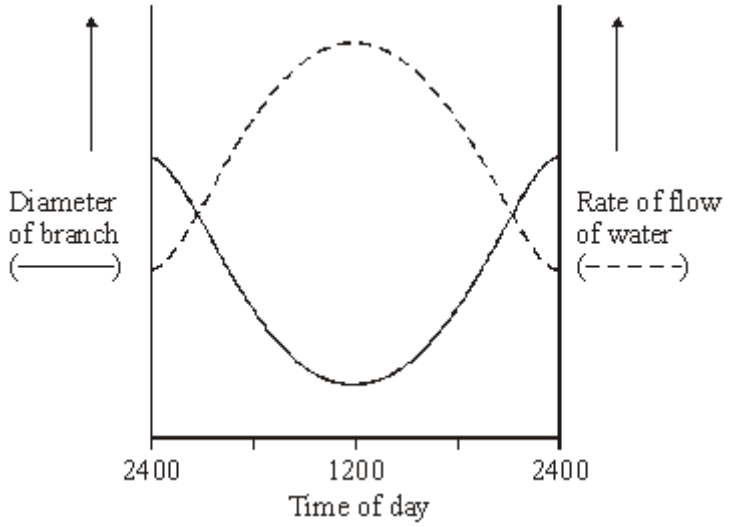
Q1.

(a) The diameter of a branch of a tree and the rate of flow of water through the branch were measured over a 24-hour period. The results are shown in the graph.



Using your knowledge of cohesion-tension theory

(i) describe and explain the changes in rate of flow of water in the branch over the 24 hour period;

_____

_____

_____

_____

_____

_____

(3)

(ii) explain why the diameter of the branch decreased during the first 12 hours.

_____

_____

(1)

(b) A stem was cut from a transpiring plant. The cut end of the stem was put into a solution of picric acid, which kills plant cells. The transpiration stream continued. Suggest an explanation for this observation.

_____

_____

_____

(2)

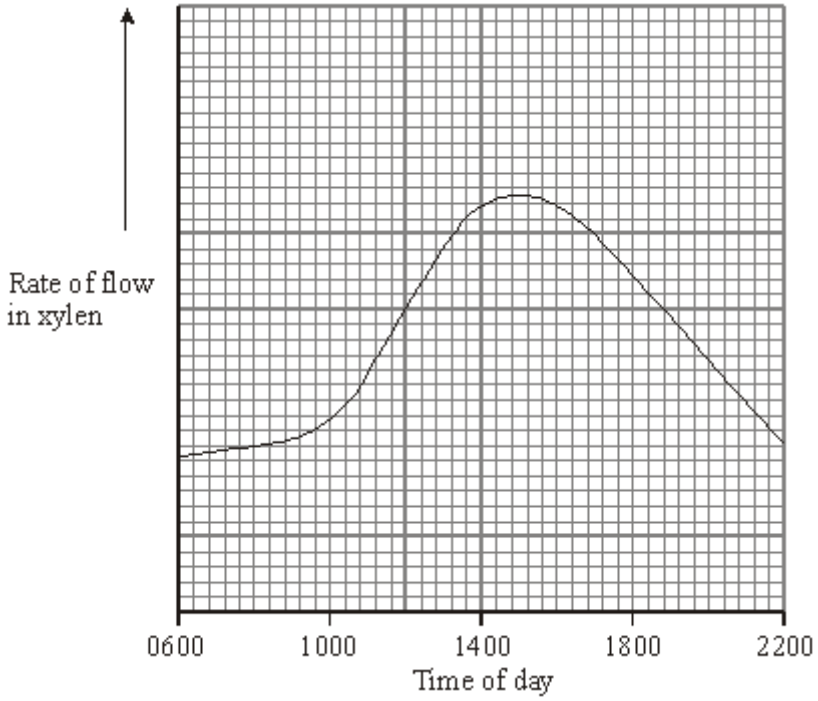
(Total 6 marks)

Q2.

(a) Explain how xylem tissue is adapted for its function.

(4)

(b) The graph shows the flow rate in the xylem in the trunk of a tree.



(i) Explain the increase in the flow rate between 1000 and 1400 hours.

_____

(2)

(ii) The diameter of the trunk decreased during the same period, reaching its minimum when the flow rate was highest. Use your knowledge of the cohesion-tension theory to suggest an explanation for this decrease.

_____

_____

_____

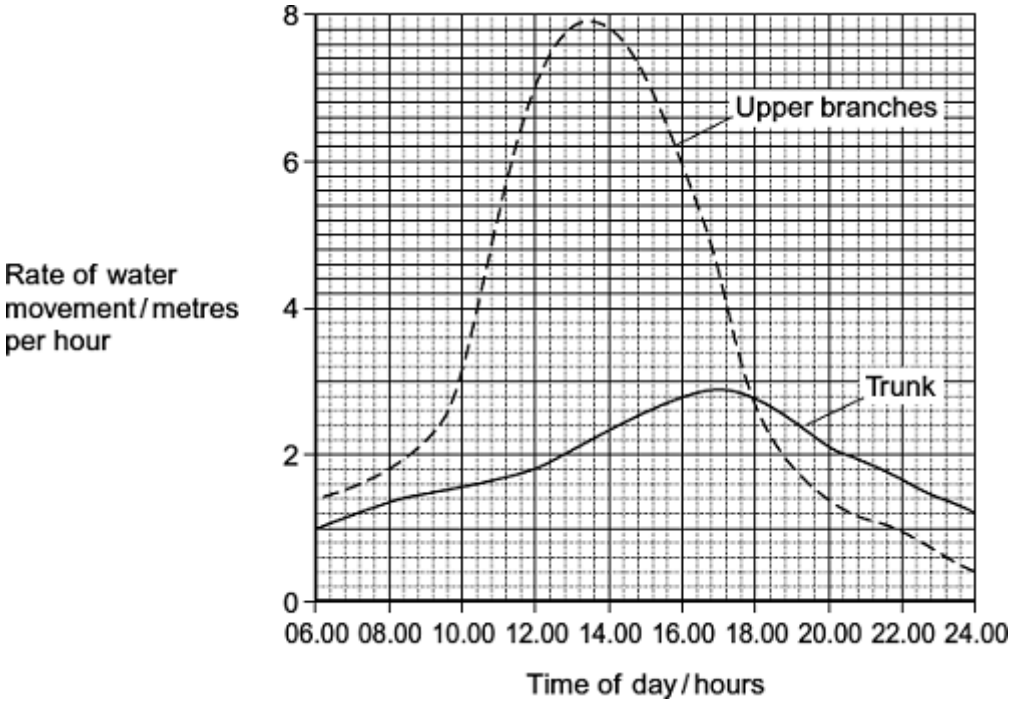
_____

(2)

(Total 8 marks)

Q3.

A biologist investigated the rate of water movement during the day in different parts of a tree. The results are shown in the graph.



(i) Describe how the rate of water movement in the upper branches changed over the period shown in the graph.

_____

_____

_____

_____

_____

(2)

(ii) The rate of water movement in the upper branches was different from the rate of water movement in the trunk. Describe how.

(2)

(iii) The results of this investigation support the cohesion tension theory. Explain how.

(2)

(Total 6 marks)

Q4.

A student investigated the distribution of stomata on leaves from two species of plant. She removed small pieces from the lower surface of the leaves of each plant species. She mounted these pieces on separate microscope slides. She then counted the number of stomata in several parts of the epidermis on each piece of leaf tissue using an optical microscope.

(a) Suggest appropriate units the student should use to compare the distribution of stomata on leaves.

(1)

(b) The pieces of leaf tissue examined were very thin.

Explain why this was important.

(2)

(c) Give **two** reasons why it was important that the student counted the number of stomata in several parts of each piece of leaf tissue.

1. _____

_____

2. _____

_____

(2)

(d) One of the two plant species used by the student in this investigation was a xerophyte.

Other than the distribution of stomata, suggest and explain **two** xerophytic features the leaves of this plant might have.

1. _____

_____

2. _____

_____

(2)

(e) The student then compared the rate of transpiration (evaporation of water) from the two species of plant. She did this by measuring the rate of water uptake by each plant species.

Suggest **two** reasons why the rate of water uptake by a plant might not be the same as the rate of transpiration.

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

Q5.

Read the following passage.

Some insect species feed on the leaves of plants. These leaf-chewers bite off pieces of leaves. Other insect species feed on sap from phloem or xylem. These sap-feeders have sharp, piercing mouthparts that they insert directly into either xylem or phloem. Leaf-chewers and insects that feed on xylem sap are active feeders; this means they use their jaw muscles to obtain their food. In contrast, insects that feed on phloem sap are passive feeders; this means they do not use their jaw muscles to take up sap from phloem.

Feeding on phloem sap presents two problems. Firstly, phloem sap has sa high sugar concentration. This could lead to a high pressure of liquid in the insect's gut because of water entering the gut from the insect's body tissues. A phloem-sap-feeder polymerises some of these sugars into polysaccharides which are passed out of its anus as 'honey dew'. The secondproblem is that phloem sap has a low concentration of amino acids. Phloem-sap-feeding insects rely on bacteria in their guts to produce amino acids. Each phloem-sap-feeding insect receives a few of these bacteria from its parent. This has resulted in a reduction in the genetic diversity of the bacteria found within these insects.

A scientist investigated the effect of three different insects on the growth of a plant called the goldenrod. He found that leaf-chewing insects and xylem-sap-feeding insects caused a much greater reduction in total leaf area than did phloem-sap-feeding insects.

Use the information from the passage and your own knowledge to answer the following questions.

(a) Phloem-sap-feeders are passive feeders (lines 6–7).
Phloem-sap-feeders do not use their jaw muscles to take up sap from phloem.

Explain why they can take up sap without using their jaw muscles.

(3)

(b) A phloem-sap-feeder polymerises some of these sugars into polysaccharides (line 12-13).
Suggest the advantage of this.

(2)

(c) Each phloem-sap-feeding insect receives a few of these bacteria from its parent. (lines 16–17).

Suggest how this has caused a reduction in genetic diversity of the bacteria.

(2)

(d) A scientist found that leaf-chewers and xylem-sap-feeders had a greater effect on plant growth than phloem-sap-feeders (lines 20–22).

Other than environmental factors, give **two** features the scientist would have controlled in his experiment to ensure this conclusion was valid.

1. _____

2. _____

(2)

(e) The scientist used the reduction in total leaf area of the experimental plants as an indicator of plant growth.

Outline a method by which you could find the area of a plant leaf.

(1)

(Total 10 marks)

Q6.

A principle of homeostasis is the maintenance of a constant internal environment. An increase in the concentration of carbon dioxide would change the internal environment and blood pH.

Explain the importance of maintaining a constant blood pH.

[Extra space] _____

_____

_____

_____

(Total 3 marks)

Q7.

(a) What is the function of the coronary arteries?

_____

_____

_____

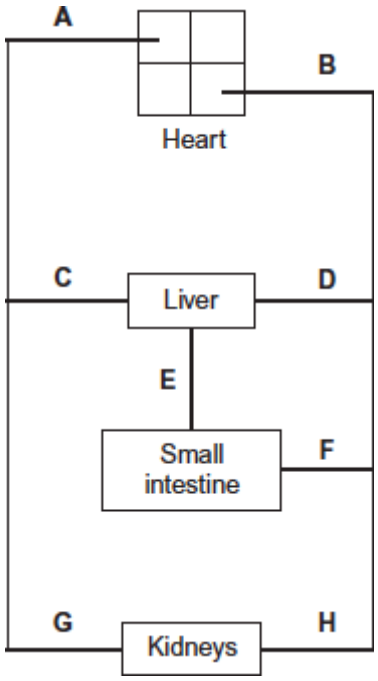
_____

_____

(2)

(b) **Figure 1** shows some of the large blood vessels in a mammal.

Figure 1



(i) Which of the blood vessels **A** to **H** is the vena cava?

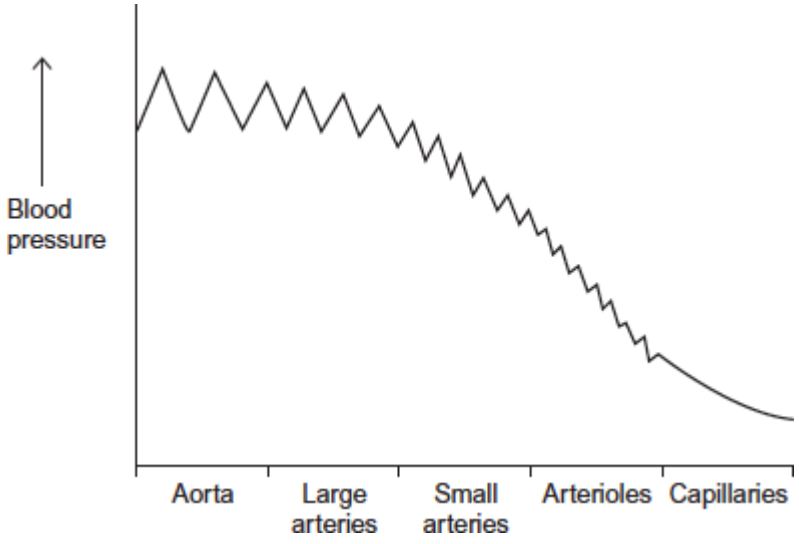
(1)

(ii) Which of the blood vessels **A** to **H** is the renal artery?

(1)

(c) **Figure 2** shows how the blood pressure changes as blood travels from the aorta to the capillaries.

Figure 2



The rise and fall in blood pressure in the aorta is greater than in the small arteries.Suggest why.

[Extra space]

(3)

(Total 7 marks)

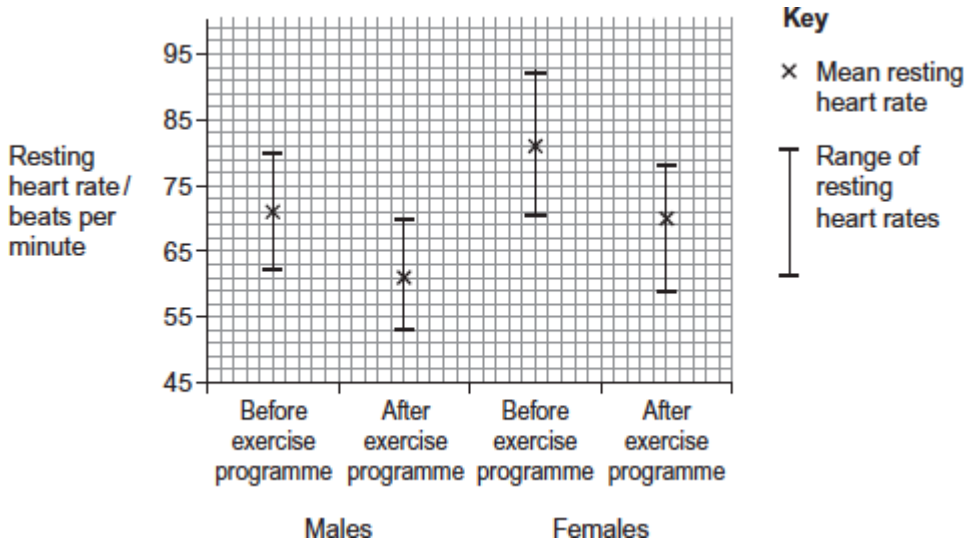
Q8.

Scientists investigated the effect of a 6-week exercise programme on the resting heart rate of males and females.

The scientists recruited a large group of male volunteers and a large group of female volunteers. They measured the resting heart rate of each volunteer before the exercise

programme. Both groups took part in the same exercise programme. The scientists measured the resting heart rate of each volunteer after the exercise programme.

The scientists determined the mean resting heart rate and the range of resting heart rates for each group before and after the exercise programme. The graph shows their results.



(a) What was the range of the resting heart rates in males after the exercise programme?

_____

(1)

(b) Calculate the percentage decrease in the mean resting heart rate of females after the exercise programme. Show your working.

Answer = _____ %

(2)

(c) The scientists used the percentage change in the mean resting heart rate after the exercise programme to compare the results for males and females.

Explain why they used percentage change in the resting heart rate.

_____

_____

_____

_____

_____

(2)

(d) The scientists calculated the cardiac output of the volunteers before and after the exercise programme. In some volunteers, their cardiac output stayed the same, even though their resting heart rate decreased.

Explain how their cardiac output could stay the same even when their resting heart rate had decreased.

(2)

(Total 7 marks)

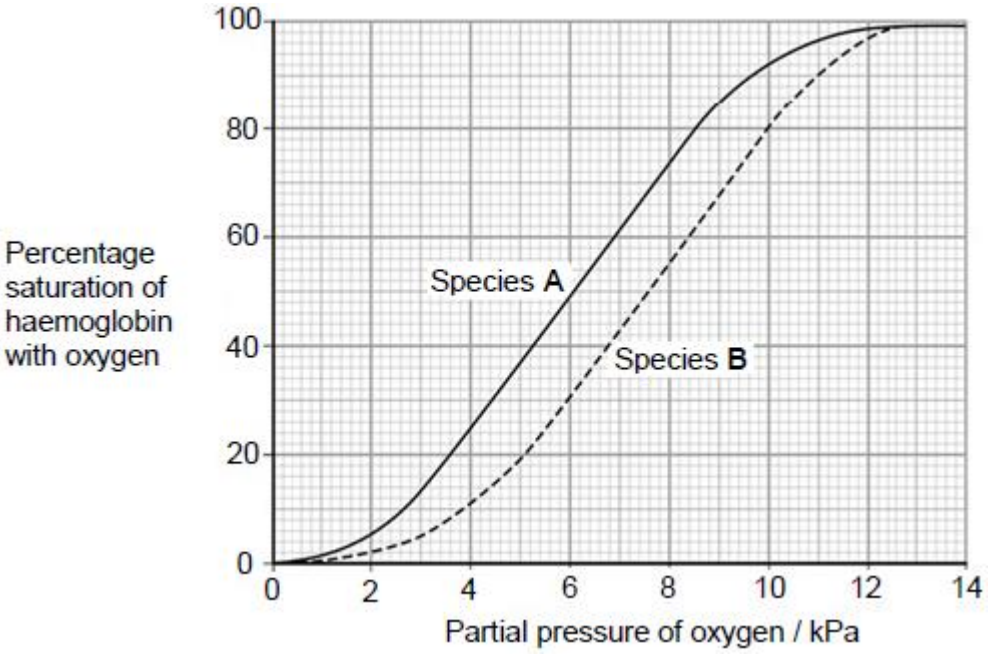
Q9.

(a) Explain **four** ways in which the structure of the aorta is related to its function.

(4)

Figure 1 shows the oxyhaemoglobin dissociation curves for two different species, **A** and **B**.

Figure 1

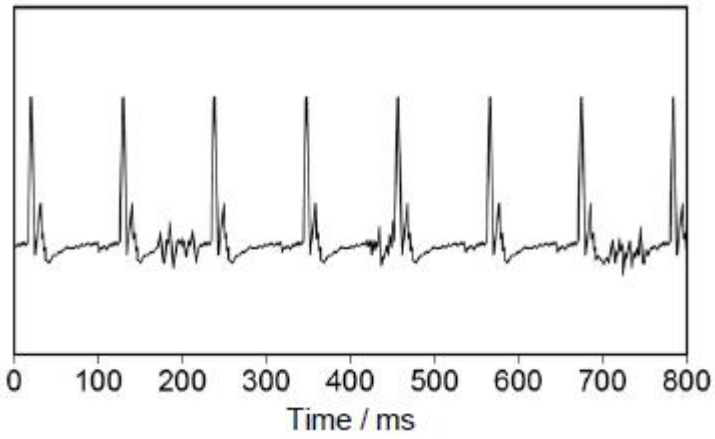


(b) Species **B** is more active than species **A**. Use **Figure 1** to explain how the haemoglobin of species **B** allows a greater level of activity.

(4)

(c) An electrocardiogram (ECG) shows the electrical activity of the heart. **Figure 2** shows an ECG for an animal of species **B** at rest. Each large spike represents a contraction of the ventricles.

Figure 2



For species **B**, the mean volume of blood leaving the left ventricle during each contraction is 0.03 cm^3.

Calculate the mean volume of blood leaving the left ventricle per minute.

Volume of blood = _____ cm^3 $minute^{-1}$

(2)

(Total 10 marks)

Q10.

The figure below represents a capillary surrounded by tissue fluid.
The values of the hydrostatic pressure are shown.

Arteriole end	*direction of blood flow* →	**Venule end**
Hydrostatic pressure = 4.3 kPa		Hydrostatic pressure = 1.6 kPa

Tissue fluid
Hydrostatic pressure = 1.1 kPa

(a) Use the information in the figure above to explain how tissue fluid is formed.

_____

_____

_____

_____

(2)

(b) The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

(1)

(c) High blood pressure leads to an accumulation of tissue fluid. Explain how.

(Extra space)

(3)

(d) The water potential of the blood plasma is more negative at the venule end of the capillary than at the arteriole end of the capillary. Explain why.

(Extra space)

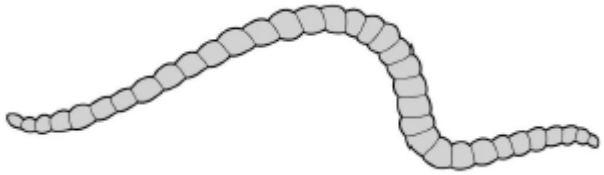
(3)

(Total 9 marks)

Q11.

Tubifex worms are small, thin animals that live in water. They have no specialised gas exchange or circulatory system.

The figure below shows a tubifex worm.



(a) Name the process by which oxygen reaches the cells inside the body of a tubifex worm.

_____

(1)

(b) Using the information provided, explain how **two** features of the body of the tubifex worm allow efficient gas exchange.

1. _____

_____

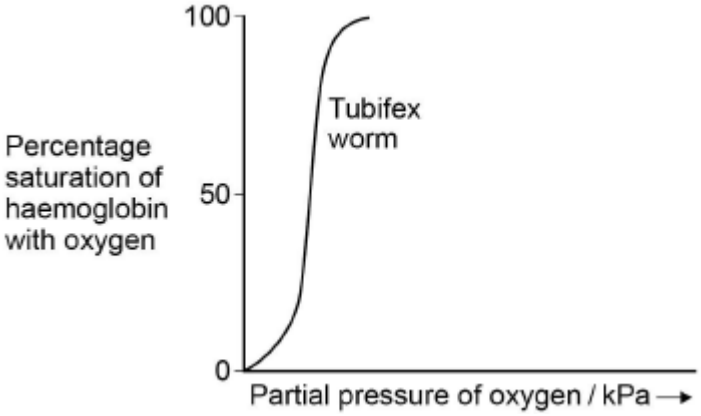
2. _____

_____

(2)

(c) Most species of tubifex worms live at the bottom of ponds, lakes and rivers where the partial pressure of oxygen is low. Pollution of water by sewage can cause the partial pressure of oxygen to fall below 0.2 kPa.

The graph shows the oxyhaemoglobin dissociation curve for a species of tubifex worm found in a river polluted with sewage.



The species of tubifex worm in the graph has 50% saturation of their haemoglobin with oxygen at 0.08 kPa.

Explain how this enables this species to survive in water polluted with sewage.

_____

_____

_____

_____

_____

(2)

(d) Species of tubifex worm that live in ponds, lakes and rivers **cannot** survive in seawater.

Use your knowledge of water potential to explain why they cannot survive in seawater.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q12.

The artery leaving the left ventricle is the aorta. One form of heart disease is aortic valve disease (AVD). In this disease, the valve (the aortic valve) between the left ventricle and the aorta opens normally but only partly closes. This means that when the ventricle relaxes some blood flows back into the ventricle from the aorta.

Severe AVD can be treated by replacing the aortic valve.

A surgeon investigated the effect of this treatment,

- He replaced the aortic valves of 19 patients with valves removed from donors who had recently died.
- The valves from donors were stored in an isotonic antibiotic solution before use.
- He recorded the maximum pressure reached in an artery (as the ventricles contract) and minimum pressure in the artery (as the ventricles relax) in each patient before and after valve replacement surgery.

His results are shown in **Table 1**.

Table 1

	Mean maximum pressure reached in the artery / kPa (± standard deviation)	**Mean minimum pressure reached in the artery / kPa (± standard deviation)**
Before surgery	21.7 (±3.5)	4.8 (±2.5)
After surgery	18.2 (±2.2)	11.0 (±1.1)

This investigation involved 19 patients.

- The mean age was 36 years (standard deviation ±17 years).
- The mean time after surgery that pressure readings were taken was 7 months (standard deviation ±5 months).

Table 2 shows the normal range of values of pressure in this artery in the UK.

Table 2

Pressure	Range of pressures / kPa
Maximum	12.0 to 18.5
Minimum	8.0 to 11.9

Aortic valves removed from donors were stored in isotonic solution containing an antibiotic before being used in valve replacement surgery.

(a) Explain why the valves were stored in an **isotonic** solution.

(2)

(b) Explain why the valves were stored in a solution containing an antibiotic.

(1)

(c) There was a significant increase in the minimum blood pressure in the artery after valve replacement surgery.
Explain why the valve replacement surgery had this effect.

(1)

(d) The surgeon concluded that there was sufficient evidence for him to continue using this treatment.

How does the information above support his conclusion?

[Extra Space]

(3)

(e) How does the information above **not** support his conclusion?

(2)

(f) From the data in **Table 1** it is **not** possible to determine the highest pressure measured. Explain why.

(1)

(Total 10 marks)

Q13.

Organic compounds synthesised in the leaves of a plant can be transported to the plant's roots.
This transport is called translocation and occurs in the phloem tissue of the plant.

(a) One theory of translocation states that organic substances are pushed from a high pressure in the leaves to a lower pressure in the roots.

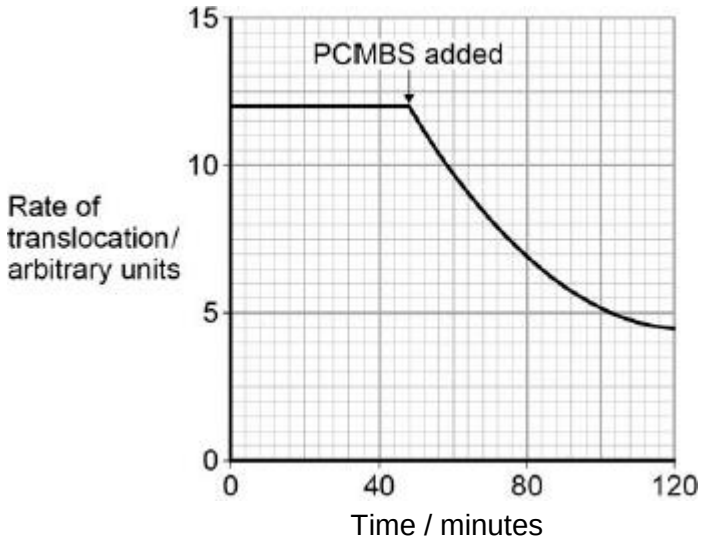
Describe how a high pressure is produced in the leaves.

(Extra space) _____

(3)

PCMBS is a substance that inhibits the uptake of sucrose by plant cells.

Scientists investigated the effect of PCMBS on the rate of translocation in sugar beet. The figure below shows their results.



(b) During their experiment, the scientists ensured that the rate of photosynthesis of their plants remained constant.
Explain why this was important.

(2)

(c) The scientists concluded that some translocation must occur in the spaces in the cell walls.
Explain how the information in the figure above supports this conclusion.

_____

_____

(2)
(Total 7 marks)

Q1.

(a) (i) rate of flow increases to max at 1200 and then decreases;
increasing transpiration / evaporation from leaves;
transpiration creates tension / increases transpirational pull;
water molecules are cohesive / stick together;
produces a water column;

3 max

(ii) (increase transpiration) produce a higher tension / reduces the pressure in the xylem reducing the diameter / adhesive forces between xylem and water;

1

(b) water moves in dead cells / xylem is non-living tissue;
the process is passive / no energy is needed;

2

[6]

Q2.

(a) long cells / tubes with no end walls;
continuous water columns;
no cytoplasm / no organelles / named organelle;
to impede / obstruct flow / allows easier water flow;
thickening / lignin;
support / withstand tension / waterproof / keeps water in cells;
pits in walls;
allow lateral movement / get round blocked vessels;

4 max

(b) (i) increase in transpiration rate / evaporation due to increase in temperature ;
increased (kinetic) energy of water molecules;

OR

increase in light (intensity) increases transpiration rate / evaporation;

greater stomatal aperture / more stomata open so increase in flow rate due to cohesion / attraction of water molecules;

2 max

(ii) adhesion / attraction of water molecules to walls of xylem;
results in tension as water pulled up stem;
pulling in walls;

2

[8]

Q3.

(i) 1. Increases then decreases;

Allow peak / maximum at any time between 13.00 - 14.00 or 7.8 - 8.0;

2. Peak / maximum at 13.00 / 14.00 (hours) / 7.8 - 8.0;

2

(ii) 1. Maximum / overall rate is higher (in branches);

Allow converse for all marking points.

2. Reaches maximum / peak earlier (in the day) (in branches);

3. Starts higher / ends lower (in branches)

2

(iii) 1. Movement starts / peaks earlier in branches / higher up;

2. Creates tension / 'negative pressure' / 'pull'

2

[6]

Q4.

(a) Stomata per mm^2 or cm^2

OR

Number per mm^2 or cm^2;

Accept: mm^{-2} or cm^{-2}.

Reject: per μm^2 or μm^{-2}.

Reject: the use of a solidus / as being equivalent to per.

Ignore: 'amount'.

1

(b) 1. Single/few layer(s) of cells;

Accept: more/too many/overlapping.

*'Single layer' without reference to cells/tissue should **not** be credited.*

2. So light can pass through;

2

(c) 1. Distribution may not be uniform

OR

So it is a representative sample;

Accept: more/fewer stomata in different areas.

Ignore: anomalies/random/bias.

2. To obtain a (reliable) mean;

Accept: 'average'.

2

(d) 1. Hairs **so** 'trap' water vapour and water potential gradient decreased;

2. Stomata in pits/grooves **so** 'trap' water vapour and water potential gradient decreased;

3. Thick (cuticle/waxy) layer **so** increases diffusion distance;

4. Waxy layer/cuticle **so** reduces evaporation/transpiration.

5. Rolled/folded/curled leaves **so** 'trap' water vapour and water potential gradient decreased;

6. Spines/needles **so** reduces surface area to volume ratio;

*1, 2 and 5. Accept: humid/moist air as 'water vapour' but **not***

water/moisture on its own.

1, 2 and 5. Accept: diffusion gradient as equivalent to water potential gradient.

1, 2 and 5. Accept: less exposed to air as an alternative to water potential gradient.

*6. Accept: spines/needles **so** 'reduce area'.*

2 max

(e) 1. Water used for support/turgidity;
2. Water used in photosynthesis;
3. Water used in hydrolysis;
4. Water produced during respiration;

2 max

[9]

Q5.

(a) 1. Contents of phloem vessel pushed into insect's mouth by high pressure;

2. (High pressure in phloem vessel) caused by loading of sugars into phloem in leaf;

3. And (resulting) entry of water by osmosis.

3

(b) 1. Polysaccharides are insoluble;

2. So do not affect water potential of gut.

2

(c) 1. (Only few bacteria passed from parent, so) only a few (copies of) genes passed on (in bacteria);

2. May not / does not include all alleles (of genes, so diversity reduced)
OR
Small number of bacteria transmitted means unrepresentative sample.

2

(d) 1. Number / mass / density of insects per plant;

2. Stage of development / size of plants / insects;

Ignore any abiotic factor

2

(e) Draw around leaf on graph paper **and** count squares;

1

[10]

Q6.

(Maintaining constant pH to avoid)

1. Named protein / enzyme (in blood) sensitive to / affected by change in pH;

Accept converse for MP2 and MP3.

Named example should be a protein that might be affected (by change in pH) eg haemoglobin, carrier protein in plasma

membrane.

Accept 'change in H^+ concentration' for 'change in pH'.

2. (Resultant) change of charge / shape / tertiary structure;

The change in charge idea relates to the enzyme / protein and not the blood (plasma) or red blood cells.

'Denaturation' alone is insufficient.

3. Described effect on named protein or enzyme.
e.g. less oxygen binds with haemoglobin / less transport across membranes / fewer substrates can fit active site / fewer enzyme-substrate complexes.

Idea of 'less' or 'fewer' required. Ignore suggestion of 'no' or 'none'.

[3]

Q7.

(a) 1. (Carry) oxygen / glucose;

Accept: oxygenated blood

Ignore references to removing waste products

Ignore references to arteries 'pumping' blood

2. (To) heart <u>muscle / tissue / cells / myocytes</u>.

Must be supply to heart or cardiac

2

(b) (i) **A**;

Accept: A on its own even if outside box

Reject if two (or more) letters given

1

(ii) **H**;

Accept: H on its own even if outside box

Reject if two (or more) letters given

1

(c) (Aorta)

1. (is) close / directly linked to the heart / ventricle / pressure is higher / is very high;

2. (Aorta has) elastic tissue;

Accept elasticity

Ignore reference to muscle

3. (Aorta has) stretch / recoil.

Q *Reject: contracts / relaxes / pumps*

Accept: for mp 2 and mp 3, converse for small arteries <u>if</u> qualified by little / less

3

[7]

Q8.

(a) 53−70 / 70-53 / 17 (beats per minute).

1

(b) 13.6 / 13.58 / 14;

If answer is incorrect, 1 mark for the principle of difference (11) divided by initial heart rate (81).

$\frac{70-81}{81}$ *or* $\frac{81-70}{81}$ *for 1 mark*

Ignore + or - signs

2

(c) 1. Allows comparison;
2. (Initial / resting) heart rates different (between males and females).

2

(d) 1. Cardiac output = stroke volume × heart rate

1. Accept CO = SV × HR

2. (So) stroke volume increases / increased size or volume of ventricles.

2. Neutral: more blood leaves heart

2. If the term stroke volume is not used, it must be defined

2 max

[7]

Q9.

(a) 1. Elastic tissue to allow stretching / recoil / smoothes out flow of blood / maintains pressure;

2. (Elastic tissue) stretches when ventricles contract
OR
Recoils when ventricle relaxes;

3. Muscle for contraction / vasoconstriction;

4. Thick wall withstands pressure **OR** stop bursting;

5. Smooth endothelium reduces friction;

6. Aortic valve / semi-lunar valve prevents backflow.

4 max

(b) 1. Curve to the right so <u>lower</u> affinity / % saturation (of haemoglobin);

2. Haemoglobin unloads / dissociates <u>more</u> readily;

3. <u>More</u> oxygen to cells / tissues / muscles;

4. For greater / more / faster respiration;

Idea of a higher rate of respiration

4

(c) 16.5–18 (cm^3 $minute^{-1}$);

Allow 1 mark if heart rate wrongly calculated but then multiplied by 0.03

2

[10]

Q10.

(a) 1. (Overall) outward pressure of 3.2 kPa;
2. Forces small molecules out of capillary.

2

(b) Loss of water / loss of fluid / friction (against capillary lining).

1

(c) 1. High blood pressure = high hydrostatic pressure;
2. Increases outward pressure from (arterial) end of capillary / reduces inward pressure at (venule) end of capillary;
3. (So) more tissue fluid formed / less tissue fluid is reabsorbed.

Allow lymph system not able to drain tissues fast enough

3

(d) 1. Water has left the capillary;
2. Proteins (in blood) too large to leave capillary;
3. Increasing / giving higher concentration of blood proteins (and thus wp).

3

[9]

Q11.

(a) (Simple) diffusion;

Reject: facilitated diffusion.

1

(b) 1. Thin/small **so** short diffusion pathway;

Reject: thin membrane/wall/cells.

2. Flat/long/small/thin **so** large surface area to volume ratio/surface area : volume;

Accept: small volume to surface area ratio.

2

(c) 1. High/50% saturation (with oxygen) below (pO_2 of) 0.2 kPa;

*Accept: fully saturated **or** above 50% saturation below 0.2kPa.*

Accept: any number between 0.08 and 0.2 kPa

2. (Oxygen) for respiration;

2

(d) 1. Water potential high<u>er</u> in worm
OR
Low<u>er</u> water potential in seawater;

Accept: correct reference to water potential gradient if direction of water movement is given.

Accept: ψ for water potential.

2. Water leaves by <u>osmosis</u> (and worm dies);

Reject: worm/cells burst.

2

[7]

Q12.

(a) 1. (Because) same water potential (as valve);

2. (So) prevents loss or gain of water by osmosis / down water potential gradient;

Loss or gain and method of loss or gain must both be in the answer

3. (So) cells / tissues in the valves aren't damaged;

2 max

(b) 1. Kills / stops growth of bacteria that could cause infection / disease (in patient);

2. Kills / stops growth of bacteria that could damage the valve;

'Kill / stop growth of bacteria' is insufficient without further explanation.

1 max

(c) (After surgery) valve closes fully / correctly / works so preventing blood flowing back into the heart;

OR

(After surgery) valve closes fully / correctly / works so preventing blood flowing out of the artery;

Do not credit the converse here

1

(d) 1. (For maximum) mean decreases, to within the normal range;

2. (For minimum) mean increases to within normal range;

3. No overlap in the (means ±) standard deviation for <u>minimum</u> pressure so there is a real difference;

Ignore references to the differences in maximum pressure

Accept idea of significant difference for 'real difference'

4. Includes wide range of ages of patients;

3 max

(e) 1. Standard deviation shows that some of the patients will be outside normal pressure range (after surgery);

Accept this as a general statement or in relation to maximum or minimum pressures

2. Small group;

3. Short follow up times;

4. No comparison with other treatments;

2 max

(f) Don't know the range;

1

[10]

Q13.

(a) 1. Water potential becomes lower / becomes more negative (as sugar enters phloem);
2. Water enters phloem by osmosis;
3. Increased volume (of water) causes increased pressure.

3

(b) 1. Rate of photosynthesis related to rate of sucrose production;
2. Rate of translocation higher when sucrose concentration is higher.

2

(c) 1. Rate of translocation does not fall to zero / translocation still occurs after 120 minutes;

2. But sucrose no longer able to enter cytoplasm of phloem cells.

2

[7]