Do not write outside the box

1 3 Monochromatic light with a photon energy of 4.1×10^{-19} J is incident on a metal surface. The maximum speed of the photoelectrons released is 4.2×10^{5} m s^{-1}.

What is the work function of the metal?

$hf = E_{K_m} + \phi$

$4.1 \times 10^{-19} - \frac{1}{2} \times 9.11 \times 10^{-31} \times (4.2 \times 10^{5})^2 = \phi$

[1 mark]

A 2.5×10^{-19} J ⬭

B 3.3×10^{-19} J ●

C 4.1×10^{-19} J ⬭

D 4.9×10^{-19} J ⬭

1 4 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. ⬭

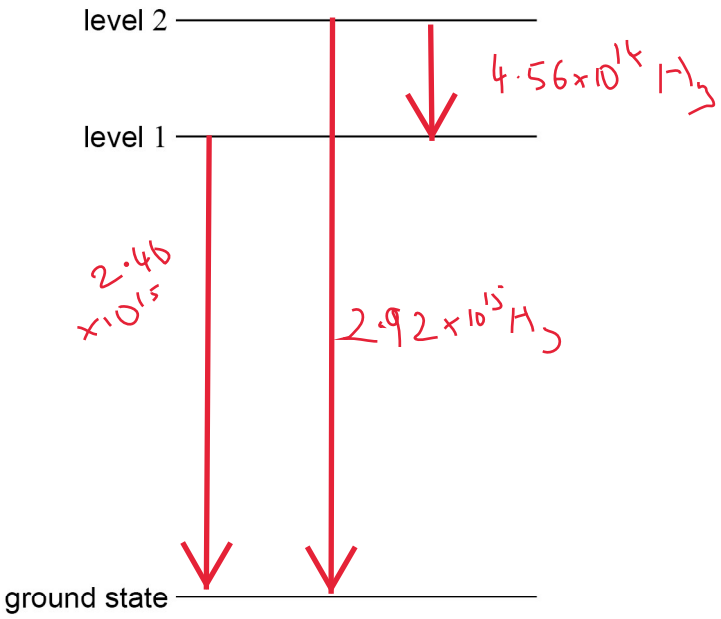
C It emits photons of visible light following ionisation or excitation. ⬭

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

Turn over for the next question

Do not write outside the box

1 5 The diagram shows the three lowest energy levels for an atom.
The energy levels have been drawn to scale.



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

4.56×10^{14} Hz
2.46×10^{15} Hz
2.92×10^{15} Hz.

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

[1 mark]

A 0.3×10^{-18} J ○

B 1.3×10^{-18} J ○

C 1.6×10^{-18} J ⊗

D 1.9×10^{-18} J ○

Do not write outside the box

1 6 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	○

Do not write outside the box

Section A

Answer **all** questions in this section.

0 1 . 1 Determine whether the following reaction is a possible decay for the neutral pion π^0.

$$\pi^0 \rightarrow e^- + \mu^+ + \bar{\nu}_e$$

[2 marks]

B: $0 \rightarrow 0 + 0 + 0$ ✓

Q: $0 \rightarrow -1 + +1 + 0$ ✓

L_e $0 \rightarrow +1 \quad -1 \quad -1$ ✗

No L_e not conserved

0 1 . 2 State the **two** possible quark configurations of a π^0.

[1 mark]

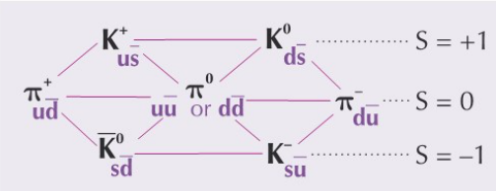
1 $u\bar{u}$

2 $d\bar{d}$

0 1 . 3 A student suggests that the kaon K^0 and the anti-kaon $\overline{K^0}$ are the same particle.

Discuss whether this suggestion is correct.

[2 marks]



$K^0 = d\bar{s}$

$\overline{K^0} = \bar{d}s$

K^0 : $S=1$ $Q=0$

$\overline{K^0}$: $S=-1$ $Q=0$

different strangeness so not the same particle

Do not write outside the box

0 1 . 4 The nucleus is held together by a force. It was predicted that a particle exists that is responsible for this force. The particle itself must experience this force.

The particle would have a rest energy between that of an electron and half that of a nucleon.

Discuss whether a kaon, a muon and a pion **each** have the properties of the predicted particle.

Information about these three particles is in the Data and Formulae Booklet.

[4 marks]

Class	Name	Symbol	Rest energy/MeV
photon	photon	γ	0
lepton	neutrino	ν_e	0
		ν_μ	0
	electron	$e^{\pm}$	0.510999
	muon	$\mu^{\pm}$	105.659
mesons	π meson	$\pi^{\pm}$	139.576
		π^0	134.972
	K meson	$K^{\pm}$	493.821
		K^0	497.762
baryons	proton	p	938.257
	neutron	n	939.551

Must be the strong force:
nucleon RE is about 939MeV. RE electron = 0.5Mev
Kaon has RE 493MeV which is over half that of nucleon
Muon doesn't experience SNF so not that
pion has RE 139MeV which is between the values required -

so Pion

9

Turn over for the next question