

Particles and radiation – A2 Physics P1

1. No. 01

0 1

Cosmic rays are high-energy particles that come from space. Most of these particles are protons. There are other particles in cosmic rays, including atomic nuclei.

Table 1 gives the data for one particular nucleus X.

Table 1

Mass / kg	8.02×10^{-26}
Specific charge / C kg ⁻¹	4.39×10^7
Kinetic energy / MeV	215

0 1 . 1

Determine the number of neutrons in nucleus X.

[3 marks]

number of neutrons = _____

0 1 . 2

Calculate the speed of X.
Ignore relativistic effects.

[3 marks]

speed = _____ m s⁻¹

A pion (π^+) and a kaon (K^+) are produced when cosmic rays interact with the upper atmosphere.

- 0 1 . 3 The π^+ decays to produce a positron and an electron neutrino.

Show how the conservation laws apply to this decay.

[2 marks]

- 0 1 . 4 The K^+ decays to produce an anti-muon and a muon neutrino.

Explain how strangeness applies in this decay.

[2 marks]

- 0 1 . 5 Write an equation for a K^+ decay that involves only hadrons.

[2 marks]

2. No. 09

The gravitational force is one of the four fundamental forces.

The ticks in the table match particles with the other fundamental forces.

In which row is the particle matched to the only other fundamental forces it experiences?

[1 mark]

	Particle	Electromagnetic force	Weak nuclear force	Strong nuclear force
A	μ^+	✓	✓	
B	$\bar{p}$	✓		✓
C	π^0	✓	✓	✓
D	ν_e		✓	✓

☐☐☐☐

3. No. 10

The proton number of uranium is 92 and the proton number of radon is 88

Which series of decays turns a uranium nucleus into a radon nucleus?

[1 mark]

A $\alpha + \beta^- + \beta^- + \alpha + \alpha$

☐

B $\beta^- + \beta^- + \alpha + \beta^- + \alpha$

☐

C $\alpha + \alpha + \alpha + \alpha + \beta^-$

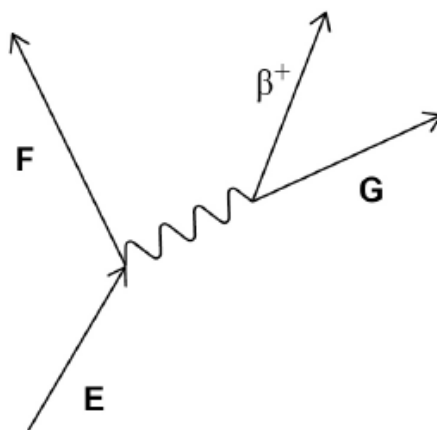
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D $\beta^- + \beta^- + \beta^- + \beta^- + \alpha$

☐

4. No. 11

The diagram represents a particle interaction.



Which row identifies particles **E**, **F** and **G**?

[1 mark]

	E	F	G	
A	up quark	down quark	neutrino	☐
B	down quark	up quark	neutrino	☐
C	up quark	down quark	antineutrino	☐
D	down quark	up quark	antineutrino	☐

5. No. 12

The quark combination of a particle is $s\bar{u}$.

Which is true for this particle?

[1 mark]

- A** It has a baryon number of 1 ☐
- B** It has a charge of -1.6×10^{-19} C. ☐
- C** It is a pion. ☐
- D** It has a strangeness of $-\frac{1}{3}$ ☐

6. No. 13

Monochromatic light with a photon energy of $4.1 \times 10^{-19} \text{ J}$ is incident on a metal surface. The maximum speed of the photoelectrons released is $4.2 \times 10^5 \text{ m s}^{-1}$.

What is the work function of the metal?

[1 mark]

A $2.5 \times 10^{-19} \text{ J}$ ☐

B $3.3 \times 10^{-19} \text{ J}$ ☐

C $4.1 \times 10^{-19} \text{ J}$ ☐

D $4.9 \times 10^{-19} \text{ J}$ ☐

7. No. 14

What is the role of the mercury vapour in a fluorescent tube?

[1 mark]

A It absorbs photons of UV light and emits visible light. ☐

B It absorbs photons of visible light and emits UV light. ☐

C It emits photons of visible light following ionisation or excitation. ☐

D It emits photons of UV light following ionisation or excitation. ☐

8. No. 15

The diagram shows the three lowest energy levels for an atom.
The energy levels have been drawn to scale.

level 2 _____

level 1 _____

ground state _____

Transitions of electrons between these energy levels produce photons of the following frequencies:

$$4.56 \times 10^{14} \text{ Hz}$$

$$2.46 \times 10^{15} \text{ Hz}$$

$$2.92 \times 10^{15} \text{ Hz.}$$

What is the difference in energy between the ground state and energy level 1?

[1 mark]

A $0.3 \times 10^{-18} \text{ J}$

☐

B $1.3 \times 10^{-18} \text{ J}$

☐

C $1.6 \times 10^{-18} \text{ J}$

☐

D $1.9 \times 10^{-18} \text{ J}$

☐

9. No. 16

A muon and an electron are travelling at the same speed.

Which row gives the particle with the greater kinetic energy and the particle with the longer de Broglie wavelength?

[1 mark]

	Greater kinetic energy	Longer de Broglie wavelength	
A	muon	muon	☐
B	muon	electron	☐
C	electron	muon	☐
D	electron	electron	☐