Question Paper

Particles

Name: _____

Class: _____

Date: _____

Time: **415 min.**

Marks: **343 marks**

Comments:

Q1.

Asinglenucleusof $^{11}_{6}C$ decaysintoanucleusof $^{11}_{5}B$.

During this decay two additional particles are emitted.

(a) Identifythisdecay.

_____

(1)

(b) Identify the neutral particle emitted in this decay.

_____

(1)

(c) Identify the antiparticle of the neutral particle in question (b).

_____

(1)

(Total 3 marks)

Q2.

A student has a source of gamma radiation and equipment that measures the radioactive count rate.

Describe the experiment the student can perform to verify the inverse-square law for gamma radiation.

In your answer you should include:

- theadditionalapparatusrequired
- themeasurementstobetaken
- howtoensuretheaccuracyoftheresults
- howtheresultsareprocessedgraphicallytoverifythelaw.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 5 marks)

Q3.

What is the specific charge of a $^{9}_{4}Be^{2+}$ ion?

A $2.1\times10^{7}Ckg^{-1}$ **B** ⬭

$4.3\times10^{7}Ckg^{-1}$ **C** ⬭

$9.6\times10^{7}Ckg^{-1}$ **D** ⬭

$2.2\times10^{-1}Ckg^{-1}$ ⬭

(Total 1 mark)

Q4.

The initial activity of a radioactive source was 192 Bq. The activity of the source is 24 Bq after 12 days.

What was the activity of the radioactive source after 4 days?

A 48Bq **B** ⬭

80Bq **C** ⬭

96Bq **D** ⬭

108Bq ⬭

(Total 1 mark)

Q5.

Radioactive decay is considered to be:

A spontaneousbecauseallnucleiofaparticularnuclide have different decay constants. ⬭

B randombecauseitisnotpossibletopredictwhether a nucleus will emit an alpha particle, a beta particle or a gamma ray. ⬭

C randombecauseitisnotpossibletopredictwhena particular nucleus will decay. ⬭

D spontaneousbecauseithappenssuddenlywhen triggered by an event. ⬭

(Total 1 mark)

Q6.

(a) Complete the table to show some of the properties of an antiproton.

Charge / C	Rest mass / kg	Specific charge / C kg^{-1}

(2)

(b) Antiprotons can be annihilated.

Describe annihilation.
Include the circumstances under which it can occur and its outcome.

_____

_____

_____

_____

(4)
(Total 6 marks)

Q7.

Fluorine–18 ($^{18}_{9}F$) is a β^+ emitter used in medicine. Its half-life is 110 minutes. Fluorine–18 decays to oxygen–18 ($^{18}_{8}O$) which is stable.

A fluorine–18 compound is injected into a patient and gamma radiation arising from the decay is detected outside the body.

A sample of pure $^{18}_{9}F$ is prepared and then stored for 220 minutes.

(a) The decay equation for $^{18}_{9}F$ is

$$^{18}_{9}F \rightarrow {}^{18}_{8}O + \beta^+ + X$$

Identify **X**.

(2)

(b) Calculate the ratio $\frac{\text{number of } ^{18}_{9}F \text{ nuclei in the sample}}{\text{number of } ^{18}_{8}O \text{ nuclei in the sample}}$ after 220 minutes.

ratio = _____

(2)

(c) Explain why the $^{18}_{9}F$ sample must be used soon after it is produced.

(2)
(Total 6 marks)

Q8.

A Geiger counter is used to measure the corrected count rate *C* from a gamma source in a vacuum.

What is the relationship between *C* and the distance *x* between the Geiger counter and the source?

A *C* is directly proportional to x^2 ⬭

B *C* is directly proportional to *x* ⬭

C *C* is inversely proportional to *x* ⬭

D *C* is inversely proportional to x^2 ⬭

(Total 1 mark)

Q9.

Complete the equation for the radioactive decay of $^{42}_{19}\text{K}$.

$$^{42}_{19}\text{K} \longrightarrow \;\_\!\_^{\_\_}_{\_\_}\text{Ca} + \;\_\!\_^{\_\_}_{\_\_} + \bar{\nu}_e$$

(Total 2 marks)

Q10.

A particle has a rest energy of 942 MeV

(a) State what is meant by the rest energy of a particle.

_____

_____

_____

_____

(2)

(b) Convert 942 MeV into joule.

942 MeV = _____ J

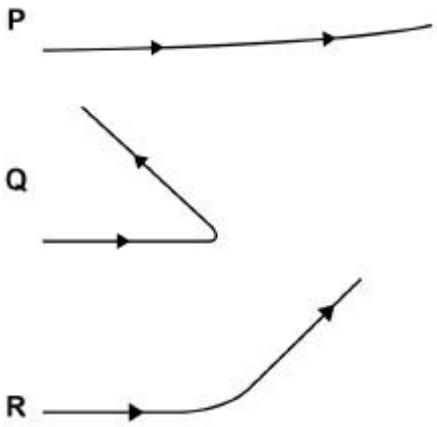
(1)

(Total 3 marks)

Q11.

P, **Q** and **R** are the paths of alpha particles in Rutherford's alpha-scattering experiment.

All of the alpha particles have the same initial energy and the paths are drawn to the same scale.



Which row identifies the order of the paths starting with the smallest distance of closest approach and ending with the greatest distance of closest approach to the target nucleus?

A P,Q,R ○

B Q,R,P ○

C Q,P,R ○

D R,P,Q ○

(Total 1 marks)

Q12.

What is the specific charge of an alpha particle relative to the specific charge of a proton?

A $\frac{1}{4}$ ○

B $\frac{1}{2}$ ○

C 2 ○

D 4 ○

(Total 1 marks)

Q13.

^{207}Pb can be formed from a series of decays beginning with ^{211}Pb. Only alpha particles and beta particles are emitted in the series.

How many alpha and beta particles are emitted in the series?

A 1alphaparticleand1betaparticle ○

B 1 alpha particle and 2 beta particles ○

C 2 alpha particles and 1 beta particle ○

D 2 alpha particles and 2 beta particles ○

(Total 1 marks)

Q14.

A detector is placed 50 cm from a gamma source that has a half-life of 40 s
The corrected count rate is found to be 1400 count s^{-1}

What will be the corrected count rate 4.0 minutes later when the detector is 2.0 m from the gamma source?

A 1.37counts^{-1} ○

B 2.73counts^{-1} ○

C 5.47counts^{-1} ○

D 10.9counts^{-1} ○

(Total 1 marks)

Q15.

What are the products of the radioactive decay of a free neutron?

A anantineutronandtwogammarays ○

B aproton,anantiprotonandanantineutrino ○

C aproton,anelectronandanantineutrino ○

D aproton,apositronandaneutrino ○

(Total 1 marks)

Q16.

Which statement about hazards from radioactive sources is **not** correct?

A Exposuretimesshouldbeminimisedbykeeping sources in lead boxes when not being used. ○

B Apersoncannotbecontaminatedfromasealed source of beta radiation if they are more than 1 m from the source. ○

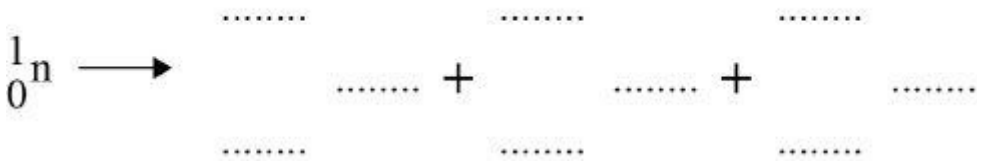
C Radioactivesourcesarekeptinleadboxesbecause alpha, beta and gamma radiation cannot penetrate lead. ○

D Radioactivesourcesshouldalwaysbehandledwith tongs to prevent direct contamination of the skin. ○

(Total 1 marks)

Q17.

Complete the equation below to show the decay of a neutron.
Show the proton numbers, nucleon numbers and symbols of all three particles produced.



(Total 3 marks)

Q18.

Positron Emission Tomography (PET) scans can be used for examining cancers. Fluorine-18 (^{18}F) decays by positron emission. The positron collides with another particle and undergoes annihilation. Radiation from this annihilation is used to build a picture of the cancer.

A solution containing ^{18}F with an activity of 320 MBq is injected into a patient.

(a) Describe the properties of a positron.

(2)

(b) Explain what is meant by annihilation in this case.

(3)

(c) Calculate the time taken for the activity of the ^{18}F to fall from its initial activity to 10 MBq.

half-life of ^{18}F = 110 min

time taken = _____ min

(2)

(Total 7 marks)

Q19.

Antiprotons, antineutrons and positrons have different magnitudes of specific charge.

What is the order of the specific charges, from smallest to largest?

A antineutron,positron,antiproton **B** ⬭

antineutron,antiproton,positron **C** ⬭

positron,antineutron,antiproton **D** ⬭

antiproton,antineutron,positron ⬭

(Total 1 marks)

Q20.

Which conservation rules were originally used to predict the existence of the neutrino?

A conservationofchargeandenergyingammadecay ⬭

B conservationofenergyandmomentuminalltypesofdecay ⬭

C conservationofenergyandmomentuminbetadecay ⬭

D conservationofmassandchargeinalphadecay ⬭

(Total 1 marks)