



# **GCSE Physics**

## **Half Life and Uses**

### **Mark Scheme**

**Time available: 55 minutes**

**Marks available: 50 marks**

**[www.accesstuition.com](http://www.accesstuition.com)**

## Mark schemes

- 1.** (a) B  
*reason only scores if B is chosen* 1
- americium has an atomic number of 95  
*allow proton number for atomic number*  
*allow B has a different atomic number*  
*allow B has an atomic number of 94* 1
- (b) 430 (years)  
*allow an answer between 420 and 440 (years)* 1
- (c) 430 (years)  
**or**  
their answer to part **(b)**  
*allow an answer between 420 and 440 (years)* 1
- [4]**
- 2.** (a)  $\text{count rate} = \frac{819}{60}$  1
- count rate = 13.65 1
- corrected count rate = 13.35 (per second)  
*allow an answer of*  
*background =  $0.30 \times 60$*   
*= 18 (per minute)*  
*corrected count rate*  
*=  $819 - 18$*   
*corrected count rate*  
*= 801 per minute* 1
- an answer of 13.35 (per second) scores 3 marks*  
*an answer of 13.95 (per second) scores 2 marks*  
*an answer of 801 (per second) scores 2 marks*
- (b) activity =  $1250 \times 180$  1
- activity = 225 000 (Bq) 1
- an answer of 225 000 (Bq) scores 2 marks*

- (c) yearly dose =  $0.003 \times 365$   
*allow yearly dose = 1.095 (mSv)*

1

which is  $\ll 100$  (mSv)

**or**

(well) below the lowest dose with evidence of causing cancer / harm

1

- (d) people are able to compare a radiation risk / dose / hazard to the radiation dose from (eating) bananas

1

[8]

3.

- (a) smoke absorbs / stops alpha radiation

*allow alpha particles for alpha radiation*

*alpha radiation does not reach the detector is insufficient*

1

- (b) alpha radiation is not very penetrating

*allow alpha particles for alpha radiation*

**or**

alpha radiation does not penetrate skin

*allow alpha radiation does not travel very far (in air)*

1

- (c) beta and gamma radiation will penetrate smoke

*allow beta and gamma radiation will not be stopped by smoke*

1

no change (in the count rate) would be detected

*allow the change detected (in the count rate) would be too small*

1

- (d) (a long half-life means) the count rate is (approximately) constant

*allow activity of source is (approximately) constant*

**or**

a short half-life means the count rate decreases quickly

1

until 1.3 half-lives the count rate is above 80 per second

*allow after 1.3 half-lives the count rate is below 80 per second*

**or**

until 1.3 half-lives the count rate is above the threshold for the smoke alarm to be activated

**or**

after 1.3 half-lives the smoke alarm will be activated all the time

*so don't have to replace source or smoke detector is insufficient*

1

(e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3-4

**Level 1:** Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

1-2

**No relevant content**

0

**Indicative content**

- short half-life or half-life of a few hours
- (short half-life means) less damage to cells / tissues / organs / body
- low ionising power
- (low ionising power means) less damage to cells / tissues / organs / body
- highly penetrating
- (highly penetrating means) it can be detected outside the body
- emits gamma radiation

[10]

4.

(a) cannot predict which dice / atom will 'decay'  
*accept answers given in terms of 'roll a 6'*

1

cannot predict when a dice / atom will 'decay'

1

(b) 3.6 to 3.7 (rolls)  
*allow 1 mark for attempt to read graph when number of dice = 50*

2

(c) 90

1

(d) uranium

1

(e) beta

1

proton number has gone up (as neutron decays to proton and  $e^-$ )

1

(f) prevents contamination

**or**

prevents transfer of radioactive material to teacher's hands

1

which would cause damage / irradiation over a longer time period.

1

[10]

5. (a) (same) number of protons  
*same atomic number is insufficient* 1
- (b) (i) nuclei split  
*do **not** accept atom for nuclei / nucleus* 1
- (ii) (nuclear) reactor 1
- (c) beta 1
- any **one** from:
- atomic / proton number increases (by 1)  
*accept atomic / proton number changes by 1*
  - number of neutrons decreases / changes by 1
  - mass number does not change  
*(total) number of protons and neutrons does not change*
  - a neutron becomes a proton 1
- (d) (average) time taken for number of nuclei to halve  
**or**  
(average) time taken for count-rate / activity to halve 1
- (e) (i) 6.2 (days)  
*Accept 6.2 to 6.3 inclusive*  
*allow 1 mark for correctly calculating number remaining as 20 000*  
**or**  
*allow 1 mark for number of*  
*80 000 plus correct use of the graph (gives an answer of 0.8 days)* 2
- (ii) radiation causes ionisation  
*allow radiation can be ionising* 1
- that may then harm / kill healthy cells  
*accept specific examples of harm, eg alter DNA / cause cancer* 1
- (iii) benefit (of diagnosis / treatment) greater than risk (of radiation)  
*accept may be the only procedure available* 1
- [11]
6. (a) protons, electrons  
*both required, either order* 1

neutrons

1

electron, nucleus

*both required, this order*

1

(b) 2.7 (days)

*allow 1 mark for showing correct use of the graph*

2

(c) put source into water at **one** point on bank

*accept the idea of testing different parts of the river bank at different times*

1

see if radiation is detected in polluted area

*accept idea of tracing*

**or**

put source into water at three points on bank (1)

see if radiation is detected downstream of factory **or** farmland **or** sewage treatment works (1)

1

**[7]**