Figure 4 shows a Geiger-Müller (GM) tube used for measuring radioactivity.

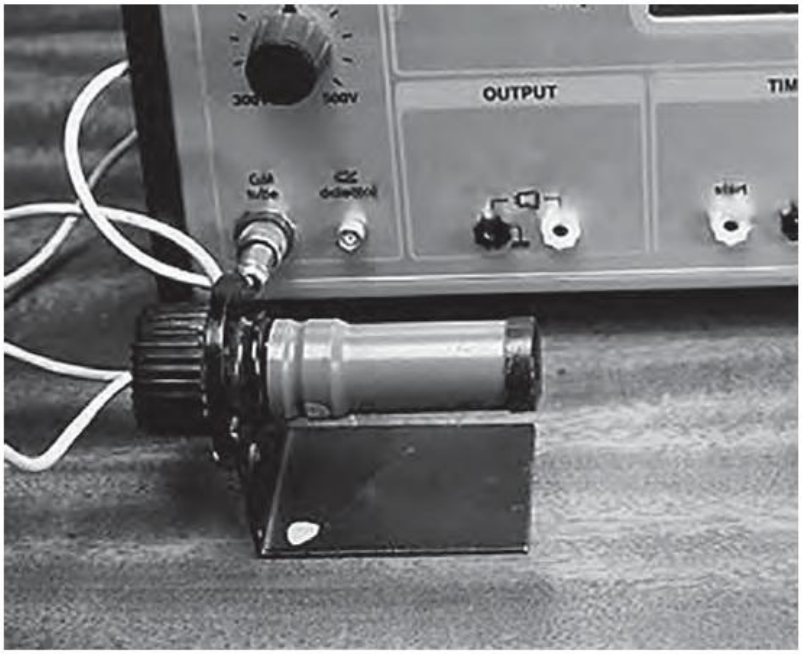




**Figure 4**

(a) Describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks.

**(4)**

(b) A hospital uses a radioactive isotope with a half-life of 6 hours.

A technician measures a count rate of 80 counts per minute (cpm) from this isotope.

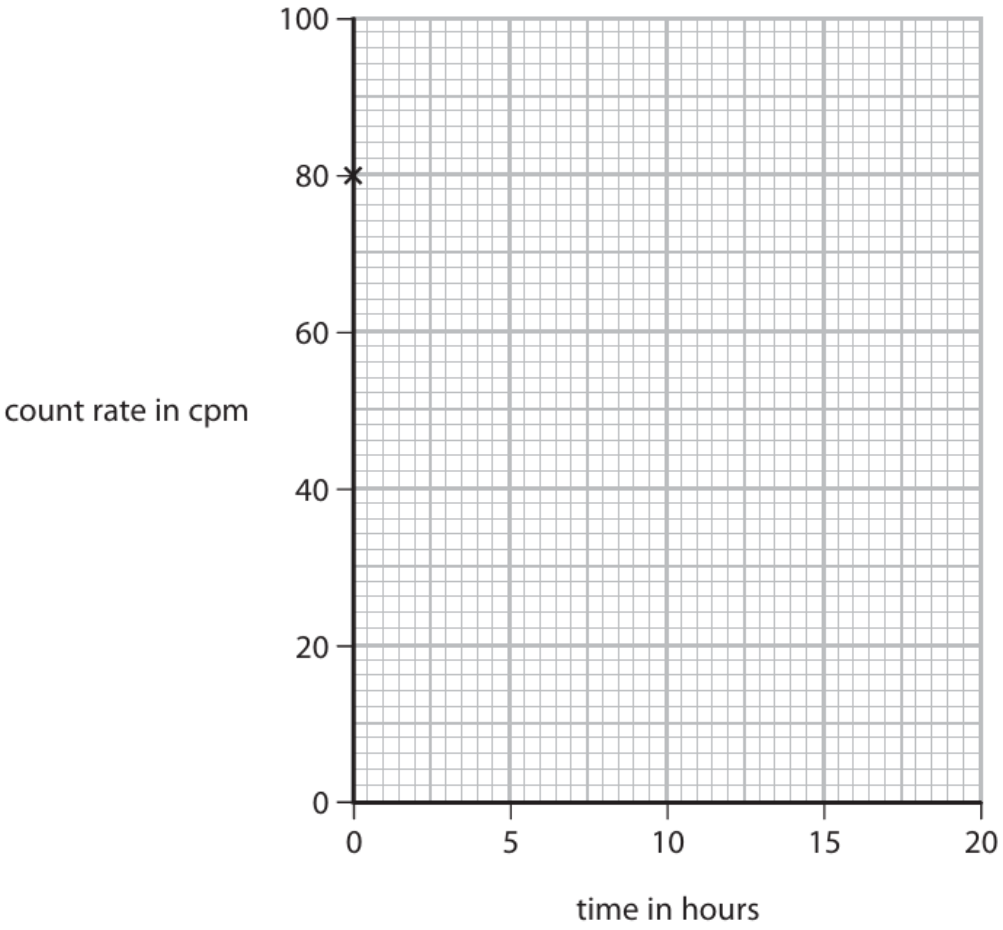


**Figure 5**

Complete the graph on Figure 5, as accurately as possible, to show how the count-rate from this isotope will change from the time of the first measurement.

The first point is already drawn in Figure 5.

**(3)**

(c) One radioactive source used in hospitals is technetium (Tc).

Technetium is produced from the radioactive decay of molybdenum (Mo).

Complete the following nuclear equation.

**(1)**

$$^{99}_{42}\text{Mo} \rightarrow \text{.....} \text{Tc} + {}^{0}_{-1}\beta$$

**(Total for Question 3 = 8 marks)**

| WWW | EBI… | DIRT Task |
|---|---|---|
| You can describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks. | … you could describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks. | Define:<br>a) Radioactive decay<br>b) GM tube<br>c) Background radiation<br>Memorise the definitions.<br>What equipment is needed to detect radiation from the rocks?<br>What should the teacher do before testing the rocks to make the results accurate?<br>How should the teacher measure the count-rate from **Rock A**?<br>How should the teacher measure the count-rate from **Rock B**?<br>What must be kept the same to make the comparison fair?<br>How can the teacher use the measurements to compare the two rocks? |
| You can complete the graph to show how the count-rate from this isotope will change from the time of the first measurement. | … you could complete the graph to show how the count-rate from this isotope will change from the time of the first measurement. | Define – half-life.<br>Memorise the definition.<br>Draw a graph to show how the activity of a radioactive substance changes over time. |
| You can complete the nuclear equation. | … you could complete the nuclear equation. | State the law of conservation of mass number.<br>State the law of conservation of atomic/ charge number.<br>What happens during alpha decay?<br>What happens during beta minus decay? |
| | ***Extension:*** | *Compare and contrast alpha decay and beta-plus decay.*<br>*HINT:*<br>What particle is emitted during **alpha decay**?<br>What particle is emitted during **beta-plus decay**?<br>How does the **mass number** change in each type of decay?<br>How does the **atomic number** change in each type of decay?<br>Where do these types of decay commonly occur (e.g., in what kind of nuclei)?<br>Write one **similarity** and one **difference** between alpha decay and beta-plus decay. |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(a)** | a description that combines 4 points from the following:<br>1. put rock(s) in front of/near tube (1)<br>2. measure (count rate) separately for the two different rocks (1)<br>3. measure each count for the same time period (1)<br>4. keep source-detector distance the same for both rocks (1)<br>5. take (into account)/ measure background count (1)<br>6. repeat readings and take average(s) (1) | not "in" tube<br>keep rocks apart | **(4)**<br>AO 2 2 |

| Question Number | Answer | | Mark |
|---|---|---|---|
| **3(b)** | • point after first half-life 6, 40 (1)<br>• point after second half-life 12, 20 (1)<br>• point after third half-life 18, 10 (1) | within 1 small square by eye<br><br>smooth curve starting at 80, with a decreasing gradient passing through one correct half-life point scores 2 marks<br><br>smooth curve starting at 80, with a decreasing gradient passing through two correct half-life points scores 3 marks<br><br>**if no other mark scored**<br><br>smooth curve showing decreasing gradient but not going through any correct points scores 1 mark | **(3)**<br>AO 3 1a |

| Question Number | Answer | Mark |
|---|---|---|
| **3(c)** | an answer containing both of the following numbers in the correct places (1)<br><br>$^{99}_{43}Tc$ | **(1)**<br>AO 2 1 |