Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Particle And Radiation

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Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Mark Schemes

Q1.

(a) 2 rows correct ✔

3 rows correct ✔✔

	K^-	P	Ω	K^0	Y
Rest energy / MeV	493.8	938.3	1672	497.8	493.8
Baryon number	0	+1	+1	0	0
Charge	-1e	+1e	-1e	0	+1e
Strangeness	-1	0	-3	+1	+1

Y's charge: Allow 1 or +1 or +1e
Y's strangeness: Allow +1 or 1

2

(b) $1672 \times 10^6 \times 1.6(0) \times 10^{-19}$ **OR**

Correct conversion of:

1672 MeV to 1.672×10^9 (eV) **OR**

Correct conversion of:

1 MeV to 1.6×10^{-13} (J) ✔

MP1 allow POT error in attempted conversion of eV to J where 1672 × 1.6 is seen.

Condone correct conversion of 1672 MeV or 1 MeV seen in an otherwise incorrect expression.

2.68×10^{-10} (J) ✔

Accept answer correctly rounded to at least 2 sf.
Calculator answer 2.6752 x 10^{-10} (J)

2

(c) Idea that the rest energy of the products is **greater** than the rest energy of the reactants. ✔

MP1 allow:
*Rest energy of reactants = 1432.1 (MeV) **and** rest energy of products = 2663.6 (MeV) or 1231.5 MeV seen.*

Idea that kinetic energy of the reactants is **greater** than the kinetic energy of the products ✔

Alternative:

The rest energies of reactants + their (additional) **kinetic energy** = rest energies of the products✔✔

MP2 allow:

The additional energy (1231.5 MeV) comes from the kinetic energy of the reactants.(Allow the idea that products don't have any kinetic energy).

MP2 must relate to kinetic energy: speed / velocity / momentum is insufficient (treat as neutral).

***Max 1** for the idea that the rest energies are not equal and **kinetic energy** of the particles accounts for the difference.*

2

(d) **MP1:** Applies conservation of baryon no. correctly to at least one decay✔

MP2:

Writes first or second decay in terms of quark compositions.

OR

Identifies decay is via weak interaction

OR

Ξ^0 has a strangeness = -2 or states quark structure as ssu✔

MP3:

The Λ^0 has a strangeness = -1

OR

Writes first two decays in terms of quark compositions.✔

MP4 :

(Quark composition Λ^0 =) uds

OR

writes 3rd decay in terms of quark compositions✔

MP1

Λ^0 is a baryon or Λ^0 consists of 3 quarks (condone any 3) or Λ^0 has a baryon number = 1 ***OR***

Ξ^0 is a baryon or Ξ^0 consists of 3 quarks (condone any 3) or Ξ^0 has a baryon number = 1

***MP2**:*

Decay 1	$\Omega^-(sss)$	$\Xi^0(uss)$	$\pi^-(d\bar{u})$
B	*1*	*1*	*0*
S	*−3*	*−2*	*0*
Q	*−1*	*0*	*−1*
Decay 2	Ξ^0 *(uss)*	Λ^0 *(uds)*	π^0 *($u\bar{u}$ or $d\bar{d}$)*

B	*1*	*1*	*0*
S	*−2*	*−1*	*0*
Q	*0*	*0*	*0*
Decay 3	$\Lambda^0(uds)$	*P(uud)*	$\pi^-(d\bar{u})$
B	*1*	*1*	*0*
S	*−1*	*0*	*0*
Q	*0*	*+1*	*−1*

*An answer of uds scores **MP1** and **MP4**.*

*Must see **MP2** and **MP3** to award these marks.*

***Award 1 mark** if strangeness quoted as positive in both MP2 and MP3 where MP2 and MP3 otherwise not awarded.*

Working can be shown on the equations above (d).

Writes all 3 decays in terms of quarks scores all 4 marks.

4

(e) Use of $E = \frac{hc}{\lambda}$ **OR** $E = hf$ **and** $c = f\lambda$ ✔

Condone POT error in any substituted values.

1.59×10^{-11} (J) ✔

Accept any answer correctly rounded to at least 2 sf.

***Max 1** mark for otherwise correct answer with POT error.*

***Max 1** mark for an answer of 7.956×10^{-12} (J)*

(Correct use of equation but divided energy by two.)

***Max 1** mark for an answer of 2.55×10^{-30} (J)*

(Assumes that 1.59×10^{-11} is in eV and attempts to convert to J.)

Calculator display = 1.5912×10^{-11} (J)

2

(f) $e^- + \bar{\nu}_e$ ✔

Tick in 2nd box only

1

[13]

Q2.

(a) An electron in the beam collides with an electron in the gas particle.

OR

An electron in the beam transfers (some of its kinetic) energy to an electron in the gas particle ✔

MP1 is awarded for the description of the electron-electron interaction or the resulting energy transfer between these electrons.

Treat the gas particles are 'excited' as neutral, must mention an interaction between beam electron and (atomic) electron or an energy transfer from beam electron to (atomic) electron as cause of excitation

Allow beam electron collides with / transfers energy to gas (particle) causing an atomic electron to gain energy

Condone use of plurals in MP1

One (atomic) electron leaves the gas particle ✔

Penalise more than one electron leaving a gas particle

Condone

***One** (atomic) electron leaves the gas (atom)/ the gas (particle) has lost **one** electron*

Physics errors that relate the effect to annihilation or beta decay or PEE or electron capture gain zero marks.

2

(b) Finds the nucleon number of the more massive isotope:

162 ÷ 2 = 81

*Alternative for **MP1**:*

Subtracts proton number from their nucleon number / subtracts total number of protons from total number of nucleons.

eg 80 − 35 or 79 – 35 or 160 – 70 or 158− 70

Condone 45 or 44 on answer line without working for one mark.

*Do **not** allow 162 − 35 or 160 − 35 or 158− 35*

OR

162 − (2 × 35) = 92 ✔

Condone 92 on answer line without working for 1 mark.

90 or 88 on answer line without working no marks

(answer =) 46 ✔ c.a.o

2

(c) The percentage is the same for both isotopes / each isotope makes up 50% of the gas (by number) ✔

Do not allow 50% of 158 and 50% of 162

Where percentage stated must be 50 %

Do not allow more than 2 isotopes

158 is made of two atoms of the lighter isotope and 162 is made of two atoms of the heavier isotope and the percentages of 158 and 162 are: both 25% / both same / present in the same ratio.

OR

Half of the 160 is made from the lighter isotope and all of the 158 is made from the lighter isotope (totalling 50%)

Or words to that effect

OR

Half of the 160 is made from the heavier isotope and all of the 162 is made from the heavier isotope (totalling 50%) ✔

Accept equivalent discussion in terms of numbers of neutrons present in nuclei in molecules / nucleon numbers of nuclei in molecules.

Restating the percentages of the molecules is insufficient for MP2.

2

[6]