Q1.

A sequence of radioactive decays starts with nuclide **P** and ends with an isotope of **P**.

Which is a possible sequence for these decays?

A one alpha decay followed by four β^- decays ○

B one alpha decay followed by two β^- decays ○

C two alpha decays followed by two β^- decays ○

D two alpha decays followed by one β^- decay ○

(Total 1 mark)

Q2.

The alpha particle, positron and proton have different charge-to-mass ratios.

Which row shows the particles that have the greatest and the smallest value of this ratio?

	Greatest charge-to-mass ratio	**Smallest charge-to-mass ratio**	
A	positron	alpha particle	○
B	positron	proton	○
C	alpha particle	proton	○
D	alpha particle	positron	○

(Total 1 mark)

Q3.

The quark structure of the antiparticle of the K^+ meson is

A $u\bar{s}$ ○

B $\bar{u}d$ ○

C $\bar{u}s$ ○

D $\bar{d}s$ ○

(Total 1 mark)

Q4.

Which nuclear change results in the nucleus with the greatest specific charge?

A the alpha decay of a $^{209}_{82}Po$ nucleus ⬭

B the beta-minus decay of a $^{28}_{12}Mg$ nucleus ⬭

C the beta-plus decay of a $^{39}_{20}Ca$ nucleus ⬭

D electron capture by a $^{105}_{47}Ag$ nucleus ⬭

(Total 1 mark)

Q5.

An ion has a specific charge of -7.1×10^{7} C kg^{-1}.
It is held stationary in a vertical electric field on the surface of the Earth.

What are the magnitude and direction of the electric field?

A 1.38×10^{-7} V m^{-1} upwards ⬭

B 1.38×10^{-7} V m^{-1} downwards ⬭

C 7.24×10^{6} V m^{-1} upwards ⬭

D 7.24×10^{6} V m^{-1} downwards ⬭

(Total 1 mark)

Q6.

Which particle pair has the largest magnitude of $\frac{\text{electrostatic force}}{\text{gravitational force}}$ when separated by the same distance?

A an electron and a positive pion ⬭

B a helium nucleus and a proton ⬭

C a proton and a positive pion ⬭

D a proton and an electron ⬭

(Total 1 mark)

Q7.

Uranium-238 absorbs a neutron in the first stage in a series of nuclear reactions that end in a nucleus Z.

$$^{238}_{92}U + n \rightarrow X\ 92$$

$$X \rightarrow Y + \beta^- + \overline{\nu_e}$$

$$Y \rightarrow Z + \beta^- + \overline{\nu_e}$$

How many neutrons does Z have?

A 144 ○

B 145 ○

C 149 ○

D 237 ○

(Total 1 mark)

Q8.

An electron and a positron annihilate each other.

Which quantity is **not** conserved in the annihilation?

A electric charge ○

B kinetic energy ○

C lepton number ○

D momentum ○

(Total 1 mark)

Q9.

Which exchange particle transfers charge during electron capture?

A meson ○

B pion ○

C virtual photon ○

D W boson ○

(Total 1 mark)

Q10.

A free neutron decays to produce a proton and

A an electron and an antineutrino. ⬭

B an electron and a neutrino. ⬭

C a positron and an antineutrino. ⬭

D a positron and a neutrino. ⬭

(Total 1 mark)

Q11.

A nucleus of bismuth-209 $\left({}^{209}_{83}\mathrm{Bi}\right)$ absorbs a neutron. The newly formed nucleus
subsequently decays in two stages to form a nucleus of nuclide **X**.
One beta-minus particle and one alpha particle are emitted during these two decays.

What are the nucleon number and the proton number of **X**?

	Nucleon number	Proton number	
A	205	82	⬭
B	205	83	⬭
C	206	82	⬭
D	206	83	⬭

(Total 1 mark)

Q12.

The concept of exchange particles was introduced to explain forces between elementary particles.

This concept requires that exchange particles have

A charge. ⬭

B momentum. ⬭

C phase. ⬭

D rest mass. ⬭

(Total 1 mark)

Q13.

A nucleus contains N neutrons and Z protons.

Which combination of N and Z gives a nucleus with the greatest specific charge?

	N	Z	
A	6	5	⬭
B	8	7	⬭
C	16	13	⬭
D	20	17	⬭

(Total 1 mark)

Q14.

Which statement about muons is correct?

A They consist of a quark and an antiquark. ⬭

B They include pions and kaons. ⬭

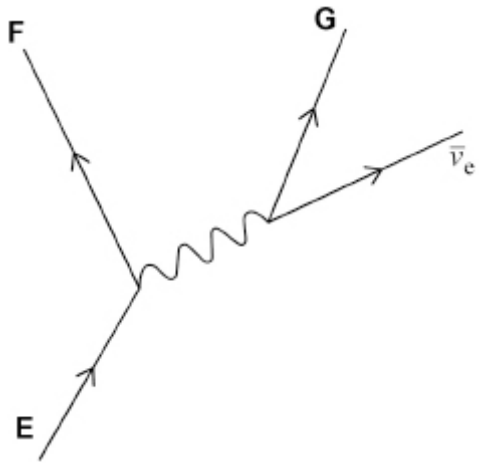
C They are subject to the strong interaction. ⬭

D They decay into electrons. ⬭

(Total 1 mark)

Q15.

The diagram represents a quark change in which an electron antineutrino is produced.



What are **E**, **F** and **G**?

	E	F	G	
A	up quark	down quark	β^-	⬭
B	down quark	up quark	β^-	⬭
C	up quark	down quark	β^+	⬭
D	down quark	up quark	β^+	⬭

(Total 1 mark)

Q16.

Which row has the largest value for

$$\frac{\text{specific charge of the particle in column X}}{\text{specific charge of the particle in column Y}}?$$

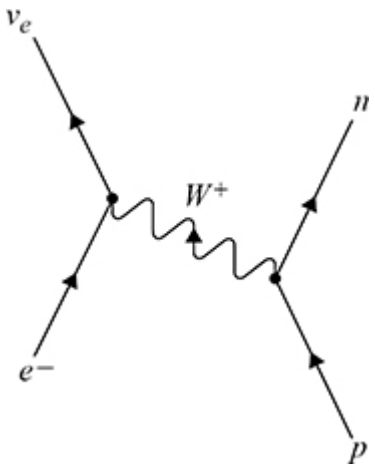
	X	Y	
A	electron	alpha particle	⬭
B	alpha particle	electron	⬭
C	electron	proton	⬭
D	proton	alpha particle	⬭

(Total 1 mark)

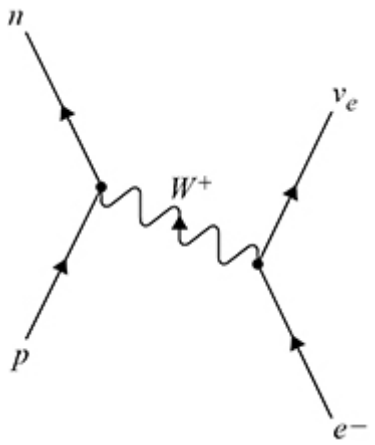
Q17.

Which diagram represents the process of electron capture?

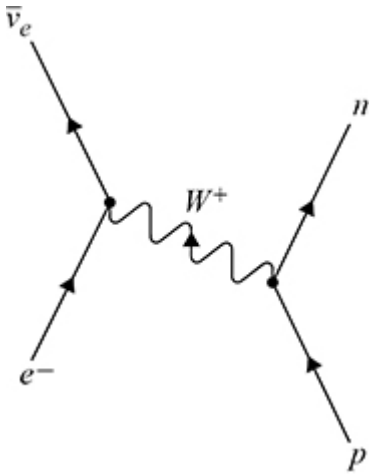
A



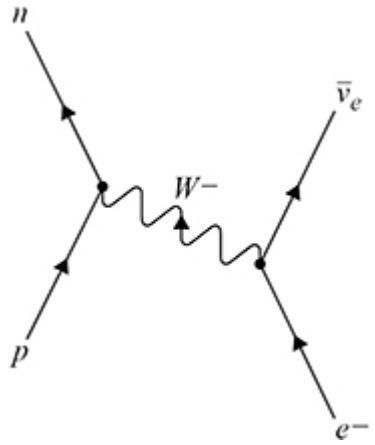
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

Q18.

Which row is correct?

	Name of particle	Classification	Quark structure	
A	antineutron	meson	$\bar{u}\bar{u}\bar{d}$	○
B	positive kaon	baryon	$\bar{u}\ s$	○
C	antiproton	baryon	$\bar{u}\bar{u}\bar{d}$	○
D	positive pion	meson	$\bar{u}\ d$	○

(Total 1 mark)

Q19.

An alpha particle and a nucleus of boron $^{10}_{5}\text{B}$ interact to form an unstable nucleus and a free neutron.

The unstable nucleus decays by positron emission to form a nucleus of nuclide **X**.

What is **X**?

A $^{13}_{5}\text{B}$ ○

B $^{13}_{6}\text{C}$ ○

C $^{13}_{7}\text{N}$ ○

D $^{13}_{8}\text{O}$ ○

(Total 1 mark)

Q20.

What is the specific charge of a $^{13}_{6}\text{C}$ nucleus?

A $4.4 \times 10^{7}\ \text{C kg}^{-1}$ ○

B $5.2 \times 10^{7}\ \text{C kg}^{-1}$ ○

C $8.3 \times 10^{7}\ \text{C kg}^{-1}$ ○

D $2.1 \times 10^{8}\ \text{C kg}^{-1}$ ○

(Total 1 mark)

Q21.

Which row describes the variation with distance of the strong nuclear force?

	Attractive	Repulsive	
A	beyond 3 fm	from 0.5 fm to 3 fm	⬭
B	from 0.5 fm to 3 fm	beyond 3 fm	⬭
C	from 0.5 fm to 3 fm	up to 0.5 fm	⬭
D	up to 0.5 fm	from 0.5 fm to 3 fm	⬭

(Total 1 mark)

Q22.

Which statement is correct?

A All strange particles are mesons. ⬭

B Strange particles are always created in pairs. ⬭

C Strangeness can only change in strong interactions. ⬭

D Strangeness can only have a value of 0 or −1 ⬭

(Total 1 mark)

Q23.

Which combination of quarks is possible?

A sd ⬭

B sū ⬭

C sūd ⬭

D ud ⬭

(Total 1 mark)

Q24.

In photoelectricity, V_s is the stopping potential.

What quantity is eV_s?

A energy of an incident photon ⬭

B maximum kinetic energy of a photoelectron ⬭

C threshold frequency × the Planck constant ⬭

D work function ⬭

(Total 1 mark)