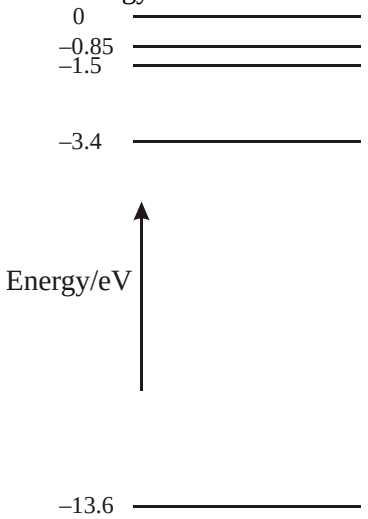
Energy Level Questions Mark Scheme

1. The diagram shows some of the energy levels for atomic hydrogen.



For each of the statements below, indicate whether the statement is true (√) or false (x)

Statement	True/False
The single electron of a hydrogen atom normally occupies the –13.6 eV energy level.	✓
An electron of energy 10 eV colliding with a hydrogen atom in its ground state could have an energy of 0.2 eV after the collision.	✗
An electron moving from the –3.4 eV to the –0.85 eV level gives out a photon of energy 2.55 eV.	✗
Light of wavelength 650 nm has sufficient energy to excite an electron from the –3.4 eV to the –1.5 eV energy level.	✓

Use this space for any calculations.

(4 marks)
[Total 4 marks]

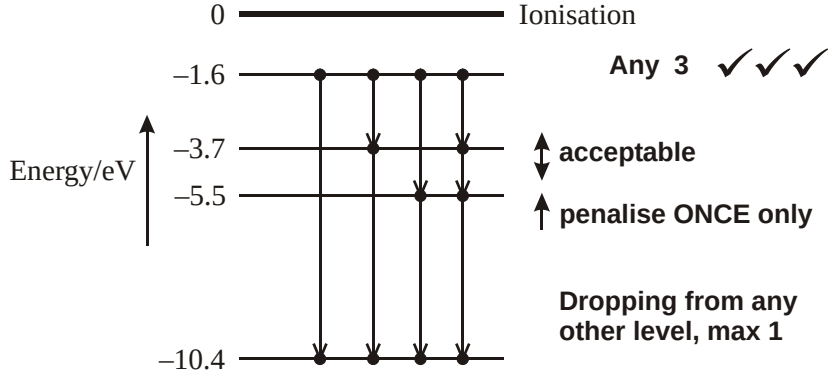
2. Table:

Description	Type of wave	
A wave capable of causing photo-electric emission of electrons	Ultraviolet	**(1)**
A wave whose vibrations are parallel to the direction of propagation of the wave	Sound	**(1)**
A transverse wave of wavelength 5×10^{-6} m	Infrared	**(1)**
The wave of highest frequency	Ultraviolet	**(1)**

4

[4]

3. The diagram shows some of the outer energy levels of the mercury atom.



Calculate the ionisation energy in joules for an electron in the -10.4 eV level.

any use of 1.6×10^{-19} (1)

Ionisation energy = **$1.66/1.7 \times 10^{-18}$ (J) (1)**
[$-1.66 \times 10^{-18} \rightarrow$ (1 only)]

Any other unit : unit penalty

(2 marks)

An electron has been excited to the –1.6 eV energy level. Show on the diagram all the possible ways it can return to the –10.4 eV level.

(3 marks)

Which change in energy levels will give rise to a yellowish line (λ = 600 nm) in the mercury spectrum?

Substitution in $\frac{hc}{\lambda}$ $\frac{6.6\times10^{-34}\times3\times10^{8}}{600\times10^{-9}}$ **(1)**

÷ 1.6 × 10^{-19} (1)

= 2.07 (2 – 2.1) (eV) (1)

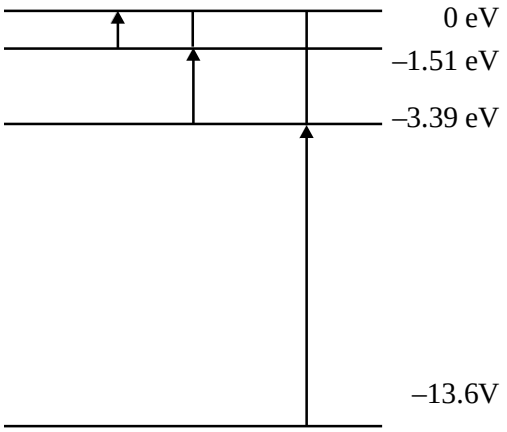
Level change -1.6 to -3.7 (1)

[Insist on '-' sign AND on higher → lower level, i.e. NOT -3.7 to -1.6]

Whole thing done backwards ⇒ 591 nm, can get 4/4

(4 marks)
[Total 9 marks]

4. Energy level diagram:



– 13.6 → 0

– 1.51 → 0 AND – 3.39 → 0 ONLY 2

Why level labelled – 13.6 eV is called ground state:
Correct reference to stability/lowest energy state/level of
the electron/ atom/hydrogen 1

Transition which would result in emission of light of wavelength 660 nm:

Correct use of $c = f\lambda$ *or* $E = hc/\lambda$ *or* $f = \frac{3\times10^{8}\ \text{ms}^{-1}}{660\times10^{-9}\ \text{m}}$

Correct use of eV/J i.e. ÷ 1.6×10^{-19}

$\Delta E = 1.88$

Transition = 1.5 → 3.39

[May be a downward arrow on diagram] 4

[7]