

Surname	Centre Number	Candidate Number
First name(s)		4



LEVEL 3 DIPLOMA

4463U60-1



S24-4463U60-1

MONDAY, 3 JUNE 2024 – MORNING

MEDICAL SCIENCE

UNIT 6: Medical Case Study

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1–5	25	
6–10	25	
11–14	25	
Total	75	

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ADDITIONAL MATERIALS

You will need the Resource Folder.

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks for this paper is 75.



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Case study 1: Osteoarthritis

Joe was diagnosed with osteoarthritis in his knees and hands when he was 47 years old. He would struggle to do things like open doors, tie his shoelaces or put the top on a bottle of water.

He had knee problems a few years before and thought it was because he was standing all day in his job. The pain when he walked upstairs was severe.

His doctor carried out some scans to measure the thickness of the cartilage in his knee. He was then referred to the rheumatology department at the hospital. The rheumatologist diagnosed him with osteoarthritis.

As a result, Joe made some lifestyle changes. He joined the gym, and with the help of a personal trainer, worked on improving his flexibility and muscle strength. After three weeks he could already walk upstairs without any pain.

As well as becoming more active, Joe decided to improve his diet by avoiding processed food to help maintain a healthy weight. He felt so much better.

Joe knows he still has osteoarthritis but wants to avoid having joint replacement surgery, if possible. He sometimes takes painkillers and he would like to find out more about the effects of dietary supplements such as glucosamine.



Figure 1: Number of knee replacements by age group per 100 000 population

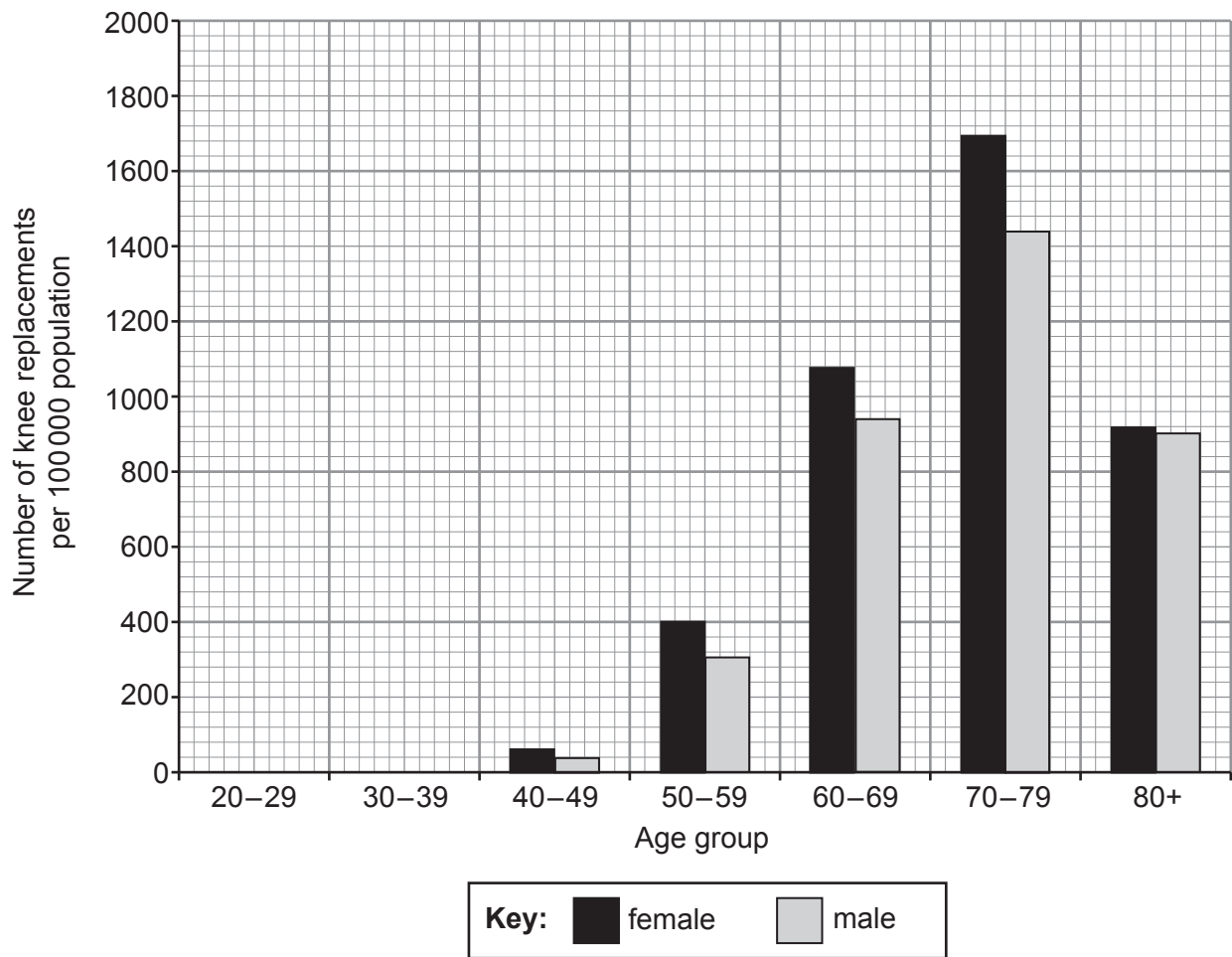
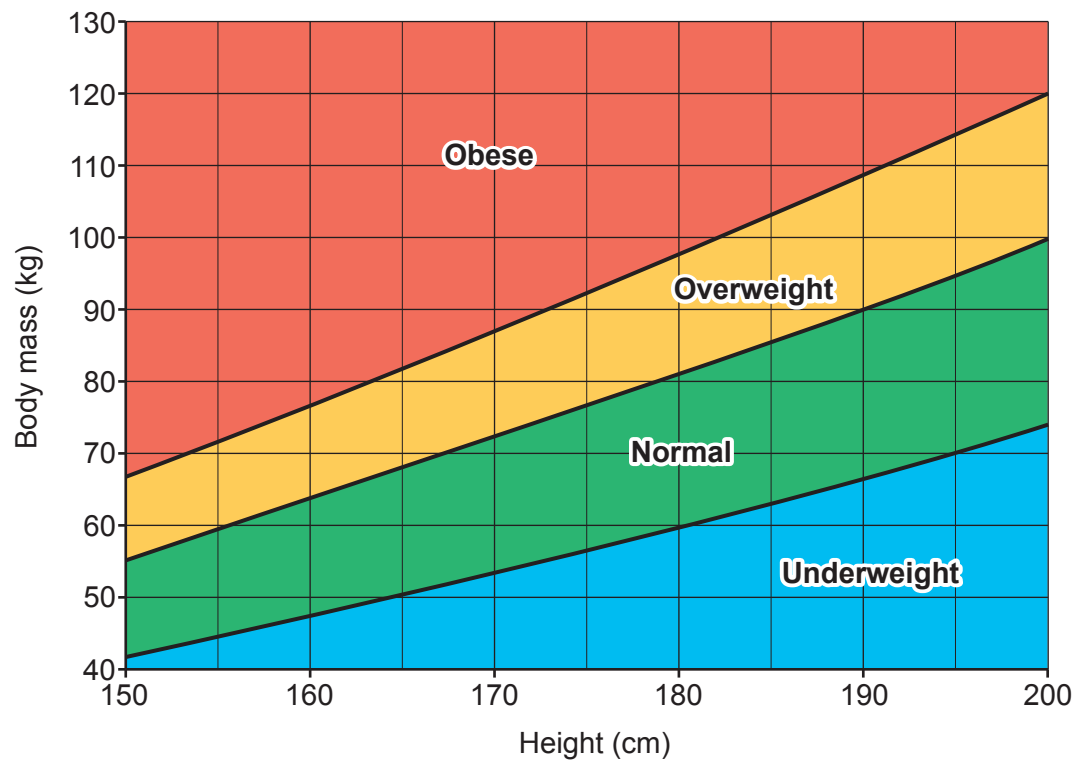


Figure 2: Body mass index chart

Answer **all** questions.

1. Osteoarthritis is a condition that causes joints to become painful and stiff. X-ray images of a healthy knee joint and osteoarthritic joint are shown below.



Healthy joint



Osteoarthritic joint

- (a) (i) State the main **visible** difference between the x-ray image of a healthy knee joint and an osteoarthritic knee joint. [1]

.....

- (ii) Suggest what might cause this change in appearance. [1]

.....

- (b) Hyaluronic acid is sometimes injected into the joint space to reduce the pain caused by osteoarthritis. State **two** effects of the hyaluronic acid on the joint. [2]

1.

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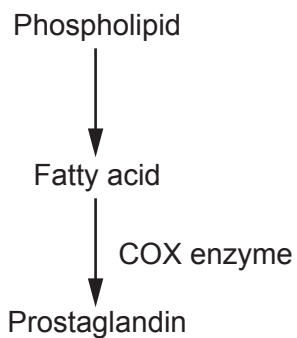
2.

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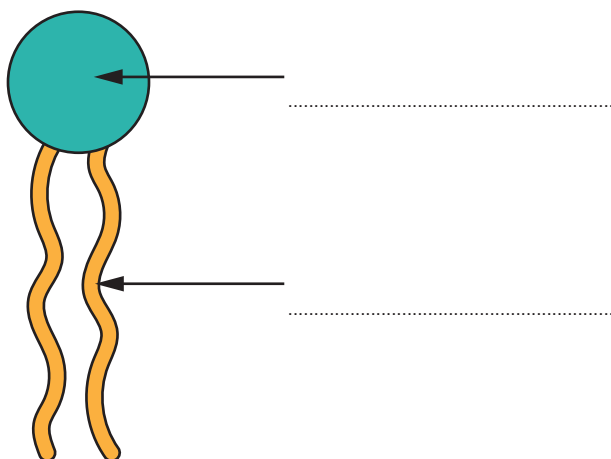
2. Prostaglandins are chemicals that cause inflammation. Cyclo-oxidase (COX) is one of the enzymes needed in the formation of prostaglandins. Diclofenac and aspirin are drugs that inhibit the action of the COX enzyme.

The COX enzyme converts a fatty acid to prostaglandin and is found attached to the inner surface of the endoplasmic reticulum membrane.



- (a) The endoplasmic reticulum membrane is made up of phospholipids. Label the diagram of the phospholipid below.

[2]



- (b) Suggest why the COX enzyme is attached to the membrane.

[1]

.....



- (c) Diclofenac is a competitive inhibitor and aspirin is a non-competitive inhibitor. Describe the action of these inhibitors. [4]

Diclofenac:

.....

Aspirin:

.....

- (d) Enzymes are proteins that have tertiary structure. Complete the table below by placing a tick (✓) to show the bond(s) present at each level of protein structure. [3]

Level of protein structure	Types of bond present (✓)			
	peptide	hydrogen	disulfide	ionic
primary				
secondary				
tertiary				

3. Figure 1 shows the number of knee replacements per age group, per 100 000 population.

Describe **two** trends shown in this graph. [2]

1.

2.



4. When Joe visited his GP, his height and body mass were measured. A scan was used to measure the thickness of the cartilage in his knee.

Osteoarthritis causes the cartilage in the knee to become thinner than normal. Use **Figure 2** and the information below to answer the questions that follow.

Joe's test results

Height (cm)	183
Body mass (kg)	79
Thickness of knee cartilage (mm)	2.2

Table to show how body mass index affects thickness of cartilage in non-arthritic population

Classification of body mass index	Average thickness of knee cartilage (mm)
underweight	2.3
normal	2.4
overweight	2.6
obese	2.8

- (a) State Joe's body mass index classification.

[1]

.....

- (b) Explain why the result for the thickness of Joe's cartilage supports the diagnosis of osteoarthritis.

[1]

.....

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5. Glucosamine is often recommended as a dietary supplement to help relieve the pain of arthritis. It can be purchased from health food shops.

- (a) A 600 ml bottle of glucosamine costs £16.95 and the recommended daily dose is 10 ml. Calculate the annual cost of this medication to the nearest pound. [2]

Space for calculation

annual cost = £

- (b) A research project was carried out to find out if glucosamine could relieve joint pain.

The research project involved collecting personal data. State **two** ethical considerations that need to be made before carrying out this investigation. [2]

1.

.....

2.

.....



- (c) Forty participants with osteoarthritis were put into two groups.

Group A was given the recommended daily dose of glucosamine and group B did not receive any glucosamine.

Participants were asked to rate the pain they were experiencing at the start of the research project and after one year. They rated the pain on a scale of 0 to 20, where 0 is no pain and 20 is the worst pain.

The results are shown below:

Mean pain rating for participants in research project

	Group A (glucosamine)	Group B (no glucosamine)
Mean pain rating at start of research project	6.0	6.0
Mean pain rating after one year	5.9	6.6

The data was analysed using a t-test and the value of t was 1.95.

Probability values for t-test

Degrees of freedom (df)	P values
	0.05
1	12.71
2	4.30
10	2.23
20	2.09
40	2.02

- (i) State the null hypothesis for this research project. [1]

.....

.....

- (ii) Using the calculated t value of 1.95 and the table of probability values, state and explain the conclusion for 38 degrees of freedom. [2]

.....

.....

.....



Case study 2: Breast cancer

Rhia was diagnosed with breast cancer in her mid-thirties. She had noticed a lump in her breast. Following a visit to her GP, she was sent for screening and a tissue biopsy, which confirmed the diagnosis. Within days of the diagnosis she underwent surgery to remove breast tissue as well as several of the lymph nodes in her armpit. This was followed by seven months of chemotherapy and then a week of radiotherapy.

After the radiotherapy Rhia was given monthly Phesgo injections. This is a new therapy involving two drugs called pertuzumab and trastuzumab. The treatments were, at times, exhausting and she found that losing her hair was devastating. However, throughout the treatments she was determined to be positive and looked on the bright side. She kept active and even ran a marathon and completed a 5K swim whilst undergoing treatment. Rhia is now a five-year survivor.



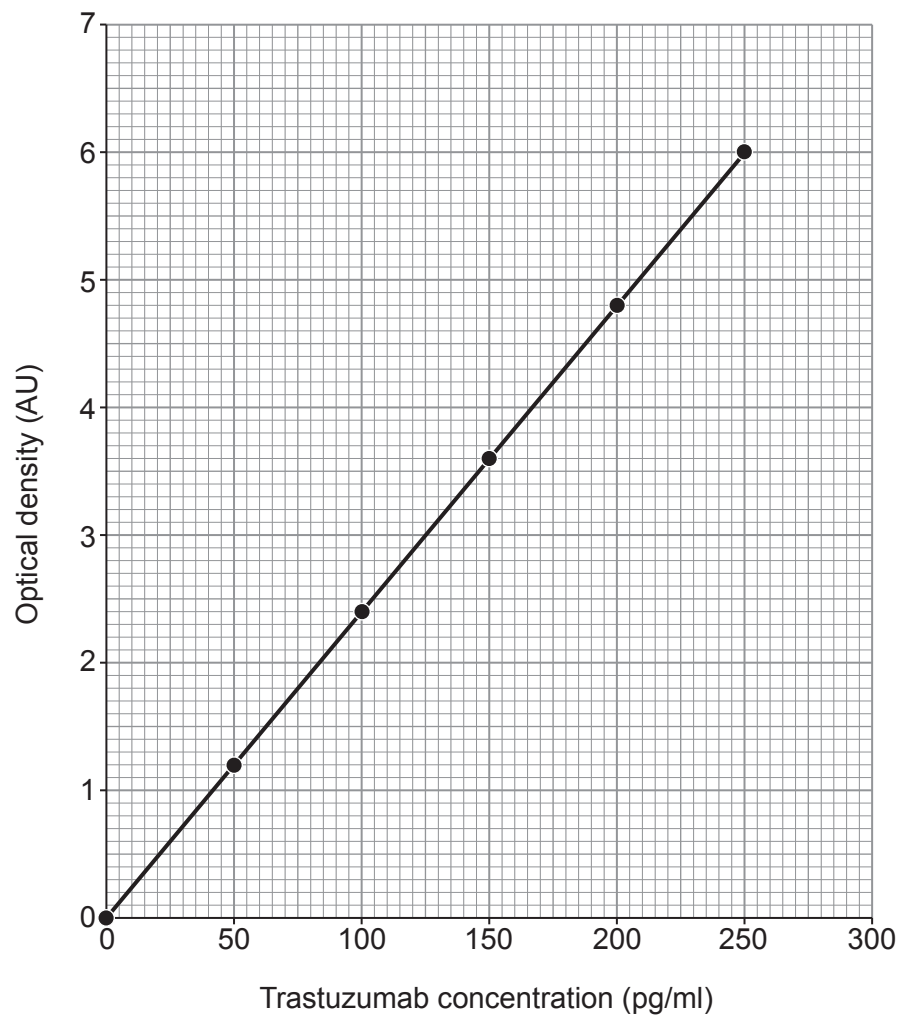
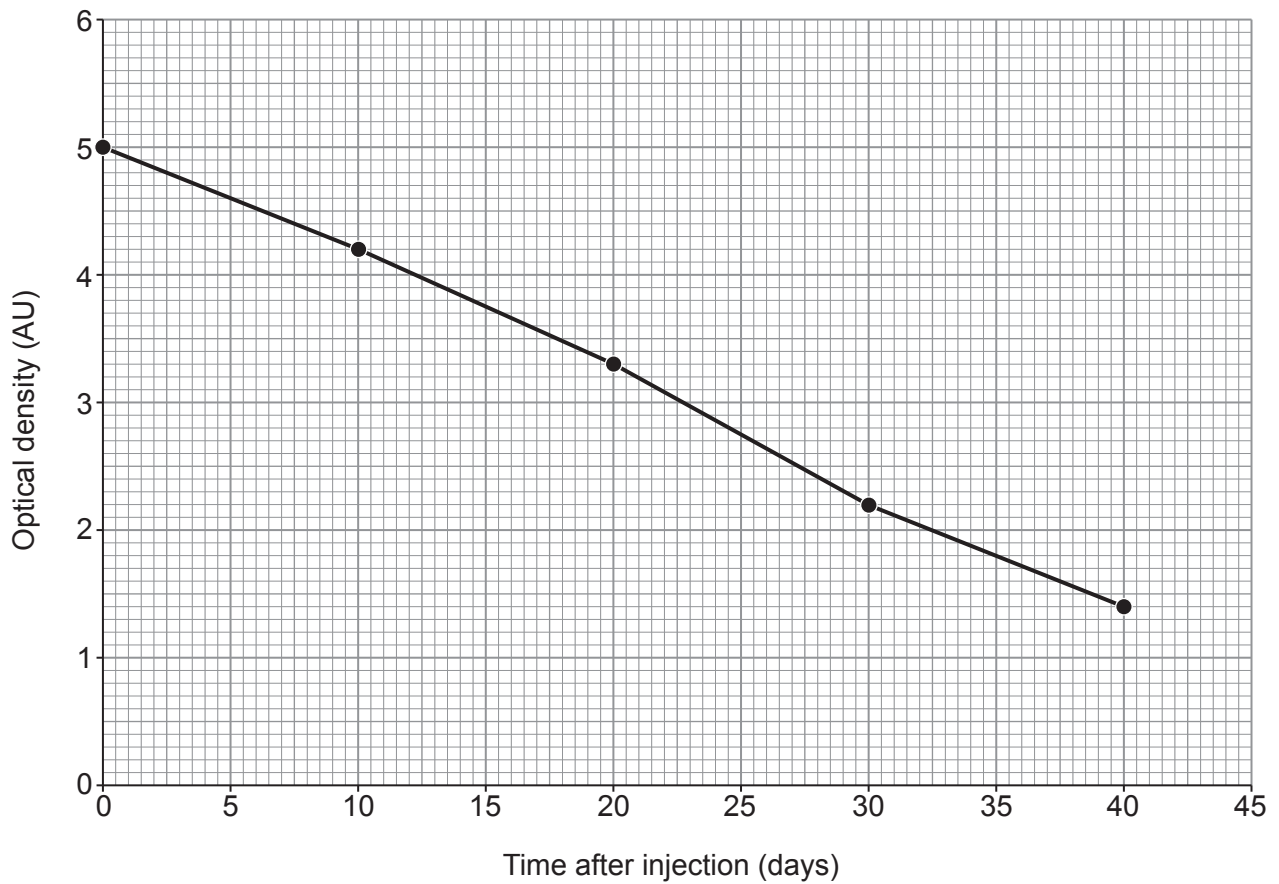
Figure 3: Calibration curve for trastuzumab

Figure 4: Rhia's blood concentration of trastuzumab

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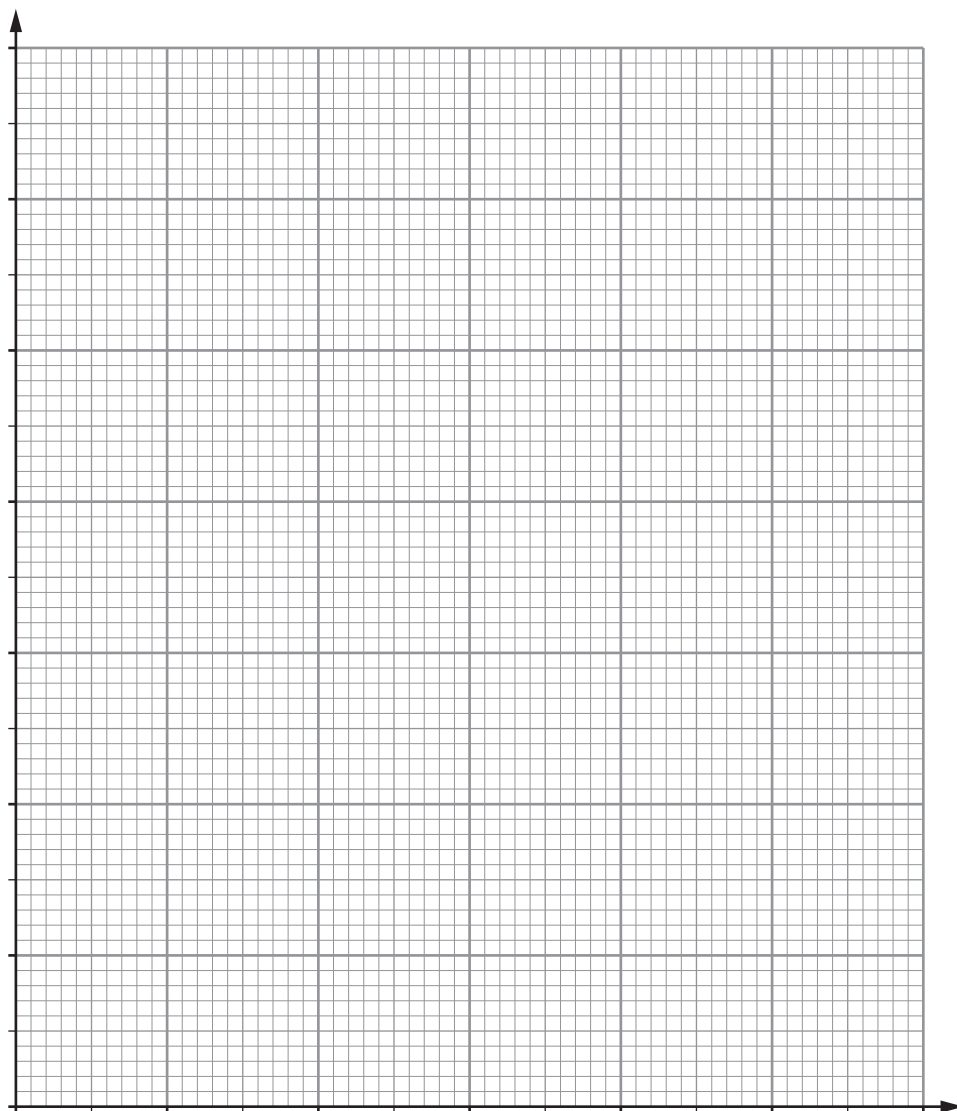


6. The table below shows the number of new cases of breast cancer per year in the UK female population.

Age range	Number of cases
30–39	2401
40–49	7533
50–59	12 668
60–69	13 642
70–79	10 739
80–89	6756

- (a) Plot the data in the table on the grid below.

[4]



- (b) Calculate the percentage increase in the number of cases between the 40–49 age group and the 60–69 age group. [2]

Space for calculation

percentage increase = ...

7. Pertuzumab and trastuzumab are laboratory produced antibodies used in immunotherapy treatment of cancer. They are injected into the blood stream of the patient.

- (a) Name the cells in the immune system that produce antibodies. [1]

.....

- (b) Name the laboratory test that can be used to detect the level of antibodies in the blood. [1]

.....

- (c) Use **Figure 3** and **Figure 4** to answer the following questions.

- (i) State the initial concentration of trastuzumab in Rhia's blood immediately after injection. [1]

initial concentration = ... pg/ml

- (ii) Explain the term 'half-life' in relation to medicines. [1]

.....

.....

- (iii) State the half-life of trastuzumab. [1]

half-life = ... days



- Describe what is involved in each of these treatments, along with the negative impacts of these treatments.

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small margins at the top and bottom. There are no vertical margin lines, text, or other markings on the page.



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9. Explain why, in addition to her breast surgery, Rhia had several of the lymph nodes in her armpit removed.

[1]

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.....

10. Suggest **three** methods for lowering the risk of developing breast cancer.

[3]

1.
2.
3.



Case study 3: Deep vein thrombosis

Owen was in his early sixties and for several years had been travelling on long haul flights to business meetings. At the end of his last flight, when he stood up to collect his case from the overhead locker, he felt very breathless and dizzy. He collapsed whilst walking off the plane. The flight attendants recognised the potential seriousness of his collapse and called an ambulance.

He was initially treated by paramedics, and then rushed to the nearest hospital. He underwent an electrocardiogram (ECG) and haematology tests. He was diagnosed as having a pulmonary embolism as the result of the breakdown of a blood clot in one of the veins in his leg. He was treated with an anticoagulant, which he had to take daily for six months. He did not suffer any serious side effects but was advised to avoid long journeys where possible.



Figure 5: Reference ranges for some common haematology tests

Test	Reference range
leucocyte count ($\times 10^9 \text{ dm}^{-3}$)	4–11
erythrocyte count ($\times 10^{12} \text{ dm}^{-3}$)	3.5–5.5
haemoglobin (g dm^{-3})	140–180
thrombocyte count ($\times 10^9 \text{ dm}^{-3}$)	150–400
haematocrit (%)	36–46

Figure 6: Maximum blood pressure in different areas of the heart

Region of heart	Maximum blood pressure (mmHg)
right atrium	2
right ventricle	25
pulmonary artery	25
left atrium	10
left ventricle	120
aorta	120



11. Deep vein thrombosis is a blood clot in a vein, usually in the leg.

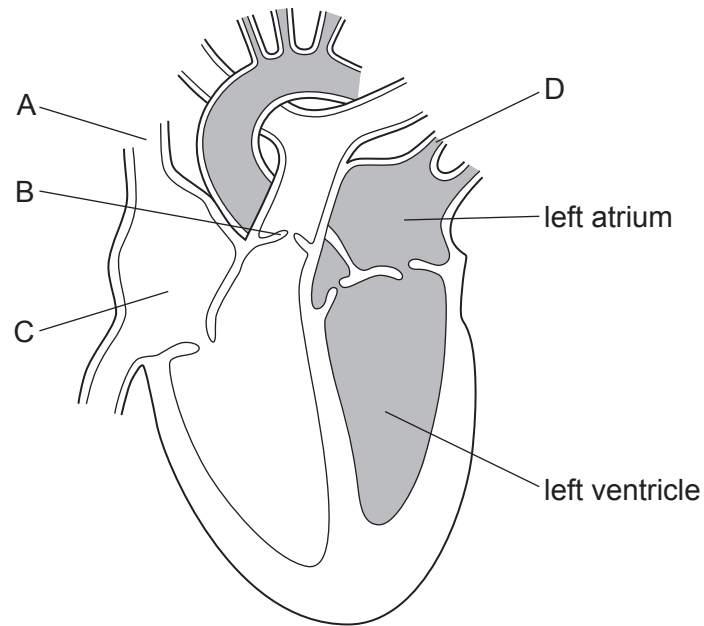
Complete the table to **compare** the **structure** of an artery and a vein.

[3]

	Artery	Vein
1		
2		
3		



12. A diagram of the heart is shown below.



(a) Name the following structures:

[3]

- A
- B
- C
- D

(b) Use the information in **Figure 6** and your own knowledge to explain the difference in pressures between the left atrium, left ventricle and right ventricle.

[3]

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.....

.....

.....

.....

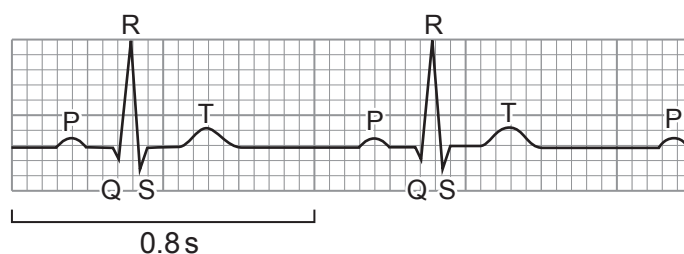
(c) Suggest why blood clots are more likely to form in veins than in arteries.

[1]

.....



13. Following admission to hospital, Owen was given an ECG. The following diagram shows a normal ECG trace taken at rest for a healthy heart. One complete heartbeat lasts 0.8 seconds, therefore the resting heart rate is 75 beats per minute.



- (a) Describe the principle of an ECG. [2]

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.....

.....

- (b) Explain what is represented by each of the following sections of the ECG: [3]

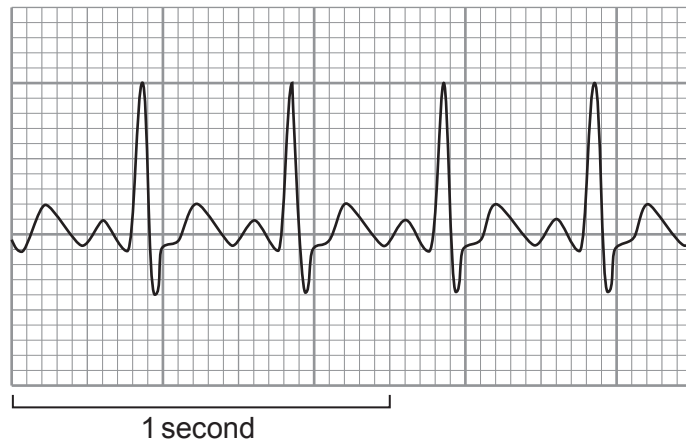
P wave:

QRS complex:

T wave:



- (c) Owen's ECG trace is shown below and plotted to the same scale as the trace on the previous page.



Describe **two** ways in which this trace is different to the normal trace.

[2]

1.
2.

- (d) State the diagnosis of Owen's condition.

[1]

.....



14. Samples of Owen's blood were collected and used for haematology tests.

(a) A total blood count gave the following results:

Test	Owen's result
leucocyte count ($\times 10^9 \text{ dm}^{-3}$)	7
erythrocyte count ($\times 10^{12} \text{ dm}^{-3}$)	5.5
haemoglobin (g dm^{-3})	179
thrombocyte count ($\times 10^9 \text{ dm}^{-3}$)	375
haematocrit (%)	50

(i) State how each test compares to the reference ranges shown in **Figure 5**. [2]

Leucocyte count:

Erythrocyte count:

Haemoglobin:

Thrombocyte count:

Haematocrit:

(ii) State what is measured by the haematocrit test. [1]

.....

.....

(b) Suggest **three** reasons why the results of a total blood count may not be accurate. [3]

1.

2.

3.



A haemocytometer is a slide used to count the number of erythrocytes in a blood sample.

Diagram of the grid on a haemocytometer slide

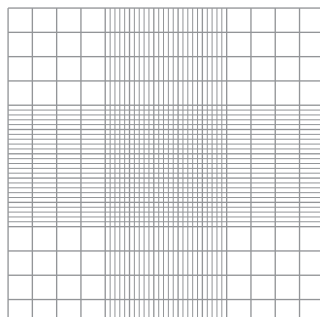
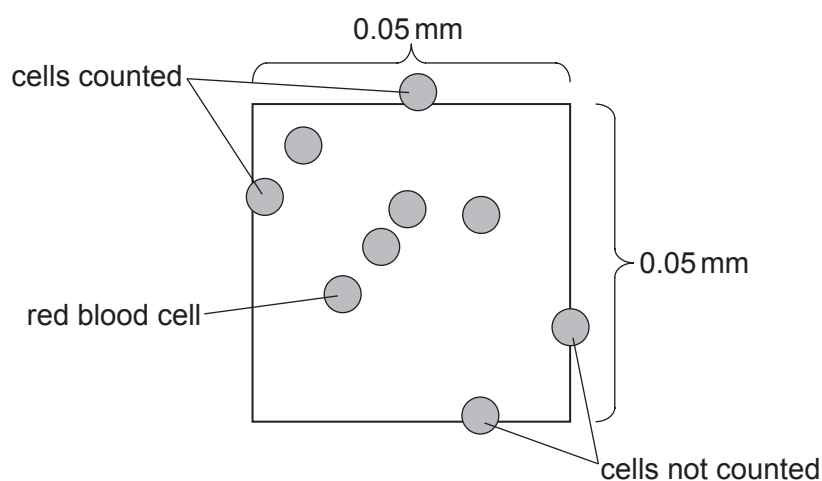


Diagram of one small square in a haemocytometer



- (c) Suggest why the cells on the bottom and right-hand side of the grid are not counted when using the slide. [1]

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