

## Section A

- 1 An element X has 11 electrons, 11 protons and 12 neutrons.

What is the proton number and nucleon number of X?

	nucleon number	proton number
<b>A</b>	11	12
<b>B</b>	12	12
<b>C</b>	23	11
<b>D</b>	23	12

- 2 The table below shows the atomic structures of six particles, represented by the letters E to J. The letters are not the symbols of the elements.

particle	number of		
	protons	neutrons	electrons
E	16	8	8
F	18	10	8
G	16	8	10
H	12	12	10
I	11	12	10
J	12	12	12

Which of the two particles from the table are an atom and a positive ion of the **same** element?

- A** E and F  
**B** F and G  
**C** I and J  
**D** H and J

3 Benzoic acid has the molecular formula  $C_7H_6O_2$ .

How many atoms are there in two molecules of benzoic acid?

- A 3
- B 15
- C 30
- D 45

4 Which of the following questions will help you to determine the mass of an atom in a substance?

- A What is the arrangement of the atoms in the substance?
- B What is the mass number of the atom?
- C What is the chemical formula of the substance?
- D How many of this atom is present in the substance?

5 What does the nucleus of an atom contain?

- A electrons, neutrons and protons
- B electrons and neutrons only
- C neutrons and protons only
- D protons only

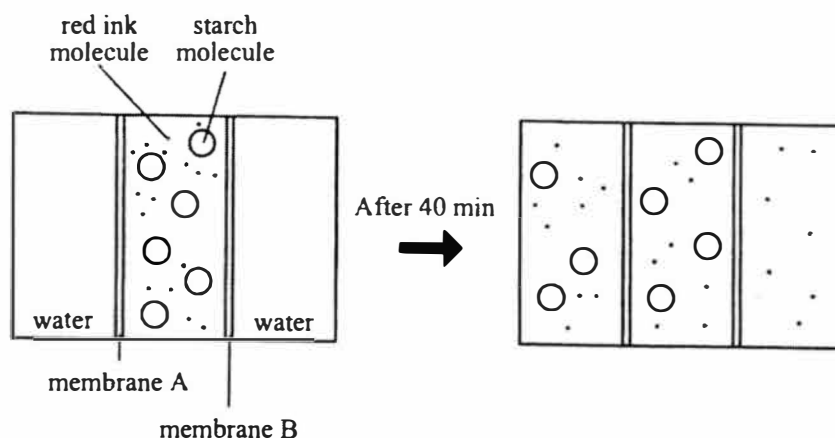
6 Which of the following is a chemical change?

- A Melting of ice glaciers.
- B Evaporating puddle of water.
- C Burning of fossil fuels.
- D Dissolving salt in water.

7 Which of the following chemical change involves oxygen as the reactant?

- A Preparation of magnesium oxide from magnesium.
- B Photosynthesis in green plants.
- C Breakdown of water into its elements.
- D Formation of an image on an X-ray film.

8 Look at the experimental set-up.

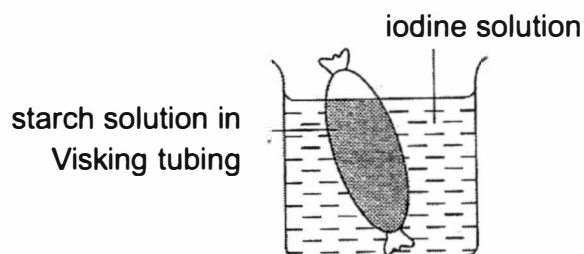


Which membrane(s) is/are partially permeable?

- A membrane A
- B membrane B
- C membrane A and B
- D None of the membranes

9 The apparatus shown below was set up and left for two hours.

Which of the following shows the correct colouration after two hours?



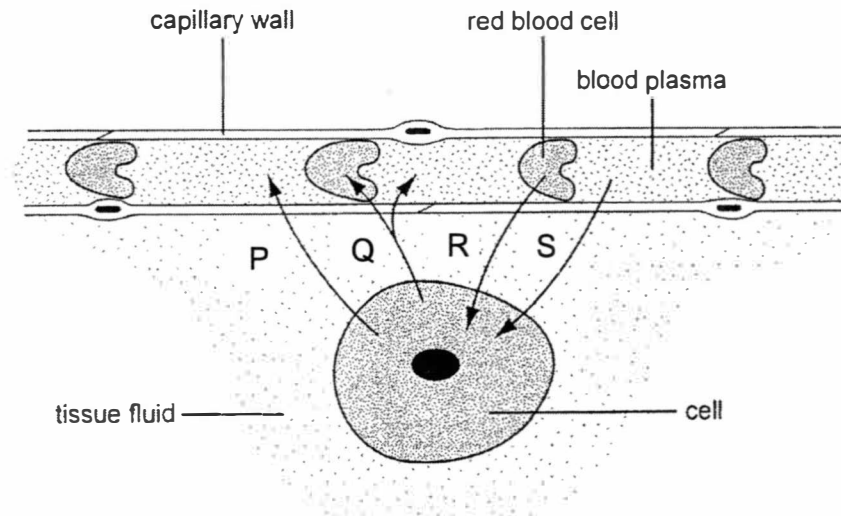
	in Visking tubing	in beaker
A	brown	brown
B	blue black	brown
C	blue Black	blue black
D	brown	blue black

10 Carbon monoxide is a pollutant emitted from car exhausts.

Why is it harmful to humans?

- A It has no colour, taste or smell.
- B It has a corrosive action on lung tissue.
- C It forms a stable compound with blood.
- D It combines with oxygen in the lungs.

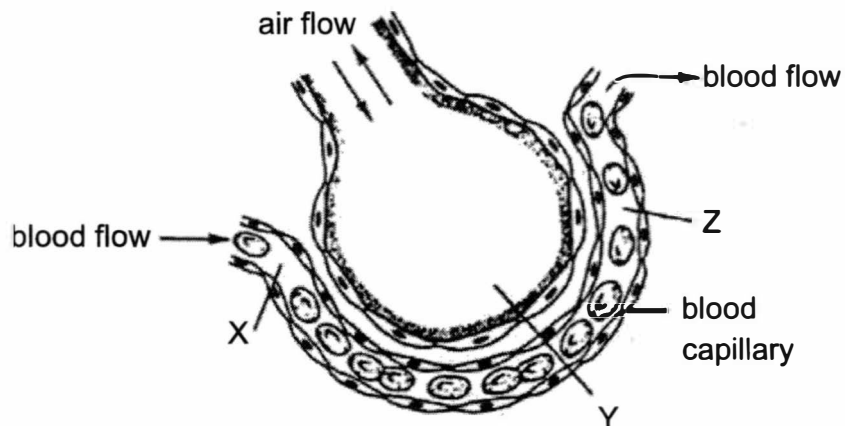
11 The diagram represents the relationship between a respiring cell and a blood capillary. The arrows indicate the directions followed by substances exchanged between the capillary contents and the cell.



What could arrows P, Q, R and S represent?

	P	Q	R	S
A	glucose	oxygen	carbon dioxide	urea
B	oxygen	carbon dioxide	mineral salts	water
C	urea	mineral salts	oxygen	plasma
D	water	carbon dioxide	oxygen	glucose

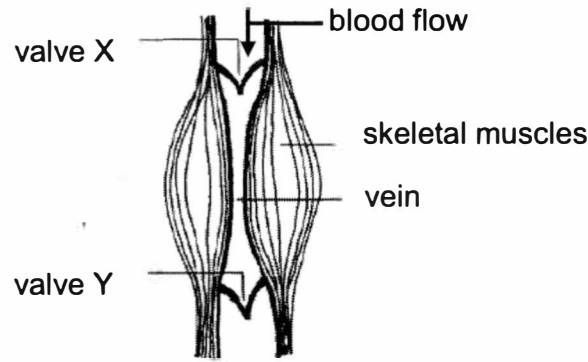
12 The diagram below shows an air sac and its blood supply.



What are the concentrations of carbon dioxide at X, Y and Z?

	X	Y	Z
A	high	low	low
B	high	high	low
C	low	high	high
D	low	high	low

- 13 The diagram illustrates a section of a vein and its surrounding skeletal muscles.



The contraction of the skeletal muscles causes the lumen of the blood vessel to become narrower whereas the relaxation of the skeletal muscles results in the lumen becoming wider.

Which of the following correctly describes the action of the skeletal muscles and their valves X and Y?

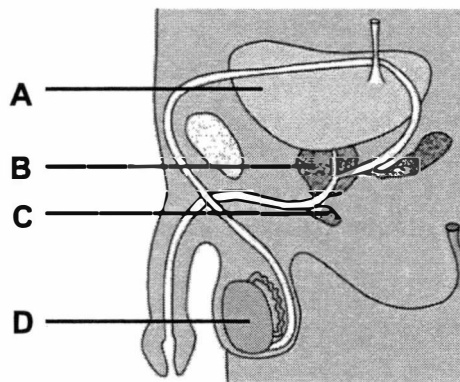
	skeletal muscle	valve X	valve Y
<b>A</b>	relaxes	open	open
<b>B</b>	relaxes	close	open
<b>C</b>	contracts	open	close
<b>D</b>	contracts	close	open

- 14 Which sequence shows the shortest route taken by blood travelling from a leg to an arm in the human body?

- A** leg → heart → lungs → kidney → arm  
**B** leg → heart → lungs → heart → arm  
**C** leg → kidney → heart → lungs → arm  
**D** leg → lungs → heart → stomach → arm

- 15 The diagram shows the male reproductive system.

Where are the sperms produced?



- 16** The scrotum is a skin bag containing the testis outside the abdominal cavity of a male.

Which of the following best explains its function?

- A** to store sperm
- B** to keep the testis at a temperature suitable for sperm production
- C** to improve the chances of successful fertilisation
- D** to provide an ideal temperature for embryo development

- 17** Which of the following characteristics can be passed from parents to offspring?

- I** hair colour
- II** eye colour
- III** blood type
- IV** fingerprints

- A** I and II
- B** III and IV
- C** I, II and III
- D** All of the above

- 18** A male chimpanzee has 48 chromosomes in each of his regular body cells.

How many chromosomes would be found in each of his sperm cells?

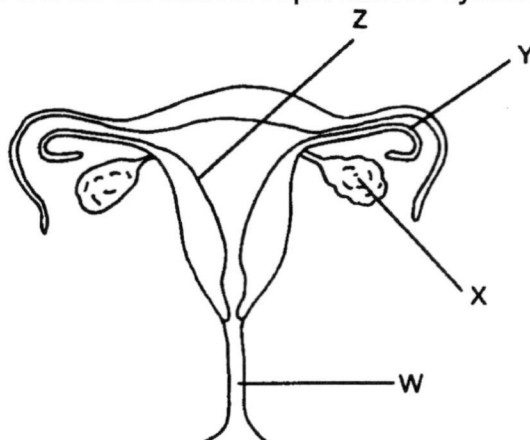
- A** 96
- B** 48
- C** 24
- D** 12

- 19** Which events can still occur naturally after a woman has undergone ligation?

- I** fertilisation
- II** implantation
- III** menstruation
- IV** ovulation

- A** I and II only
- B** III and IV only
- C** I, II, III and IV
- D** I, III and IV only

- 20 The diagram below shows the human reproductive system of an individual.



Which of the following sets of descriptions for the labelled parts is correct?

	W	X	Y	Z
<b>A</b>	passes urine out of the body	where implantation takes place	where embryo implantation occurs	where fertilization occurs
<b>B</b>	passes semen out	produces ova	where fusion of gametes occurs	where placenta develops
<b>C</b>	a canal for both foetus and urine	where fertilization takes place	muscular contraction during birth	accommodates the foetus
<b>D</b>	where uterine lining leaves body	produces female sex hormones	where fertilization takes place	enlarges during pregnancy

**End of Section A**

## Section B

Answer **all** questions.

Write **all** your answers in the spaces provided.

- 21** Table 21.1 shows the chemical formulae of various types of particles found in substances. Each chemical formula can be used once, more than once or not at all.

$\text{CH}_4$	$\text{H}_2\text{O}$	$\text{P}_4$	$\text{Al}^{3+}$	$\text{C}_6\text{H}_{12}\text{O}_6$	$\text{S}^{2-}$
$\text{Mg}^{2+}$	$\text{CO}_2$	$\text{HCl}$	$\text{O}_3$	$\text{F}^-$	$\text{Ar}$

**Table 21.1**

- (a)** With reference to Table 21.1, write down the formula(e) of the following:

- (i)** two molecules of compounds that have four or more atoms

..... [1]

- (ii)** one molecule of an element

..... [1]

- (iii)** an electrically neutral atom

..... [1]

- (iv)** a metallic ion

..... [1]

- (b)** Complete Table 21.2 on the number of sub-atomic particles for each of the following particles.

particles	protons	electrons	neutrons
$\text{Ca}^{2+}$		18	
$\text{P}^{3-}$			16

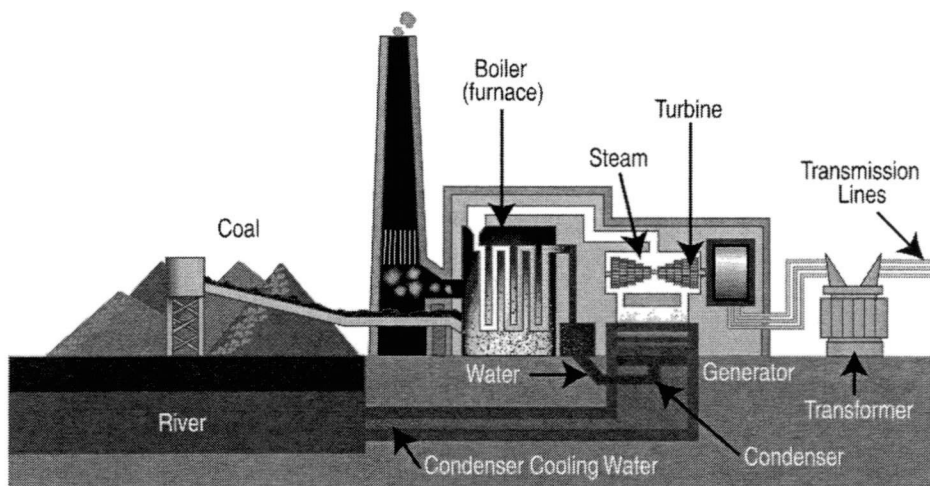
**Table 21.2**

[4]



- 22** Since the beginning of the industrial revolution in the early 1800s, fossil fuel-powered machines have driven an unprecedented burst of human industry and advancement. The unfortunate consequence, however, has been the emission of billions of tonnes of carbon dioxide and other greenhouse gases into Earth's atmosphere.

The following figure shows a typical steam-cycle coal power plant (proceeding from left to right).



**Figure 22.1**

- (a) Circle on the diagram where chemical change occurs. [1]
- (b) (i) The burning of fossil fuels release air pollutants such as soot and toxic gases in the atmosphere. One harmful effect of burning fossil fuels is the formation of acid rain.

State one pollution problem that is caused by acid rain.

..... [1]

- (ii) Other than the formation of acid rain, suggest one other pollution problem that is caused by the release of air pollutants.

..... [1]

- (iii) Suggest a way we can conserve energy to decrease air pollution.

..... [1]

- 23 Figure. 23.1 shows the neutralisation reaction between two colourless solution, x and Y.  
 Solution X turns moist red litmus paper blue.  
 Solution Y turns moist blue litmus paper red.

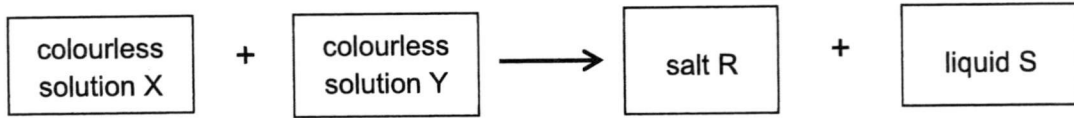


Figure 23.1

- (a) (i) Identify the nature of solution X and Y by circling either acidic or alkaline.

solution	nature of solution	
X	acidic	alkaline
Y	acidic	alkaline

[2]

- (ii) State another property of solution X.

..... [1]

- (iii) Name the colourless liquid S.

..... [1]

- (iv) State the pH of the salt solution.

..... [1]

- (b) Give two reasons why the reaction between solution X and solution Y is considered a chemical reaction.

.....  
 .....  
 .....

[2]

**24** CODIS is an identification system that helps to identify potential crime suspects using DNA found at crime scenes. A sample of blood containing only red blood cells and plasma was found at a crime scene.

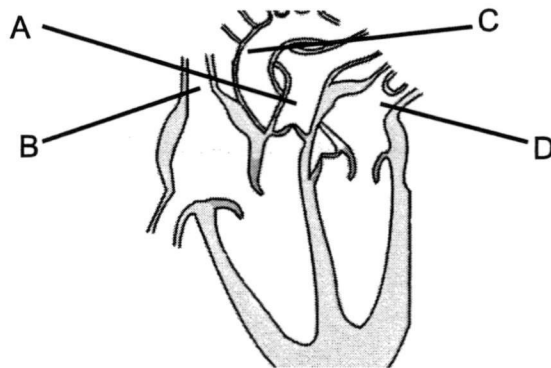
**(a)** Explain why this sample of blood will be useless in allowing the CODIS system to identify potential crime suspects.

.....  
.....  
[1]

**(b)** Suggest what component of the blood is necessary to identify the potential crime suspects.

.....  
[1]

**25 (a)** The diagram shows the heart and the arrows show the flow of blood in the heart. A, B, C and D are blood vessels.



**Figure 25.1**

**(i)** State which of the above blood vessels are arteries and which are veins.

Arteries .....

Veins .....

[2]

**(ii)** Explain your answer in **(a)(i)**.

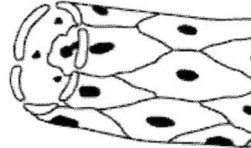
.....  
.....  
[2]

(iii) State two ways in which the structure of arteries differs from the structure of veins.

.....  
.....  
.....

[2]

(b) The diagram shows a short length of a blood capillary.



Explain how the wall is suited to the functions of this blood vessel.

.....  
.....

[2]

26 (a) Hermes started to outgrow his clothes very quickly when he began Secondary 2 this year. Pimples also started to sprout all over his face.

(i) What is the term used to describe this period of growth?

.....

[1]

(ii) What caused these changes?

.....

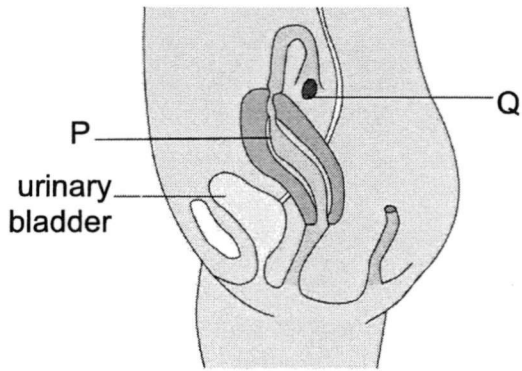
[1]

(b) Explain why the ovum, which is not mobile, yet it can 'travel' along the oviduct to the uterus.

.....  
.....

[1]

27 The following shows a diagram of the female reproductive system.



**Figure 27.1**

(a) Study the diagram and explain why a woman has a greater tendency to feel the urge to urinate when she is pregnant.

.....

.....

[1]

(b) Using the letter "A", label clearly on the diagram the part where an intra-uterine device (IUD) is placed. [1]

(c) Name two physical side effects of abortion.

.....

.....

[2]

(d) Explain why a 6 year old girl is theoretically unable to be pregnant.

.....

.....

[2]

(e) The calendar for September is shown below.

September						
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Mrs Vui's menstrual cycle follows an average of 28 days and the first day of her menstruation is on 3<sup>rd</sup> September.

(i) When will her next menstruation start?

..... [1]

(ii) Shade on the calendar, the period of time in which Mrs Vui is most fertile. [1]

**28** Antiviral drugs are used to manage HIV in patients with HIV. The antiviral drugs slow down the reproduction of HIV in the patient's body, therefore stopping the onset of AIDS for many years. Before antiviral drugs were available, death rates of those infected with HIV were high.

(a) What does AIDS stand for?

..... [1]

(b) Explain why a patient with HIV will die if not given antiviral drugs.

.....  
.....  
..... [2]

(c) Suggest two precautions which could help prevent the spread of AIDS.

.....  
.....  
..... [2]

(d) Suggest why syphilis and gonorrhoea cannot be treated with antiviral drugs.

.....  
..... [1]

(e) If contraceptives were not used before or during sexual intercourse, drug X can be used after sexual intercourse to prevent pregnancy. Drug X contains hormones that disrupt or delay ovulation.

(i) Suggest how drug X prevents pregnancy.

.....  
.....  
.....

[2]

(ii) One of the methods of birth control is known as the rhythm method. Briefly explain how this method prevents pregnancy.

.....  
.....  
.....

[2]

**End of Section B**

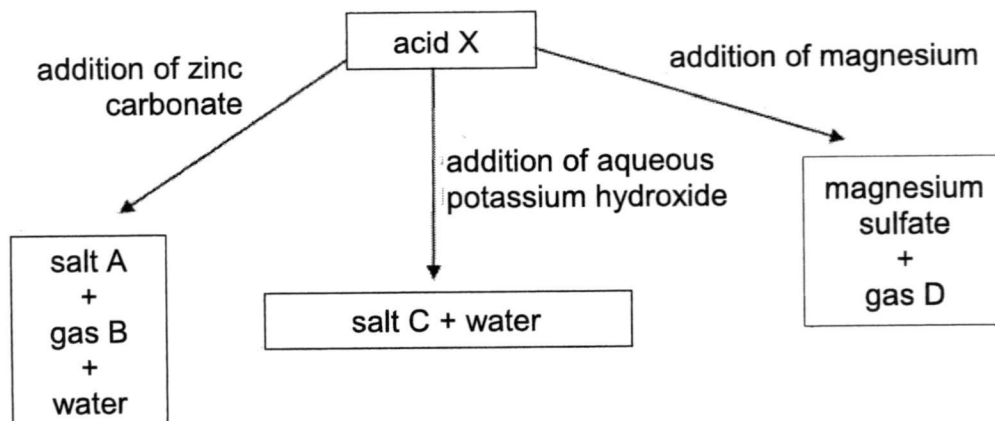
### Section C

Answer all **three** questions on the writing papers provided.

Question **29** is in the form of either/or and only **one** of the alternatives should be attempted.

#### EITHER

**29** The flowchart in Figure. 29.1 shows a series of chemical reactions involving acid X.



**Figure. 29.1**

- (a) Identify A, B, C and D. [4]
- (b) Identify acid X and explain how you arrived at that conclusion. [2]
- (d) Carbon dioxide is a slightly acidic gas, which is soluble in water.

Table 29.1 shows the colours of indicators P, Q, R and S in solutions of different pH.

	pH 5	pH 6	pH 7	pH 8	pH 9
P	green		yellow		
Q	colourless				pink
R	red		no change	blue	
S	orange			violet	

**Table 29.1**

- (i) A little indicator P was added into a beaker of pure water before carbon dioxide was dissolved into it.  
State and explain the colour change of the indicator P. [2]
- (ii) An unknown solution is green in P and orange in S.  
Suggest the pH of that solution. [1]
- (iii) What colour will R have in sodium hydroxide? [1]



OR

29 (a) State **two** physical properties of an acid. [2]

(b) In an experiment, dilute hydrochloric acid was added into a piece of magnesium ribbon. Hydrogen gas was produced.

Copy and complete the following word equation to show the products of the reaction on the writing papers provided.

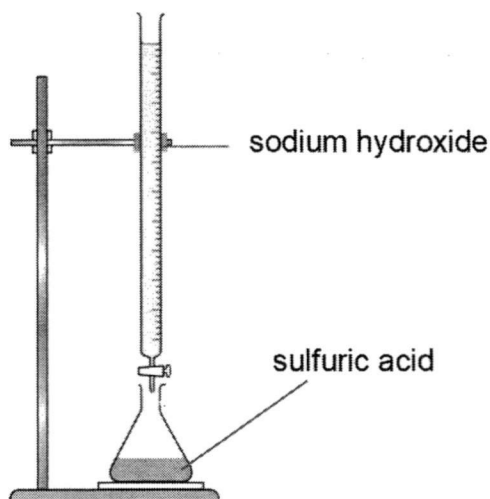
magnesium + hydrochloric acid  $\rightarrow$  ..... + ..... [1]

(c) In another experiment, dilute hydrochloric acid was added into some egg shells which contain a calcium compound. A gas was produced, which caused a white precipitate to form in limewater.

(i) Name the gas produced. [1]

(ii) Suggest the name of the calcium compound. [1]

(d) 25 cm<sup>3</sup> of dilute sulfuric acid was measured into a conical flask. A piece of Universal Indicator paper was added into the acid. Sodium hydroxide was added slowly into the acid. The pH value of the mixture was measured.



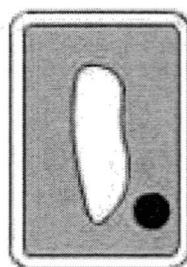
- (i) Identify correct pH to show the changes in the pH when aqueous sodium hydroxide was added slowly into the dilute sulfuric acid and write the number on the writing papers provided.

	approximate pH of the chemicals in the conical flask		
when no aqueous sodium hydroxide has been added to the acid yet	2	7	13
when sufficient sodium hydroxide was added to the acid such that all the acid has reacted	2	7	13
when excess sodium hydroxide was added to the acid after it has been reacted	2	7	13

[3]

- (ii) Name the salt that was in the mixture after the reaction. [1]
- (iii) What is the name of the reaction when an acid reacts with an alkali? [1]

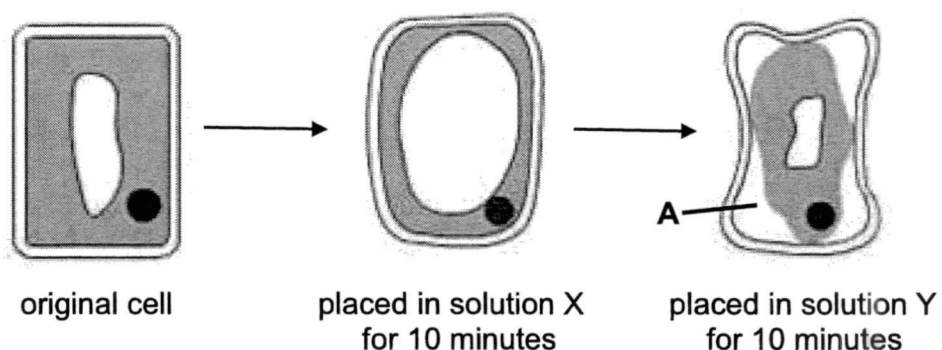
- 30 (a) The following shows a cell from an organism.



Name the type of living organism in which a cell similar to the one above could be found? [1]

- (b) The cell is placed in solution X for 10 minutes, and is then transferred into solution Y for another 10 minutes.

Figure. 30.1 shows the appearance of the cell after being placed in X, and then Y respectively.

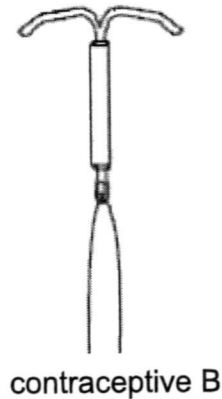
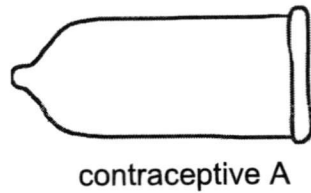


**Figure. 30.1**

- (i) The solutions used are concentrated salt solution and distilled water. Identify X and Y. [2]
- (ii) Explain what has occurred to cause the cell to appear as it does when it is placed in solution X. [3]
- (iii) What will be found in region A of after the cell is placed in solution Y? Explain your answer. [2]
- (iv) What would happen if white blood cell is placed in solution X for 12 hours? [1]
- (v) State the function of a white blood cell. [1]

- 31 (a) Study the two contraceptives below.

State one similarity and one difference between the two contraceptives. [2]



- (b) Figure. 31.1 illustrates a stage in human reproduction.

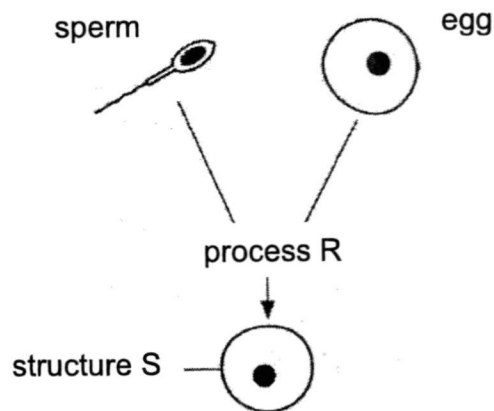


Figure. 31.1

- (i) Identify process R and structure S. [2]
- (ii) Describe the following development of structure S in the female reproductive system. [2]
- (c) Fig. 31.2 shows the front cross-section view of the female reproductive system.

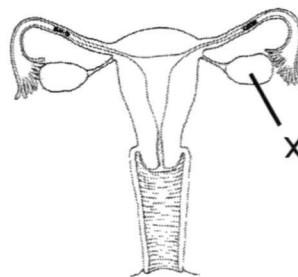


Figure. 31.2

- (i) Describe the function of structure X. [2]
- (ii) Using evidence from Figure. 31.2, suggest why this woman is infertile. [2]

**End of Paper**

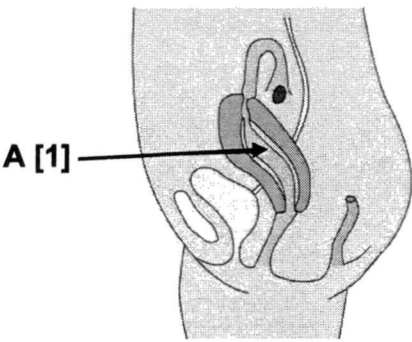
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### Section A

1	C	6	C	11	D	16	B
2	D	7	A	12	A	17	C
3	C	8	B	13	D	18	C
4	B	9	B	14	B	19	B
5	C	10	C	15	D	20	D

### Section B

Q no.	Answer	Remarks			
21 ai	CH <sub>4</sub> and C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	[1]			
ii	P <sub>4</sub> / O <sub>3</sub>	[1]			
lii	Ar	[1]			
iv	Al <sup>3+</sup> / Mg <sup>2+</sup>	[1]			
b	particles	protons	electrons	neutrons	[1] each
	Ca <sup>2+</sup>	20	18	20	
	P <sup>3-</sup>	15	18	16	
22 a	Boiler / Furnace	[1]			
bi	Acid rain <u>destroys plants and kills fishes and other aquatic life.</u> / Acid rain <u>corrodes buildings and other structures.</u>	[1] [1]			
ii	Polluted air leads to <u>difficulty in breathing</u> / increases the risk of <u>respiratory illnesses.</u>	[1]			
iii	We should switch off all electrical items when not in use. (Accept any other reasonable answer.)	[1]			
23 ai	X – alkaline;	[1]			
	Y – acidic	[1]			
ii	bitter taste / soapy feel	[1]			
iii	Water	[1]			
iv	pH = 7	[1]			
b	A <u>new substance</u> is formed. The <u>properties of the products differ</u> from the reactants. <u>Heat is produced</u> (accept other possible answers)	Accept any two correct answers			
24a	Red blood cells do not contain nuclei which contain DNA.	[1]			
b	White blood cells will be required.	[1]			
25ai	Arteries – A and C Veins – B and D	[1] [1] No half marks			

Q no.	Answer	Remarks
ii	In A and C, blood is flowing out of the heart. In B and D, blood is flowing into the heart.	[1] [1]
iii	Arteries have a thicker muscular and elastic wall while veins have a thinner, less muscular and less elastic wall. Arteries do not have valves but veins have valves to prevent the backflow of blood.	[1] [1]
b	The <u>one-cell</u> thick walls allow for <u>diffusion of substances easily</u> .  - diffusion and easily/efficiently/faster must be present to be awarded 1m for second part - independent marking	[1] [1]
<b>26ai</b>	Puberty	[1]
ii	Sex hormones	[1]
b	The rippling movements of the muscles in the oviduct pushes the ovum towards the uterus /Contraction and relaxation of muscles/Muscles push ovum (½)	[1]
<b>27a</b>	The weight of foetus is acting on the (urinary) bladder.  Reject: - Bladder shrinks - Bladder enlarges - Embryo	[1]
b		
c	<u>Infection of uterus, prolonged bleeding</u>	[1] each
d	She has not <u>undergone puberty</u> , hence has yet to produce female <u>sex hormones and gametes/ mature ova/ egg</u> .	[1] [1]
<b>27 ei</b>	1 <sup>st</sup> October	[1]
ii	13 <sup>th</sup> to 19 <sup>th</sup> September	[1]
<b>28a</b>	Acquired Immune Deficiency Syndrome  No mark for spelling error	[1]
b	HIV attacks the <u>immune system</u> of the patient. The patient dies as the body is <u>unable to fight off infections / bacteria</u> .	[1] [1]

Q no.	Answer	Remarks
c	Use of condoms Abstinence from sex No sharing of contaminated needles	Accept any two correct answers
d	Syphilis and gonorrhoea are <u>caused by bacteria</u> / <u>not caused by virus</u> .	[1]
ei	Drug X <u>prevents/delays the release of an ovum</u> from the ovaries.	[1]
	Sperm <u>does not fuse</u> with an ovum, hence <u>fertilisation is prevented</u> .	[1]
eii	Sexual intercourse is <u>avoided</u> during <u>ovulation</u> or <u>fertile period</u> .	[1]
	Hence, sperms <u>will not meet with</u> or <u>will not fertilise</u> the ovum.	[1]

### Section C

Q no.	Answer	Remarks
<b>Either</b>	<b>A:</b> zinc sulfate	[1]
<b>29 ai</b>	<b>B:</b> Carbon dioxide	[1]
	<b>C:</b> Potassium sulfate	[1]
	<b>D:</b> Hydrogen	[1]
ii	<u>Sulfuric acid</u> <u>Sulfate salts</u> were produced	[1] [1]
di	Colour change from yellow to green; Pure water is neutral whereas carbon dioxide is slightly acidic	[1] [1]
ii	pH5/6	[1]
iii	Blue	[1]
<b>Or</b>	Acid is a substance that <u>dissolves in water</u> /when aqueous to produce <u>hydrogen ions/ H<sup>+</sup></u> .	[1]
<b>29 a</b>	<b>b</b> magnesium chloride + hydrogen	[1]
	<b>c i</b> carbon dioxide	[1]
	<b>ii</b> calcium carbonate	[1]
<b>d i</b>	2 for row 1 7 for row 2 13 for row 3	[1] for each correct answer
<b>ii</b>	sodium sulfate	[1]
<b>iii</b>	neutralisation	[1]
<b>30a</b>	Plant Accept: Leaf cell, fern, fungi, root cell	1m
<b>bi</b>	X is distilled water [1] Y is concentrated salt solution [1].	2m
<b>ii</b>	There must have been a <u>higher water potential in X</u> compared to that in the cell.	[1]
	This resulted in <u>osmosis</u> to take place where <u>water molecules will move through the partially permeable cell membrane</u> into the cell, / <u>water molecules move from</u>	[1]
		[1]



Q no.	Answer	Remarks
	<p><u>distilled water into the cell</u>, causing the cell to appear turgid.</p> <p>1/2m: water move into the cell Reject: cell absorb water</p>	
iii	<p>Solution Y will be found in A. [1] The cell membrane pulls away from the cell wall as the cell becomes flaccid, <u>creating space for solution Y to enter</u> through the permeable cell wall.</p> <p>Accept: Salt solution will be found in <b>A</b>. Accept: The cell wall is fully permeable. Reject: The cell membrane pulls away from the cell wall. Reject: Salt will be found in <b>A</b>. Reject all explanations if "salt" or "Y" was not mentioned at all.</p>	<p>[1] [1]</p>
iv	White blood cell would swell and burst.	[1]
v	White blood cells keep the <u>body healthy</u> by <u>fighting diseases</u> .	[1]
31a	<p>Similarity Both are <u>temporary contraceptive methods</u>.</p> <p>Difference Contraceptive A prevents sperm from reaching the ovum, while B prevents implantation of fertilized ovum. or A is placed on penis while B is placed in the uterus.</p> <p>Any reasonable comparison.</p>	<p>[1] [1]</p>
bi	<p><b>R</b> fertilisation [1] <b>S</b> zygote [1] (rej: fertilised egg)</p>	<p>[1] [1]</p>
ii	It divides to form a ball of cells known as the <u>embryo</u> ; <u>implanted</u> into the uterine lining.	<p>[1] [1]</p>
ci	Structure X produces <u>eggs</u> and <u>female sex hormones/ oestrogen and progesterone</u> .	<p>[1] [1]</p>
ii	There is blockage in oviducts/ fallopian tube; <u>sperm is unable to meet the egg</u> to fertilise it.	<p>[1] [1]</p>

## The Periodic Table of the Elements

Group																																			
I	II											III	IV	V	VI	VII	0																		
<p style="text-align: center;"><b>key</b></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">           proton (atomic) number            atomic symbol            name            relative atomic mass         </div>											1 <b>H</b> hydrogen 1												2 <b>He</b> helium 4												
											3 <b>Li</b> lithium 7		4 <b>Be</b> beryllium 9												5 <b>B</b> boron 11		6 <b>C</b> carbon 12		7 <b>N</b> nitrogen 14		8 <b>O</b> oxygen 16		9 <b>F</b> fluorine 19		10 <b>Ne</b> neon 20
11 <b>Na</b> sodium 23		12 <b>Mg</b> magnesium 24												13 <b>Al</b> aluminium 27		14 <b>Si</b> silicon 28		15 <b>P</b> phosphorus 31		16 <b>S</b> sulfur 32		17 <b>Cl</b> chlorine 35.5		18 <b>Ar</b> argon 40											
19 <b>K</b> potassium 39		20 <b>Ca</b> calcium 40		21 <b>Sc</b> scandium 45		22 <b>Ti</b> titanium 48		23 <b>V</b> vanadium 51		24 <b>Cr</b> chromium 52		25 <b>Mn</b> manganese 55		26 <b>Fe</b> iron 56		27 <b>Co</b> cobalt 59		28 <b>Ni</b> nickel 59		29 <b>Cu</b> copper 64		30 <b>Zn</b> zinc 65		31 <b>Ga</b> gallium 70		32 <b>Ge</b> germanium 73		33 <b>As</b> arsenic 75		34 <b>Se</b> selenium 79		35 <b>Br</b> bromine 80		36 <b>Kr</b> krypton 84	
37 <b>Rb</b> rubidium 85		38 <b>Sr</b> strontium 88		39 <b>Y</b> yttrium 89		40 <b>Zr</b> zirconium 91		41 <b>Nb</b> niobium 93		42 <b>Mo</b> molybdenum 96		43 <b>Tc</b> technetium -		44 <b>Ru</b> ruthenium 101		45 <b>Rh</b> rhodium 103		46 <b>Pd</b> palladium 106		47 <b>Ag</b> silver 108		48 <b>Cd</b> cadmium 112		49 <b>In</b> indium 115		50 <b>Sn</b> tin 119		51 <b>Sb</b> antimony 122		52 <b>Te</b> tellurium 128		53 <b>I</b> iodine 127		54 <b>Xe</b> xenon 131	
55 <b>Cs</b> caesium 133		56 <b>Ba</b> barium 137		57 – 71 lanthanoids		72 <b>Hf</b> hafnium 178		73 <b>Ta</b> tantalum 181		74 <b>W</b> tungsten 184		75 <b>Re</b> rhenium 186		76 <b>Os</b> osmium 190		77 <b>Ir</b> iridium 192		78 <b>Pt</b> platinum 195		79 <b>Au</b> gold 197		80 <b>Hg</b> mercury 201		81 <b>Tl</b> thallium 204		82 <b>Pb</b> lead 207		83 <b>Bi</b> bismuth 209		84 <b>Po</b> polonium -		85 <b>At</b> astatine -		86 <b>Rn</b> radon -	
87 <b>Fr</b> francium -		88 <b>Ra</b> radium -		89 – 103 actinoids		104 <b>Rf</b> Rutherfordium -		105 <b>Db</b> dubnium -		106 <b>Sg</b> seaborgium -		107 <b>Bh</b> bohrium -		108 <b>Hs</b> hassium -		109 <b>Mt</b> meitnerium -		110 <b>Ds</b> darmstadtium -		111 <b>Rg</b> roentgenium -		112 <b>Cn</b> copernicium -		114 <b>Fl</b> flerovium -		116 <b>Lv</b> livermorium -									

lanthanoids

57 <b>La</b> lanthanum 139		58 <b>Ce</b> cerium 140		59 <b>Pr</b> praseodymium 141		60 <b>Nd</b> neodymium 144		61 <b>Pm</b> promethium -		62 <b>Sm</b> samarium 150		63 <b>Eu</b> europium 152		64 <b>Gd</b> gadolinium 157		65 <b>Tb</b> terbium 159		66 <b>Dy</b> dysprosium 163		67 <b>Ho</b> holmium 165		68 <b>Er</b> erbium 167		69 <b>Tm</b> thulium 169		70 <b>Yb</b> ytterbium 173		71 <b>Lu</b> lutetium 175	
89 <b>Ac</b> actinium -		90 <b>Th</b> thorium 232		91 <b>Pa</b> protactinium 231		92 <b>U</b> uranium 238		93 <b>Np</b> neptunium -		94 <b>Pu</b> plutonium -		95 <b>Am</b> americium -		96 <b>Cm</b> curium -		97 <b>Bk</b> berkelium -		98 <b>Cf</b> californium -		99 <b>Es</b> einsteinium -		100 <b>Fm</b> fermium -		101 <b>Md</b> mendelevium -		102 <b>No</b> nobelium -		103 <b>Lr</b> lawrencium -	

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.)