Questions are for separate science students only

Q1.

A teacher measured the background radiation in a laboratory. **(Physics only)**

(a) Which sources of background radiation are natural and which are man-made?

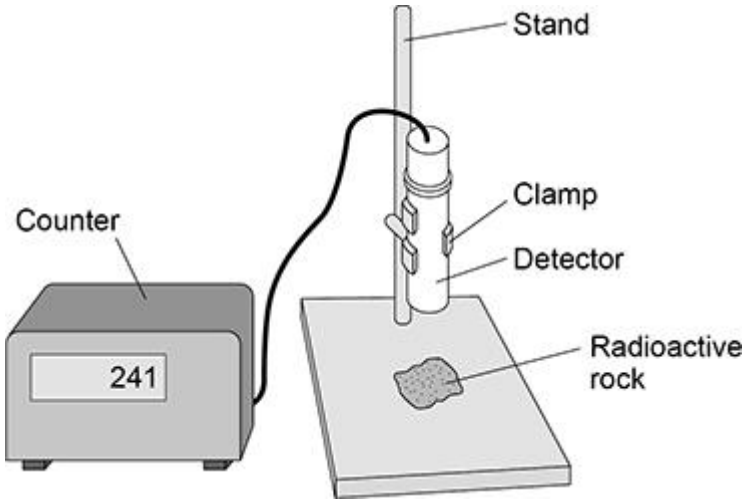
Tick (✓) **one** box in **each** row.

Source of background radiation	**Natural**	**Man-made**
Cosmic rays		
Medical X-rays		
Nuclear accidents		
Radon gas		

(2)

The teacher measured the radiation emitted by four different types of radioactive rock.

The figure below shows the equipment used.



Each radioactive rock was placed below the detector one at a time.

The radiation was recorded as the number of counts in 1 minute.

The experiment was repeated with different materials between each rock and the detector.

The table below shows the results.

	Number of counts in 1 minute		
	No material	One sheet of paper	Thick aluminium sheet
No rock	21	20	22
Rock **A**	450	448	18
Rock **B**	385	387	356
Rock **C**	870	21	20
Rock **D**	620	473	214

(b) Which radioactive rock emitted only alpha radiation?

Give a reason for your answer.

Tick (✓) **one** box.

Rock **A** ☐

Rock **B** ☐

Rock **C** ☐

Rock **D** ☐

Reason _____

_____

(2)

(c) Which radioactive rock emitted only beta radiation?

Give a reason for your answer.

Tick (✓) **one** box.

Rock **A** ☐

Rock **B** ☐

Rock **C** ☐

Rock **D** ☐

Reason _____

_____

(2)

(d) The teacher took safety precautions during the experiment.

Which precaution would prevent the teacher from becoming contaminated by the radioactive rocks?

Tick (✓) **one** box.

Displaying the radiation hazard symbol ☐

Handling the rocks with clean hands ☐

Wearing protective gloves ☐

(1)

(e) What is the activity of each rock after one half-life?

Tick (✓) **one** box.

The activity is a quarter of the original activity. ☐

The activity is half the original activity. ☐

The activity is double the original activity. ☐

The activity is zero. ☐

(1)

(f) How does the activity of a radioactive source affect the risk of harm from the source?

Tick (✓) **one** box.

The smaller the activity, the greater the risk of harm. ☐

The activity does not affect the risk of harm. ☐

The greater the activity, the greater the risk of harm. ☐

(1)

(Total 9 marks)

Q2.

(a) Different radioactive isotopes have different half-lives. **(Physics only)**

What does 'half-life' mean?

Tick (✓) **one** box.

Half the time taken for all of the nuclei in a sample to decay.	☐
The time taken for half the nuclei in a sample to decay.	☐
The time taken for one nucleus to split in half.	☐

(1)

(b) **Table 1** shows the half-life of some different isotopes of carbon.

Table 1

Isotope	Half-life in seconds
Carbon-15	2.45
Carbon-16	0.75
Carbon-17	0.19
Carbon-18	0.09

Which isotope is the least stable?

Tick (✓) **one** box.

Carbon-15	☐
Carbon-16	☐
Carbon-17	☐
Carbon-18	☐

(1)

(c) Workers in nuclear power stations must be aware of nuclear irradiation and radioactive contamination.

Draw **one** line from each term to an example of the term.

Term	Example
Radioactive contamination	Exposure to a beam of gamma rays
	Exposure to ultraviolet radiation from the Sun
Nuclear irradiation	Accidental transfer of plutonium onto a human body
	Using a mobile phone

(2)

(d) Why are workers required to walk across a sticky floor before leaving the nuclear power station?

Tick (✓) **one** box.

- To remove alpha particles from their shoes. ☐
- To remove gamma radiation from their shoes. ☐
- To remove radioactive dust from their shoes. ☐

(1)

(e) The places where people work and live contribute to the nuclear radiation they are exposed to.

Table 2 shows the mean daily dose of radiation caused by two different jobs.

Table 2

Job	Mean daily dose in mSv
Aeroplane pilot	0.072
Nuclear power station worker	0.00050

Calculate the number of days a nuclear power station worker must work before receiving the same dose that an aeroplane pilot receives in one day.

_____

_____

_____

Number of days = _____

(2)

(Total 7 marks)

Q3.

Radioactive isotopes emit different types of nuclear radiation. **(Physics only)**

(a) What does an alpha particle consist of?

Tick (✓) **one** box.

2 protons and 2 electrons ☐

2 protons and 2 neutrons ☐

4 protons ☐

4 neutrons ☐

(1)

(b) What is a beta particle?

Tick (✓) **one** box.

An electron ☐

A neutron ☐

Electromagnetic radiation ☐

(1)

(c) A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

What is the correct equation for this decay?

Tick (✓) **one** box.

$^{85}_{36}Kr + {}^{0}_{-1}e \longrightarrow {}^{85}_{37}Rb$ ☐

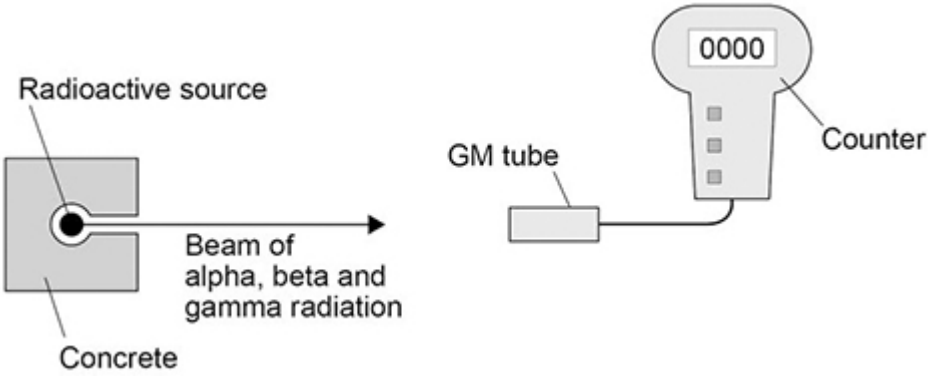
$^{85}_{36}Kr \longrightarrow {}^{85}_{37}Rb + {}^{0}_{-1}e$ ☐

$^{85}_{37}Rb \longrightarrow {}^{85}_{36}Kr + {}^{0}_{-1}e$ ☐

(1)

(d) The figure below shows an experiment to demonstrate how alpha, beta and gamma radiation penetrate different materials.

The experiment takes place in a vacuum.



Three different materials are used:

- a sheet of paper
- a 0.5 cm thick sheet of aluminium
- a 10 cm block of lead.

Each material is placed one at a time between the radioactive source and the GM tube.

The GM tube and counter show whether the material has stopped the radiation.

Complete below table to show how alpha, beta and gamma radiation penetrate the materials in the figure above.

Use the words **Yes** and **No**.

Part of below table has been completed for you.

Type of radiation	**Most radiation is stopped by:**		
	the sheet of paper	**the sheet of aluminium**	**the block of lead**
Alpha			Yes
Beta	No		
Gamma		No	

(3)

(e) Alpha, beta and gamma radiation have different ionising powers.

Draw **one** line from each radiation type to the correct ionising power.

Radiation type	**Ionising power**
Alpha	Zero
Beta	Low
Gamma	Medium
	High

(3)

(f) Some sources of background radiation are natural and other sources are man-made.

Which of the following is a man-made source of background radiation?

Tick (✓) **one** box.

Cosmic rays ☐

Nuclear accidents ☐

Rocks ☐

(1)

(g) The average background radiation dose per year in the UK is 2.0 millisieverts.

A dental X-ray gives a patient a radiation dose of 0.005 millisieverts.

Calculate how many dental X-rays would be the same as the average background radiation dose per year.

_____

_____

_____

Number of dental X-rays = _____

(2)

(Total 12 marks)