

24.3 PET scanning

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS positron 正电子 • tracer 示踪剂 • antiparticle 反粒子 • photon 光子
• momentum 动量

Objective

Build the skills to answer exam questions on **PET scanning**.

You must be able to:

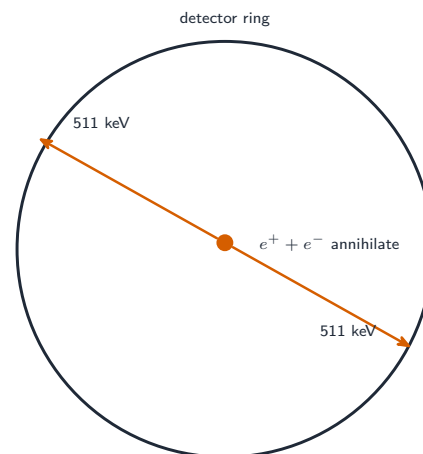
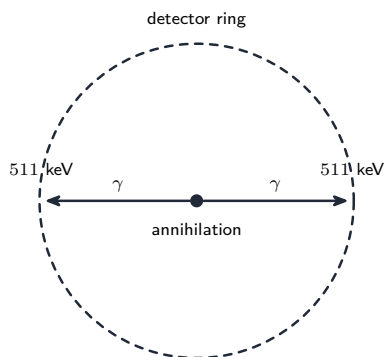
- explain the **tracer** and **annihilation**
- calculate the **annihilation photon energy**
- explain how the photons locate the event

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Tracer and annihilation

A **tracer** is a radioactive substance put into the body and taken up by the tissue studied. In **PET** it is a β^+ (**positron**) **emitter**. The positron meets an **electron** and they **annihilate**:



two photons, opposite directions — the coincidence fixes the line

PET detects annihilation photons

Mass-energy and **momentum** are conserved. Since the total momentum is $\sim$ zero, **two** γ photons go in **opposite directions**, each of energy $m_e c^2 = 511 \text{ keV}$.

Detecting **both** photons (and their arrival times) lets the scanner work out the **line** they came from, building an image of tracer concentration.

2 Practice

Now apply the methods above.

2.1 State what a **tracer** is. [1]

2.2 State the type of **decay** a PET tracer undergoes. [1]

2.3 Explain what **annihilation** is. [2]

2.4 State the **energy** of each annihilation photon. [1]

3 Exam-style questions

3.1 In PET, the two γ photons from an annihilation travel: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A in the same direction
 - B in opposite directions
 - C at right angles
 - D in random directions

3.2 Calculate the **energy** of each γ photon produced when an electron and positron annihilate. ($m_e = 9.11 \times 10^{-31}$ kg.) [3]

3.3 Explain why **two** photons are produced (not one), travelling in opposite directions.[2]

3.4 Explain how detecting the two photons helps locate the **annihilation** event. [2]