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GCSE (9–1) Physics A (Gateway Science)

J249/04 Paper 4, P5 – P8 and P9 (Higher Tier)

Friday 15 June 2018 – Morning

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Physics A (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- The data sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **28** pages.

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SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

1 Which of the following correctly describes the domestic electricity supply in the UK?

A 230 V a.c. at 50 Hz

B 230 V a.c. at 60 Hz

C 230 V d.c. at 50 Hz

D 230 V d.c. at 60 Hz

Your answer ☐ **[1]**

2 A student measures the time it takes for the sound from a firework to reach the observer.

She takes 3 measurements of the time taken for four different distances, **A**, **B**, **C** and **D**.

Distance	Time taken (s)		
	1st measurement	**2nd measurement**	**3rd measurement**
A	2.16	2.19	2.17
B	1.99	2.02	1.97
C	1.80	1.81	1.89
D	1.69	1.68	1.71

Which distance **A**, **B**, **C** or **D**, has the largest range of values?

Your answer ☐ **[1]**

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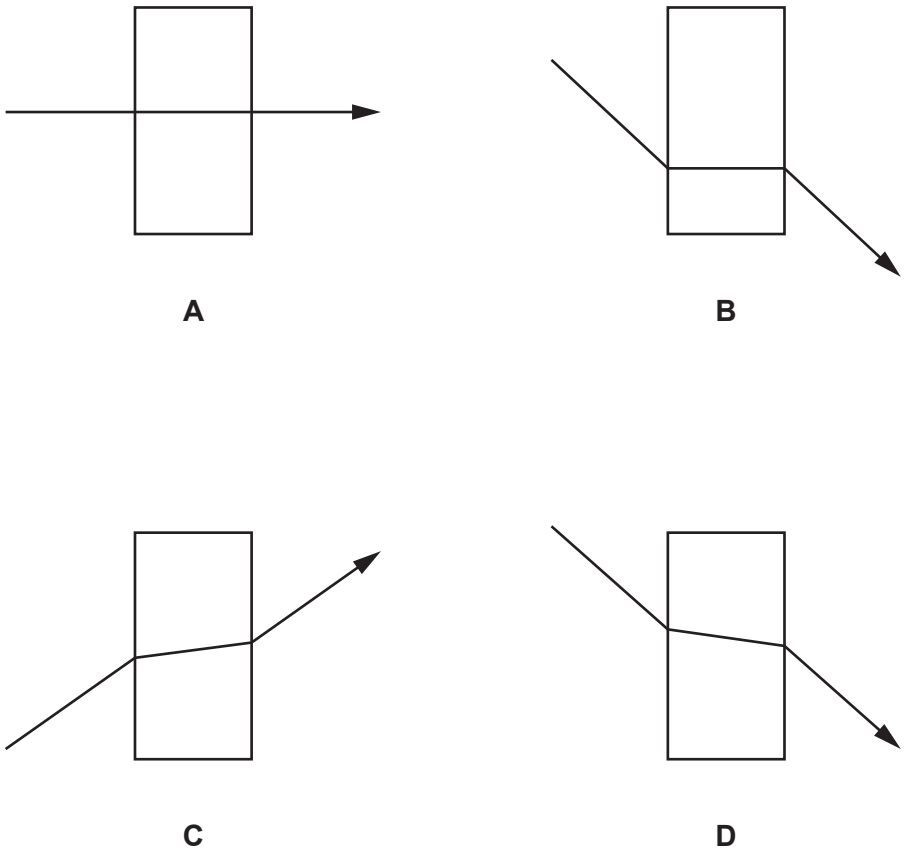
3 Look at the diagrams of a light ray as it passes from air through a glass block.



Which diagram shows an **incorrect** refraction?

Your answer ☐ **[1]**

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4 Beta radiation is used to check the thickness of thin aluminium foil at a factory.

Why is beta radiation used?

A All electromagnetic radiation is reflected by aluminium foil.

B Beta radiation will **not** pass through aluminium foil.

C Beta radiation will partially pass through aluminium foil.

D Beta radiation is reflected by aluminium foil.

Your answer ☐ **[1]**

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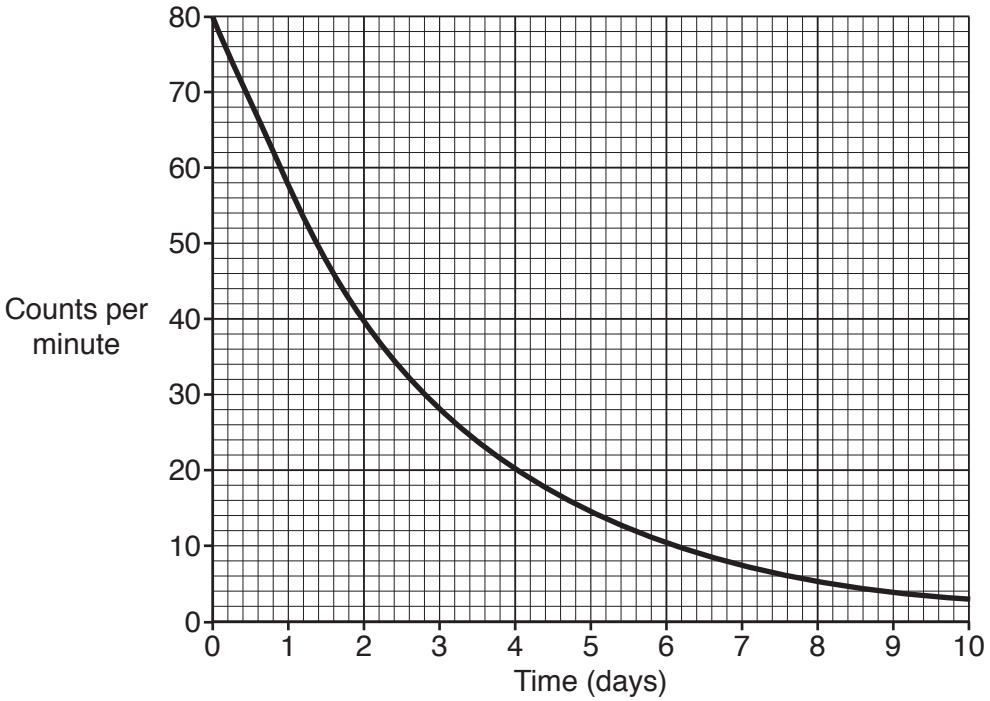
5 A teacher measures the radiation from a radioactive source for 10 days.



What is the half-life of this radioactive source?

A 1 day

B 2 days

C 4 days

D 5 days

Your answer ☐ **[1]**

6 An alpha particle collides with an atom to produce a positive ion.

What happens to the atom for it to become a positive ion?

A It loses an electron from inside the nucleus.

B It loses an electron from outside the nucleus.

C It loses a neutron from inside the nucleus.

D It loses a proton from outside the nucleus.

Your answer ☐ **[1]**

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7 A car accelerates from 0 to 60 mph (miles per hour) in about 9 seconds.

Use the relationship: 1 m/s = 2.24 mph

Estimate the acceleration for this car in m/s^2.

A 1 m/s^2

B 3 m/s^2

C 7 m/s^2

D 15 m/s^2

Your answer ☐ **[1]**

8 A planet moves in a circular orbit around its star.

Which statement is correct?

A The planet travels at changing speed and changing velocity.

B The planet travels at changing speed but constant velocity.

C The planet travels at constant speed and velocity.

D The planet travels at constant speed but changing velocity.

Your answer ☐ **[1]**

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9 A student measures the time it takes for a bicycle to stop in an emergency.

She repeats the measurement to get three results.

The average time for her results is 2.72 s.

The first two results are 2.66 s and 2.60 s.

What is the value of her third result?

A 2.63 s

B 2.66 s

C 2.72 s

D 2.90 s

Your answer ☐ **[1]**

10 A gas fire, used to heat a room, has an input energy transfer of 180 000 J per minute.

The fire has an efficiency of 0.8.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Calculate the useful output energy transfer per minute.

A 600 J

B 2400 J

C 36 000 J

D 144 000 J

Your answer ☐ **[1]**

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11 A pump lifts 500 kg of water to a water tank at the top of a building.

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

Use the equation: Potential energy = Mass × Height × Gravitational field strength

Calculate the height of the water tank.

A 4.8 m

B 48 m

C 240 m

D 480 m

Your answer ☐ **[1]**

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12 An artificial satellite is kept in its low polar orbit by a gravity force from a planet.

The satellite is moved to a higher orbit above the planet.

Which statement is correct about the satellite in this higher orbit?

A The force of gravity is greater and its speed decreases.

B The force of gravity is greater and its speed increases.

C The force of gravity is less and its speed decreases.

D The force of gravity is less and its speed increases.

Your answer ☐ **[1]**

13 Which row **A**, **B**, **C** or **D**, describes what has happened to light that has undergone red shift?

	Wavelength	**Frequency**
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Decreases
D	Increases	Increases

Your answer ☐ **[1]**

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14 An adult on a bicycle travels at 8 m/s on a level road. She sees a hazard and applies her brakes using full force.

Estimate the force of the brakes.

A 5 N

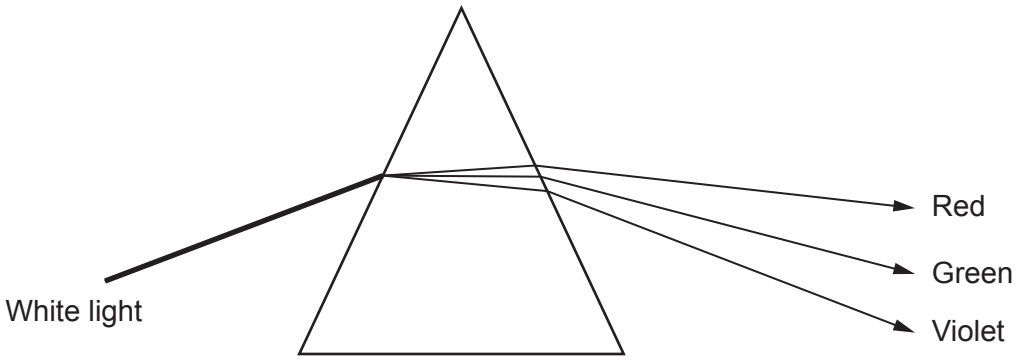
B 50 N

C 500 N

D 5000 N

Your answer ☐ **[1]**

15 Look at the diagram of white light as it passes through a prism.



A spectrum of colours is seen. It ranges from red to violet.

Why does the **violet** light refract **more** than the red light?

A Violet light changes frequency more than red light.

B Violet light has the largest change in speed.

C Violet light has the smallest change in speed.

D Violet light increases its speed in the glass prism.

Your answer ☐ **[1]**

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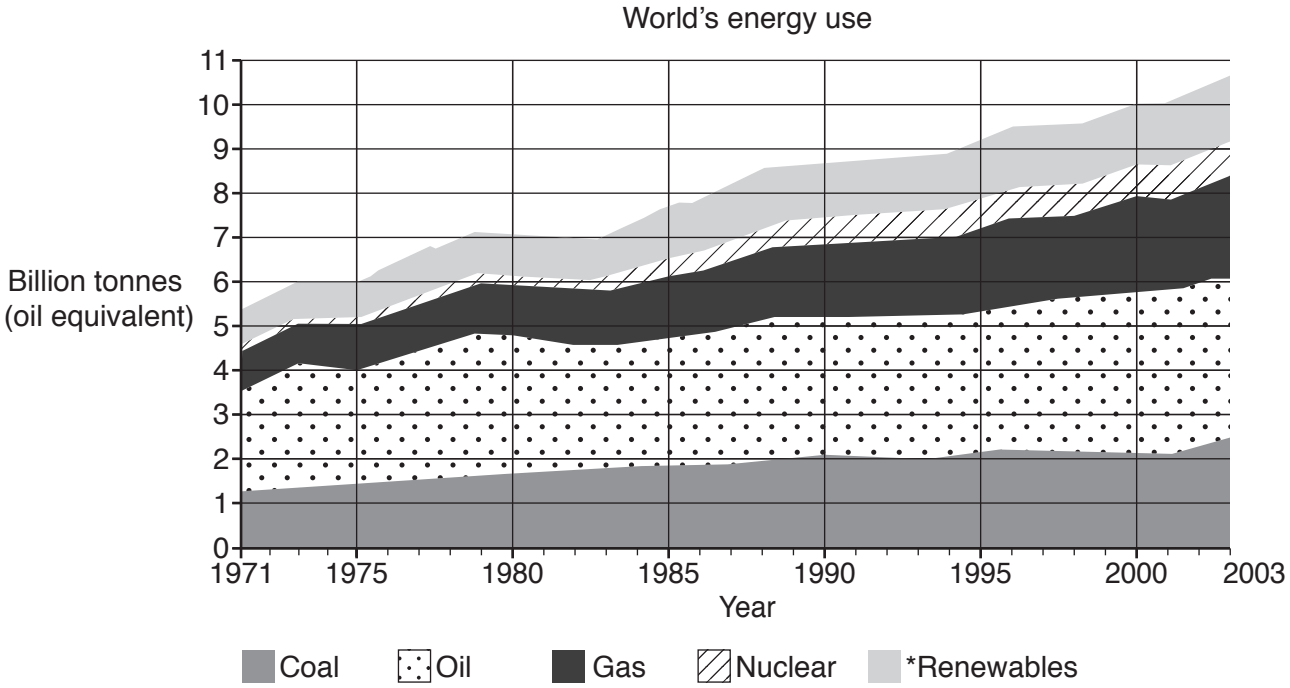
SECTION B

Answer **all** the questions

16 The graph shows how the World's energy use has changed from the year 1971 to the year 2003.

It also shows the amount of different energy sources used.



*Includes hydroelectric, combustible renewables, geothermal, solar, wind, etc.

(a) **(i)** Approximately how much did the total World's energy use increase from the year 1971 to the year 2003?

Answer = ... billion tonnes (oil equivalent) **[1]**

(ii) Which energy source had the **greatest** use in the year 2003?

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

(iii) The total energy use in the year 2003 was 10.6 billion tonnes (oil equivalent).

Approximately what percentage of this amount was due to fossil fuel use?

Answer = ...% **[2]**

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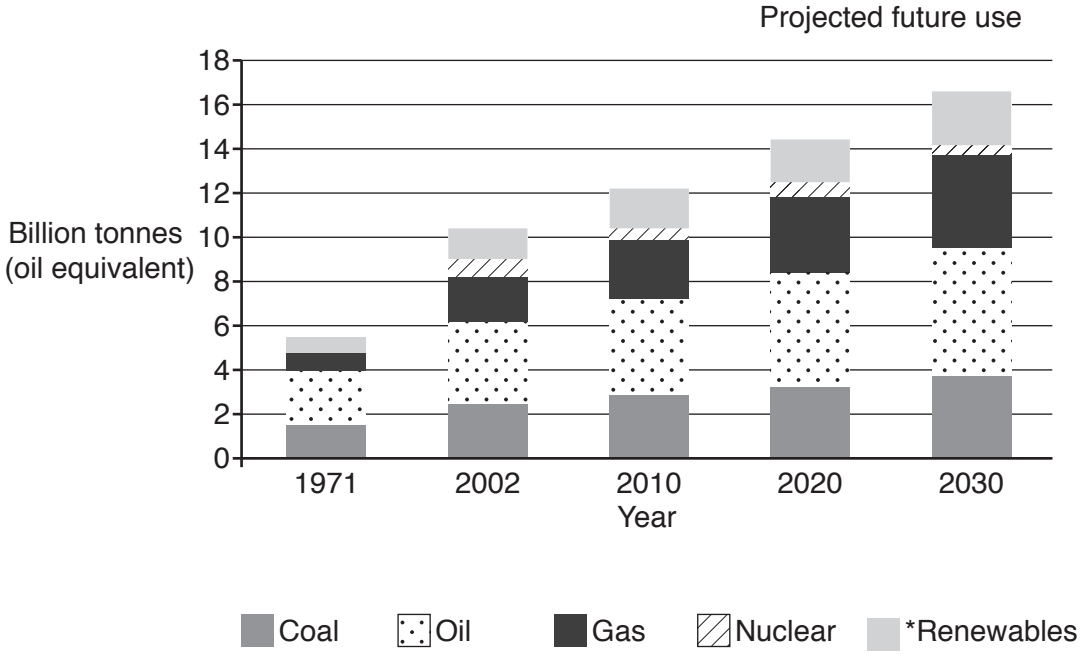
(b) Scientists are researching the World's energy use for the future.

The graph shows some of their research.



*Includes hydroelectric, geothermal, solar, wind etc.

(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1. .....

.....

2. .....

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

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

.....

.....

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

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(c) Power stations in the UK generate electricity at 25 kV a.c.

The voltage is then increased to 400 kV a.c. and distributed by power lines.

(i) Write down the full name of the device used to **increase** the voltage.

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

(ii) Why is it important to increase the voltage in these power lines?

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

(iii) The high voltages across the power lines are reduced to 230 V a.c. for use in the home.

A phone charger changes the 230 V a.c. to a 5 V d.c.

Explain the difference between d.c. and a.c.

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

(d) A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

(i) The domestic wind turbine has an electrical resistance of 23 Ω.

It generates a current of 11 A on a windy day.

Calculate the **power** output in kW of the turbine on this day.

Answer = ... kW **[4]**

(ii) Suggest why the manufacturer gives a range for the power rating of the wind turbine.

.....

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

(iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

.....

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

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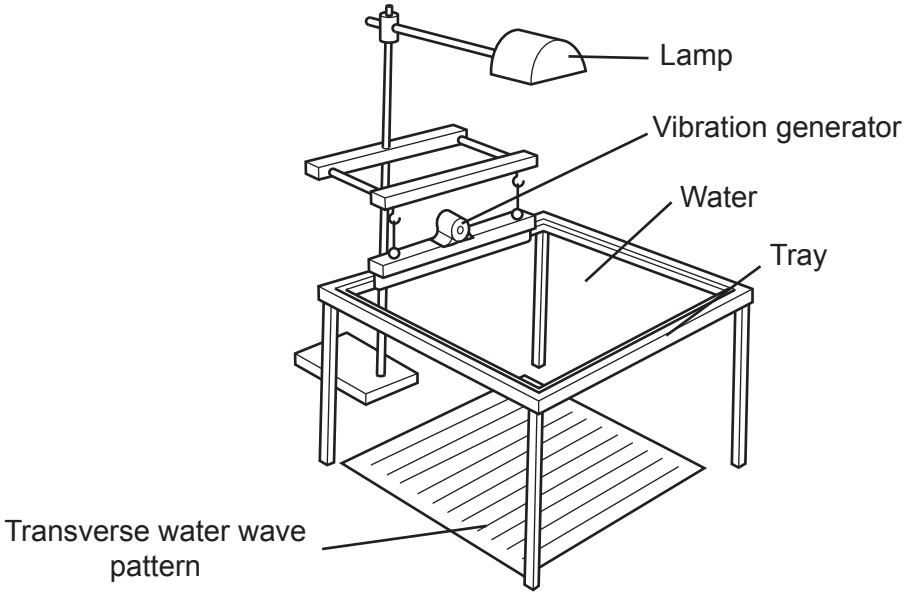
17 A teacher uses water waves in a ripple tank to demonstrate **transverse** waves.



She makes measurements of the water waves.

(a) The frequency of the water waves is 0.5 Hz.

(i) Calculate the number of water waves produced in 5 seconds.

Answer = ... **[1]**

(ii) The teacher **increases** the frequency of the water waves.

Describe what happens to the speed **and** the wavelength of the water waves.

.....

.....

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

(iii) A student tries to describe water waves in the sea.

'The water waves move up and down. The water particles move all the way across the surface of the sea. This means that water moves in the direction of the waves.'

Part of his explanation is **incorrect**.

Write an improved and correct description about water waves in the sea.

.....

.....

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

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(b) A student watches a ball game on the school field.

The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is much greater than the speed of sound.

Describe an experiment which measures the speed of **sound** in air.

In your answer describe the measurements, calculations and procedures needed to gather **accurate** and **reliable** results.

You may draw a diagram as part of your answer.

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..... **[5]**

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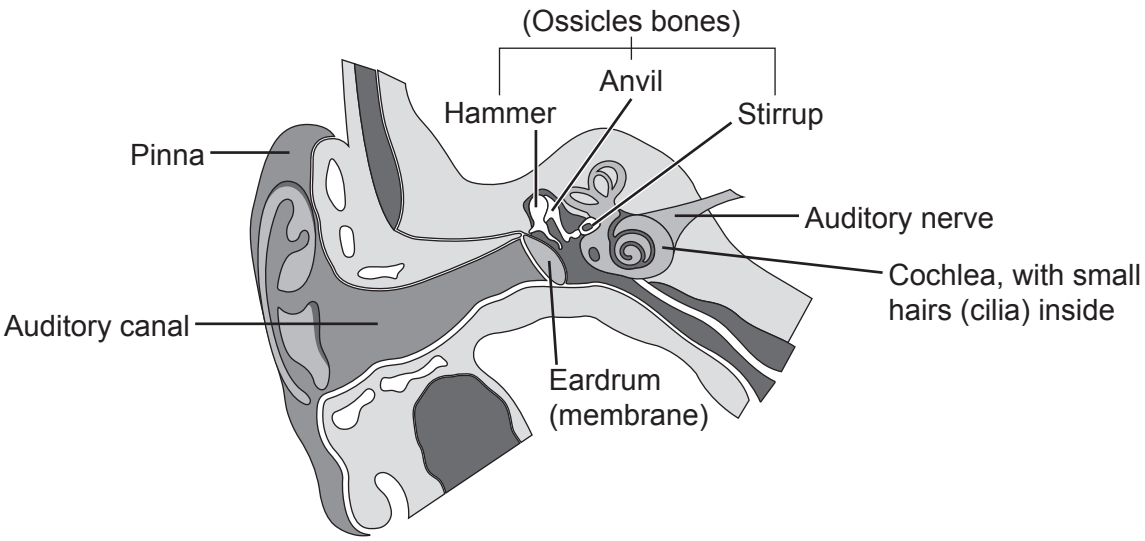
(c) Look at the diagram of a human ear.



Sound wave disturbances, outside the ear, transfer energy to the small hairs (cilia) inside the cochlea.

The cochlea then sends nerve impulses along the auditory nerve to the brain.

Explain how sound wave disturbances in the air outside the ear transfer to the small hairs (cilia) inside the cochlea.

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..... **[3]**

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18 Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 μm				

(a) The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

[2]

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

Answer = ... nm **[3]**

(b) Ultra-violet waves can damage human skin.

Describe the damage caused to human skin by ultra-violet waves.

.....

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

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(c) Sun cream can be used to protect skin from ultra-violet waves. Sun creams have different sun protection factors (SPF).

Look at the information about a bottle of sun cream.

This sun cream has a SPF of 10. If used sensibly it can allow you up to 10 × longer in the Sun without increasing the risk from ultra-violet waves.

(i) A doctor says 'adults should not sunbathe for more than 20 minutes in the midday sunshine when **not** using sun cream'.

If an adult used sun cream with SPF 6, how long could they safely sunbathe for?

Answer = ... minutes **[1]**

(ii) The doctor says that children should always use at least SPF 50 sun cream.

Suggest reasons why.

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

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(d)* Ultrasound and X-rays are used to scan patients in hospital.

Look at the information about these two different waves.

Name	Frequency	Wavelength	Type	Description
Ultrasound	≥ 2 MHz	≤ 1.6×10^{-4} m	Longitudinal	Pressure sound wave
X-rays	≥ 3×10^{16} Hz	≤ 10 nm	Transverse	Electromagnetic wave

Ultrasound and X-rays are used to scan different parts of the patient.

Explain how ultrasound and X-rays are used and evaluate the risks and benefits of using these two different waves to scan patients in hospital.

Use the information in the table in your answer.

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..... **[6]**

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19 Nuclear radiation, such as gamma, is used to irradiate some fresh food to increase its 'shelf-life' and make it last longer.

Fresh herbs and spices are dried and irradiated with gamma rays.

(a) Explain the difference between nuclear **irradiation** and nuclear **contamination**.

.....

.....

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

(b) Explain how the gamma rays can increase the 'shelf-life' of herbs and spices to make them last longer.

.....

.....

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

(c) Some people are worried about eating irradiated food.

Write down two **concerns** they may have about irradiated food.

1. .....

.....

2. .....

.....
[2]

(d) Carbon is a common element. Carbon has two different isotopes called carbon-12 and carbon-14. Both of these isotopes have six protons in the nucleus.

(i) Carbon-14 is radioactive and carbon-12 is **not** radioactive.

Explain why some isotopes are radioactive.

.....

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

(ii) Describe how the nucleus of carbon-12 is different to the nucleus of carbon-14.

.....

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

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(e) Decay equations are used to show the type of emission from different radioactive elements.

(i) Complete the decay equation for **alpha** emission.

$$^{230}_{92}U \rightarrow {}^{4}_{2}He + {}^{.....}_{.....}Th$$ **[2]**

(ii) Complete the decay equation for **beta** emission.

$$^{214}_{83}Bi \rightarrow {}^{.....}_{.....}\beta + {}^{214}_{84}Po$$ **[2]**

(iii) Complete the decay equation for **gamma** emission.

$$^{235}_{.....}U \rightarrow {}^{0}_{0}\gamma + {}^{.....}_{92}U$$ **[2]**

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20 A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	24
E	8	5	6
F	32	30	120

(a) Most of the drivers tested the car on a dry day, on a level road.

Which driver tested the car on an **icy** road?

Driver ..... tested the car on an **icy** road. **[1]**

(b) Which driver has the **quickest** reaction time?

Driver ..... has the **quickest** reaction time.

Calculate their reaction time.

Answer = ... s **[3]**

(c) Give **two** drivers that have the **same** reaction time.

Drivers ..... have the **same** reaction time.

Explain your answer.

.....

.....

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

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(d) Driver **C** travels at 32 m/s on the road and then stops. The car has a mass of 1200 kg.

(i) Show that the **kinetic energy** stored by the car at 32 m/s is 614 000 J.

[2]

(ii) Describe what happens to the kinetic energy of the car as it brakes and stops.

.....

.....

.....

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

(iii) The braking distance of the car is 96 m.

Calculate the **braking force** on the car.

Give your answer to **4** significant figures.

Answer = ... N **[3]**

(e) Driver **B** travels at 16 m/s on the road. The thinking distance is 13 m and the braking distance is 24 m.

Driver **B** now drives the car **uphill** at the same speed on the same road.

How will driving the car **uphill** affect thinking, braking and stopping distances?

The reaction time will stay the same.

Complete the sentences.

The **thinking distance** will ..... .

The **braking distance** will ..... .

The **stopping distance** will ..... .

[2]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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