Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) Use of specific charge = charge / mass
eg $1.60 \times 10^{-19} / (1.67(3) \times 10^{-27} + 1.67(5) \times 10^{-27})$ ✔

Any substitution or equation suggesting specific charge = charge/mass gains the first mark.

4.8×10^{7} (C kg^{-1}) ✔

Use of ½ × proton specific charge gains full credit.

2

(b) Pion ✔

1

(c) (Short-range) attraction up to about 3 fm ✔

Allow 1-5 fm.

(Very short-range) repulsion closer than 0.5 fm ✔

Allow 0.5-1 fm.

Allow 1 mark for stating both a value at which attraction occurs and a value at which repulsion occurs.

Prevent proton and neutron moving closer or further apart ✔

MP3 is for a suggestion that an equilibrium point exists or that nucleus doesn't collapse.

Any suggestion of electric forces between proton and neutron loses MP3.

3

(d) Correct description of alpha decay
OR
Consequence of alpha decay ✔

Either MP1 or MP2 lost if answer suggests that decay mode is valid.
Accept answers in terms of A and Z, or that use accepted nomenclature eg $^{4}_{2}\mathrm{He}$.

Correct description of electron capture
OR
Consequence of electron capture ✔

Correct description of beta decay, with explicit conclusion that this mode is valid ✔

Condone absence of antineutrino.

3

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Q2.

(a) Neutron number increases by one **and** proton number decreases by one $_1$✔

Or

A proton changes/decays to a neutron $_1$✔

(because) up (quark) changes to a down (quark) $_2$✔

Allow use of symbols: N increases by one and Z decreases by one
Allow this expressed as an equation symbols for proton and neutron.
Allow u (quark) changes to d (quark)
Allow uud → dud
Where decay equation is attempted, condone incorrect leptons (quarks must be correct).

2

(b) Conversion of 0.52 MeV to eV seen $_1$✔

Or

Conversion of 0.52 MeV to J $_1$✔

Or

Use of $p = \frac{E}{c}$ $_1$✔

(p =) 2.77×10^{-22} or 2.8×10^{-22} $_2$✔ **c.a.o**

5.2×10^5 (eV) seen for MP1
Condone POT error in conversion to joule
Expect to see: 8.32×10^{-14} (J) for MP2
With substitution of student's value for E (where conversion hasn't been completed or completed incorrectly)

2

(c) Shades detector opposite **P** ✔

The leader line from label 'patient's head' passes through a box.
Expect to see shaded the box below the 'leader line' box.
Allow either of the boxes adjacent to expected box.
Penalise more than one box shaded.

1

(d) 2 photons (are produced) / Photons must move off in opposite directions (along the same line)$_1$✔

The photons must have equal and opposite momentum / must conserve momentum $_2$✔

2

(e) Use of $(\text{gradient}=)\frac{\Delta v}{\Delta t}$ $_1$✔

Condone power of ten errors and leaving time in hours (or incorrect conversion to seconds)
Correct read off; condone errors in read off that lead to ± 1mm s^{-1} in Δv

and ±0.02 h in ∆t.

For 1 mark expect to see

(79-60) ÷ 1.18

(65-60) ÷ 0.3

(70-60) ÷ 0.6

(75-60) ÷ 0.92

(76-60) ÷ 1

***Max 1** for answer where there is failure to notice false origin. MP2 is available in this case where there is only the false origin error.*

4.5(1) × 10^{-6} (m s^{-2}) $_2$✔

Range = 4.40 × 10^{-6} ≤ accepted value < 4.65 × 10^{-6}

2

(f) Acceleration increases$_1$✔

Condone correct acceleration statement linked to incorrect explanation.

Larger change in momentum (because more photons are reversing direction of motion) <u>therefore</u> a larger force on solar sail $_2$✔

Or

More momentum gained per second (from the photons) $_2$✔

Or

Larger force on photons <u>therefore</u> larger force on sail $_2$✔

2

[11]