AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.4.3 HAZARDS AND USES OF RADIOACTIVE EMISSIONS AND OF BACKGROUND RADIATION (PACK 1)

SCORE	PERCENTAGE
/274	%

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Q1.

(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 × 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 × 180

1

activity = 225 000 (Bq)

1

*an answer of 225 000 (Bq) scores **2** marks*

(c) yearly dose = 0.003 × 365

allow yearly dose = 1.095 (mSv)

1

which is << 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]

Q2.

(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

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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]

Q3.

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(a) 7

1

(b) 3

1

number of <u>protons</u>

reason only scores if 3 chosen

1

(c) levels

1

(d) $^{4}_{2}He$

correct order only

1

1

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

1

(e) shorter half-life (than the other sources)

1

exposure time to radiation is shorter

1

[9]

Q4.

(a) cosmic rays

1

radon gas

1

(b) radioactive decay is a random process

1

(c) the lead lining absorbs the emitted radiation

1

(d) subtract the background count from 159

1

(e) beta

1

beta is negatively charged

1

(so is) attracted to positive plate
or
(so is) repelled by negative plate

1

[8]

Q5.

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(a) Nucleus splitting into two fragments and releasing two or three neutrons

1

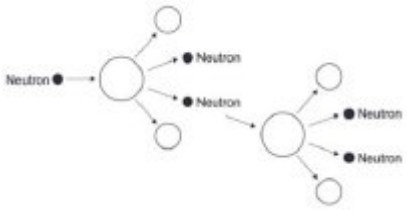
(at least one) fission neutron shown to be absorbed by additional large nucleus and causing fission

1

two or three additional neutrons released from fission reaction

1

*This diagram would gain all **3** marks:*



(b) lowering the control rods increases the number of neutrons absorbed

accept converse description

1

(so) energy released decreases

1

*allow changing the position of the control rods affects the number of neutrons absorbed for **1** mark*

(c) rate of increase between 240 and 276 (MW / min)

2

*allow **1** mark for attempt to calculate gradient of line at 10 minutes*

[7]

Q6.

(a) 2 protons and 2 neutrons

accept 2p and 2n

accept (the same as a) helium <u>nucleus</u>

symbol is insufficient

do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) <u>electron(s)</u>

1

(c) any **one** from:

- wear protective clothing
- work behind lead/concrete/glass shielding
- limit time of exposure
- use remote handling

accept wear mask/gloves

wear goggles is insufficient

wear protective equipment/gear is insufficient

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accept wear a film badge
accept handle with (long) tongs
accept maintain a safe distance
accept avoid direct contact

1

[4]

Q7.

(a) cell damage or cancer

accept kills / mutates cells
radiation poisoning is insufficient
ionising is insufficient

1

(b) (i) any **one** from:

- use tongs to pick up source
- wear gloves
- use (lead) shielding
- minimise time (of exposure)
- maximise distance (between source and teacher).

accept any other sensible and practical suggestion
ignore reference to increasing / decreasing the number / thickness of lead sheets

1

(ii) <u>background</u>

1

(c) (i) curve drawn *from point 2,160*

*do **not** accept straight lines drawn from dot to dot*

1

(ii) (also) increases

less radiation passes through is insufficient

1

(iii) 50

accept any value from 40 to 56 inclusive

1

(d) gamma

1

only gamma (radiation) can pass through lead

*accept alpha **and** beta cannot pass through lead*
a general property of gamma radiation is insufficient

1

[8]

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Q8.

(a) (average) time taken for the amount / number of nuclei / atoms (of the isotope in a sample) to halve
or
time taken for the count rate (from a sample containing the isotope) to fall to half
accept (radio)activity for count rate

1

(b) *60* ±*3* (days)

1

indication on graph how value was obtained

1

(c) (i) cobalt(-60)

1

gamma not deflected by a magnetic field
or
gamma have no charge
dependent on first marking point
accept (only) emits gamma
gamma has no mass is insufficient
*do **not** accept any reference to half-life*

1

(ii) strontium(-90)

1

any **two** from:

- *only* has beta
- alpha would be absorbed
- gamma unaffected
- *beta penetration / absorption depends on thickness of paper*

*if thorium(-232) or radium(-226) given, max **2** marks can be awarded*

2

(iii) cobalt(-60)

1

shortest half-life
accept half-life is 5 years
dependent on first marking point

1

so activity / count rate will decrease quickest

1

(iv) *americium(-241) / cobalt(-60) / radium(-226)*

1

gamma emitter

1

(only gamma) can penetrate lead *(of this box)*

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do not allow lead fully absorbs gamma

1

[14]

Q9.

(a) (i) nuclear reactor

1

star

1

(ii) nuclei are joined (not split)

accept converse in reference to nuclear fission

*do **not** accept atoms are joined*

1

(b) (i) any **four** from:

- neutron
- (neutron) absorbed by U (nucleus)

  ignore atom
  *do **not** accept reacts*
  *do **not** accept added to*
- forms a larger nucleus
- (this larger nucleus is) unstable
- (larger nucleus) splits into two (smaller) nuclei / into Ba and Kr
- releasing three neutrons and energy

  accept fast-moving for energy

4

(ii) 56 (Ba)

1

57 (La)

*if proton number of Ba is incorrect allow **1** mark if that of La is 1 greater*

1

$^{0}_{-1}\beta$

accept e for β

$^{139}_{56}Ba \longrightarrow {}^{139}_{57}La + {}^{0}_{-1}\beta$

*scores **3** marks*

1

[10]

Q10.

(a) (i) 18

1

(ii) the count rate for the source

1

(iii) the alpha radiation would not cover such a distance

1

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(iv) plots correct to within ½ small square

*allow **1** mark for 4 correct points plotted*

2

correct curve through points as judged by eye

1

(v) two attempts at finding 'half-distance' using the table

20 to 10 cpm d = 0.4 m
125 to 56 cpm d = 0.2 m
31 to 14 cpm d = 0.4 m

*allow **1** mark for one attempted comparison*

2

obeyed or not obeyed

dependent on previous two marks

1

(b) (i) there is no effect on the count rate in experiment 1 because the field is parallel **or** beta particles are not deflected **or** there is no force

1

count rate is reduced in experiment 2 because field is perpendicular **or** beta particles are deflected **or** there is a force

1

(ii) only background radiation (as beta do not travel as far)

1

slightly different values show the random nature of radioactive decay

1

[13]

Q11.

(a) cosmic rays

1

radon gas

1

(b) (i) Radioactive decay is a random process

1

(ii) 19

1

(iii) 140

accept 159 – their (b)(i) correctly calculated

1

(iv) gamma

1

the count stayed the same

1

or

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gamma does not have a charge

accept gamma is an electromagnetic wave

(so) gamma is not deflected / affected by the magnetic field

accept magnet for magnetic field

*do **not** accept is not attracted to the magnet*

last two marks may be scored for an answer in terms of why it cannot be alpha or beta

only answer simply in terms of general properties of gamma are insufficient

1

(c) lead absorbs (some of the) radiation

accept radiation cannot pass through (the lead)

or

less radiation emitted into the (storage) room

1

(d) Should radioactive waste be dumped in the oceans

1

[10]

Q12.

(a) (i) any **one** from:

- nuclear power (stations)

  accept nuclear waste
  accept coal power stations

- nuclear weapons (testing)

  accept nuclear bombs / fallout

- nuclear accidents

  accept named accident, eg Chernobyl or Fukushima

  accept named medical procedure which involves a radioactive source
  accept radiotherapy
  accept X-rays
  accept specific industrial examples that involve a radioactive source

  nuclear activity / radiation is insufficient

  smoke detectors is insufficient

1

(ii) (radioactive decay) is a random process

accept an answer in terms of background / radiation varies (from one point in time to another)

1

(b) any **one** from:

- (maybe) other factors involved

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accept a named 'sensible' factor, eg smoking

- evidence may not be valid
  accept not enough data
- may not have (a complete) understanding of the process (involved)

1

(c) (i) 2

1

2

1

(ii) 218

correct order only

1

84

1

(d) 3.8 (days)

*allow **1** mark for showing correct method using the graph provided no subsequent steps*

*correct answers obtained using numbers other than 800 and 400 gain **2** marks provided the method is shown*

2

[9]

Q13.

(a) (both graphs show an initial) increase in count rate

accept both show an increase

1

(b) only the right kidney is working correctly

1

any **two** from:

*if incorrect box chosen maximum of **1** mark can be awarded*

reference to named kidney can be inferred from the tick box

- count-rate / level / line for <u>right</u> kidney decreases (rapidly)
  it decreases is insufficient
- count-rate / level / line for <u>left</u> kidney does not change
  it does not change is insufficient
- radiation is being passed out into urine – if referring to right kidney
- radiation is not being passed out – if referring to the left kidney
- <u>left</u> kidney does not initially absorb as much technetium-99

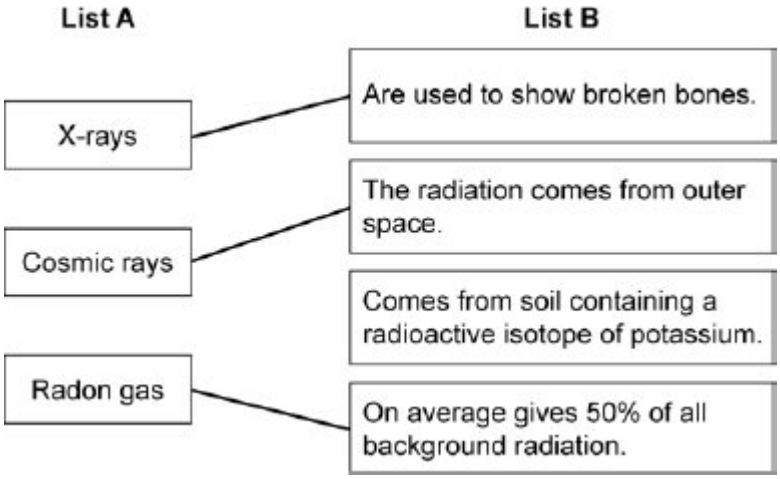
2

[4]

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Q14.

(a) 1 mark for each correct line



*if more than 1 line has been drawn from a box in **List A** then all those lines are marked incorrect*

3

(b) higher in village B

1

by 6 units

*allow **1** mark for correctly obtaining a height difference of 180 (m) / 4 times higher – this refers to height not radiation levels*

*accept for **3** marks in village A it is 2 units (extra) and in village B it is 8 units (extra) allow **1** mark for a correct radiation calculation based on incorrect height readings*

2

[6]

Q15.

(a) (i) 2.5

1

(ii) The radiation dose from natural sources is much greater than from artificial sources

1

(b) (i) any **one** from:

- different concentrations in different rooms
- to average out daily fluctuations

accept to find an average

accept to make the result (more) reliable / valid

*do **not** accept to make more accurate on its own*

1

(ii) average level (much) higher (in **C** and **D**)

accept converse

1

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some homes have very high level (in **C** and **D**)

*accept maximum level in **A** and **B** is low*

1

or

maximum level in some homes (in **C** and **D**) is very high

*accept higher radiation levels (in **C** and **D**) for **1** mark*

[5]

Q16.

(a) (i) on average, cosmic rays produce less background radiation than rocks.

1

having no X-rays reduces a person's radiation dose.

1

(ii) 4

*allow **1** mark for 350 / 4*

*allow **1** mark for an answer 3.5*

2

(b) (i) (risk) increases

1

(ii) C

*reason only scores if **C** chosen*

1

shows a lower risk for low doses (than for zero exposure)

accept risk reduces when you go from low to moderate (doses)

1

(c) (i) *no mark for YES or NO, marks are for the explanation*

YES

fewer mice exposed first to a low dose

1

get cancer (than those only exposed to a high dose)

only scores if first marking point scores

NO

the results are for mice (1)

and may not be applicable to people (1)

1

(ii) ethical

1

[10]

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Q17.

(a) (i) 1.25 (mSv)

1

(ii) any **two** from:

- (frequent) flying
  accept stated occupation that involves flying
- living at altitude
- living in areas with high radon concentrations
  accept a specific area, eg Cornwall
- living in a building made from granite (blocks)
- having more than the average number of X-rays
  or
  having a CT scan
  accept more medical treatments
- working in a nuclear power station
  accept any suggestion that could reasonably increase the level from a specific source

2

(b) (i) to be able to see the effect of exposure (to radon gas)
or
as a control
accept to compare (the effect of) exposure (with no exposure)

1

(ii) increased levels of exposure increases the risk (of developing cancer)
accept exposure (to radon gas) increases the risk

1

smoking increases the (harmful) effect of radon
answers that simply reproduce statistics are insufficient

1

(c) LNT model – risk increases with increasing radiation (dose) level
accept in (direct) proportion
accept low doses increase the risk

1

Radiation hormesis - low radiation (dose) levels reduce the risk

1

(d) two valid points made – examples:

- animals have no choice and so should not be used
- should not make animals suffer
- better to experiment on animals than humans

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- experiments lead to a better understanding / new knowledge
- experiments may lead to health improvement / cures for humans
  results for animals may not apply to humans is insufficient

2

[10]

Q18.

(a) cobalt-(60)

1

gamma (radiation) will pass through food / packaging
this can score if technetium chosen

1

long half-life so level of radiation (fairly) constant for (a number) of years
this can score if strontium / caesium is chosen
accept long half-life so source does not need frequent replacement
accept answers in terms of why alpha and beta cannot be used
gamma kills bacteria is insufficient

1

(b) (i) people may link the use of radiation with illness / cancer
accept (they think) food becomes radioactive
accept (they think) it is harmful to them
'it' refers to irradiated food

1

(ii) not biased / influenced (by government views)

1

(iii) any **two** from:

- data refers only to (cooked) chicken
- data may not generalise to other foods
- the content of some vitamins increases when food / chicken is irradiated
- no vitamins are (completely) destroyed
- (only) two vitamins decrease (but not significantly)
  accept irradiated chicken / food contains a higher level of vitamins
  marks are for the explanation only

2

(iv) so can choose to eat / not eat that (particular) food
accept irradiated food may cause health problems (for some people)
accept people may have ethical issues (over eating irradiated food)

1

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(c) (i) electron
from nucleus / neutron
***both** parts required*

1

(ii) 90 years
*allow **1** mark for showing 3 half-lives*

2

[11]

Q19.

(a) (i) half / 50 %

1

(ii) Measure the radon gas level in more homes in this area

1

(b) (i) 86

1

(ii) 222

1

[4]

Q20.

(a) (i) any **one** from:

- food / drink
- rocks / building materials
- cosmic rays / rays from space
  accept correctly named example

1

(ii) any **one** from:

- nuclear power / coal power (stations)
  accept nuclear waste
- nuclear accidents
  accept named accident eg Chernobyl
- nuclear weapons testing
  accept named medical procedure which involves a radioactive source
  accept radiotherapy
  nuclear activity / radiation is insufficient
  *do **not** accept CT scans*

1

(iii) different number of / fewer protons
accept does not have 86 protons
accept only has 84 protons

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or
different atomic number
*do **not** accept bottom number different*
reference to mass number negates this mark

1

(b) 168

accept 169 if clear, correct method is shown
*allow **1** mark for a correct dose ratio involving the spine*
eg 2:140 etc
***or** ratio of days to dose is 1.2*
***or** ratio of dose to days is 0.83*

2

(c) (i)

Group A	Group B
J M O	K L N

all correct
any order within each group

1

(ii) similar (number) / same (number) / large (number)
accept the same specific number in each group eg three
reference to other factors such as age is neutral

1

(iii) how many people in each group developed cancer
a clear comparison is required

1

(iv) *there are no marks for **Yes** or **No** the mark is for the reason*

Yes
the benefit of having the scan is greater than the risk
or
the risk is (very) small (compared to the chance from natural causes)
accept the risk is much greater from natural causes

No
no additional risk is acceptable

1

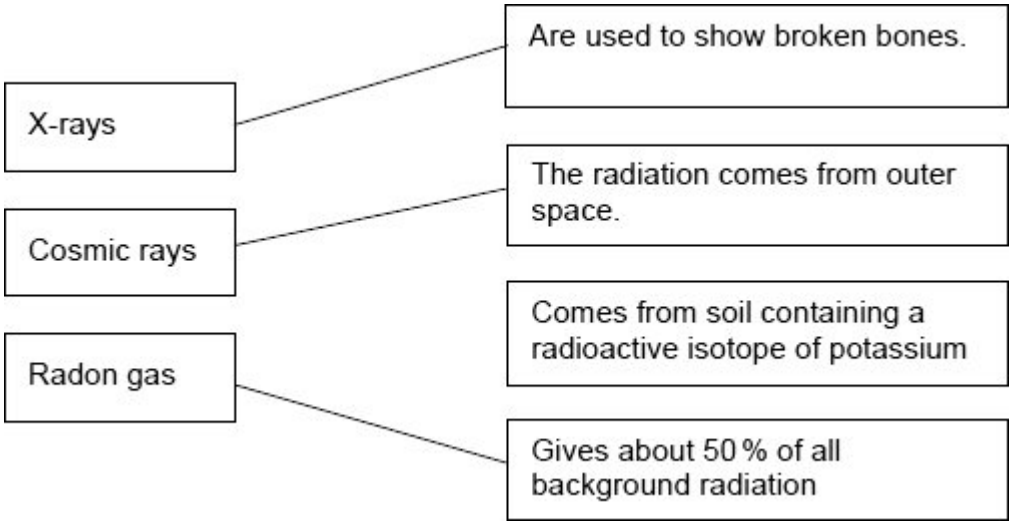
[9]

Q21.

1 mark for each correct line

*If more than 1 line has been drawn from a box in **List A** then all those lines are marked incorrect.*

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[3]

Q22.

(a) gamma will pass through the body

it refers to gamma

or

alpha will not pass through the body

answers must relate to the body

accept skin for body

1

gamma is only slightly ionising

accept gamma causes less damage to cells / tissue

or

alpha is heavily ionising

*do **not** accept gamma causes no damage to cells*

less harmful is insufficient

1

(b) (i) (both graphs show an initial) increase in count-rate

accept both show an increase

1

(ii) only the right kidney is working correctly

1

any **two** from:

*if incorrect box chosen maximum of **1** mark can be awarded*

reference to named kidney can be inferred from the tick box

- count-rate / level / line for right kidney decreases (rapidly)
  it decreases is insufficient
- count-rate / level / line for <u>left</u> kidney does not change
  it does not change is insufficient
- radiation is being passed out / into urine - if referring to right kidney
- radiation is not being passed out - if referring to the left kidney

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2

(c) (i) time taken for number of nuclei to halve
or
time taken for the count-rate to halve

1

(ii) short half-life – the level of radiation (in the body) decreases rapidly
it refers to short life isotope

1

to a safe / very small level
or
a long half-life – the radiation remains in the body / for a long time

level of radiation remains high
answers in terms of damage eg cancer are insufficient

1

[9]

Q23.

(a) (i) 2.5

1

(ii) The radiation dose from natural sources is much greater than from artificial sources.

1

(b) (i) other factors may be involved
accept a specific suggestion
eg they may be exposed to other types of radiation
accept cannot be sure (in many cases) that the cause of death is radon (poisoning)

1

(ii) any **one** from:

- different concentrations in different rooms
- to average out daily fluctuations
accept to find an average
accept to make the result (more) reliable / valid
*do **not** accept to make more accurate on its own*

1

(iii) average level (much) higher (in **C** and **D**)
accept converse

1

some homes have very high level (in **C** and **D**)
*accept maximum level in **A** and **B** is low*
or
maximum level in some homes (in **C** and **D**) is very high
*accept higher radiation levels (in **C** and **D**) for **1** mark*

1

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[6]

Q24.

(a) (i) half / ½ / 50%

accept 1 (part) in 2 (parts) 1

1

(ii) (the) food (we eat) is radioactive

accept because of the food (we eat)

accept we breathe in radon

radon in the air is neutral

1

(b) higher in village B

1

by 6 units

allow 1 mark for correctly obtaining a height difference of 180(m)/ 4 times higher – this refers to height and not radiation levels

accept for 3 marks in village A it is 2 units (extra) and in village be it is 8 units (extra)

allow 1 mark for a correct radiation calculation based on incorrect height readings

2

[5]

Q25.

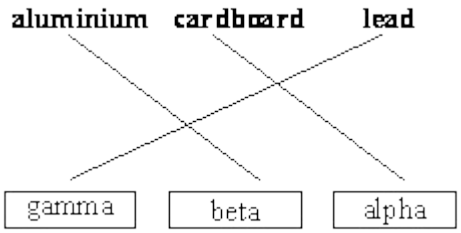
(a) (i) **P**

1

(ii) **Q**

1

(b) 3 lines correct



*allow **1** mark for 1 correct line*

two lines drawn from any source or box – both incorrect

2

(c) (i) **K**

1

(ii) 56

accept 50 – 60 inclusive

1

(iii) **K**

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1

(iv) to inject... tracer

1

[8]

Q26.

(a) (i) beta and gamma

both answers required

accept correct symbols

1

(ii) alpha and beta

both answers required

accept correct symbols

1

(iii) gamma

accept correct symbol

1

(b) nothing *(*you do to a radioactive substance / source*)* changes the count rate / activity / rate of decay / radiation (emitted)

accept it = radiation emitted

or *(*reducing*)* the temperature does not change the activity / count rate / rate of decay / radiation (emitted)

1

(c) (i) has <u>one</u> more neutron

correct answer only

1

(ii) 14 days

no tolerance

*allow **1** mark for showing a correct method on the graph*

2

(iii) any **two** from:

- beta particles / radiation can be detected externally
- beta particles / radiation can pass out of / through the plant
- long half-life gives time for phosphorus to move through the plant / be detected / get results
- phosphorus-32 is chemically identical to phosphorus-31
- phosphorus-32 is used in the same way by a plant as phosphorus-31

2

[9]

Q27.

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(a) top and bottom boxes identified

1

(b) Medical (treatment)

or X-rays

answer must be in table
accept treatment for medical treatment

1

(c) 15

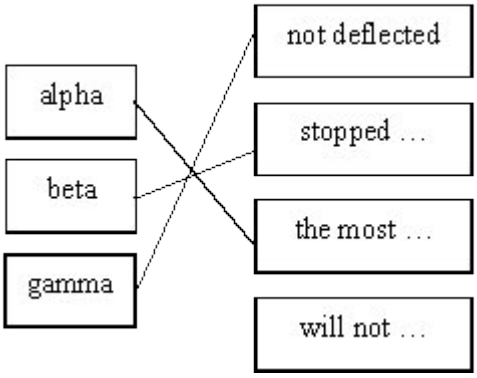
*allow **1** mark for correctly identifying 300 as the average dose*

2

[4]

Q28.

(a) 3 lines correctly drawn



***1** mark for each correct line if more than one line is drawn from a box in List **A** all lines from that box are wrong*

3

(b) nucleus

accept nuclei
*do **not** accept nuclear*

1

(c) **Y**

*do **not** accept gamma*

any **two** from:

*do **not** accept other properties of gamma*

- least dangerous (inside the body)

  *do **not** accept not dangerous*
  accept not as harmful as alpha (inside the body)

- least ionising

- penetrates through the body

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*do **not** accept can be detected externally*

1

- is a gas / can be breathed in

  accept it is not a solid
  *(cannot score if **Z** chosen)*
  *if **X** chosen can score this gas mark*
  *if **Z** chosen can score **both** gamma marks*

2

(d) any **one** from:

*do **not** accept kills bacteria*

- longer shelf life

  accept stays fresh longer / stops it going bad / mouldy

- food can be supplied from around the world
- wider market for farmers
- cost to consumers (may be) lower
- less likely to / will not get food poisoning

  accept infection / disease / ill for food poisoning

1

[8]

Q29.

(a) (i) 3 fewer neutrons

accept fewer neutrons
accept different number of neutrons
*do **not** accept different number of electrons*

1

(ii) electron from the nucleus

both points needed

1

(iii) 32 (days)

*allow **1** mark for clearly obtaining 4 half-lives*

2

(iv) has a **<u>much</u>** longer half-life

accept converse answers in terms of iodine-131
accept it has not reached one half-life yet

1

little decay happened / still in the atmosphere

accept it is still decaying

1

(b) any **two** from:

marks are for reasons

- some children developed TC before 1986

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- some children (after 1986) that developed TC did not live in highly contaminated areas
- the (large) increase can (only) be explained by (a large increase in) radiation as caused by Chernobyl
- all areas would be contaminated (and raise the risk of TC)
- no evidence (of effect) of other variables

2

(c) People not exposed (to the radiation but who were otherwise similar)

accept people not affected (by the radiation)

1

(d) any **two** from:

*answers should be in terms of nuclear power and **not** why we should not use other fuels*

- produce no pollutant / harmful gases

  accept named gas or greenhouse gases
  *do **not** accept no pollution*

- produces a lot of energy for a small mass (of fuel) **or** is a concentrated energy source

  accept amount for mass
  accept high energy density

- it is reliable **or** it can generate all of the time
- produces only a small volume of (solid) waste

  accept amount for volume

2

[11]

Q30.

(a) (i) protons

1

neutrons

answers may be in either order

1

(ii) 86

1

(iii) two **fewer** protons and two **fewer** neutrons

*do **not** accept two fewer protons and neutrons*

or 84 protons 134 neutrons

*do **not** accept 218 protons and neutrons*

1

(b) (i) 0.4

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accept $\frac{2}{5}$ */ accept 40 % for 2 marks*

*allow **1** mark for correct totalling = 1.8*
*allow **1** mark for a clearly correct method with a clearly incorrect total*

2

(ii) any **one** from:

- nuclear weapon testing
  *do **not** accept nuclear*
- nuclear power (stations)
  accept nuclear/ radioactive waste
- nuclear accidents
- medical
  accept X-rays

1

(c) (i) 2

accept 2:1
accept twice as big
ignore units

1

(ii) No with a reasonable reason explained

only going for two weeks so

or even staying for a year

total exposure well under lowest limit for causing cancer

__1__ mark is for a time frame
__1__ mark is for correctly relating to a dose

1

or Yes with a reasonable reason explained

all levels of radiation are (potentially) hazardous (1)

accept low doses could still cause cancer
accept all levels affect you
*do **not** accept radiation dose is high(er)*
*do **not** accept level of background radiation is higher in Germany*

harm caused by lower doses may not have been recorded (1)

or evidence may not be complete

or insufficient research into effect of small doses

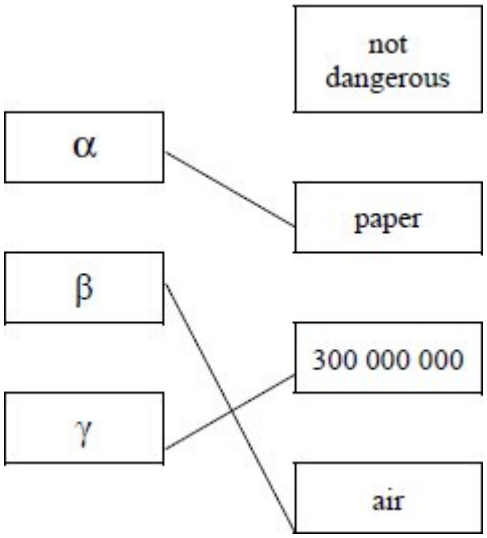
1

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[10]

Q31.

(a) 3 correct lines drawn



any box in list A with 2 or more lines,
all lines for that box do not score

3

(b) radiation damages our cells

accept radiation can cause cancer
accept kills cells
accept changes DNA / causes mutations
accept dangerous / poisonous / harmful / toxic
accept so precautions can be taken

1

(c) it can pass through the human body

1

(d) (i) 6 (hours)

no tolerance

1

(ii) 6 (hours)

accept their (d)(i)

1

[7]

Q32.

(a) (i) alpha

1

(ii) damages them / changes DNA

accept kills them / destroys
accept causes cancer
accept causes cell mutations

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*do **not** accept they ionise cells on its own*

1

(b) count is (roughly) the same

1

gamma is not affected by magnetic field

accept magnet for magnetic field

1

or

alpha and beta are deflected by a magnetic field (1)
count would go down significantly (1)

(c) time taken for number of nuclei to halve

*do **not** accept time for radioactivity to halve*

or

time taken for count rate to fall to half
(its initial value)

*do **not** accept time for nuclei to halve*

1

(d) not enough time to take measurements / make observations

1

before level of radiation became insignificant

1

[7]

Q33.

(a) (i) <u>electromagnetic</u> (wave / radiation)

accept <u>em</u> (wave / radiation)
ignore reference to frequency

1

(ii) gamma can penetrate the crate / box / packaging

accept converse (but must relate to both alpha <u>and</u> beta)
ignore just gamma radiation kills bacteria
accept can get through to food

1

(iii) neutrons

1

(b) (i) absorb gamma / radiation

accept it stops / reduces the radiation

1

(ii) any **one** from:

- slow down the conveyor belt
- food does more than one circuit

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- stay on the conveyor belt longer
- food closer to the source / radiation
  ignore larger doses / use more of the source
  ignore thinner packaging

1

(c) (i) idea of testing food on humans / animals

1

no (measured) ill effects **or** monitor their health
accept monitor people that have eaten the food
*accept a measurement / comparison for **1** mark*
eg measure the amount of radiation in treated food
*comparison plus a reason for the comparison would get **2** marks*
*eg idea of measuring level of radiation in treated food **with** no measurable increase in level = **2** marks **or** comparing it to untreated food = **2** marks*

1

(ii) so can make own decision about eating or not eating treated food
accept may be against their religious / moral views
accept some people prefer food that hasn't been tampered with
ignore in case they don't like the idea of eating treated food
accept don't want to eat treated food
ignore might be allergic to the food
*eg think it will give them cancer = **0** marks*
*think it will give you cancer so I need to know so that I can choose = **1** mark1*

1

[8]

Q34.

(i) any **one** from:

the ground
the air
radon (gas)
building materials
buildings
rocks / granite
food
cosmic rays or solar rays
*do **not** accept mobile phones*

X-rays
nuclear weapons testing
nuclear power stations / accidents

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accept from outer space
*accept sun but **not** sunlight*
accept medical uses

1

(ii) 2

allow $\frac{1200}{60 \times 10}$ ***or*** $\frac{120}{600}$ ***or*** 120

2

[3]

Q35.

(a) (i) two protons and two neutrons **or** the nucleus of a helium atom

1

(ii) different numbers of neutrons **or** one has (3) more or less neutrons than the other

accept different mass (numbers)

if give a number as a difference it must be 3

1

(iii)

*if polonium or hydrogen chosen gets **0** marks*

technetium (99) or none

1

any **two** from:

*do **not** accept gamma rays are less dangerous*

gamma rays less dangerous inside the body

gamma radiation less likely to be absorbed by cells **or** gamma rays do not ionise cells

gamma rays can penetrate the body (to be detected externally)

first 3 points valid if either technetium or iridium or none is given

2

short half-life so safe levels inside body soon reached

half-life long enough to obtain measurements

half-life short enough not to cause long term damage

last 3 points valid if either technetium or uranium or none is given

(b) 2200 ± 200

*allow **1** mark for attempted use of 70% on the graph*

2

[7]

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