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

Q1.

A strong interaction between a negative kaon (K^-) and a proton (p) produces an omega-minus (Ω^-) particle, a neutral kaon (K^0) and an unidentified particle **Y**.

The interaction is:

$$K^- + p \rightarrow \Omega^- + K^0 + \mathbf{Y}$$

The table below contains information on the particles in this interaction.

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

(a) Complete the table above.

(2)

(b) Calculate, in J, the rest energy of the Ω^-.

rest energy = _____ J

(2)

(c) Suggest how energy is conserved in this interaction.
Refer to the rest energies of the particles in the table above.

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(2)

The quark structure of the Ω^- particle is sss.

The Ω^- is unstable. It decays into a proton through a series of decays:

$$\Omega^- \rightarrow \Xi^0 + \pi^-$$

followed by

$$\Xi^0 \rightarrow \Lambda^0 + \pi^0$$

followed by

$$\Lambda^0 \rightarrow p + \pi^-$$

The Ξ^0 and Λ^0 are both hadrons.

(d) Deduce the quark structure of the Λ^0 particle.

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quark structure of Λ^0 = _____

(4)

The products of the decay series include π^0 and π^- particles. These particles are unstable and decay.

(e) The π^0 decays into gamma photons. Each gamma photon has a wavelength of 1.25×10^{-14} m.

Calculate the energy of one of these photons.

energy of photon = _____ J

(2)

(f) The negative pion π^- decays.

Which row shows the particles that could be created in this decay?
Tick ✓ **one** box.

$\mu^- + \nu_\mu$ ☐

$e^- + \overline{\nu}_e$ ☐

$e^- + \nu_e$ ☐

$e^- + e^+ + e^-$ ☐

(1)

(Total 13 marks)

Q2.

A sample of bromine gas contains a mixture of two isotopes. An experiment is done to find the percentage of each isotope in this sample.

(a) In the experiment, the gas is ionised by a beam of electrons.

Explain how the beam of electrons causes a particle of the gas to have a charge of $+1e$.

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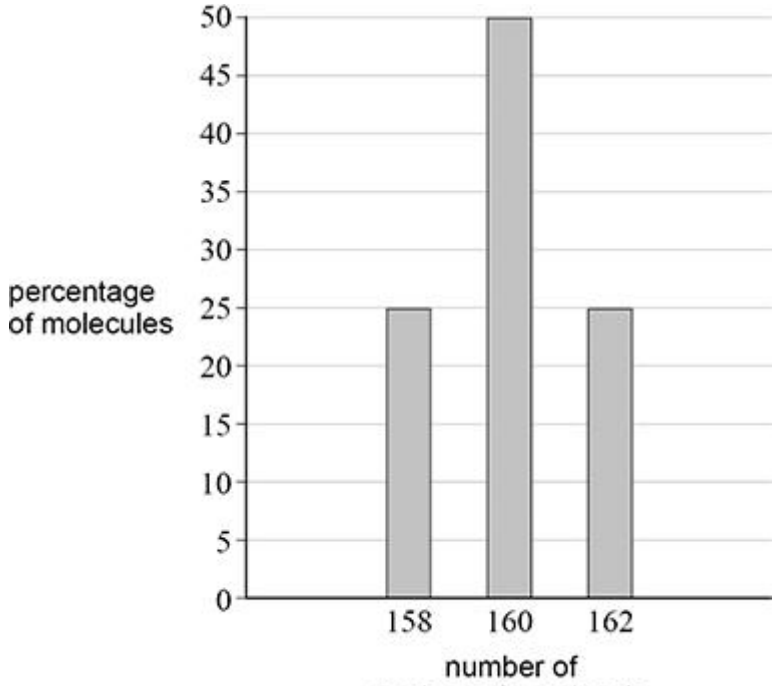
(2)

The gas consists of bromine molecules. Each molecule has two bromine atoms. The experiment finds that the bromine molecules contain 158, 160 or 162 nucleons.

The figure below shows the percentage of these different molecules in the sample.



(b) Bromine has a proton number of 35
The two isotopes in the sample have different nucleon numbers.

Calculate the number of neutrons for the isotope that has the greater nucleon number.

number of neutrons = _____

(2)

(c) Deduce the percentage of each isotope in the gas.
Justify your conclusion.

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(2)
(Total 6 marks)