

Physical activity and heart rate

Investigate and describe the effect of physical activity on the heart rate

For Cambridge IGCSE Biology 0610 (and 0970, which has the same content). Teacher answers start on a new page.

Name

Date

Aim

To investigate how different levels of physical activity affect the heart rate, measured as the pulse rate in beats per minute.

Background

The activity of the heart can be monitored by an ECG, by the pulse rate and by listening to the sounds of the valves closing. The **pulse rate** is the number of times the artery wall expands each minute as blood is pumped through it, and it is the same as the heart rate. It can be felt at the wrist or the neck.

Supplement: during physical activity the muscles respire faster, so they need more oxygen and glucose and produce more carbon dioxide. The heart rate increases so that blood flows faster, bringing oxygen and glucose to the muscles faster and removing carbon dioxide faster.

After exercise the heart rate falls back to the resting rate. The time this takes is the **recovery time**. The harder the exercise, the higher the heart rate and the longer the recovery.

Hypothesis

The harder the physical activity, the higher the heart rate and the longer the time taken to return to the resting rate, because the muscles need more oxygen and glucose.

Variables

Independent	The level of physical activity (rest, walking, jogging, running on the spot), each for 2 minutes
Dependent	Heart rate (pulse rate) in beats per min, found from the number of beats in 15 s, and the recovery time in min
Control	• The same person doing every activity • The same length of time (2 minutes) for each activity • The same place for taking the pulse and the same way of counting it • The same time of day • Full recovery to the resting pulse before starting the next activity

Equipment

- Stop-clock or stopwatch reading to 1 s or better
- Chair
- A flat, clear, dry area to exercise in
- Results table and pencil

Risk assessment

Hazard	Risk	Precaution
Physical exercise	Dizziness, breathlessness or muscle strain, especially for a person with a heart or breathing condition.	Do not take part if you have a medical condition that affects exercise. Stop at once if you feel dizzy, faint or unwell.
Running on the spot	Slipping or tripping.	Exercise on a clear, dry floor away from furniture and wear suitable footwear.

Method

1. Sit on a chair and rest for 5 minutes.
2. Find your pulse with two fingers on the inside of your wrist, below the thumb. Do not use your thumb.
3. Start the stop-clock and count the number of beats in 15 s. Record the number of beats. This is the resting pulse.
4. Walk on the spot for 2 minutes.
5. Sit down at once, find your pulse and count the beats in 15 s, then record the number of beats.
6. Count the beats in 15 s again at the start of every minute until the count is back to the resting value. Record the recovery time to the nearest minute.
7. Rest until your pulse is back to the resting value.
8. Repeat steps 4 to 7 for jogging on the spot, then for running on the spot, each for 2 minutes. Keep everything else the same.
9. Repeat the whole investigation a second time and record the second set of readings.
10. Calculate the mean number of beats in 15 s for each activity.
11. Calculate the heart rate in beats per min using: heart rate = mean number of beats in 15 s $\times$ 4.
12. Present the results as a bar chart of heart rate against activity.

Results

Pulse counts before and after physical activity					
activity	beats in 15 s: 1	beats in 15 s: 2	mean beats in 15 s	heart rate / beats per min	recovery time / min
rest					–
walking on the spot					
jogging on the spot					
running on the spot					

Graph

A bar chart with the activity (rest, walking, jogging, running) on the x-axis and heart rate / beats per min on the y-axis. The activities are separate categories, so draw bars of equal width that do not touch. Choose a scale so that more than half of the grid is used, label both axes with the quantity and unit, and draw the bars with a ruler.



Exam questions 10 questions · 26 marks

1 A student counts 29 beats in 15 s. Calculate the heart rate in beats per min. **[2 marks]**

Answer =

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2 A student investigates the effect of physical activity on heart rate. (a) State the independent variable. [1] (b) State the dependent variable. [1] (c) State one variable that must be kept constant. [1] **[3 marks]**

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- 3** The student measures the resting pulse before the exercise, and waits until the pulse returns to the resting rate before the next activity. Explain why each of these is done. **[2 marks]**

- 4** The resting heart rate was 78 beats per min and the heart rate after running was 148 beats per min. Calculate the percentage increase in heart rate. Show your working. **[3 marks]**

Answer =

- 5** The table shows the results of a student's investigation. Describe the effect of the level of activity on the heart rate and on the recovery time. **[3 marks]**

Heart rate and recovery time		
activity	heart rate / beats per min	recovery time / min
rest	78	–
walking	96	1
jogging	128	3
running	148	6

- 6** Supplement. Explain why the heart rate increases during physical activity. **[3 marks]**

7 Describe two safety precautions for the person doing the exercise. **[2 marks]**

8 Suggest three ways to improve the method so that the results are more reliable or more accurate. **[3 marks]**

9 Describe how the heart rate data in question 5 should be presented as a graph. **[3 marks]**

10 State what is meant by the recovery time and describe how it is measured. **[2 marks]**

Teacher answers

Practical skill 10: Physical activity and heart rate. The example results are practice data, not real measurements.

Example results

Example results (practice data)					
activity	beats in 15 s: 1	beats in 15 s: 2	mean beats in 15 s	heart rate / beats per min	recovery time / min
rest	19	20	19.5	78	–
walking on the spot	25	23	24.0	96	1
jogging on the spot	31	33	32.0	128	3
running on the spot	38	36	37.0	148	6

Conclusion

The heart rate increased as the physical activity became harder, from 78 beats per min at rest to 148 beats per min after running on the spot. The recovery time also became longer, from 1 min after walking to 6 min after running. This supports the hypothesis. Supplement: the muscles respire faster during harder activity, so they need more oxygen and glucose and produce more carbon dioxide. The heart beats faster so that the blood delivers oxygen and glucose to the muscles faster and removes carbon dioxide faster. After hard exercise the heart rate stays high for a while, to carry lactic acid from the muscles to the liver.

Errors and improvements

Error	Effect on the results	Improvement
The pulse is counted for only 15 s and then multiplied by 4.	Missing one beat changes the heart rate by 4 beats per min, so the readings are not very precise.	Count for 30 s or 60 s, or use a pulse sensor or heart rate monitor.
The pulse falls quickly after exercise, so the count starts late.	The heart rate recorded is too low.	Start counting immediately after stopping, and use a pulse monitor that records during the exercise.
The level of exercise is judged by eye and is not the same each time.	The activity is not a fair test, so the heart rate readings vary.	Use a fixed exercise such as step-ups on a step of fixed height at a fixed rate with a metronome.
Only one person is used and each activity is done once or twice.	The results may not be typical, and one reading may be anomalous.	Repeat more times and use several people of the same age and fitness, then calculate a mean.
The person does not fully recover before the next activity.	The next activity starts from a higher heart rate, so its heart rate is too high.	Wait until the pulse is back to the resting value, for example check that the count is the same as at the start.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [2]

- 29×4 (1)
- 116 beats per min (1) unit required; allow bpm

2. [3]

- (a) the level / type / intensity of physical activity (1)
- (b) heart rate / pulse rate (1) allow number of beats in 15 s
- (c) any one from: same person / same length of time for each activity / same time of day / same way of counting the pulse / same rest between activities (1)

3. [2]

- the resting rate is needed for comparison / to show the effect of the exercise (1)
- so that each activity starts from the same heart rate / so that the previous activity does not affect the result (1)

4. [3]

- $148 - 78 = 70$ (1)
- $70 \div 78 \times 100$ (1)
- 89.7% (1) allow 90% or 89.74%

5. [3]

- the harder the activity, the higher the heart rate (1)
- the harder the activity, the longer the recovery time (1)
- quotes paired data, e.g. heart rate rises from 78 at rest to 148 beats per min after running / recovery time from 1 min to 6 min (1)

6. [3]

- muscles respire faster / more (aerobic) respiration (1)
- more oxygen and glucose needed by the muscles / more carbon dioxide produced (1)
- blood flows faster so oxygen and glucose are delivered faster / carbon dioxide is removed faster (1)
- allow lactic acid removed faster (1)
- reject 'to make energy'
- Max 3

7. [2]

- do not take part if you have a heart or breathing condition / medical condition (1)
- stop if you feel dizzy / faint / unwell (1)
- exercise on a clear, dry floor away from furniture (1)
- Max 2

8. [3]

- repeat each activity more times and calculate a mean (1)
- use more people (of the same age and fitness) (1)
- count the pulse for longer than 15 s, e.g. 30 s or 60 s / use a pulse sensor or heart rate monitor (1)
- use a fixed exercise, e.g. step-ups on a step of fixed height at a set rate (1)
- start counting immediately after the activity stops (1)
- Max 3

9. [3]

- bar chart, because the activities are separate categories (1)
- activity on the x-axis and heart rate / beats per min on the y-axis (1)
- bars of equal width that do not touch (1)
- suitable scale using more than half the grid (1)
- Max 3

10. [2]

- time taken for the heart rate to return to the resting rate after exercise (1)
- count the pulse every minute after exercise until it is the same as the resting rate (1)

Exam tips

- Pulse rate and heart rate are the same thing. Count the beats for a set time and show the working:
beats in 15 s $\times$ 4 = beats per min.
- Always give the unit beats per min. Table headings should be written as quantity / unit, for example heart rate / beats per min.
- Name the independent variable (the activity), the dependent variable (heart rate) and one control, such as the same person.
- Supplement: say that heart rate increases to deliver oxygen and glucose faster and to remove carbon dioxide faster. Do not say that it gives the muscles energy.
- Use a bar chart for activities (categories). Bars have equal width and do not touch.