5. Nuclear physics

5.1 The nuclear model of the atom

Paper 3 and 4

Answer Key

Paper 3

Q1.

Question	Answer	Marks
(a)(i)	(number of neutrons =) 52	**A2**
	nucleon number – proton number = number of neutrons **OR** 90 – 38	(C1)
(a)(ii)	38	**B1**

Q2.

Question	Answer	Marks
(a)(i)	(nucleon number =) 225 (proton number =) 89 (Ac)	**B1**
(a)(ii)	(number of electrons =) 89	**B1**

Q3.

Question	Answer	Marks
(a)(i)	$^{9}_{4}Be$	**B1**
(a)(ii)	neutron(s)	**B1**

Q4.

Question	Answer	Marks
(a)(i)	53	**B1**
(a)(ii)	(131 – 53 =) 78	**B1**

Q5.

Question	Answer	Marks
(a)(i)	neutron	**B1**
(a)(ii)	electron	**B1**
(a)(iii)	14	**B1**

Q6.

Question	Answer	Marks
(a)	line from A to middle box: nucleon number	B1
	line from Z to bottom box: proton number	B1

Q7.

Question	Answer	Marks
(a)(i)	3 (electrons)	B1
(a)(ii)	7 (is the nucleon number)	B1
(a)(iii)	4 (neutrons)	B1

Q8.

Question	Answer	Marks
(a)(i)	6	B1
(a)(ii)	8	B1
(a)(iii)	6	B1

Q9.

Question	Answer	Marks
(a)	positive	B1
	positive	B1
	negative	B1
(b)(i)	88	B1
(b)(ii)	138	B1
(b)(iii)	$^{223}_{88}Ra$	B1
(c)	3 half lives (until 1.0 mg remains)	C1
	$(3 \times 1600) = 4800$ (years)	A1

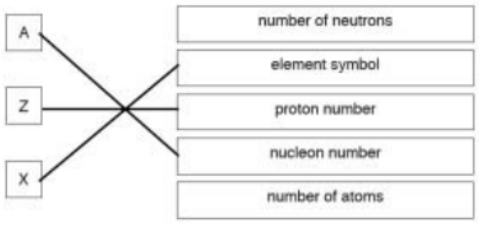
Q10.

Question	Answer	Marks
(a)	1. 6	B1
	2. 6	B1
	3. 8	B1

Q11.

Question	Answer	Marks
(a)	line from 'nucleus' to 'is the centre of an atom'	B1
	line from 'electrons' to 'orbit around centre of an atom'	B1
	line from 'neutrons' to 'has no electric charge'	B1

Q12.

Question	Answer	Marks
(a)	symbol description  1 mark for each correct line. 2 or more lines from any section loses the mark.	3

Paper 4

Q13.

Question	Answer	Marks
(a)	6 electrons **AND** 6 protons (i.e. 6 × **AND** 6 ●)	**B1**
	8 neutrons (i.e. 8 ○)	**B1**
	protons and neutrons in nucleus **AND** electrons orbiting nucleus	**B1**
(b)	(carbon) has one more neutron **OR** nitrogen has one fewer neutron	**B1**
	(carbon) has one fewer proton / electron **OR** nitrogen has one more proton / electron	**B1**

Q14.

Question	Answer	Marks
(a)	(92 is) the proton number / number of protons (in the nucleus) / atomic number	**B1**
	(235 is) the nucleon number / number of nucleons (in the nucleus) / mass number	**B1**
(b)(i)	(nuclear) fission	**B1**
(b)(ii)	nucleus converted to (more stable) nuclei with smaller total mass	**B1**
	mass (difference) is released / converted as (kinetic) energy (of products) / thermal energy	**B1**
(c)(i)	any **three** from: • (thermal energy) used to heat / boil (cold) water OR make steam • steam is at high pressure • steam drives a turbine • turbine (connected to and) drives a generator • turbine moves a coil in a magnetic field	**B3**
(c)(ii)	advantage - any **one from:** • (much) small(er) amount of fuel needed (to produce same amount of energy) • no greenhouse gases produced OR low carbon dioxide emissions • no air pollution (when operating normally)	**B1**
	disadvantage – any **one** from • danger if any leak of radiation • produces hazardous / dangerous / toxic waste **OR** difficulty of storage of used radioactive material **OR** nuclear waste must be stored for a long time • expensive to build or decommission nuclear power plant or store nuclear waste	**B1**

Q15.

Question	Answer	Marks
(a)(i)	same number of protons / both have one proton	**B1**
(a)(ii)	it / hydrogen-3 / $_{(1)}^{3}H$ has one more neutron	**A2**
	different number of neutrons / nucleons	C1

(b)(i)	(high temperature produces) high (kinetic) energy / momentum / speed / ability to do large quantity of work	**B1**
	they repel each other	**B1**
	are positively charged / have like charges **or** need to come close together	**B1**
(b)(ii)	$_{2}^{4}X$ **or** $_{2}^{4}He$ **or** $_{2}^{4}\alpha$	**B1**
	$_{0}^{1}n$ **and** no other particle	**B1**

Q16.

Question	Answer	Marks
(a)	(very small) nucleus **and** surrounded by electrons (in orbit / shells)	**B1**
	92 protons **or** 92 electrons **or** number of protons = number of electrons	**B1**
	protons and neutrons in nucleus	**B1**
	143 neutrons	**B1**
(b)	(uranium-238 has) three more neutrons (in nucleus)	**B1**
(c)	$_{(38)}^{94}(E)$	**B1**
	$_{38}^{(94)}(E)$	**B1**

Q17.

Question	Answer	Marks
(a)	(very small) nucleus **AND** (surrounded by) electrons (in orbit / shells)	**B1**
	neutrons and protons in nucleus	**B1**
	4 electrons (in atom) OR number of electrons = number of protons	**B1**
	4 neutrons (in nucleus)	**B1**

Q18.

Question	Answer	Marks
(a)	$^{2}_{1}H$ **and** $^{3}_{1}H$ **and** in this order	**B1**
(b)(i)	joining together of (small / H) nuclei	**B1**
	to produce a bigger nucleus / He nucleus **or** with the release of energy	**B1**
(b)(ii)	($^{2}_{1}H + ^{3}_{1}H \rightarrow$) $^{1}_{0}n$	**B1**
	(+) $^{4}_{2}(....)$	**B1**
	He **or** α seen	**B1**
(c)	any **two** from: • geothermal (energy) • tidal (energy) • nuclear (energy)	**B2**

Q19.

Question	Answer	Marks
(a)	nuclear fission – nucleus / atom splits (into two) **AND** nuclear fusion – two nuclei / atoms join together	**B1**
	One from • {nuclear fission –large(r) mass (number) OR heavy nuclei / atoms involved OR neutrons involved / emitted} **AND** nuclear fusion – small(er) mass (number) OR light nuclei / atoms involved OR no neutrons • fission in a nuclear reactor AND fusion in Sun / stars • fission produces very radioactive / long lasting waste • fission makes lighter new elements AND fusion makes heavier new elements • fission at normal p / T AND fusion at high p / T • fusion produces more energy (than fission)	**B1**