

Mark Scheme

Particles

Name: _____

Class: _____

Date: _____

Time: **415 min.**

Marks: **343 marks**

Comments:

Mark schemes

Q1.

- (a) Beta-plus **or** positron (emission) ✓

Accept ${}_{+1}^0\beta$

Accept correct decay equation in which beta plus is seen

Just beta decay is insufficient

1

- (b) (electron) neutrino ✓

Accept correct symbols

Reject anti-neutrino.

1

- (c) the correct antiparticle to student's (b). ✓

Accept correct symbols

*Expect (electron) antineutrino but **not** if (b) is incorrect*

ecf from (b)

1

[3]

Q2.

Additional apparatus: Ruler (ignore stopwatch) ✓

Measurements:

Background measurement taken *or* subtracted ✓

Count rate measured at various distances ✓

Accuracy: counts taken for a long time **or** large range of distances mentioned **or** repeats and averages **or** reference to end correction ✓

Process results: Graph: **either** C vs $1/r^2$ **or** $1/C^{1/2}$ vs r ✓

Straight line (through the origin) ✓

Log-log graph ✓

MP6 requires MP5

[Max 5]

Q3.

A

[1]

Q4.

C

[1]

Q5.

C

Q6.

- (a) $-1.6 \times 10^{-19} \text{ (C)}$ ✓

Numbers all correct – 1 mark

$1.67 \times 10^{-27} \text{ (kg)}$ ✓

Accept $1.66 \times 10^{-27} \text{ (kg)}$

$(-)9.58 \times 10^7 \text{ (C kg}^{-1}\text{)}$ ✓

*Numbers all correct and charge given as negative
– 2 marks*

2

- (b) A particle and its (corresponding) antiparticle (or particle–antiparticle pair) ✓

*Accept a proton and an antiproton but not a
particle and an antiparticle*

Cease to exist / are destroyed OWTTE ✓

*Allow “vanished” and “eliminated”; do not allow
“annihilated”*

Two (gamma) photons are produced ✓

The photons have the same total energy as the mass–energy of the particles
or momentum is conserved ✓

Allow “converts their (rest) mass into energy”

4

[6]

Q7.

- (a) Any mention of neutrino (1 mark) ✓

Electron-neutrino OR ν_e (2 marks) ✓

$\bar{\nu}_e$ OR anti - electron neutrino scores max 1

2

- (b) Two half-lives so the F-18 has quartered ✓

Accept 1 : 3, 33%, $\frac{1}{3}$

$\frac{25\%}{75\%} = 0.33$ ✓

Do not credit $\frac{1}{4}$ without working seen

2

- (c) The activity (of the sample) must be large enough ✓
to be distinguishable from background radiation

OR

so that it is not all absorbed by the body (OWTTE) ✓

*Condone idea that too much of the F-18 will have
decayed (in a short time) for MP1*

2

[6]

Q8.

D

[1]

Q9.

${}^0_{-1}\text{e}$ ✓

Accept e^- , β^- or β with the correct numbers. Not b or B

${}^{42}_{20}\text{Ca}$

[2]

Q10.

(a) The energy equivalent of the mass of the particle... ✓

Rest mass **OR** when the particle has zero momentum or velocity **OR**

Reference to $E = mc^2$ ✓

Not just "at rest".

"Energy equivalent of the rest mass (of the particle)" gets 2 marks

2

(b) $1.5(1) \times 10^{-10} \text{ (J)}$ ✓

Correct answer only

1

[3]

Q11.

B

[1]

Q12.

B

[1]

Q13.

B

[1]

Q14.

A

[1]

Q15.

C

[1]

Q16.

C

[1]

Q17.

proton correct (1,1) accept p or p^+ ✓

electron correct (0,-1) accept e or e^- or β or β^- ✓

(electron-)antineutrino correct (0, 0) ✓

Must be an antineutrino

[3]

Q18.

(a) same mass as an electron / mass of 9.11×10^{-31} kg ✓

Same magnitude of charge as on electron but charge is positive

Allow charge = +1

OR charge of $+1.6 \times 10^{-19}$ C (plus sign clearly seen) ✓

2

(b) meets an electron or the antiparticle

Both particles destroyed / cease to exist ✓

(Accompanied by) emission of **two** gamma rays OR **two** photons ✓

3

(c) Identifies that five half-lives are needed / makes a clear attempt to calculate the activity though a sequence of half lives ✓

550 (min) ✓

Correct answer only

2

[7]

Q19.

B

[1]

Q20.

C

[1]