Grove Academy

National 5 Physics

Radiation

Problems

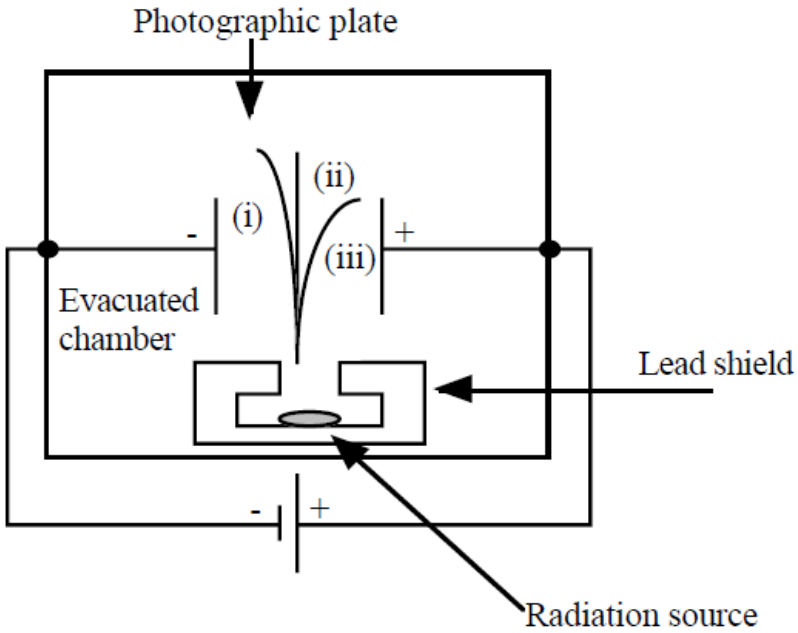
Nuclear radiation

1. Using a diagram, describe the simple model of an atom.

2. Copy and complete the following table.

Type	Nature	Charge	Absorbed by
α			
β			
γ			

3. In an experiment, radiation from a sample of radium is passed through an electric field.
It is split into three different components (as shown in the diagram below).



   a) Name the radiations labelled (i), (ii) and (iii).
   b) Which radiation is deflected most by the electrostatic field?
   c) What is the function of the lead shield?
   d) Why is the experiment carried out in an evacuated chamber?
   e) What is the purpose of the photographic film?

4. The brain can suffer from a type of cancer called glioblastoma. This form of cancer is treated by injecting the patient with boron-10 and then irradiating the patient with neutrons. This produces one lithium particle and one alpha particle.
   a) Explain how the alpha particle could help with the glioblastoma.
   b) Why could this process be dangerous for healthy tissue?

5. The table below represents data obtained from an absorption experiment using three separate radioactive sources (background count = 20 counts per minute).

	Count rate (per minute)		
Absorber	Source A	Source B	Source C
air	3125	900	420
paper	3130	880	38
1mm aluminium	3000	380	20
10mm lead	1900	20	21

   a) What effect did paper have on each of the three sources?
   b) Use the data in the table to identify the type of radiation from each source.

6. Describe what is meant by the term ionisation.

Dosimetry

7. State what meant by the term ‘activity’ of a radioactive material.

8. If there are 5×10^7 decays from a particular source in 25s, state the activity.

9. A sample of rock has an activity of 50·0 Bq. Calculate the number of nuclei that decay every hour.

10. State 3 factors that can affect the risk of biological harm of radiation.

11. Give 2 ways to reduce the risk of biological harm of radiation on a person.

12. The unit for absorbed dose is the gray, Gy. Explain this term and give another unit for absorbed dose.

13. State what background radiation is and from where it originates from.

14. If radiation with 20 J of energy is absorbed by a 2 kg organ of the body, calculate the absorbed dose.

15. If a 90 kg man had his whole body irradiated with gamma radiation and his absorbed dose was 0.11 Gy, calculate how much energy has he received.

16. State what the radiation weighting factor for each radiation gives us an indication of.

17. A worker spends some time in an area where she is exposed to the following radiations:

thermal neutrons = 8 mGy	radiation weighting factor = 3
fast neutrons = 40 μGy	radiation weighting factor = 10

    a) Calculate the equivalent dose for each type of neutron.
    b) Calculate the total equivalent dose for the exposure.

18. In the course of his work an industrial worker receives an equivalent dose of 200 μSv. Determine the absorbed dose if he is exposed to alpha particles, with a radiation weighting factor of 20.

19. An unknown radioactive material has an absorbed dose of 500 μGy and gives an equivalent dose of 1 mSv. Calculate the radiation weighting factor of the material.

20. Alpha particles produce an equivalent dose of 50 mSv from an absorbed dose of 2.5mGy.
    a) Calculate the radiation weighting factor of the alpha particles.
    b) Explain why exposure to alpha radiation increases the risk of cancer more than X-rays or gamma rays.

21. A physics teacher uses an alpha source in an experimental demonstration on absorption. The teacher receives an absorbed dose of 40 μGy in 8 hours. Calculate her equivalent dose rate if the radiation weighting factor for alpha radiation is 20.

22. State what the average annual background radiation is in the UK.

23. State the annual effective equivalent dose and exposure safety limits for the general public and for workers in the radiation industry.

Half-life

1. Explain what is meant by the term ‘half-life’.

2. The following data was obtained from an experiment to determine the half-life of a radioactive source:

Time (mins)	0	20	40	60	90
Count rate (number of counts per minute)	100	60	45	30	20

   a) Describe how you could carry out this experiment.
   b) Determine the half-life of the radioactive source.

3. A radioactive material has a half-life of 5 days. If the original activity was 120 Bq, what will the activity be after 20 days?

4. If a radioactive material has a half-life of 600 years, how long will it take for the activity to fall to 10 kBq if the original activity was 80 kBq?

5. A radioactive substance has a half-life of 4 hours. What fraction of the original activity will be remaining after one day?

6. The activity of a source starts at 100 MBq. After 20 days it has fallen to 6.25 MBq. Calculate the half-life of the source.

7. What is the half-life of a radioactive source if the activity falls from 4000 kBq to 125 kBq in 40 days?

8. The half-life of Cobalt-60 is 5 years. If the source, 25 years ago, had an activity of 500kBq, what would be the activity now?

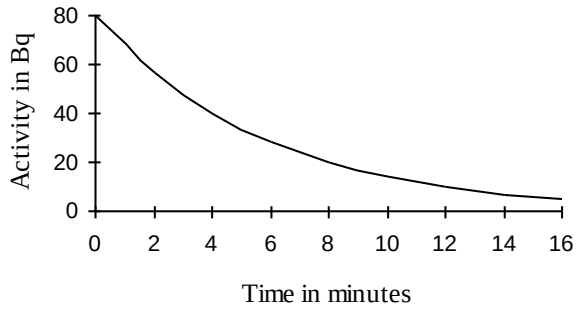
9. The table of results below show how the count rate for a radioactive source varies with time. The background count was 60 counts per minute.

Time (mins)	0	5	10	15	20
Count rate (number of counts per minute)	1660	1100	750	510	350

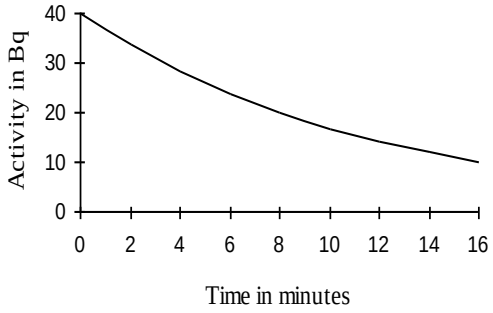
   a) Plot a graph of corrected count rate against time.
   b) Determine the half-life of the source.

10. A medical physicist set up an experiment to check the half-life of some radioactive samples to be used as radioactive tracers in kidneys. He plotted the results from each experiment on graphs shown below.

Source A



Source B



Use the graphs to estimate the half-life of each radioactive source.

11. The background radiation in a science lab is 14 counts per minute. When Alan and David set about calculating the half-life of a radioactive source they found that its activity fell from 94 counts per minute to 24 counts per minute in 3 hours. Use their results to calculate the half-life of the source.

12. A radioactive source has an activity of 375 Bq and this drops to 60 Bq in 9 days. If the background radiation is 15 Bq, calculate the half-life of the source.

13. Describe the safety procedures when handling radioactive materials.

14. Describe how film badges monitor exposure to radiation.

15. Explain what is meant by a radioactive tracer.

16. Give a use for tracers in medicine, agriculture and industry.

17. Explain which type of radiation is used as a tracer.

Fission and Fusion

1. Explain what is meant by the term ‘fission’.

2. Nuclear fission can be either **spontaneous** or **induced**. Explain the difference between these two processes.

3. a) State what is meant by a chain reaction.
   b) Explain how a chain reaction works in a nuclear reactor and a nuclear bomb.

4. Give some advantages and disadvantages of using nuclear fuel to generate electricity.

5. a) Give a reason why radioactive waste worries many people.
   b) Describe the problems with the storage and disposal of radioactive waste.

6. Explain what is meant by the term ‘fusion’.

7. Nuclear fusion reactors are currently only at the experimental stage.

   a) Give a major difficulty associated with the building of a fusion reactor.
   b) Give an advantage that fusion reactors could have over fission reactors.