WJEC CBAC

GCE AS/A level

1661/01

APPLIED SCIENCE
UNIT 1

A.M. THURSDAY, 9 January 2014

1 hour 30 minutes

For Examiner's use only			
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1-12**	**29**	
	13	12	
	14	9	
Section B	15	8	
	16	12	
	17	10	
	Total	**80**	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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.

A data sheet can be found on page 28.

INFORMATION FOR CANDIDATES

Section A is based on the pre-release article (included).

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

You are reminded that assessment will take into account the quality of written communication used in your answers.

The following information is adapted from the Stop Smoking Wales website.

1

Case Study

A serious illness during Christmas 2007 gave 62-year-old Olwen Morgan from Carmarthen a "wake up call" that she needed to pack in the cigarettes for good.

Smoking in excess of 400 cigarettes a week for nearly 50 years had taken its toll on Olwen's health. Her near-death experience gave her good reason to evaluate her life and the negative effects smoking was having on her well-being.

Being realistic and knowing that packing in the cigarettes would need great determination and willpower after nearly 50 years of smoking, Olwen recruited the help of the Stop Smoking Wales service. Her daughter, Jane also decided to support her mother and stopped smoking at the same time.

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A meeting was set up with Stop Smoking Wales for both mother and daughter and a quit date was set. Now, after more than three months without touching a cigarette, Olwen and Jane are reaping the health benefits of quitting smoking.

Olwen is now enjoying walking everywhere and is saving herself a fortune in taxi costs. Olwen said: "I have so much more energy now that I don't have to take taxis everywhere, I'll just walk instead!"

Research has shown that just eight hours after stopping smoking, the levels of carbon monoxide and nicotine in the blood are cut by half, and by 48 hours, there is no nicotine left in the body.

20

Olwen added: "I'll be realistic – it isn't easy giving up cigarettes at times, but access to services to help you quit couldn't be easier. The support I have received from Stop Smoking Wales and its trained specialists has been wonderful and without them I would have struggled to do it."

Olwen and Jane both used nicotine patches to help overcome their nicotine withdrawal. Also proving invaluable were the weekly sessions held locally by Stop Smoking Wales that gave Olwen and Jane the help and motivation to keep off the cigarettes.

After 50 years of smoking, Olwen can now officially call herself smoke-free and is a great role model in showing it's never too late to give up!

What is Stop Smoking Wales?

30   Stop Smoking Wales is a free, NHS service to help people quit smoking.

Research has shown that smokers are four times more likely to quit with a support programme like Stop Smoking Wales than going it alone.

Stop Smoking Wales provides evidence based advice and behavioural support for adult smokers who want to stop smoking.

Stop smoking Wales is the NHS Smoking Cessation Service. Smokers who use the service are four times more likely to stop smoking.

40   The service is funded and run by Public Health Wales – an NHS organisation providing professionally independent public health advice and services to protect and improve the health and well-being of the population of Wales. It contributes to national and local tobacco control initiatives and has a key role in reducing the impact of tobacco on the health of people in Wales.

Stop Smoking Wales holds weekly group sessions across Wales. Group sessions start a few weeks before individuals plan to quit and help them to prepare for their quit date. Group sessions last for six weeks.

Why quit?

50   This is a question many smokers ask. Here are just a handful of reasons why stopping smoking is the smart choice:

- To improve health

- Because of the smell of tobacco smoke

- So that smokers' children don't become smokers

- To avoid being addicted

- Smoking is very expensive

Health benefits

Quitting smoking is one of the most effective steps a person can take to improve their health. After one year the risk of a heart attack falls to about half that of a smoker and after 15 years it's the same as someone who's never smoked!

60   **Health Benefit Timeline**

The body will start to feel the benefit as soon as smoking stops.

Time	Effect
8 hours	Nicotine and carbon monoxide levels in the blood reduce by half. Oxygen levels return to normal.
24 hours	Carbon monoxide will be eliminated from the body, lungs start to clear of mucus and other smoking debris.
48 hours	There is no nicotine left in the body and ability to taste and smell is greatly improved.
72 hours	Breathing becomes easier. Bronchial tubes begin to relax and energy levels increase.
2-12 weeks	Circulation improves.
3-9 months	Coughs, wheezing and breathing problems improve as lung function is increased by up to 10%.
1 year	Risk of heart attack falls to about half that of a smoker.
10 years	Risk of lung cancer falls to about half that of a smoker.
15 years	Risk of heart attack falls to the same as someone who has never smoked.

Beneficial health changes when you stop smoking

Stopping smoking is always urgent but it is never too late to benefit from doing so. Every cigarette smoked damages the lungs in a way that may not show up until later in life. After the age of 35-40 years, for every year of continued smoking a person loses 3 months of life expectancy. Many smokers think that they will be more miserable when they stop but the evidence is that they will have better mental health and be happier.

Source: ASH

What's in a cigarette?

It is well known that cigarettes contain tobacco and nicotine but what about the other components? There are over 4 000 chemicals in cigarettes and cigarette smoke.

The diagram below shows exactly what a cigarette is made of:
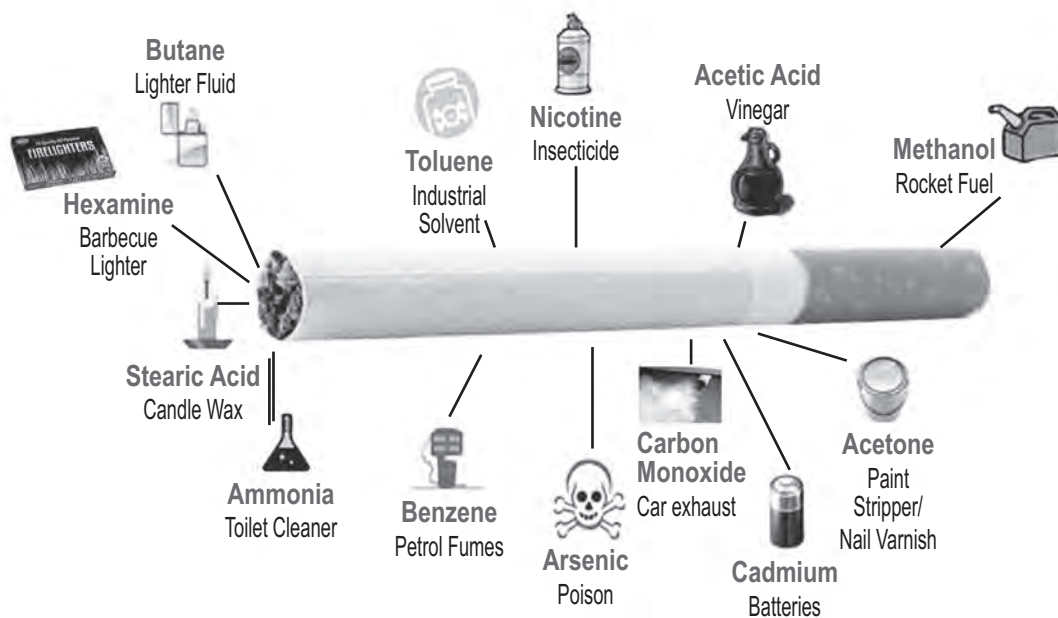
Cigarettes look deceptively simple, consisting of paper tubes containing chopped up tobacco leaf, usually with a filter at the mouth end. In fact, they are highly engineered products, designed to deliver a steady dose of nicotine.

Cigarette tobacco is blended from two main leaf varieties: yellowish 'bright', also known as Virginia where it was originally grown, contains 2.5-3% nicotine; and 'burley' tobacco which has a higher nicotine content (3.5-4%).

In addition to the leaf blend, cigarettes contain 'fillers' which are made from the stems and other bits of tobacco which would otherwise be waste products. These are mixed with water and various flavourings and additives. The ratio of filler varies among brands. For example, a high filler content makes a less dense cigarette with a slightly lower tar delivery.

Additives are used to make tobacco products more acceptable to the consumer. They include humectants (moisturisers) to prolong shelf life; sugars to make the smoke seem milder and easier to inhale; and flavourings such as chocolate and vanilla. While some of these may appear to be quite harmless in their natural form they may be toxic in combination with other substances. Also when additives are burned, new products of combustion are formed and these may be toxic.

The nicotine and tar delivery can also be modified by the type of paper used in the cigarette. Using more porous paper will let more air into the cigarette, diluting the smoke and (in theory) reducing the amount of tar and nicotine reaching the smoker's lungs. Filters are made of cellulose acetate and trap some of the tar and smoke particles from the inhaled smoke. Filters also cool the smoke slightly, making it easier to inhale. They were added to cigarettes in the 1950s, in response to the first reports that smoking was hazardous to health. Tobacco companies claimed that their filtered brands had lower tar than others and encouraged consumers to believe that they were safer.

Tobacco smoke is made up of "sidestream smoke" from the burning tip of the cigarette and "mainstream smoke" that is delivered to the smoker via the filter or mouth end.

Tobacco smoke contains thousands of different chemicals which are released into the air as particles and gases. Many toxins are present in higher concentrations in sidestream smoke than in mainstream smoke and, typically, nearly 85% of the smoke in a room results from sidestream smoke.

100

The particulate phase includes nicotine, "tar" (itself composed of many chemicals), benzene and benzopyrene. The gas phase includes carbon monoxide, ammonia, dimethylnitrosamine, formaldehyde, hydrogen cyanide and acrolein. Some of these have marked irritant properties and more than 60, including benzopyrene and dimethylnitrosamine, have been shown to cause cancer.

Nicotine is an extremely powerful drug. The Royal College of Physicians has confirmed that the way in which nicotine causes addiction is similar to drugs such as heroin and cocaine. Nicotine is contained in the moisture of the tobacco leaf: When the cigarette is lit, it evaporates, attaching itself to minute droplets in the tobacco smoke inhaled by the smoker. It is absorbed by the body very quickly, reaching the brain within 10-19 seconds. It stimulates the central nervous system, increasing the heart beat rate and blood pressure, leading to the heart needing more oxygen. However, compared to other components of tobacco, nicotine is relatively harmless. Indeed, pure nicotine can be consumed safely in the form of nicotine replacement therapy (e.g. gum, patches, lozenges etc) to help people stop smoking. It works by helping smokers deal with nicotine cravings while cutting down or stopping smoking.

110

Carbon monoxide, the main poisonous gas in car exhausts, is present in all cigarette smoke. It binds to haemoglobin much more readily than oxygen, therefore reducing the capacity of the blood to carry oxygen. Heavy smokers may have the oxygen carrying power of their blood cut by as much as 15%.

120

Health Problems from Smoking

It is well known that lung cancer is associated with smoking. The graphs below show the link between lung cancer and smoking cigarettes.

Turn over.

Other problems associated with smoking include:

Hair loss

Poor Eye Sight

Mouth Cancer

Stroke

Wrinkles

Throat Cancer

Increased Coughing & Sneezing

Heart Disease

Kidney Cancer

Stomach Cancer

Fertility Problems

Skin Cancer

Poor Circulation

Gangrene
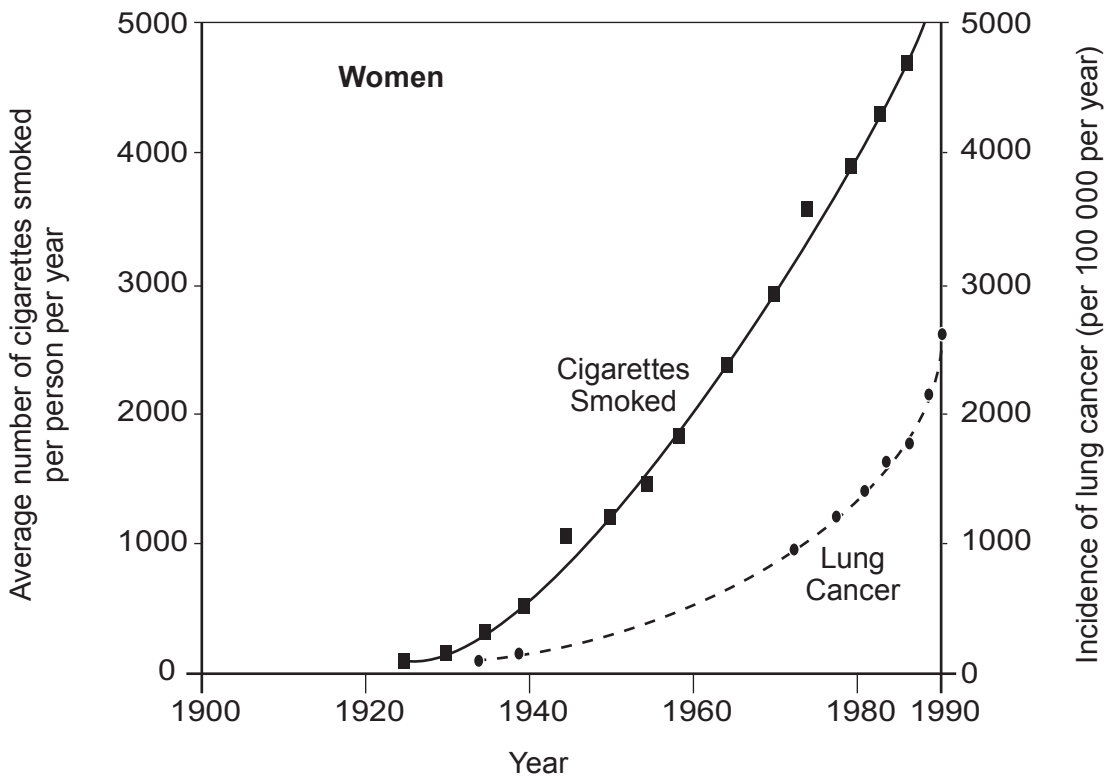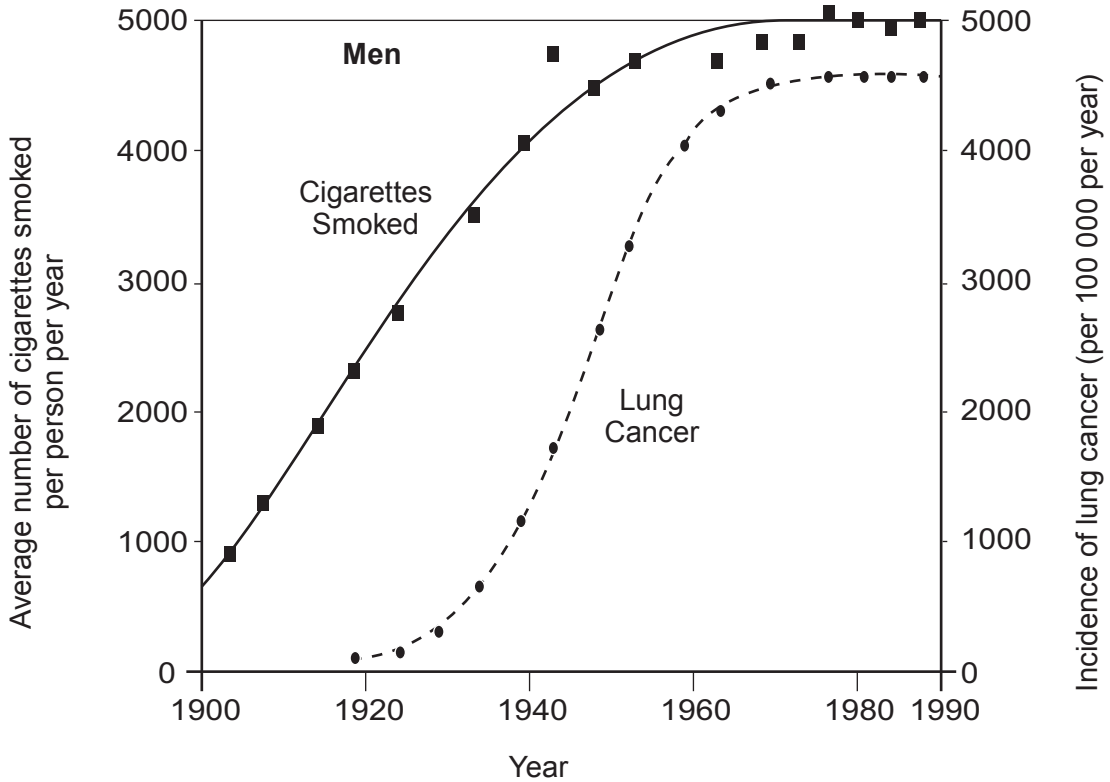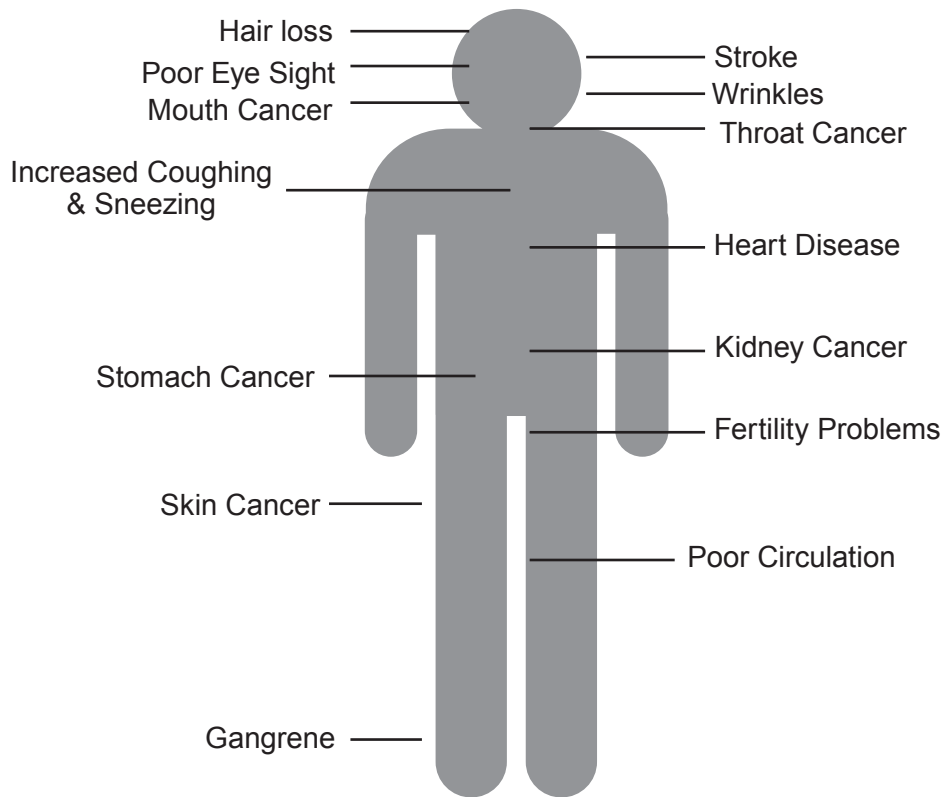
Secondhand Smoke

Secondhand smoke is made up mainly of sidestream smoke which is about four times more toxic than mainstream smoke. This is because sidestream smoke contains much higher levels of many of the poisons and cancer-causing chemicals in cigarettes.

130   Scientific evidence shows that there is no safe level of exposure to secondhand tobacco smoke. Secondhand smoke causes lung cancer and heart disease among adult non-smokers and a number of serious illnesses in adults and children can be attributed to secondhand smoke.

The desire to stop smoking

Many smokers continue smoking not through free choice but because they are addicted to cigarettes. A large part of this addiction arises from dependence on the nicotine delivered rapidly to the brain with each inhalation.

Approximately half of all smokers make at least one attempt to stop in a given year but only about 2-3% of smokers succeed long term. It is not clear why some attempts to stop

140   succeed and others do not, though smoking fewer cigarettes per day, not needing to smoke first thing in the morning and not suffering from mental health problems or other addictions are favourable factors for success.

Withdrawal symptoms

Withdrawal symptoms are the physical and mental changes that occur following interruption or termination of drug use. They are normally temporary and are a product of the physical or psychological adaptation to long-term drug use, requiring a period of re-adjustment when the drug is no longer ingested. In the case of smoking, some of these are:

Withdrawal symptom	Duration	Proportion of those trying to quit who are affected
Irritability / aggression	Less than 4 weeks	50%
Depression	Less than 4 weeks	60%
Restlessness	Less than 4 weeks	60%
Poor concentration	Less than 2 weeks	60%
Increased appetite	Greater than 10 weeks	70%
Light-headedness	Less than 48 hours	10%
Night-time awakenings	Less than 1 week	25%
Craving	Greater than 2 weeks	70%

Weight gain

150 The possibility of weight gain is often of particular concern to those who want to give up smoking. Weight gain is often progressive for a period of at least a year and, on average, ex-smokers will gain around 5 kg in weight. However, this is the weight gain made without any special attempts at dieting or exercise and it presents a minor health risk when compared with the risk of continued smoking. In addition, improved lung function and some of the other health benefits of giving up smoking are likely to make exercise both easier and more beneficial.

Pipes and cigars

Some smokers switch to pipes or cigars in the belief that this is a less dangerous form of smoking. However, such smokers may incur the same risks and may even increase them, especially if they inhale the pipe or cigar smoke.

Smoking cessation aids

These fall into two categories, medications and psychological support.

Medications

Medications aim to help smokers to stop by reducing the chemically-driven need to smoke without providing the same satisfaction as smoking and so not becoming the object of dependence. The assumption is that all the time that the smoker is not taking in nicotine from cigarettes the brain is gradually getting back to normal so that when the course of medication is completed, most smokers will be able to deal with the desire to smoke without help. These include nicotine chewing gum, skin patches, lozenges, nasal spray or inhalator. There are two types of specialist anti-smoking tablets that can also be prescribed – these are Bupropion (Zyban) and Varenicline (Champix).

Psychological support

Psychological support aims to strengthen the smoker's motivation not to smoke and advise on ways of avoiding, escaping from or minimising urges to smoke with simple practical strategies. Types of psychological support include specialist-facilitated stop smoking groups, individual face-to-face support, and telephone support.

Trends in smoking

Maternity, children and young people

- In 2005, 37% of mothers smoked at some stage during their pregnancy or the year before it, with 22% of mothers smoking throughout pregnancy.

- In 2005/06, 37% of households with children contained at least one adult who smoked daily.

- Regular (weekly) smoking was reported by 19% of 15-year-old boys and 28% of 15-year old girls in 2004.

Adult smoking

- The percentage of adults in Wales who smoke has fallen over the last thirty years.

- In 2005/06, 25% of adults reported that they currently smoked regularly.

- Men were slightly more likely to smoke than women; the percentage of the population who are smokers decreased with age.

- Adults in households headed by someone in the semi-routine / routine occupation group or someone who had never worked / was long-term unemployed were more likely to smoke than those in other socio-economic groups.

- Adults in more deprived areas were more likely to smoke than those in less deprived areas.

- Factors associated with smoking include age, socio-economic group, area deprivation, housing tenure and level of education.

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SECTION A

*Answer **all** questions.*

1. State **three** health problems associated with smoking. [2]

    ....

    ....

    ....

2. There is much debate as to whether attendance at non-smoking groups should be free. Suggest an argument for **and** against attendance being free. [2]

    for: ....

    ....

    against: ....

    ....

3. Carbon monoxide is found in cigarette smoke. Explain why carbon monoxide is particularly harmful. [2]

    ....

    ....

4. Explain how smoking during pregnancy can affect the development of the foetus. [2]

    ....

    ....

5. The number of smokers in Wales is falling. Suggest **three** reasons why this is the case. [3]

    1. ....

    ....

    2. ....

    ....

    3. ....

    ....

6. Name **one** chemical in tar that causes cancer. [1]

....

7. Explain why passive smoking is particularly dangerous. [2]

....

....

....

8. State the effects of nicotine on the heart and blood pressure. [2]

....

....

9. State why withdrawal symptoms occur. [1]

....

....

10. *(a)* Emphysema is a condition associated with smoking. Describe what happens to the structures of the lung during emphysema. [2]

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....

....

(b) Explain how emphysema affects the process of gas exchange. [2]

....

....

....

(c) State how the peak flow rate of a patient suffering from emphysema differs from a normal person. [1]

....

11. An MRI scanner is used to examine the lungs to diagnose conditions such as emphysema.

(a) State why MRI is a suitable imaging method for this type of examination. [1]

....

(b) There are a number of hazards associated with having an MRI scan. Describe **one** hazard for a patient having an MRI scan and the precaution taken to protect them. [2]

hazard: ....

....

precaution: ....

....

12. The link between lung cancer and smoking cigarettes is illustrated by the graphs on page 7.

Use **only** this information to:

(a) compare the trends in smoking of men and women between 1900 and 1990; [2]

....

....

....

....

(b) give evidence to support the claim that smoking causes lung cancer. [2]

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SECTION B

*Answer **all** questions.*

13. A medical student is learning about coordination of the heart beat.

A ....

B ....
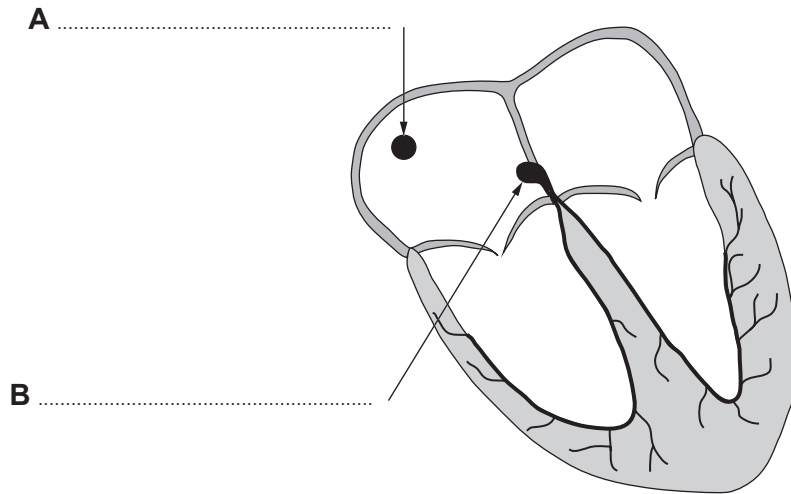
(a) On the diagram above label structures **A** and **B**.   [2]

(b) The cardiac cycle involves the structures found in the diagram above. Describe how the sequence of electrical impulses is spread through the structures in the heart.   [4]

....

....

....

....

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....

(c) The ECG below shows a normal heart trace.
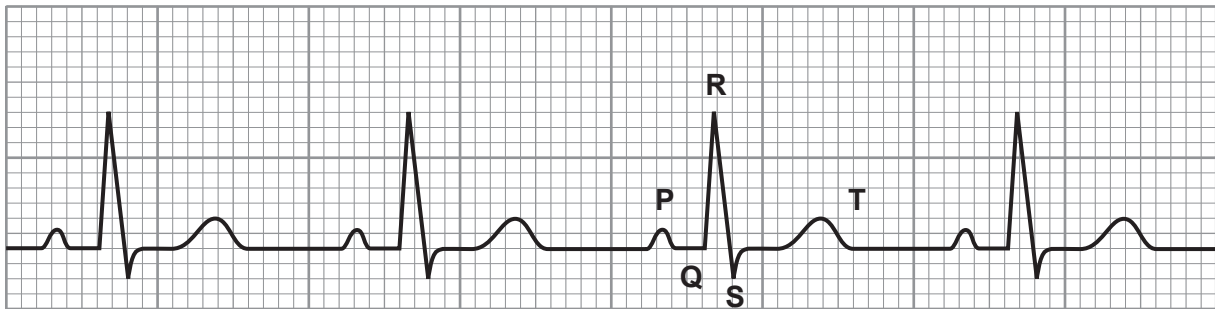
Complete the following table to state what is happening in each region of the ECG.   [3]

Region	What happens in the heart
P	....
QRS	....
T	....

(d) Tachycardia, ventricular fibrillation and bradycardia are heart problems that can be distinguished by an ECG trace. Following the example in *(c)*, sketch ECG traces, on the graph paper below, that you would expect for (i) tachycardia, (ii) ventricular fibrillation and (iii) bradycardia. [3]

(i) Tachycardia
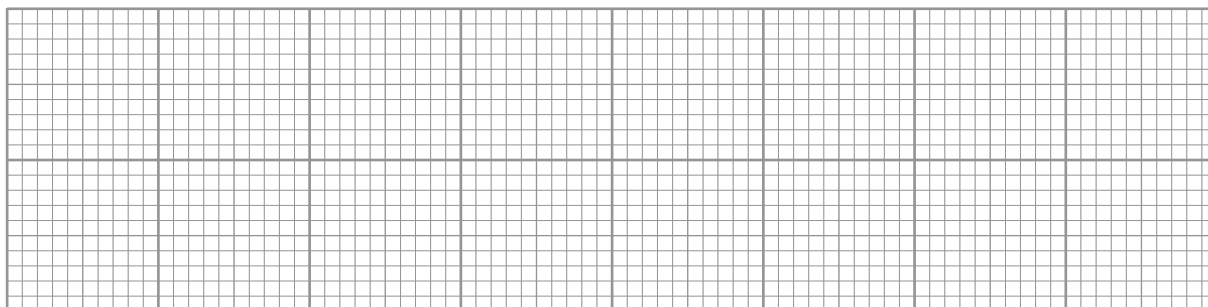
(ii) Ventricular fibrillation
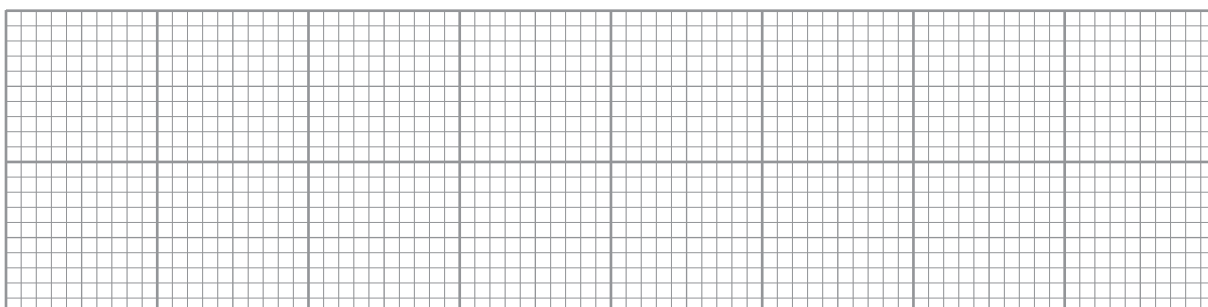
(iii) Bradycardia
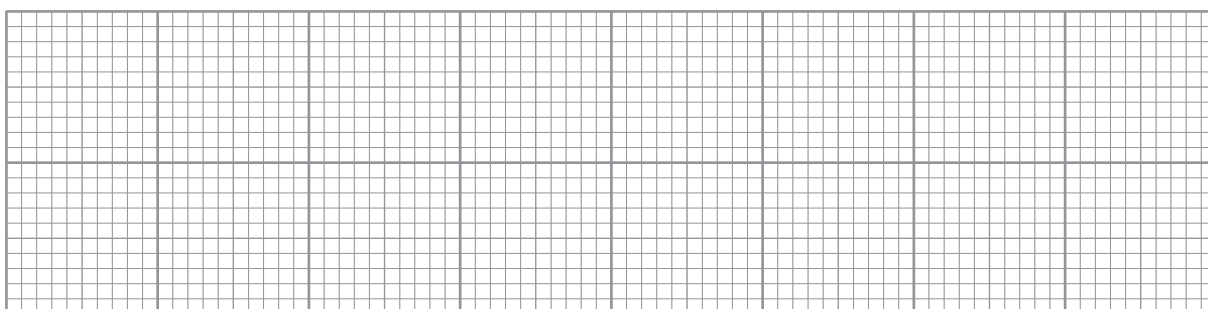
14. Coronary heart disease is a common condition in the UK. In this condition, particular blood vessels can become blocked. One way to treat this condition is to place a stent in the vessels to alleviate the blockage as shown below.
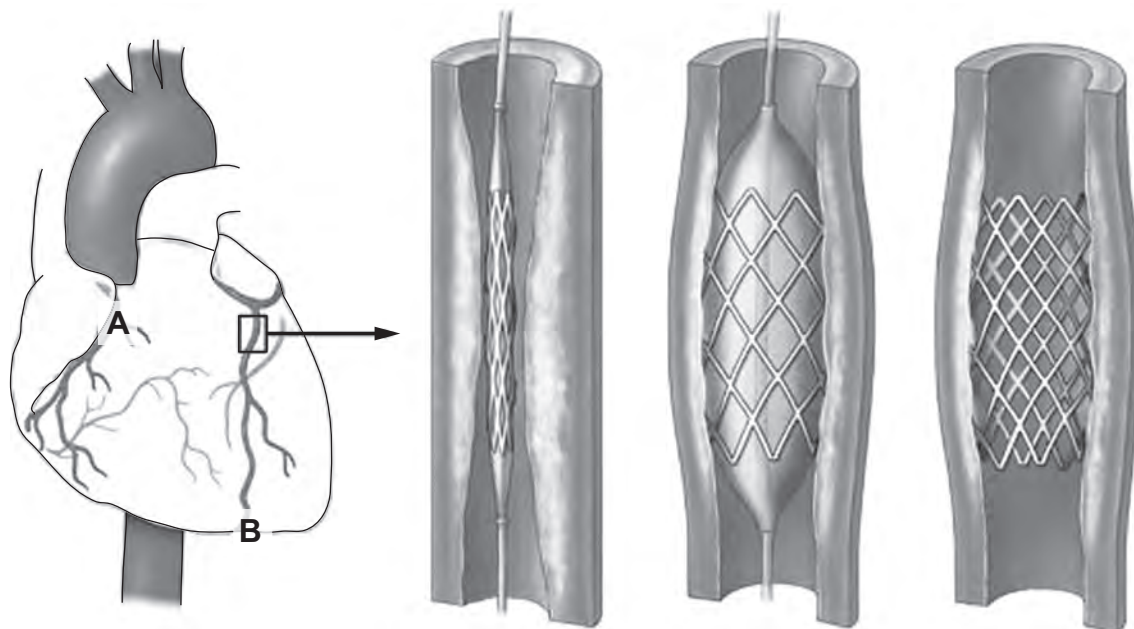
(a) State the name of the blood vessel into which the stents are placed. [1]

....

(b) Explain why the stent is beneficial to the patient. [3]

....

....

....

....

....

(c) Explain why a blockage in region **A** in the diagram is likely to be more serious than a blockage in region **B**. [1]

....

....

(d) High blood pressure is a risk factor for coronary heart disease. It is recommended that blood pressure is regularly monitored to reduce the incidence of coronary heart disease. Describe the standard procedure for taking blood pressure. *You must make reference to the pressure readings that need to be recorded in your procedure.* [4]

....

....

....

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....

....

15. The Welsh Blood Service is responsible for thousands of blood collections each year. The diagram below shows how different blood groups are compatible with each other.

Donor

Type	O-	O+	B-	B+	A-	A+	AB-	AB+
AB+	♦	♦	♦	♦	♦	♦	♦	♦
AB-	♦		♦		♦		♦	
A+	♦	♦			♦	♦		
A-	♦				♦			
B+	♦	♦	♦	♦				
B-	♦		♦					
O+	♦	♦						
O-	♦							

Recipient

♦ = Compatible

(a) (i) Which blood group can be received by the most patients? [1]

....

(ii) Which blood group can be received by the least patients? [1]

....

(b) The Blood Transfusion Service splits blood into its component parts. Complete the table below to show the components of blood and their functions. [4]

Component	Function
erythrocytes	....
....	produces antibodies
thrombocytes	....
....	transport of glucose

(c) During a routine screen a blood donor was found to have a white cell count of $25 \times 10^9 \ dm^{-3}$. Referring to the data sheet on page 28, explain whether the blood from this donor can be used. [2]

....

....

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16. Owen was studying different parts of the circulatory system.

(a) The table shows the maximum and minimum blood pressure in different parts of the circulatory system. Plot this data on the graph paper below. [4]

Area	Right Ventricle	Pulmonary Artery	Lung Capillaries	Pulmonary Vein	Left Ventricle	Aorta	Body Capillaries	Vena Cava
Minimum pressure (mm Hg)	1	10	7	6	1	80	26	9
Maximum pressure (mm Hg)	24	24	8	6	125	128	34	9
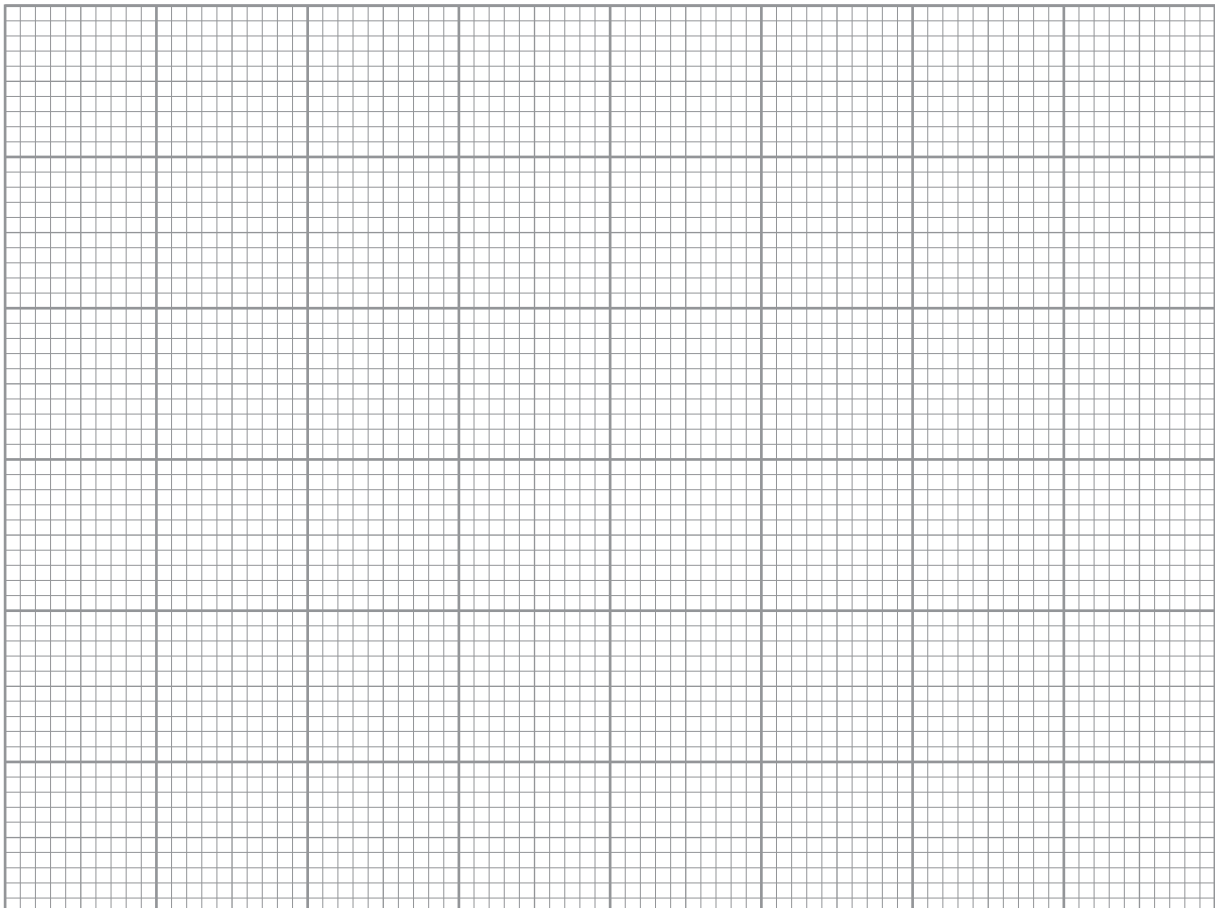
(b) What is the average pressure in the aorta? [1]

Answer: ....

(c) Explain why the pressure is low in the lung capillaries. [1]

....

....

(d) Explain why pressure is higher in the arteries than in the veins. [1]

....

....

(e) Explain how low pressure blood is returned to the heart. [3]

....

....

....

(f) Tissue fluid is formed when liquid is forced out of the capillaries. State **two** ways in which the capillaries are adapted to allow the formation of tissue fluid. [2]

1. ....

....

2. ....

....

17. Jeremy was having a fitness assessment before starting a new job. Part of the fitness assessment involved measuring the ventilation rate.

(a) Outline the mechanism of ventilation in the lungs by completing the table below (the first row has been done for you). [4]

Component	Inspiration	Expiration
External Intercostal muscles	contract	relax
Ribcage		
Diaphragm		
Volume of thorax		
Pressure in thorax		

Jeremy's ventilation rate was measured using a spirometer. The spirometer trace is shown below.
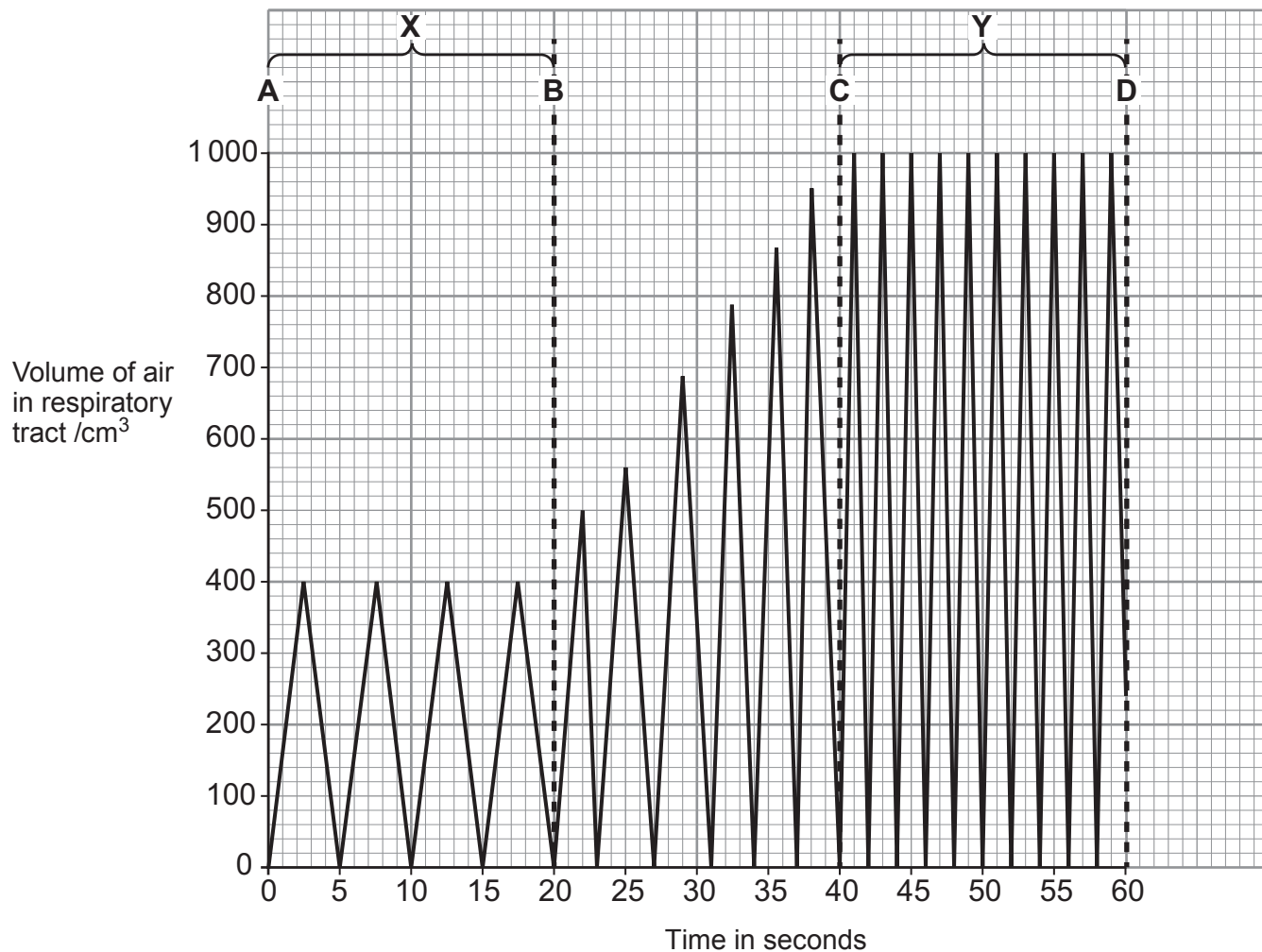
(b) Calculate the volume of air that enters the lungs per minute when Jeremy breathes at the rate shown between **A – B** and **C – D**. [2]

   (i) **A – B**

.... per minute

   (ii) **C – D**

.... per minute

(c) Suggest reasons why the trace is different in the region **X** to **Y**. [2]

....

....

....

....

(d) Suggest why only some of the air breathed in during each breath reaches the gaseous exchange surface. [1]

....

....

(e) Explain why it is important for the reliability of results, that the spirometer remains at a constant temperature. [1]

....

....

END OF PAPER

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 Turn over.

Data Sheet

Table 1 Normal values for some physiological indicators

Indicator	Adult Male	Adult Female
Pulse Rate	60 – 80 beats per minute	60 – 80 beats per minute
BREATHING Rate Tidal volume Vital Capacity Peak Flow	 12 – 15 breaths per minute 400 – 500 cm^3 4.8 dm^3 400 – 600 dm^3 min^{-1}	 12 – 15 breaths per minute 400 – 500 cm^3 3.1 dm^3 400 – 600 dm^3 min^{-1}
BLOOD PRESSURE 20 years old 40 years old	 125/80 mmHg 135/85 mmHg	 123/80 mmHg 133/85 mmHg

Table 2 Reference ranges for some common blood tests

Test	Adult Male	Adult Female
Glucose (Fasting)	4.5 – 6.1 mmol dm^{-3}	4.5 – 6.1 mmol dm^{-3}
Sodium ions	133 – 147 mmol dm^{-3}	133 – 147 mmol dm^{-3}
Potassium ions	3.5 – 5.0 mmol dm^{-3}	3.5 – 5.0 mmol dm^{-3}
Calcium ions	1.15 – 1.29 mmol dm^{-3}	1.15 – 1.29 mmol dm^{-3}
Zinc ions	10 – 17 µmol dm^{-3}	10 – 17 µmol dm^{-3}
RED BLOOD CELLS Haemoglobin Red Cell count	 140 – 180 g dm^{-3} 4.5 – 6.5 × 10^{12} dm^{-3}	 115 – 160 g dm^{-3} 3.8 – 5.8 × 10^{12} dm^{-3}
WHITE BLOOD CELL COUNT	4 – 11 × 10^9 dm^{-3}	4 – 11 × 10^9 dm^{-3}
PLATELET COUNT	150 – 400 × 10^9 dm^{-3}	150 – 400 × 10^9 dm^{-3}