AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.4.3 HAZARDS AND USES OF RADIOACTIVE EMISSIONS AND OF BACKGROUND RADIATION (PACK 2)

SCORE	PERCENTAGE
/119	%

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Q1.

(i) photographic film / paper

accept X-ray film

1

(ii) (when developed) the film is darker

must have a comparison

1

(iii) to prevent them receiving / being exposed to too much radiation **or** so they know how much radiation they have been exposed to

accept if he gets too much radiation there may be something wrong with the plant

*any statement making reference to a need for preventive or corrective action gains **1** mark*

*an isolated statement of fact of the effect of radiation gains **0** marks*

1

[3]

Q2.

(i) radon (gas)

*do **not** accept gas*

1

(ii) background

1

[2]

Q3.

(a) all points correctly plotted

tolerance ± $\frac{1}{2}$ square on y axis only

*allow **1** mark for 3 correctly plotted points*

2

attempt made to draw a smooth curve

*do **not** accept dot-to-dot line*

1

(b) (i) 3 days $\pm$ 0.2
or any value correctly obtained using their graph line

if no line drawn in (a), answer must be exactly 3

1

(ii) 3 days or their (b)(i)

1

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(c) radon-222

*accept radon **or** 222*
accept alpha or 3.8
correct isotope required for reason to score

1

has the shortest <u>half-life</u>

accept the others have longer <u>half-lives</u>

1

[7]

Q4.

(i) any **one** from

cosmic rays

rocks

food

air

1

(ii) any **one** from

medical

nuclear power stations

nuclear weapons testing

food

***but** do **not** accept food in both (1) and (ii)*

1

[2]

Q5.

(a) X emits beta

accept β

1

Y emits alpha, beta, gamma

must have all three accept α, β, γ

1

(b) gamma

accept beta and gamma
any mention of alpha loses first mark

1

radiation can penetrate (the plastic)

1

kills bacteria **or** microbes **or** micro-organisms **or** viruses

***not** germs*

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1

[5]

Q6.

(i) radiation (received by the body) due to our environment

__not__ naturally occurring radiation
accept radiation all around us
accept radiation that is always there

1

(ii) larger than average dose of <u>cosmic rays</u>

must have idea of comparison

1

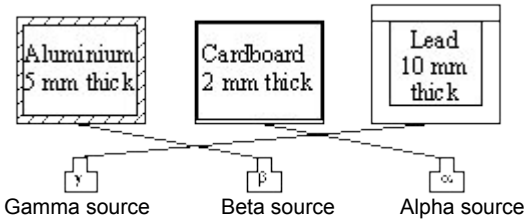
when flying less air to absorb **or** shield from radiation

1

[3]

Q7.

(a) all **3** correct



allow __1__ mark for __one or two__ possible links
no marks for more than one line from a source or to a box

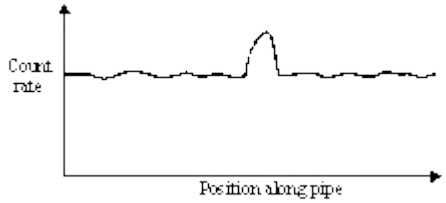
2

(b) (i) geiger-müller (tube)

accept G-M (tube)
accept geiger tube or geiger counter

1

(ii) steady line rising then falling at leak



must be one peak only

1

(c) (i) can penetrate (skull **or** head)

accept goes through body
accept most penetrating
do __not__ accept strongest
do __not__ accept can penetrate skin

1

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(ii) cancer cells receive full dose **or** more radiation

accept healthy cells not damaged

1

healthy **or** other cells receive low dose only

*do **not** accept it is safer*

1

(iii) any **two** properties from:

- travel through a vacuum
  *do **not** accept they are an energy form*
- travel at same speed in air **or** vacuum
- can be diffracted
  treat as a list ignoring 1 and 2
- can be reflected
- can be refracted
- travel in straight lines
- all transverse
- can be polarised
- transfer energy

2

[9]

Q8.

(a) (i) an unstable nucleus **or** atom **or** isotope

accept nucleus has too much energy

an atom **or** nucleus **or** isotope which decays

1

(ii) sodium – 24

if Mg-27 chosen can get third mark if explained

sufficiently long to allow circulation and take readings

short enough that levels of radiation in the body will become insignificant quickly

3

(iii) each axis is given a linear scale

1

curve concave to axes drawn

1

(curve) shows correct half-life of five years

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must show two half lives check first two plotted points correct to ± half square

1

(b) any **three** points from the following:

- waste remains radioactive for a long time **or** waste has to be disposed of
- waste may leak from its storage point
- possibility of accident at power station **or** in transport of fuel
- contamination of the local environment
- people living close to a power station may have a greater risk of developing cancer **or** leukaemia

  accept harmful to people
- high cost to decommission power station

  *do **not** accept expensive*

3

[10]

Q9.

(a) (i) cosmic rays

1

(ii) any **two from:**
rocks
cosmic rays
food
radon

2

(b) (i) 15

1

(ii) 450

e.c.f. 465 – (d)(i)

*do **not** accept negative number*

1

(iii) beta

count (greatly) reduced by aluminium
***or** alpha not reach GM tube and gamma would pass (unaffected) through the aluminium*

accept aluminium stops beta

2

[7]

Q10.

(a) (i) it is random

*do **not** accept unpredictable*

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*do **not** accept irregular*

1

(ii) source adds nothing **or** little to the count

1

continues to record background level

accept a clear explanation of background

1

(b) (i) an electron

accept $^{0}_{-1}e$

1

(ii) <u>electromagnetic</u> wave with **high frequency** or short wavelength

*must have high frequency **or** short wavelength*

1

(iii) 15

*allow **1** mark for **3** iterative steps 584/2 292/2 146/2*

allow I mark for 45/3

3

(iv) [A] a safe level of radiation reached much quicker

could answer in terms of isotope but answer must be clear whether it refers to isotope or sodium-24

1

[B] long enough to obtain measurements

1

[10]

Q11.

(a) (i) electron
neutron
proton
nucleus

1 mark for each correct label

4

(ii) H-1 has no neutrons
H-3 has 2 neutrons

more neutrons gets 1 mark

2

(iii) nucleus unstable

2

(b) lead/concrete
lead/concrete needed to stop gamma rays

2

[10]

Q12.

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(a) two from:
internal/bodies
thoron
building materials
soil
food
rocks
radon
gamma rays
cosmic rays/outer space

any 2 for 1 mark each

2

(b) only a very small amount of the background radioactivity comes from nuclear power owtte.

accept any sensible response for 1 mark

1

(c) use G.M. tube/meter/counter or film
'count' higher than or compare with background/normal/control or film is blacker

for 1 mark each

2

(d) more neutrons/different number

gains 1 mark

but I-131 has 4 extra neutrons = 2
or I-131 has 78 neutrons I-127 has 74 (2)

gains 2 marks

2

(e) (i) emits radiation
ionises
molecules
in cells
radiation damages cells/mutation/kills cells
may cause cancer
β /☌/radiation is penetrating
half-life is long enough for damage to be caused

any 4 for 1 mark each (4 from above)

4

(ii) e.g. replace I-127 in body/body cannot tell the difference/causes thyroid cancer/causes cancer (but not if already given in (i))

for 1 mark

1

(iii) **Either** No
half-life = 8 days many half lives have passed/attempts to calculate number of half-lives **or** explains meaning of half-life so very little left/become harmless

for 1 mark each

or Yes half-life = 8 days such a large quantity was released although little left it is still harmful

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for 1 mark each

3

[15]

Q13.

Quality of written communication

The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme

Any **three** from

radon releases (alpha) radiation

accept radon is radioactive

1

(radon **or** radiation causes) harm **or** damage to body **or** cells

accept cause cancer / mutations / radiation sickness

1

idea that living near radiation over long period will lead to large 'dose' of radiation

radon (is a gas) that can be breathed in

1

[3]

Q14.

Quality of written communication

correct use of **three** scientific terms e.g. radiation / α **or** β **or** γ / cells / ionisation / mutation (not cells or body) / chromosomes / DNA / genes / cancer

1

any **three** from:

(materials emit) radiation

named type of radiation (α **or** β **or** γ)

damage / harm / kill

dangerous is neutral

cells / chromosomes / DNA / genes

cancer

mutations

ionisation

gloves or glass absorb radiation / prevent radiation reaching body or cells

3

[4]

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Q15.

(i) (strontium-90)
beta rays <u>partly</u> absorbed by aluminium

*accept gamma rays not absorbed **and** alpha all absorbed*

if phosphorus -32 then one mark max for beta ray explanation

1

long half life means it can be <u>used for a long time</u>

1

(ii) (technetium-99)
(gamma) rays will <u>pass out</u> of body / less likely to be absorbed

accept (gamma) less damaging or alpha / beta will damage cells if cobalt -60 then one mark max for gamma ray explanation

1

short half life means it will <u>not affect body over a long period</u>

1

[4]

Q16.

(a) sensible scales

full use of y axis

1

completely accurate plotting

1

a smooth curve going through all bar one of the points

do not accept a dot-to-dot graph if two parts shown for curves accept the more correct

1

at least one line or a clear mark showing how to obtain the half life from the graph and obtaining between 13 and 15

at the bottom of the page cross or ticks in the order of the mark scheme

1

(b) (i) to let the beta particles get through

*accept must be there to let the radiation through **or** if thick they may be stopped*

1

(ii) alpha particles would be stopped by the glass **or** cannot penetrate glass

do not accept alphas are weak

1

(c) (i) it will give more counts per minute for a small quantity **or** it does not last so long so may not be as dangerous

accept answers in terms of 5 years assume it refers appropriately

1

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(ii) it will not be there long enough to act as a tracer **or** it could cause radiation damage as all its activity will be in the first place it enters the system

accept answer in terms of 5 seconds

accept not there long enough to work assume it refers appropriately

1

[8]

Q17.

(a) evidence of $\frac{7350}{15}$

gains 1 mark

but

490

gains 2 marks

but

4900

gains 3 marks

units cm^3

for 1 further mark

4

(b) some of radioactive solution gets into cells/body organs
some of radioactive solution gets into urine (in the kidney)
the radioactive solution becomes less radioactive during the test
variability in readings

in any order for 1 mark each

3

(c) *ideas that*

- won't lose (too) much radioactivity during the test
- won't stay radioactive/harm cells for too long after test is over

for 1 mark each

2

[9]

Q18.

(a) γ/gamma

- because more penetrating
- so can reach/damage cells from outside body/through skin

but

α/alpha

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- does more damage/more likely to cause cancer
- can only do this if <u>inside</u> the body/cells

each • for 1 mark
[credit same ideas expressed conversely]

4

(b)
- must emit alpha / α radiation
- *idea that* half-life must be just long enough to kill cancer cells

each for 1 mark
[do not credit simply short half-life]
(allow 'must be liquid / in solution)

2

(c) *evidence of repeated halving* ***then***
<u>n</u> × 3.6

gains 1 mark

but
answer in range
22 – 25.2 days
(ie >6 and up to 7 half lives)

gains 2 marks

2

[8]

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