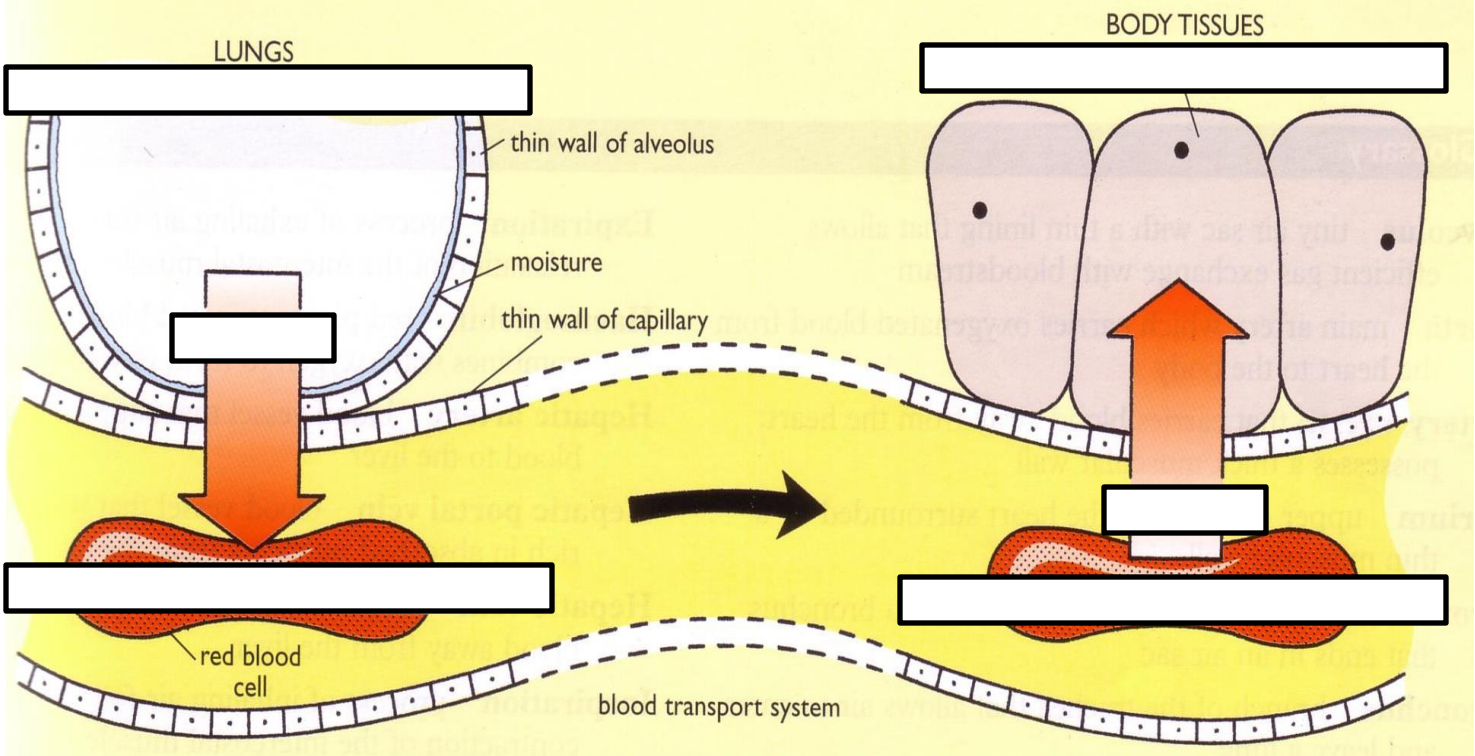
OXYGEN TRANSPORT

What is haemoglobin?

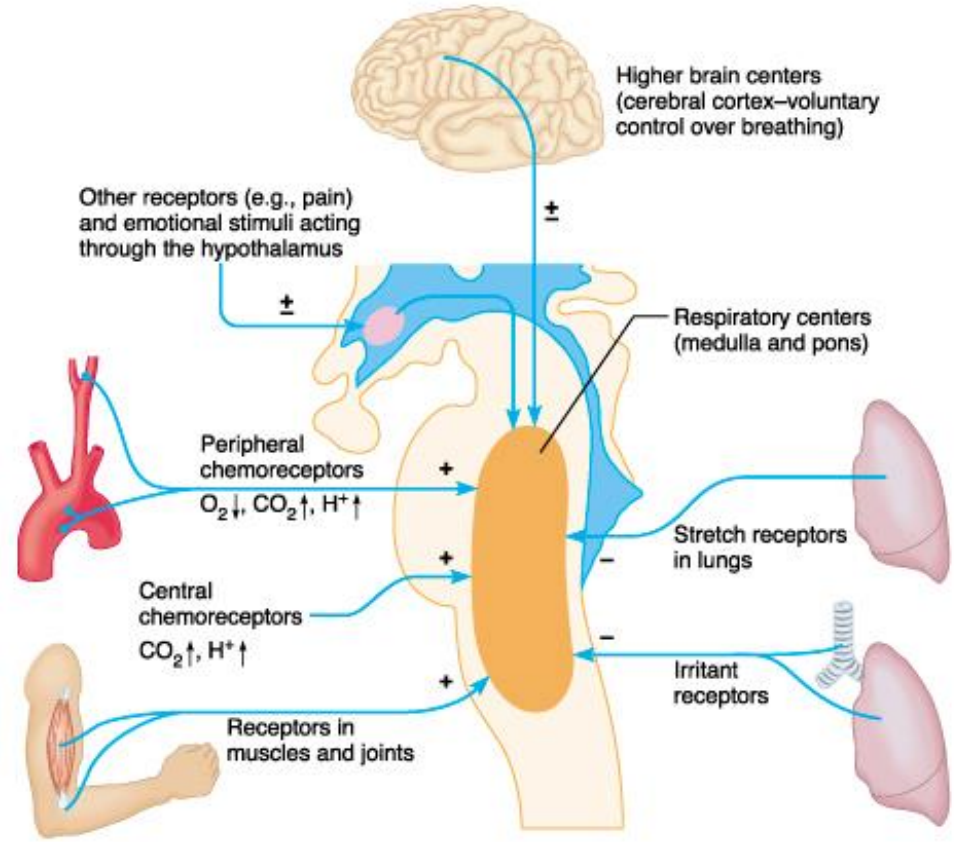


Role of haemoglobin

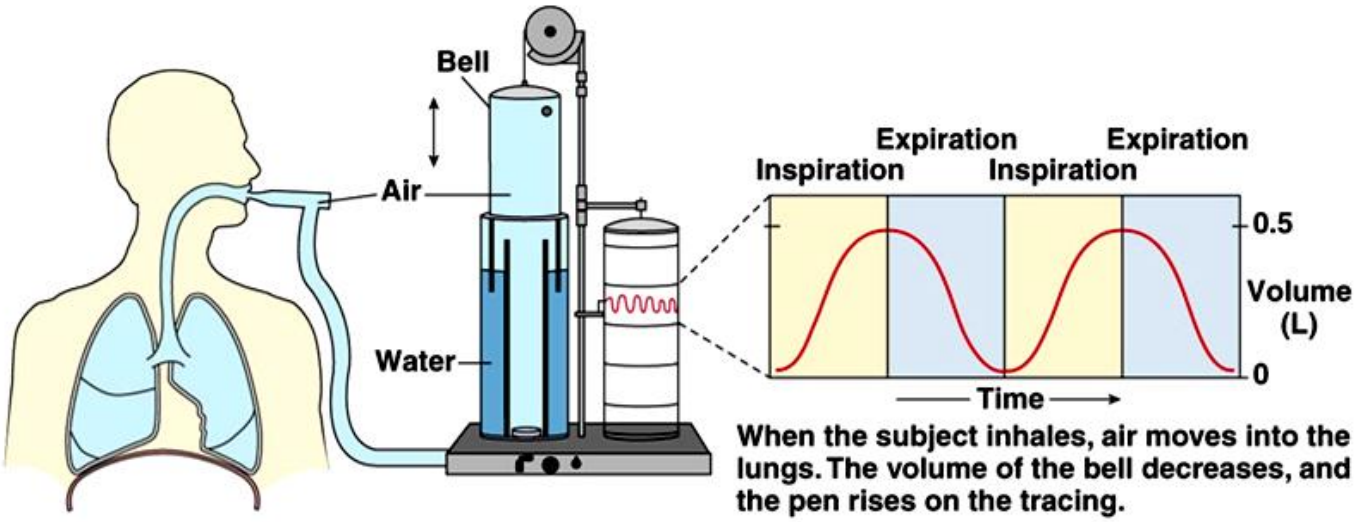
Annotate the diagram below to show how oxygen is transported in the blood



Why does ventilation rate increase as rate of exercises increases?



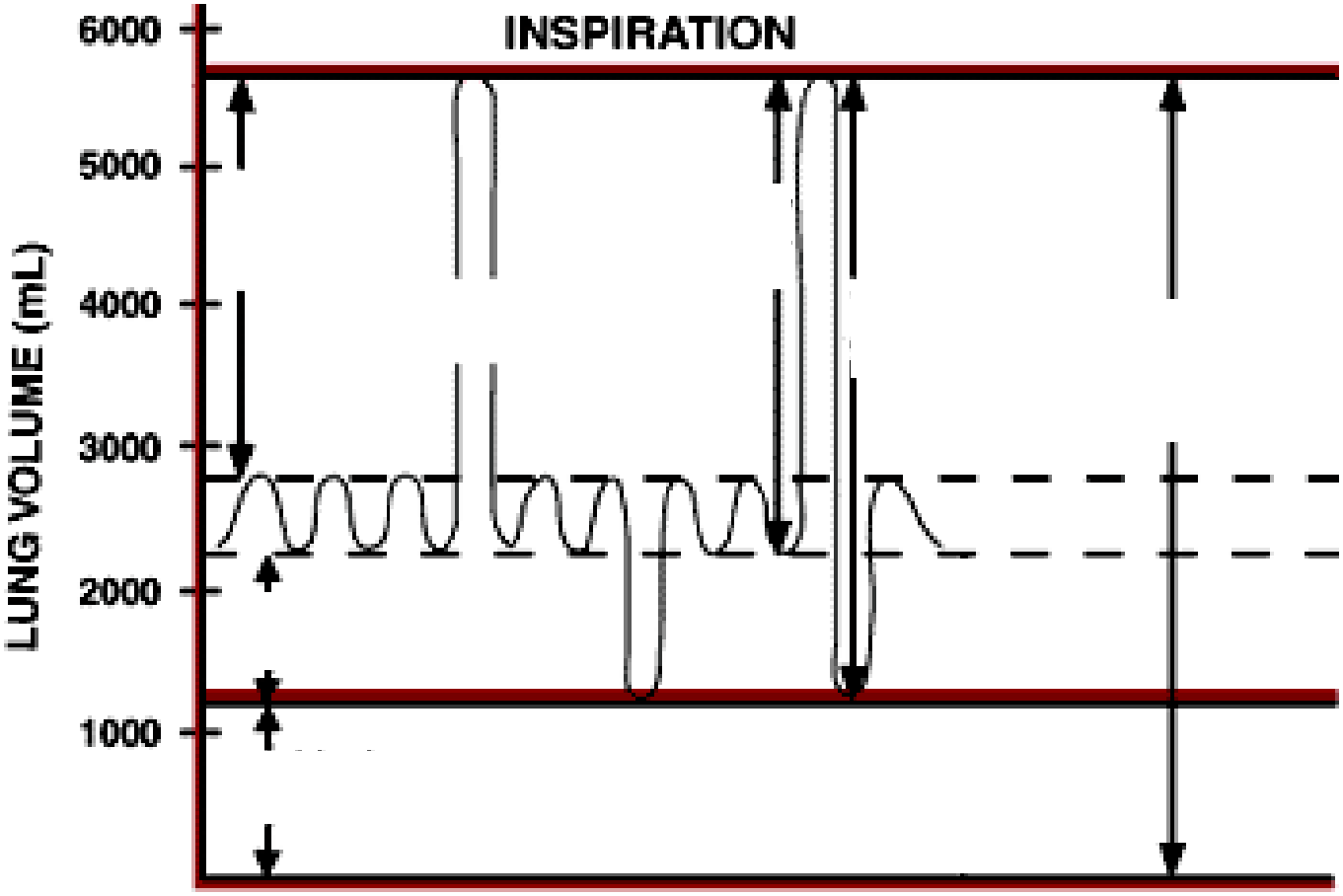
MEASURING LUNG VOLUMES AND CAPACITY
Spirometer



- A device that measures the _____ of gas entering or leaving the mouth
- A spirometer measures changes in _____ _____
- A spirometer measures subdivisions of _____ _____
- A spirometer does NOT measure _____ _____

Key term	Definition
pulmonary ventilation	
total lung capacity (TLC)	
vital capacity (VC)	
tidal volume (TV)	
expiratory reserve volume (ERV)	
inspiratory reserve volume (IRV)	
residual volume (RV)	

Spirometer trace



BUILD YOUR OWN SPIROMETER – PRACTICAL ACTIVITY

Materials

- 3 liter soda bottle (empty) with cap
- 2 foot piece of plastic tubing
- measuring cylinder
- a bucket or pan that can hold more than 3 liters of water
- marker

Method to build the spirometer

1. Add 100ml of water to the soda bottle using the measuring cylinder and mark a line with the marker at the top of the water level.
2. Repeat this until the bottle is full.
3. When the bottle is full, put the cap on the bottle.
4. This is done to put measuring lines on the bottle.
5. Add sufficient water to the container to submerge the soda bottle.
6. Invert the soda bottle and submerge it in the bucket, and remove the cap under the water.
7. Open the bottle underwater to prevent any unwanted air from entering the bottle.
8. Place one end of the tubing into the soda bottle in the water, and leave the other end outside of the water.

Method to use the spirometer:

1. While a partner holds the bottle to keep it from flipping over,**inhale normally**, then exhale the air normally into the tubing connected to the spirometer.
2. Be sure not to blow out all the "extra" air in your lungs.
3. Estimate of the volume of air you exhaled, remembering that each line on the bottle represents 100ml, starting from the top down.
4. Write this number down, it is your "**tidal volume**."

   Tidal volume:_____

5. Refill the bottle with water and reinsert the tubing.
6. While your partner holds the bottle, take a few normal breaths to help get a good reading on this next step, and **then inhale as much air as you can and exhale this air into the end of the tubing** outside of the water.
7. Estimate the volume of air you exhaled by looking at the lines on the soda bottle.
8. Write this number down, it is your "**inspiratory reserve**."

   Inspriratory reserve: :_____

9. Refill the bottle with water and reinsert the tubing.
10. While your partner holds the bottle, take a few normal breaths to get yourself back to a normal breath, and **then exhale as much air as you can into the end of the tubing** outside of the water.
11. Estimate the volume of air you exhaled by looking at the lines on the soda bottle.
12. Write this number down, it is your "**expiratory reserve".**

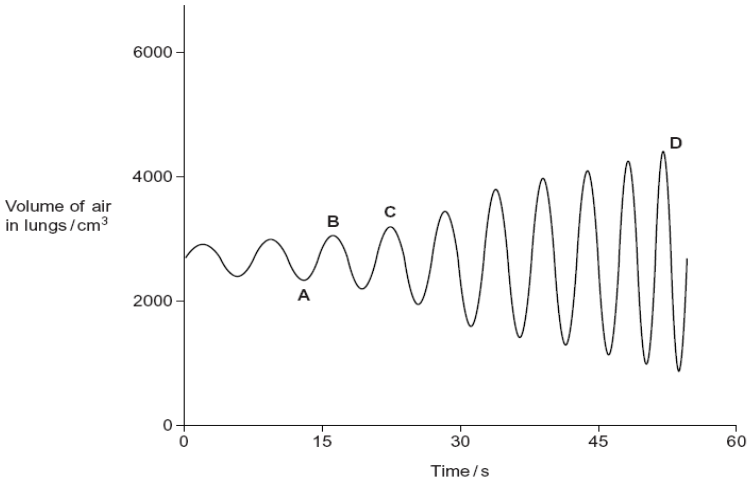
    Inspriratory reserve: :_____

13. How much air can my lungs hold?
14. If the "inspiratory reserve" and the "expiratory reserve" and the "tidal volume" are added together, then you get the "vital capacity," or the functional capacity of the lungs.
15. The vital capacity is the greatest change in volume that can occur in the lungs.
16. **This is not the total volume of air that fits in the lungs, but it is a good approximation**.
17. **Inspiratory Reserve + Expiratory Reserve + Tidal Volume = Vital Capacity**

    Complete the calculation in the space below

SPIROMETER TRACE PAST PAPER QUESTION

The graph shows changes in the volume of air in a person's lungs during breathing.



(a) The person was breathing in between times **A** and **B** on the graph.

(a) (i) Explain how the graph shows that the person was breathing in between times **A** and **B**.

.....

.....

(1 mark)

(a) (ii) Describe and explain what happens to the shape of the diaphragm between times **A** and **B**.

.....

.....

.....

.....

(2 marks)

(b) The person's pulmonary ventilation changed between times **C** and **D**.
Describe how the graph shows that the pulmonary ventilation changed.

.....

.....

.....

.....

.....

.....

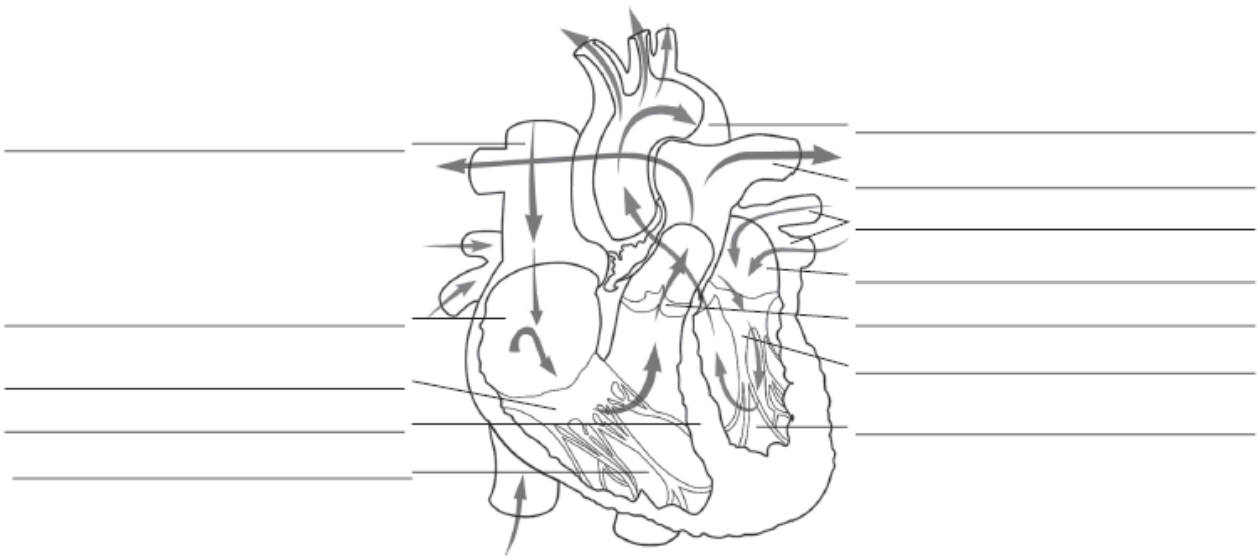
(3 marks)

COMPOSITION OF BLOOD

Match the statements

Red blood cells are called…	…55 per cent of the volume of blood.
The main function of red blood cells…	…is to transport oxygen.
In the red blood cells is haemoglobin; this helps…	…by going to the source of infection.
White blood cells protect the body…	…the transportation of oxygen to the working muscles.
White blood cells are also called…	…erythrocytes.
White blood cells are produced…	…in both the long bones and the lymph tissue of the body.
The platelets' job is…	…leukocytes.
Platelets are smaller parts…	…to clot the blood.
Plasma is 90 per cent water and makes up…	…the circulation between cells and tissue.
Plasma contains plasma proteins that help…	…of larger cells.

STRUCTURE OF THE HEART



Word bank

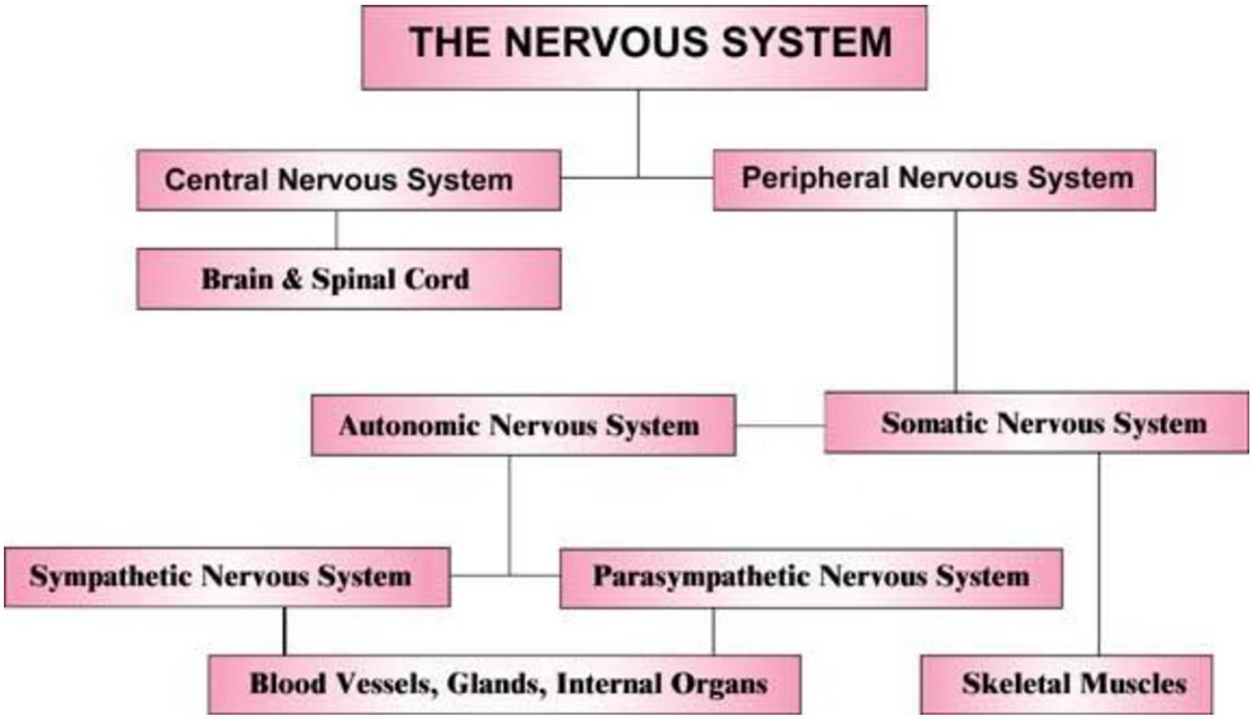
Heart
- Left atrium
- Right atrium
- Left ventricle
- Right ventricle

- Mitral valve
- Tricuspid valve
- Semi-lunar valve
- Septum

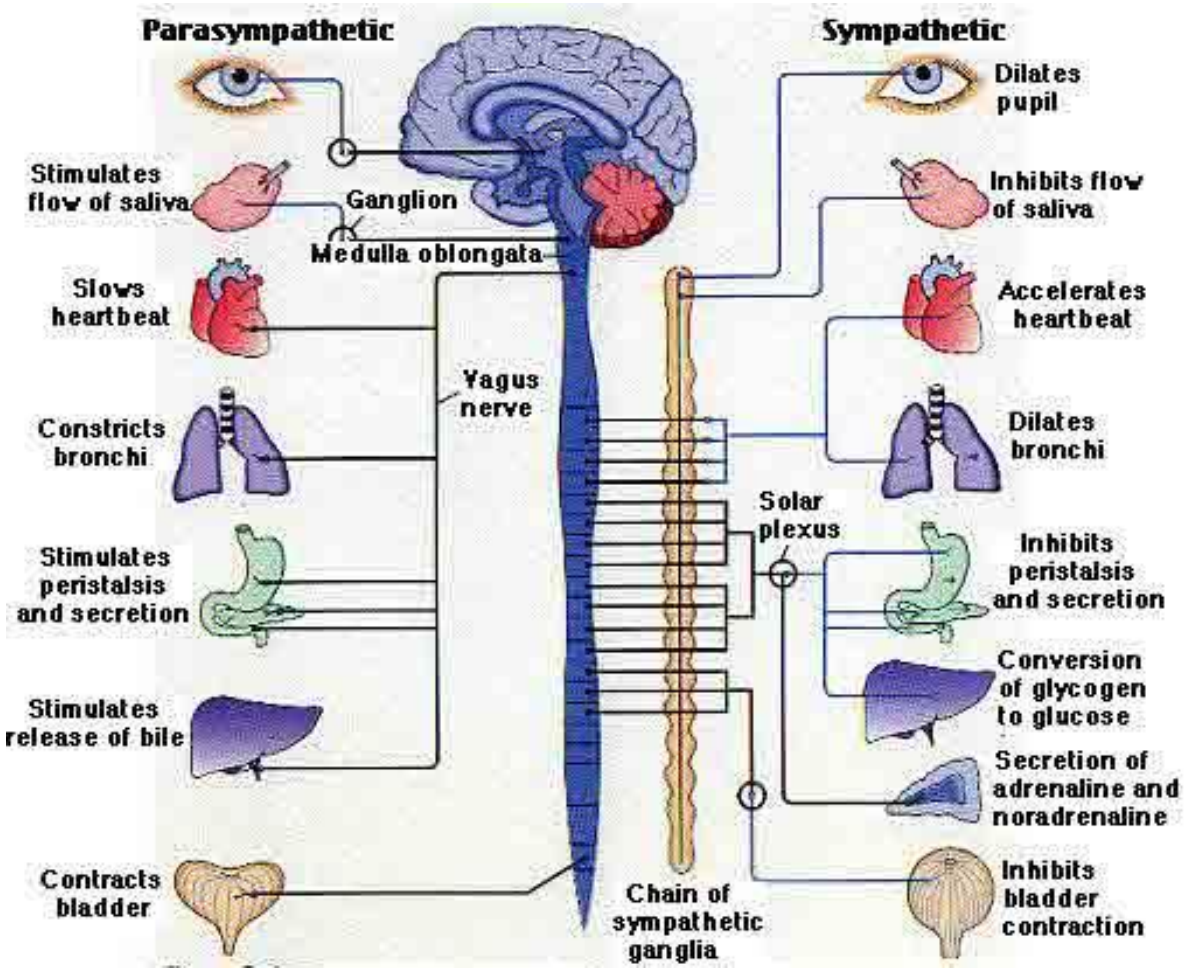
Blood vessels
- Pulmonary artery
- Pulmonary vein
- Superior vena cava
- Aorta

Blood
- Oxygenated blood
- Deoxygenated blood

THE NERVOUS SYSTEM



The autonomic nervous system



THE CARDIAC CYCLE SONG

Your heart, your heart keeps blood pumping round your body
It starts, it starts with a stage we call _____
The heart's _____, blood's coming through the veins

Blood flow, blood flow keeps the pressure in
the _____rising
It so, it so strong it causes the _____to open
Allowing blood to pass into the _____
That's one stage

When we sing this stage
There's not a lot else we can say
The _____cycle
In three simple ways

_____
Atrial systole
Then there's one more:
_____systole

Atrial _____is the next step in the cycle
It pumps, it pumps remaining blood into the
_____
The ventricles will stay _____

_____of the ventricles is the final stage
The _____will close preventing the
back flow of blood
_____valves will push blood through
the _____
And the pulmonary _____

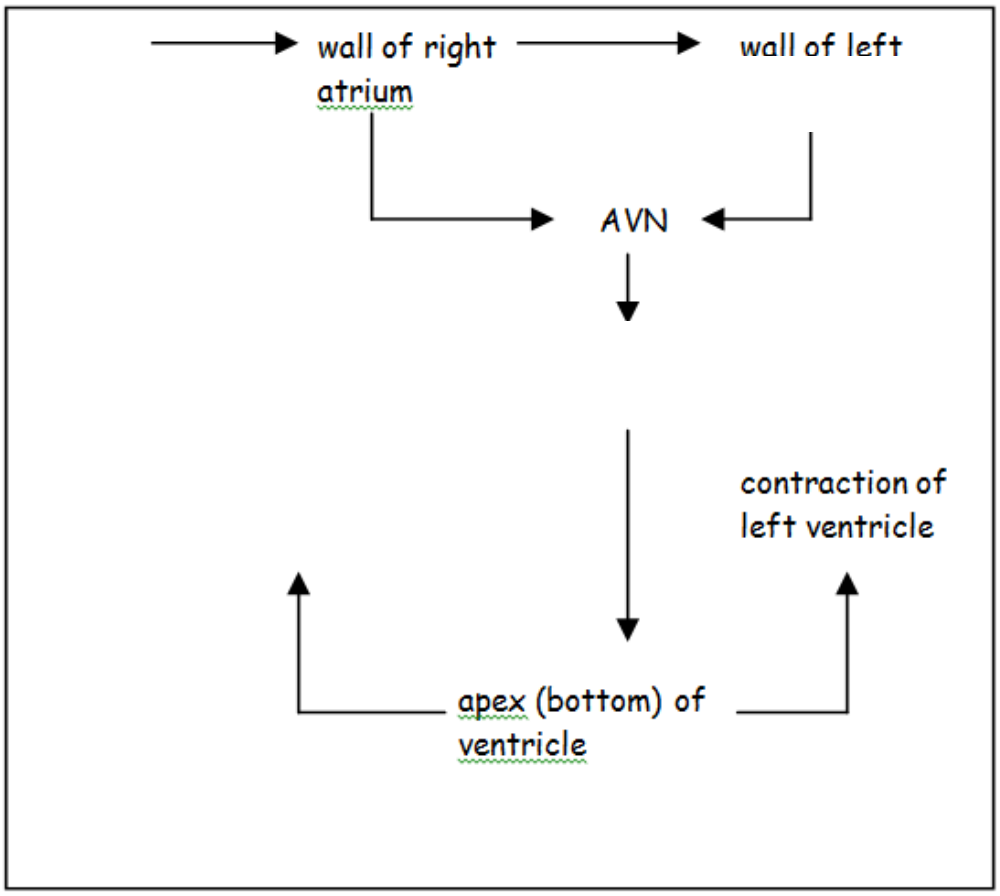
When we sing this stage
There's not a lot else we can say
The cardiac cycle
In three simple ways

Diastole
_____systole
Then there's one more:
Ventricular systole

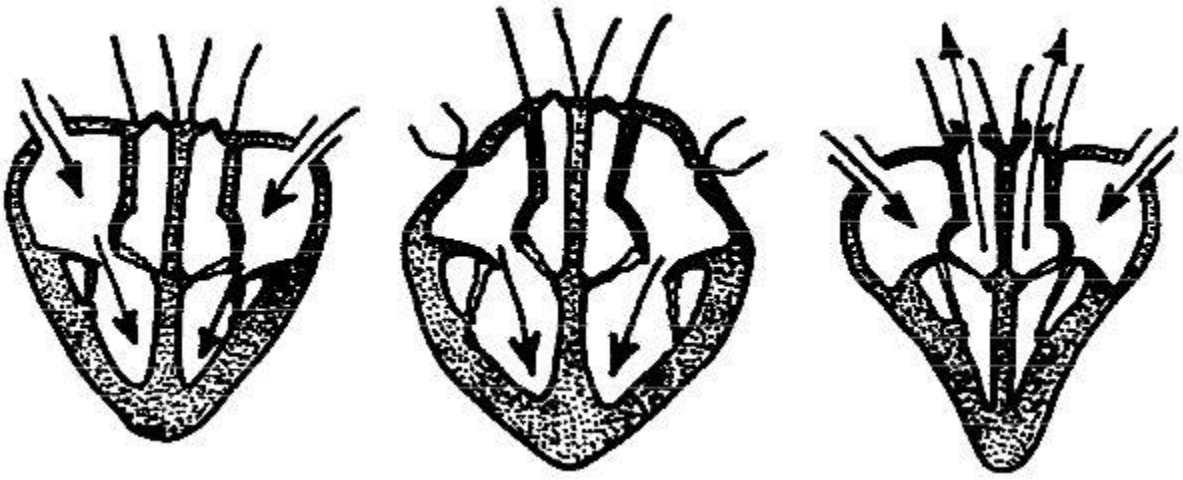
DEFINE:

Key word	**Definition**
Myocyte	
Sino-atrial node	
Atrio-ventricular node	
Indefatigable	
Action potential	
Purkinje fibres (Bundle of His)	
Myocardial contraction	
Autonomic nervous system	

OUTLINE the control of heart rate



ANNOTATE this diagram of the cardiac cycle:



EXPLAIN control of heart rate

1. Increased rate of…	
2. As a result CO_2 levels in blood…	
3. This is detected by …….	
4. The medulla oblongata sends a signal to secrete the hormone…..	
5. The hormone travels through the bloodstream to the …….	
6. The effect of this hormone is to …….	
7. As a result the CO_2 levels in the blood …….	
8. This is again detected by ….	
9. This time a hormone called acetylcholine is secreted from the brain which affects the…….	
10. Eventually the heart rate will…..	

PAST PAPER QUESTION

How is breathing rate regulated by the body to meet the increasing demands of exercise during a game of netball? ***(4 marks)***

CARDIAC OUTPUT

Define the following key terms

Term	Definition (including formula)	Unit	Symbol
Pulmonary circulation			
Systemic circulation			
Cardiac output			
Stroke volume			

Individual Activity

Show your working to calculate your personal cardiac output in the space below

Class Activity

AIM: To investigate the difference in stroke volume between males and females

HYPOTHESIS:

MATERIALS:

- **stopwatch**

METHOD:

1. Take your resting HR by finding your pulse and recording over 15 seconds then multiplying by four
2. The average Q for a person is 5 litres per minute – using this information – calculate your stroke volume and enter the data into the data table
3. Note down the rest of the classes results…make sure you collect everyone's!
4. Separate the class stroke volumes by male & female
5. Calculate mean SV for the males and the females.

RESULTS:

Name	Gender	Q (l/min)	HR (bpm)	SV (l)
		5		
		5		
		5		
		5		
		5		
		5		
		5		
		5		
		5		
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		5		
		5		
		5		
		5		

ANALYSIS:

Is there a difference between males and females?

If so, explain why.

What conclusions can you draw about the general fitness of males compared to females?

What conclusions can you draw about the general fitness of the class?

CHANGES TO CARDIAC OUTPUT DURING EXERCISE

Individual Activity – Types of Exercise CLOZE

Choose the correct wards from the word bank below. There are more words than required.

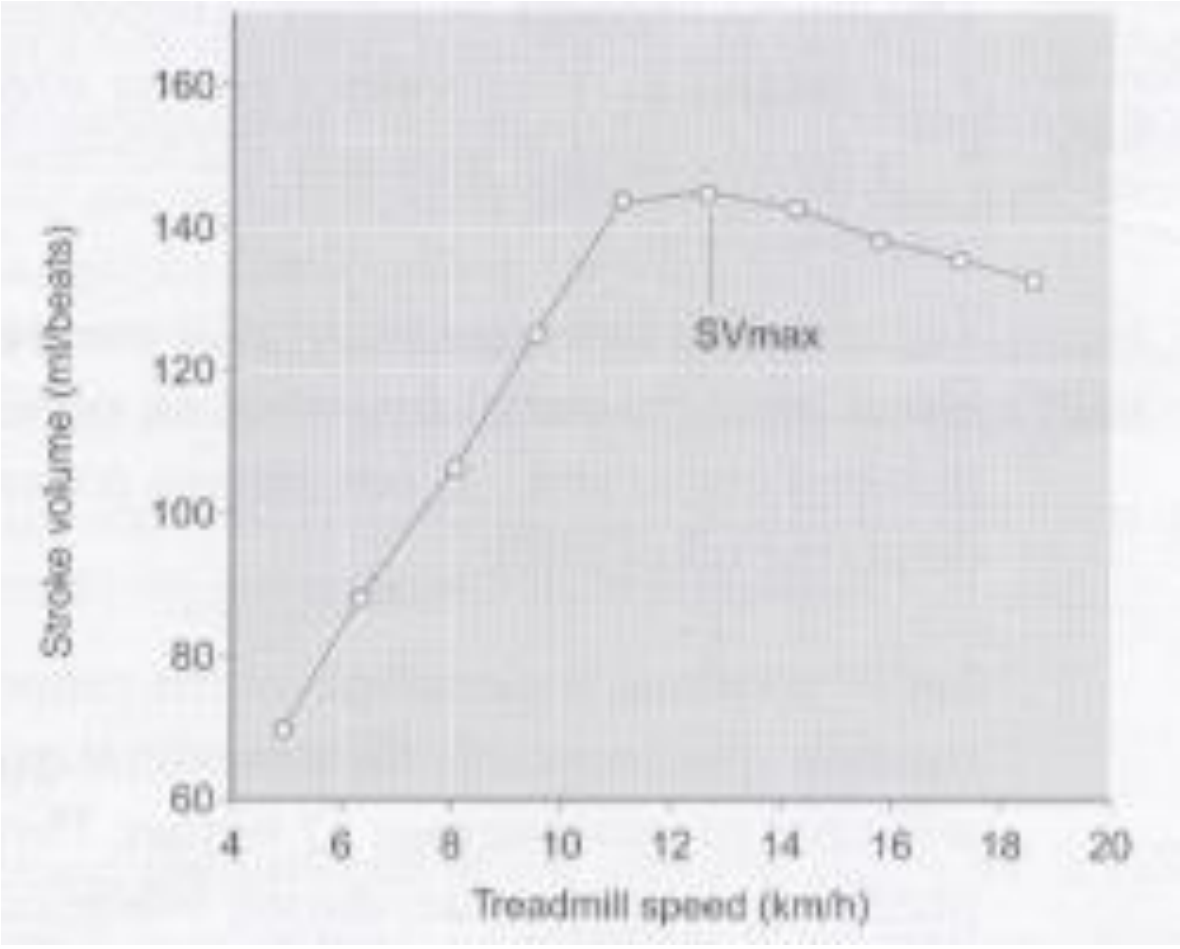
Sub-maximal exercise is the average method of working out; you are not working at your physiological _____ Heart rate is measured in _____ _____ _____ and relates to sub-maximal exercise in that when you are exercising, your measured heart rate is not as . _____ as it could be.

When you reach your maximum amount of work that you are physiologically capable of performing, your heart rate will _____. Heart rate should respond in a _____ fashion to physical activity; however, other factors such as your medical history and level of fitness may play a role. _____ exercise should _____ the heart rate, but not bring it to its maximum.

WORD BANK:

maximum	beats per minute	fast	plateau	
linear	sub-maximal	increase	slow	decrease

Stroke volume



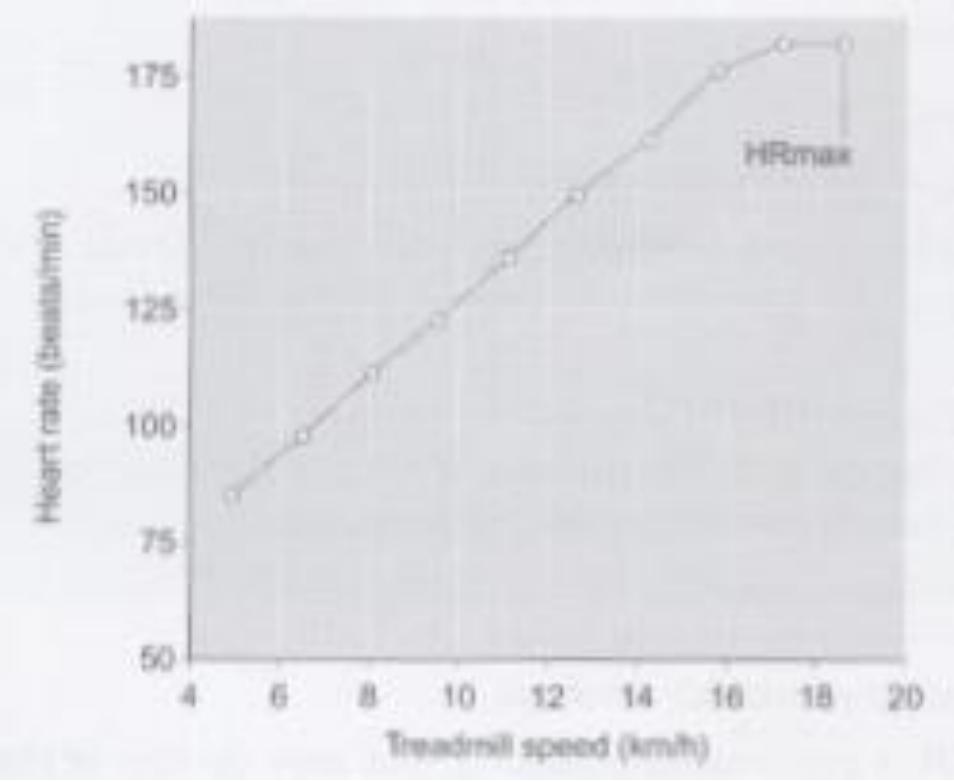
- _____ during exercise – why?
- At a _____ rate to the speed/intensity of the exercise (up to about _____-_____
- Once 40-60% of maximum intensity is reached stroke volume _____
- Therefore stroke volume reaches its _____ during _____ exercise

What causes stroke volume (and therefore Q) to increase?

- More blood is being returned to the heart – this is called _____ _____
- Less blood left in heart (_____ _____ _____)
- Increased _____ _____ occurs, this increases the pressure and stretches the walls of the ventricles, which means that a more forceful contraction is produced
- This is known as _____ _____ (more stretch = more forceful contraction)

- During maximal exercise the cardiac output will need to be increased, however stroke volume has already reached its maximum
- Heart rate _____
- As a result of this stroke volume starts to _____ – the increase in HR means that there is not as much time for the ventricles to fill up with blood, so there is less to eject (causes the HR to increase even more)

Heart Rate



Before Exercise

- Increases above resting HR before exercise has begun – known as _____ _____ , is as a result of the release of adrenalin which stimulates SA node

Sub-maximal Exercise

- Plateaus during sub-maximal exercise, called _____ _____ – this means that the oxygen demand is being meet

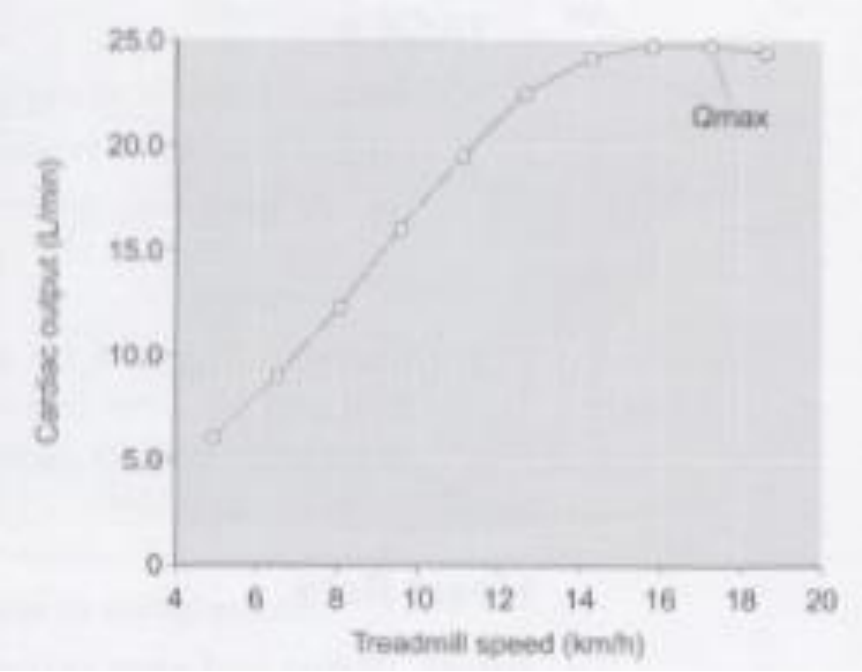
Maximal Exercise

- _____ dramatically once exercise starts, continues to increase as _____-_____ increases
- _____ as exercise intensity decreases

After Exercise

- After exercise – decreases _____
- Then _____ decreases

Cardiac Output



- _____ directly in line with intensity from resting up to maximum
- _____ during sub-maximal exercise

DATA ANLAYSIS OF CARDIAC OUTPUT

The table below shows the cardiovascular responses during **dynamic** whole-body exercise for 2 adult males of similar age (20 years old) and size (1.8m, 70kg). One of the individuals is sedentary and the other obe is a well-trained **endurance** athlete.

The data reflects 3 levels of exercise intensity:

1. Rest
2. Sub-maximal exercise (exercise at a fixed intensity)
3. Maximal exercise (exercise to the point of exhaustion)

Measurement	Intensity	Untrained adult male	Trained adult male
Heart rate (beats.min^{-1})	Rest	75	50
	Sub-max.	110	80
	Max.	197	195
Stroke volume (ml.beat^{-1})	Rest	60	90
	Sub-max.	85	112
	Max.	120	190
Cardiac output (L.min^{-1})	Rest	4.6	4.5
	Sub-max.	9.4	90
	Max.	19.7	32.2

Evaluate the effect of training on the cardiovascular responses to sum-maximal and maximal dynamic exercise.

Aside from any differences in training status, **predict** any differences that you would expect if the data in the above table were compared to an adult female.

Sub-maximal cardiovascular responses are different in children and adults. Both boys and girls have a lower cardiac output than adults at a given absolute sub-maximal rate of work. This lower cardiac output is attributable to a lower stroke volume, which is partially compensated for by a higher heart rate.

The table below shows the data from a study comparing cardiovascular responses to cycling and treadmill running in 7-9 year old children versus 18-26 year old adults.

Exercise	**Cardiac output ($L.min^{-1}$)**		**Stroke volume ($ml.beat^{-1}$**		**Heart rate ($beats.min^{-1}$)**	
	Child	***Adult***	***Child***	***Adult***	***Child***	***Adult***
Cycle 60W	9.4	12.4	61.9	126.8	153.1	97.8
Run 3 mph	6.7	12.3	57.3	135.7	11.6	92.0

Compare the cardiac output, stroke volume and heart rate between the child and the adult

Explain the cardiac output, stroke volume and heart rate between the child and the adult

ADAPTATIONS OF THE HEART TO EXERCISE

	Heart Rate	Stroke Volume	Cardiac Output
Rest			
Exercise			

PAST PAPER QUESTIONS

Briefly explain the terms 'cardiac output' and 'stroke volume', and the relationship between them. **(3)**

Explain how it is possible for a trained performer and an untrained performer to have the same cardiac output for a given workload. **(4)**

CALCULATING MAXIMAL HEART RATE FOR TRAINING

To make sure you are getting the most out of your workouts, you should exercise within what is called your "Training Heart Rate Zone".

This activity will teach you how to calculate for that zone/range, which is 60-80% of your maximum heart rate.

60% = low intensity, 70% = moderate intensity, 80% = high intensity

Part I- Calculate your HR Zones using both formulas

Use the Maximum HR Formula to get the HR zones:

Calculate your **Resting Heart Rate (RHR)** _____

- The RHR should be taken first thing on **3 consecutive mornings** upon waking and before getting out of bed.

Calculate your estimated **Maximal Heart Rate (MHR)** _____

- (220 – Age = MHR)

Calculate your **Target Heart Rate Zone (THRZ)** 65% _____ and 80% _____ of your MHR.

- (MHR X 0.65 = 65% of MHR) and (MHR X 0.80 = 80% of MHR

Use the Karvonen Formula to get the HR zones: (This is a much harder way to get your zones)

Calculate your **Resting Heart Rate (RHR)**_____

- RHR should be taken first thing in the morning upon waking and before getting out of bed.

Calculate your **Maximum Heart Rate (MHR)**_____

- Go outside and sprint as hard as you possibly can until you cannot go anymore and you feel a lot of muscle pain. Take your 6 second pulse and add a 0 (zero). Write this number down.

Calculate your **Target Heart Rate Zone** at 65%_____and 80%_____ of your HR Reserve.

- [(MHR – RHR) X .65] + RHR and [(MHR – RHR) x .80] + RHR

Part II- Perform the following activities and write down your HR response

Perform each activity.

- Carry out each activity listed below for **TWO MINUTES**
- Take your heart rate at the end of each activity.
- Use your **carotid** or **radial** artery and count the beats for 6 seconds.
- Add 0 to the number that you count.

Activity	**Heart Rate**	**THRZ (Y or N)**
Laying (Resting HR)	_____	_____
Standing	_____	_____
Medium Paced Walk	_____	_____

Continued Part II- Perform the following activities and write down your HR response

Activity	**Heart Rate**	**THRZ (Y or N)**
Push Ups	_____	_____
Forearm Planks	_____	_____
Jump Rope	_____	_____
Run up and down stairs	_____	_____
Jogging	_____	_____
Triceps Dips	_____	_____

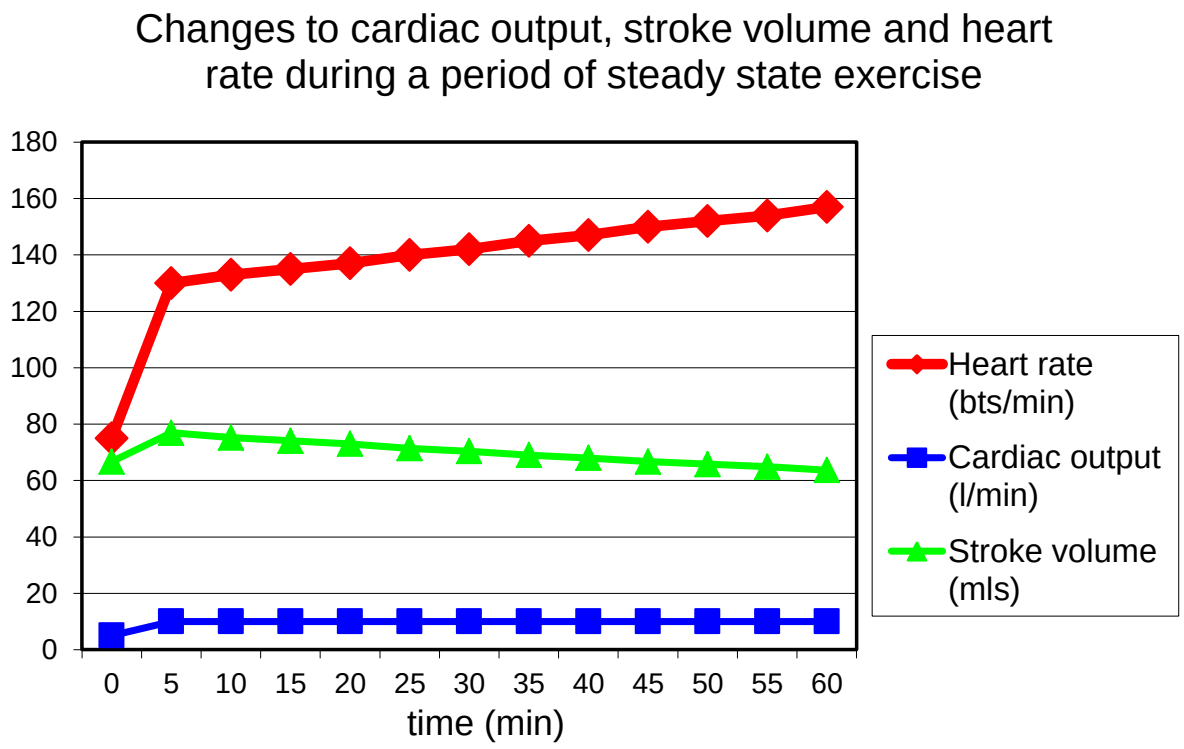
Analysis

To gain optimum fitness, do you want to train in the higher end of the zone or lower end of the zone? Why?

To burn the most calories, what do you need to do to your HR? Why?

What do you think happens to your RHR over time if you have a regular workout program? Why?

CARDIAC DRIFT



- _____ _____ exercise lasting _____
- Cardiac output stays _____
- Stroke volume _____
- Heart rate_____

Explanation for cardiac drift

- Continuous exercise – lots of _____
- Fluid seeps into surrounding tissues and cells
- Fluid lost to sweating
- If athletes fail to re-hydrate, can further reduce the volume of blood returning to heart
- Reduces _____ _____ and hence reduces_____ _____

- Therefore reduced _____ -

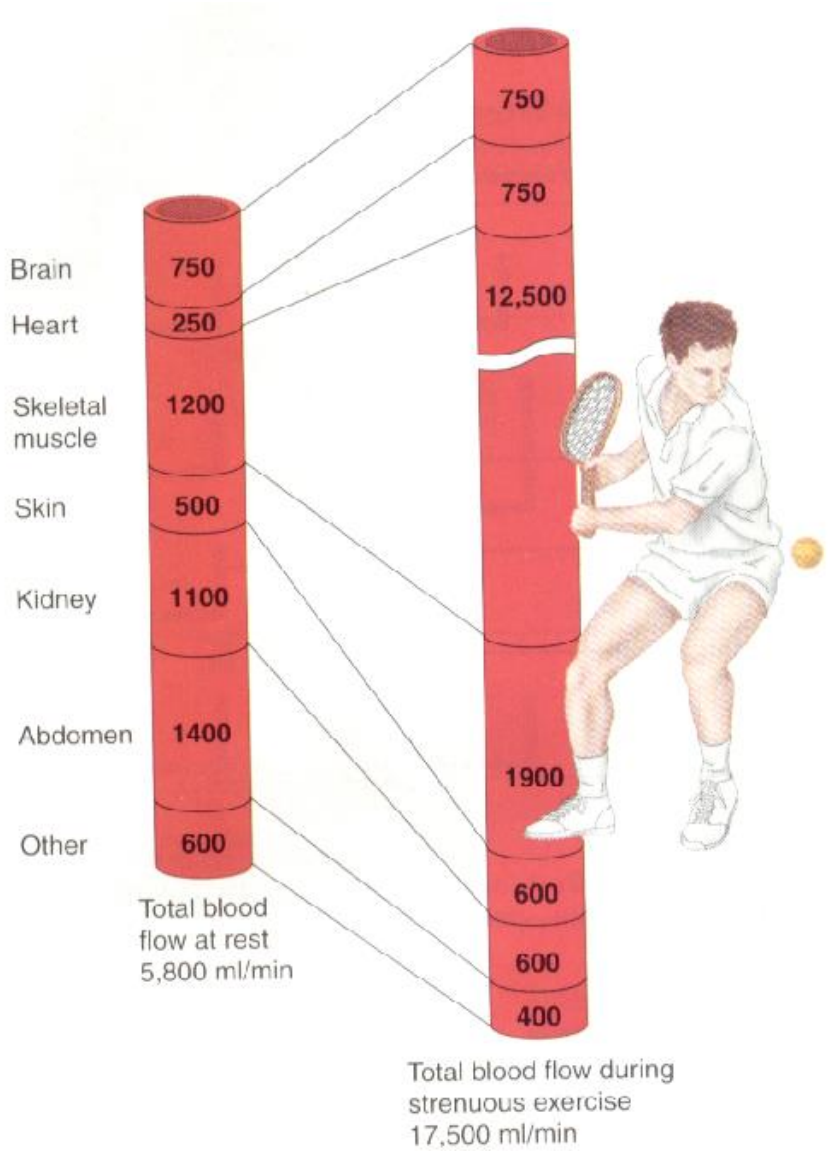
According to Starling's Law

- Cardiac output (Q) needs to be kept constant
- Q = _____ - if SV _____, then HR must _____
- Hence need for _____ in heart rate during steady state exercise to maintain

REDISTRIBUTION OF BLOOD FLOW

Define

vasodilation	
vasoconstriction	



Read the passage below and highlight key terms and ideas.

Blood flow changes dramatically once exercise commences. At rest, only 15-20% of cardiac output is directed to skeletal muscle (the majority of it goes to the liver and the kidneys. Blood is redirected to areas where it is needed most. This is known as shunting or accommodation. When exercising, the increased metabolic activity increases the concentration of carbon dioxide and lactic acid in the blood. This is detected by chemoreceptors and sympathetic nerves stimulate the blood vessel size to change shape.

Vasodilation will then allow a greater blood flow, bringing the much needed oxygen and flushing away the harmful waste products of metabolism. The redistribution of blood is controlled primarily by the vasoconstriction and vasodilation of arterioles. They react to chemical changes of the local tissues.

For example, vasodilation will occur when arterioles sense a decrease in oxygen concentration or an increase in acidity due to higher CO_2 and lactic acid concentrations.

Sympathetic nerves also play a major role in redistributing blood from one area of the body to another. The smooth muscle layer (tunica media) of the blood vessels is controlled by the sympathetic nervous system, and remains in a state of slight contraction. By increasing sympathetic stimulation, vasoconstriction occurs and blood flow is restricted and redistributed to areas of greater need. When stimulation by sympathetic nerves decreases, vasodilation is allowed which will increase blood flow to that body part.

Complete the right hand side of the table with the complementary 'Explain' statement from the board.

DESCRIBE	**EXPLAIN**
Skeletal muscle – massive increase in blood flow (26 fold) to working muscle. At maximum effort muscle takes 88% of blood flow	
Coronary vessels – blood vessels that serve cardiac muscle (which needs oxygen and respiratory substrates). Nearly a 5 fold increase in blood flow during exercise.	
Skin – small increase in blood flow to the skin during exercise.	
Kidneys – significant reduction in blood flow during exercise.	
Liver & gut - significant reduction in blood flow during exercise	
Brain – blood flow is maintained at the same level during exercise	
Whole body – the volume of blood pumped per minute is the same measure as **cardiac output**	

PAST PAPER QUESTION

In a variation of baseball, the batter has to run every time he strikes the ball. At the end of an extended innings, the information in the table was obtained.

Estimated blood flow in cm^3 per minute

Organ system	Prior to batting	%	After extended innings	%
Skeletal muscle	1200	21.0	12500	72.0
Heart	250	4.0	750	4.0
Skin	500	8.5	1900	11.0
Kidneys	1100	19.0	600	3.5
Abdominal organs	1400	24.0	600	3.5
Brain	750	13.0	750	4.0
Other	600	10.5	400	2.0
Total	**5800**	**100**	**17500**	**100**

Using information from the table **explain** the changes in the blood flow during exercise to:

(i) The skin:

(ii) The heart:

BLOOD PRESSURE

- Measured in blood vessels (_____)
- Determined by _____ _____ and _____ _____ _____ of blood in vessels
- Resistance to flow affected by _____ of blood vessels
- Narrower vessels (_____)
- Wider vessels (_____)

Complete the paragraphs below using terms for the word banks provided

(i) **The heart** makes _____ beating sounds. The first is called _____, and is made by the lower chambers _____ and pushing blood at _____ pressure into the arteries. The actual sound is caused by the heart valves closing. The second sound is called _____ and is made by the _____ chambers contracting, pushing blood down into the lower chambers. During exercise these sounds get louder, mainly because of an _____ in blood pressure.

(ii) **Blood pressure** is the force exerted by _____ on the walls of the _____. It increases during exercise because more blood is pumped around the body, increasing pressure on the _____ _____.

(iii) **Systolic blood pressure** is the _____ pressure the in the arteries when the heart contracts and pushes blood through the _____ into the body. It rises during _____ or excitement as more blood is required by the body. It falls during sleep when the body is at _____.
Diastolic blood pressure is the pressure of the blood during the _____ phase between heartbeats. It depends on the _____ of the arteries and the quality of the _____. Pulse pressure is the difference between _____ and _____ blood pressures.

(i) Diastole
Two
Increase
Systole
Upper
Contracting
High

(ii) Blood vessels
Arteries
Blood

(iii) Activity
Systolic
Maximum
Diastolic
Aorta
Rest
Vessels
Elasticity
Relaxation

Factors affecting blood pressure

Factor	Explanation
Cardiovascular centre	
Smoking	
Diet	
Adrenaline	
Increase in blood viscosity	

DATA ANALYSIS QUESTION

	Activity	Diastolic pressure (mmHg)	Systolic Pressure (mmHg)
80kg healthy male	Rest	75	116
	Running	80	180
	Lifting	150	240
100 kg unhealthy male	Rest	95	150

The table above presents data for a healthy trained 80kg male at rest and performing two different actions (running fast, a dynamic activity, trying to lift a very heavy object, static but very high forces), as well as resting data for another untrained and unhealthy individual.

Answer the following questions

1. Compare the effect of dynamic exercise and static exercise on blood pressure

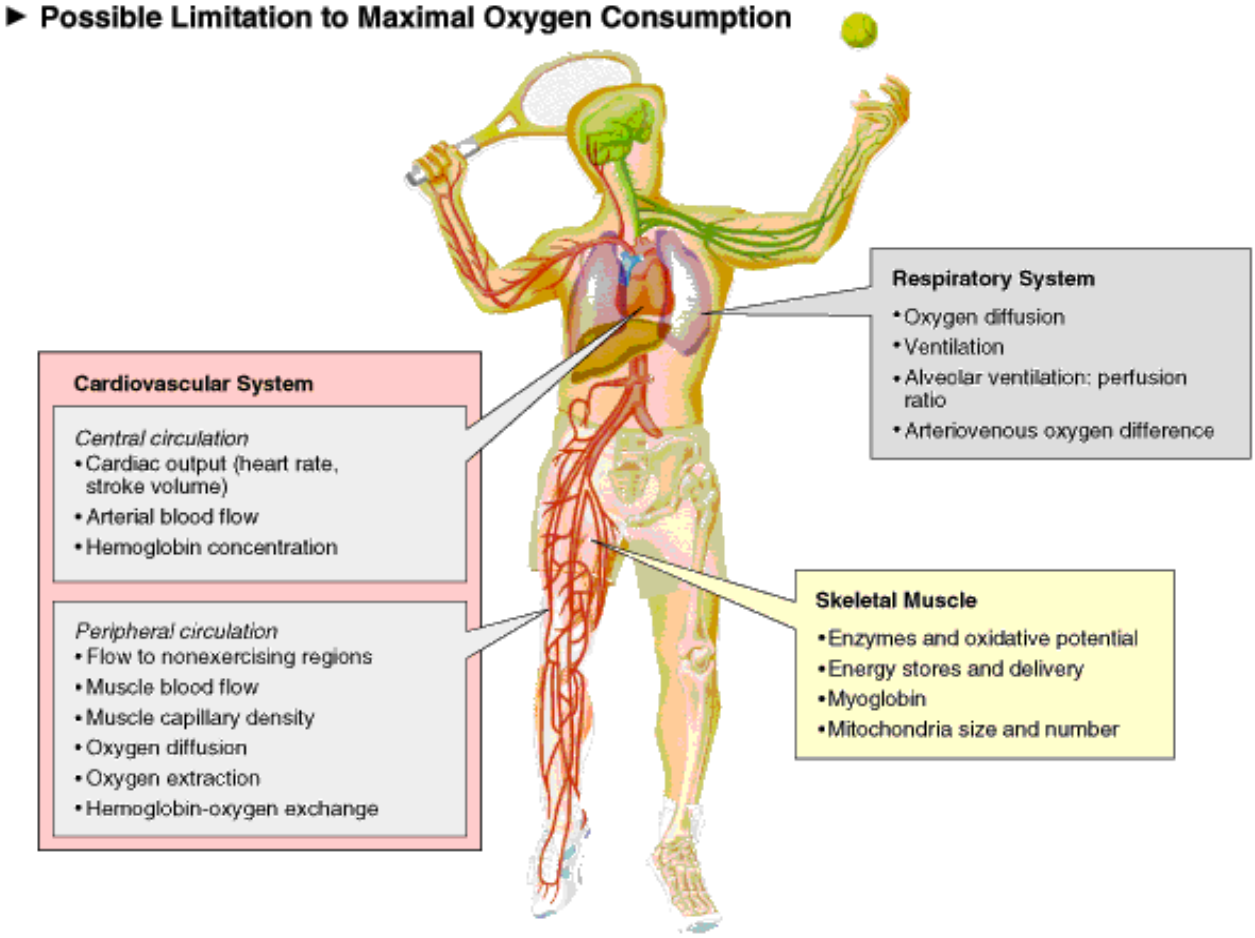
2. Explain why one is higher than the other

3. Describe the difference between the two participants at rest

MAXIMAL OXYGEN CONSUMPTION

Define VO_2 max (don't forget to include units)

List the factors that VO_2 max depends on.



Fick Equation

	Cardiac output $L.min^{-1}$		**$(A\text{-}V)O_2$ ml per 100ml**		**VO_2 max $L.min^{-1}$**	
	Child	***Adult***	***Child***	***Adult***	***Child***	***Adult***
Cycle 60W	9.4	12.4	11.1	8.9		
Run 3mph	6.7	12.3	8.7	8.4		

Complete the table to explain the different factors that affect VO_2 max

Factor	Explanation

PRACTICAL ACTIVITY - BLEEP TEST

What is tested: VO_2^{max}- aerobic fitness level
Equipment needed: Stereo; bleep test CD; cones
Purpose of test: To estimate maximal oxygen uptake and utilization (VO_2^{max}) by administering a progressive shuttle run test.

Procedure & Measurement:

1. Measure a distance of 20 metres and mark with two cones.
2. The client should perform a short warm including CV and stretching
3. Start the CD, the participants will run 20 metres to the furthest cone when the first three bleeps sound.
4. When the bleep sounds on the CD the participant turns around to run back
5. The client must reach the line before the third bleep
6. The participants continue to run between the cones and the time between the bleeps becomes shorter- hence the participants need to run faster to reach the cones.
7. If the participant fails to get to the other end before the bleep on 3 consecutive occasions then they are out (2 chances).
8. Record the level at which the participant stopped the test.
9. Compare to VO_2 max tables.

Notes: As this is a **maximal** test, certain precautions should be taken. Participants should have no apparent health problems. A qualified First Aider should be present during the test.

Stage	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Level																
1																
2																
3																
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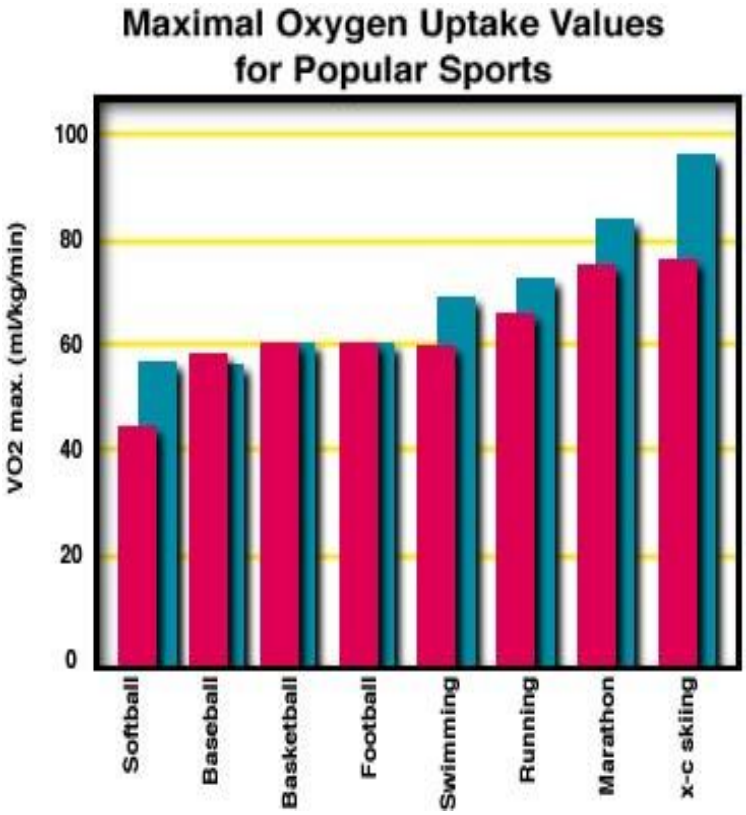
21																

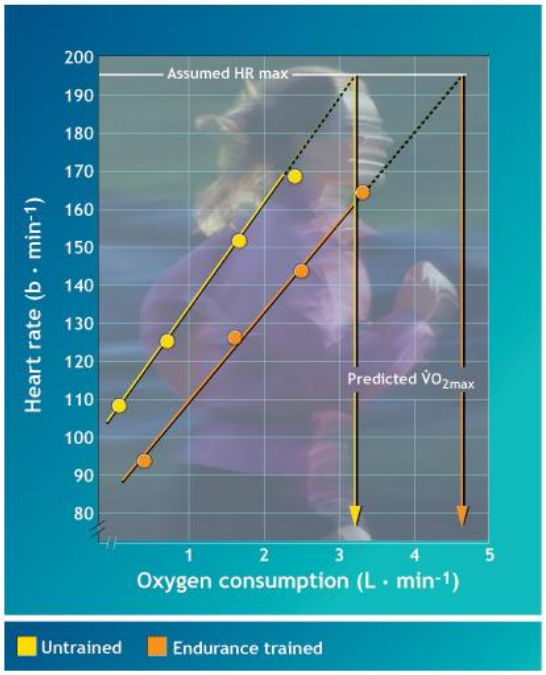
* * mark off the stage you reached, for each level, the last box filled in is your score**

Results for the comparison tables:

Interpret the data form the recording table above and write into the box below

Exercise and VO_2 max





PAST PAPER QUESTION

The VO_2 max was studied for a person exercising on a treadmill. Data was collected for 13 minutes of progressively faster and steeper running until a peak VO_2 was reached.

Time / mins	VO_2 per kg / ml min^{-1} kg^{-1}	Heart rate / beats min^{-1}	Ventilation rate / breaths min^{-1}
00:47	27.4	126	26.0
02:17	36.6	134	26.0
03:47	40.9	140	26.5
05:17	45.6	149	32.2
06:46	49.2	153	31.1
08:17	53.1	162	34.0
09:47	57.2	167	37.1
11:17	59.2	172	38.4
12:47	62.4	176	41.8
13:17	63.2	177	42.9

(a) State the maximum VO_2 per kg for this subject. *[1]*

. . . . . .

(b) Determine which has had a greater percentage increase, ventilation rate or heart rate, during the duration of the exercise. Show your working. *[2]*

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. . . . . .

(c) The subject weighed 70.0 kg at the time of this exercise. Calculate the VO_2 max. *[1]*

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. . . . . .

(d) Evaluate the limitations of the data provided by this research. *[2]*

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. . . . . .

. . . . . .

(a) (i) Define *stroke volume*. *[1]*

. . . . . .

. . . . . .

(ii) Define *cardiac output*. *[1]*

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. . . . . .

(b) As fitness increases, a person's heart rate drops. Suggest a reason for this phenomenon. *[1]*

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. . . . . .

. . . . . .

(c) Describe distribution of blood flow at rest and during exercise. *[3]*

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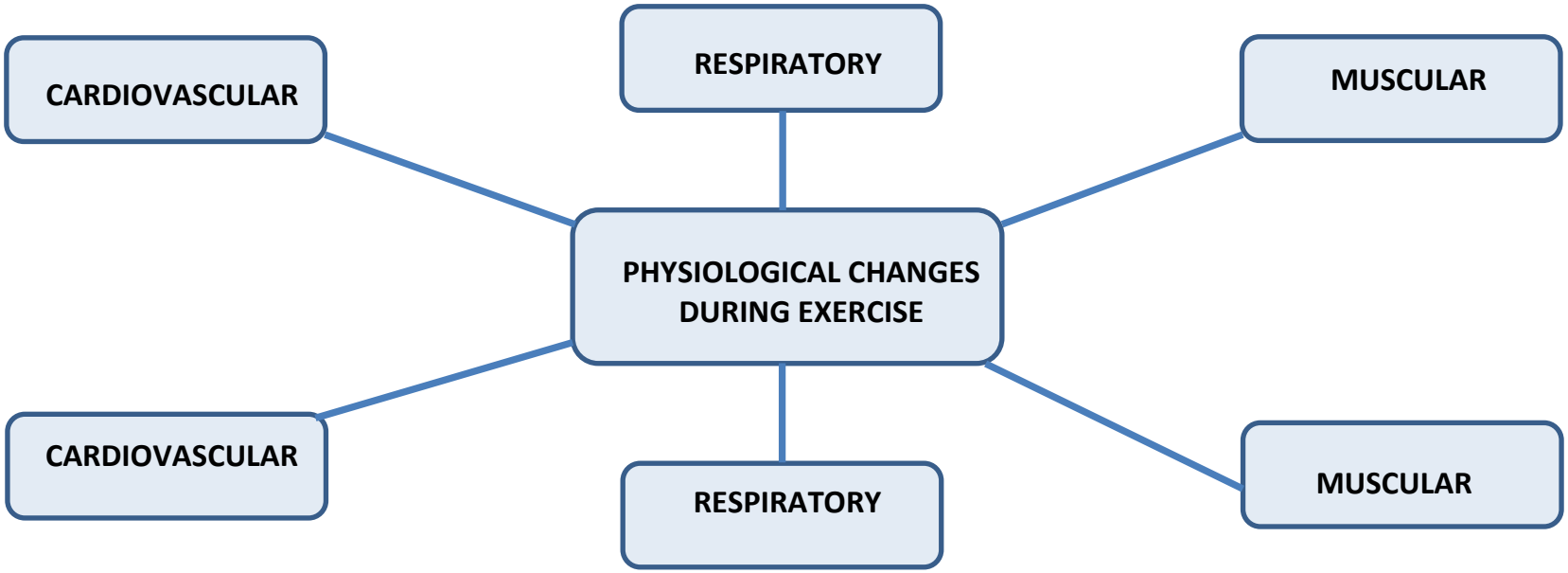
CARDIOVASCULAR
RESPIRATORY
MUSCULAR
PHYSIOLOGICAL CHANGES DURING EXERCISE
CARDIOVASCULAR
RESPIRATORY
MUSCULAR