AQA – Particles and radiation – AS Physics P2

1. June/2021/Paper_7407_02/No.06

An atom of oxygen-15 $\left({}^{15}_{8}\mathrm{O}\right)$ gains two electrons to form an ion.

What is the specific charge of the ion?

[1 mark]

A $-1.3 \times 10^{7}\ \mathrm{C\ kg^{-1}}$ ⬭

B $-2.4 \times 10^{7}\ \mathrm{C\ kg^{-1}}$ ⬭

C $-5.1 \times 10^{7}\ \mathrm{C\ kg^{-1}}$ ⬭

D $-6.4 \times 10^{7}\ \mathrm{C\ kg^{-1}}$ ⬭

2. June/2021/Paper_7407_02/No.07

Which is an exchange particle for the weak interaction?

[1 mark]

A lepton ⬭

B photon ⬭

C pion ⬭

D $\mathrm{W^{+}}$ ⬭

3. June/2021/Paper_7407_02/No.08

A particular baryon has a quark structure dss and decays by the weak interaction.

What are possible decay products of this baryon?

The quark structure of Λ^{0} is uds.

[1 mark]

A $\Lambda^{0} + \pi^{-}$ ⬭

B $\mathrm{n} + \pi^{-}$ ⬭

C $\Lambda^{0} + \mathrm{e^{-}}$ ⬭

D $\mathrm{K^{+}} + \mathrm{K^{0}}$ ⬭

4. June/2021/Paper_7407_02/No.09

A muon and an antimuon annihilate to produce the minimum number of photons.

What is the maximum wavelength of the photons?

[1 mark]

A 5.9×10^{-15} m ⬭

B 1.2×10^{-14} m ⬭

C 5.9×10^{-9} m ⬭

D 1.2×10^{-8} m ⬭

5. June/2021/Paper_7407_02/No.10

An electron has speed v. The electron's kinetic energy is doubled.

What is the new speed of the electron?

[1 mark]

A $\frac{v}{\sqrt{2}}$ ⬭

B $\sqrt{2}v$ ⬭

C $2v$ ⬭

D $4v$ ⬭

6. June/2021/Paper_7407_02/No.12

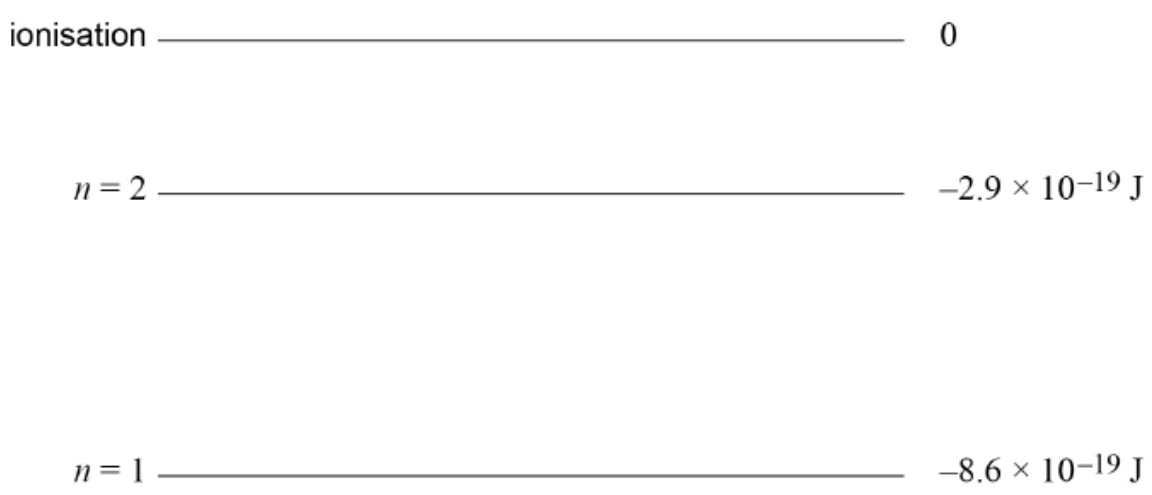
Which row describes the nature of the strong nuclear force between two nucleons at separations of 0.25 fm, 2.0 fm and 8.0 fm?

[1 mark]

	At a separation of 0.25 fm	At a separation of 2.0 fm	At a separation of 8.0 fm	
A	attractive	repulsive	negligible	⬭
B	repulsive	attractive	attractive	⬭
C	negligible	repulsive	attractive	⬭
D	repulsive	attractive	negligible	⬭

7. June/2021/Paper_7407_02/No.13

Some energy levels of a lithium atom are shown below.



A free electron with kinetic energy 6.0×10^{-19} J collides with a stationary lithium atom in its $n = 1$ energy level. The lithium atom is excited to the $n = 2$ energy level.

What is the kinetic energy of the free electron after the collision?

[1 mark]

A 0.3×10^{-19} J ⬭

B 2.6×10^{-19} J ⬭

C 3.1×10^{-19} J ⬭

D 5.7×10^{-19} J ⬭

8. June/2021/Paper_7407_02/No.14

What are the products when a free neutron decays?

[1 mark]

A $p + e^- + \nu_e$ ⬭

B $p + e^+ + \bar{\nu}_e$ ⬭

C $p + e^- + \bar{\nu}_e$ ⬭

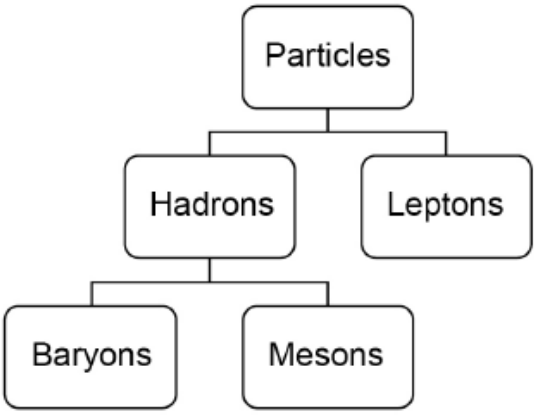
D $p + e^+ + \nu_e$ ⬭

9. June/2021/Paper_7407_02/No.35

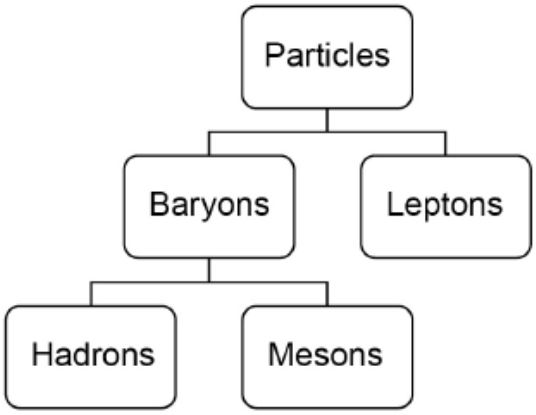
Which shows the classification of particles?

[1 mark]

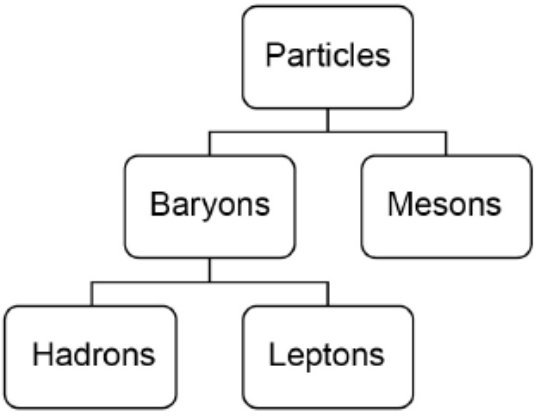
A



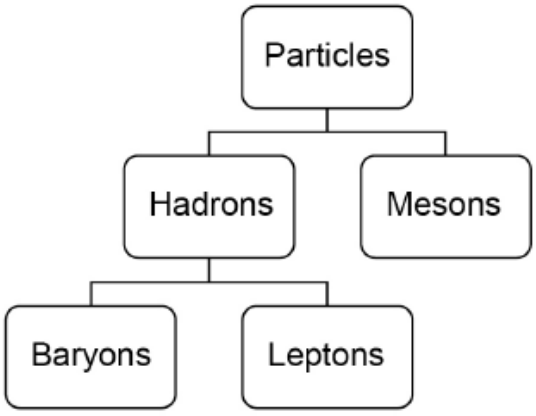
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

10. June/2020/Paper_7407_02/No.04

0 4 Scintillation counters are used to detect beta particles. A scintillation counter consists of a scintillation material and a photomultiplier tube (PMT).

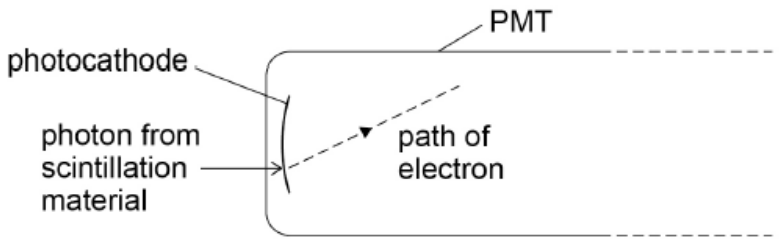
0 4 . 1 Beta particles collide with atoms in the scintillation material, which emits photons of light as a result.

Explain how photons are produced by collisions between beta particles and atoms.

[2 marks]

0 4 . 2 A photon of light from the scintillation material enters the PMT, as shown in **Figure 7**. The front of the PMT contains a thin photocathode. The photon strikes the photocathode to release an electron.

Figure 7



The longest wavelength of light that releases an electron from this photocathode is 630 nm.

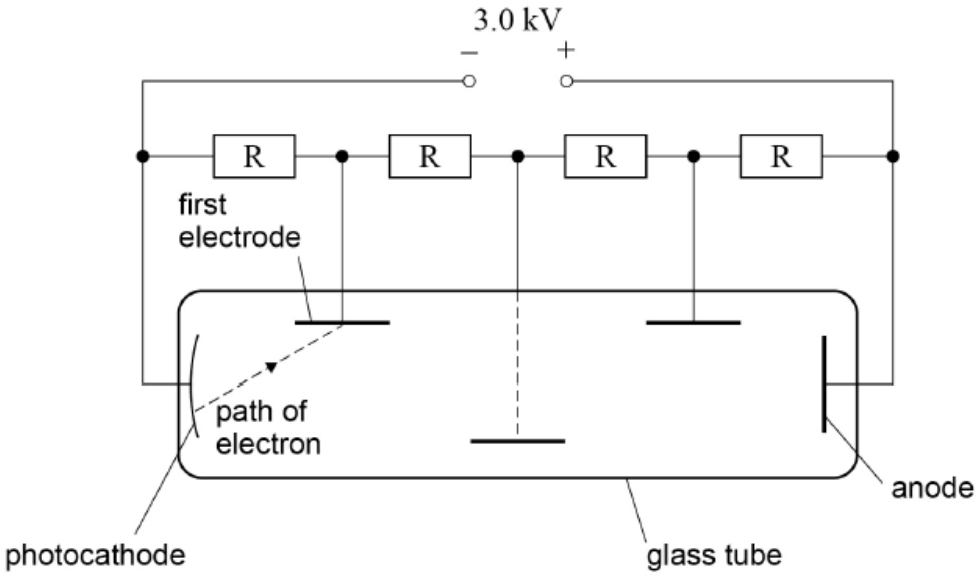
Calculate the minimum photon energy required to remove an electron from the photocathode.

[2 marks]

minimum photon energy = _____ J

0 4 . 3 The PMT consists of an evacuated glass tube containing the photocathode, an anode and three metal electrodes, as shown in **Figure 8**.

Figure 8



The electrodes, anode and photocathode are connected to a potential divider consisting of four identical resistors R. The emf of the electrical supply is 3.0 kV.

The potential difference between the photocathode and the first electrode accelerates the electron along the path shown in **Figure 8**.

Calculate, in J, the maximum kinetic energy transferred to the electron when it accelerates from the photocathode to the first electrode.

[2 marks]

maximum kinetic energy = _____ J

0 4 . 4 The electron hits the first electrode and causes the release of several electrons. **Figure 9** shows how a series of accelerations and collisions produces a large number of electrons. These electrons hit the anode and produce a pulse of current in an ammeter.

Figure 9

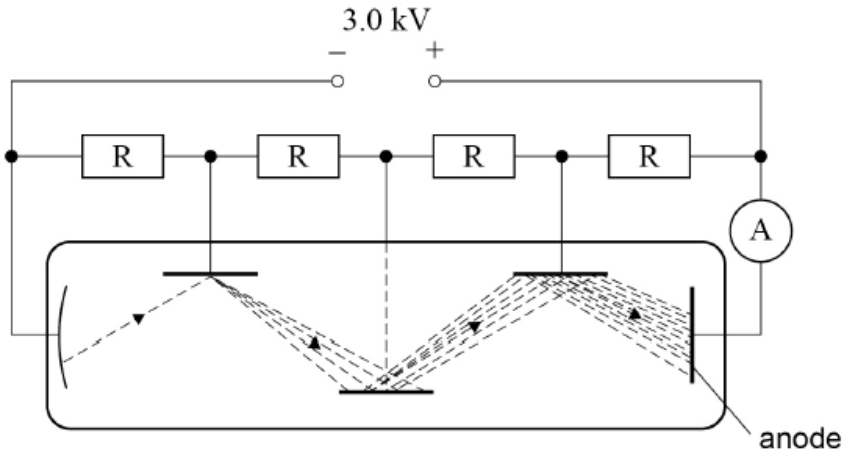
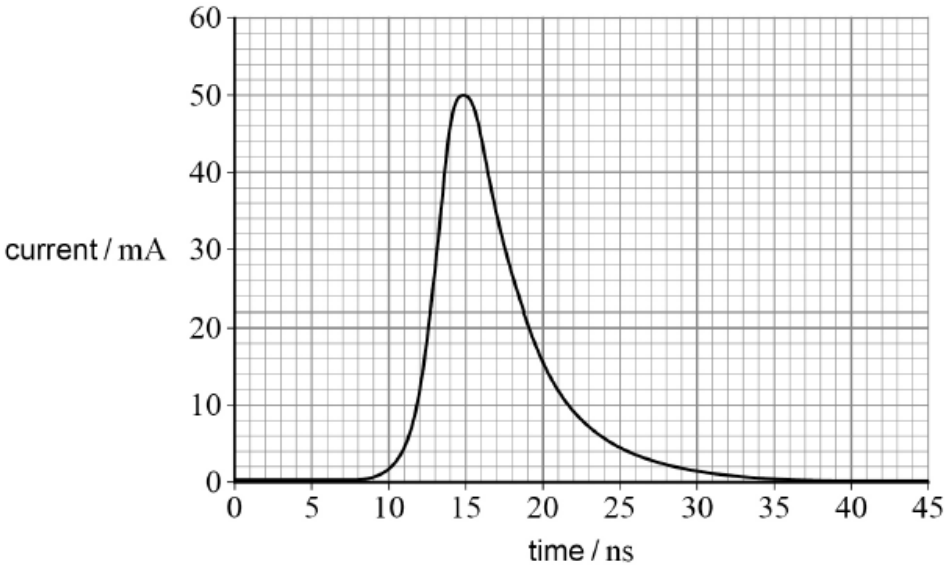


Figure 10 shows the variation of current in the ammeter with time due to this pulse.

Figure 10



Determine the number of electrons that flow through the ammeter.

[4 marks]

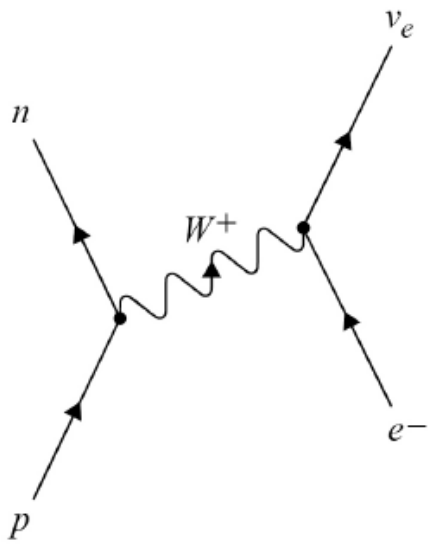
number of electrons = _____

11. June/2020/Paper_7407_02/No.06

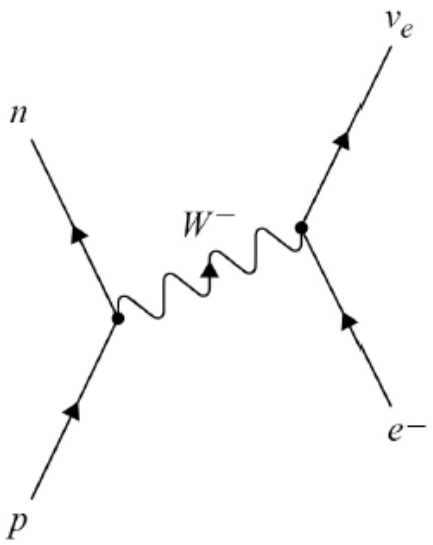
Which diagram represents electron capture?

[1 mark

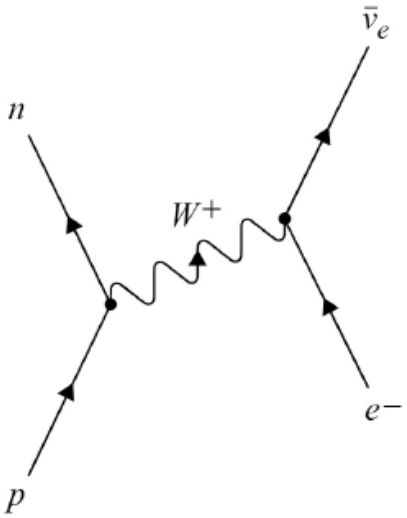
A



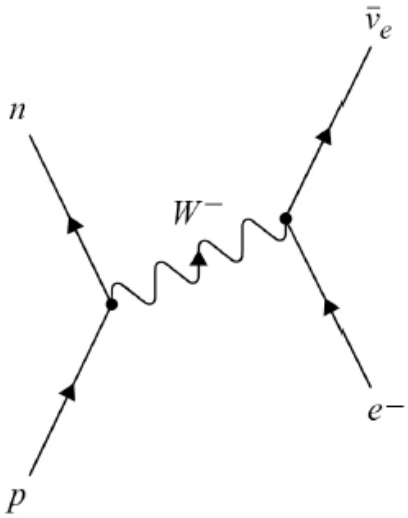
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

12. June/2020/Paper_7407_02/No.07

$^{x}_{81}\mathrm{Tl}$ decays to $^{206}_{82}\mathrm{Pb}$ by a series of four radioactive decays.

Each decay involves the emission of either a single α particle or a single β^- particle.

What is x?

[1 mark]

A 207 ⬭

B 209 ⬭

C 210 ⬭

D 212 ⬭

13. June/2020/Paper_7407_02/No.08

What is the number of up quarks and down quarks in a $^{9}_{4}\mathrm{Be}$ nucleus?

[1 mark]

	Number of up quarks	Number of down quarks	
A	11	16	⬭
B	13	14	⬭
C	14	13	⬭
D	16	11	⬭

14. June/2020/Paper_7407_02/No.09

Which decay of a positive kaon (K^+) particle is possible?

[1 mark]

A $K^+ \rightarrow \pi^0 + e^+ + \bar{\nu}_e$ ⬭

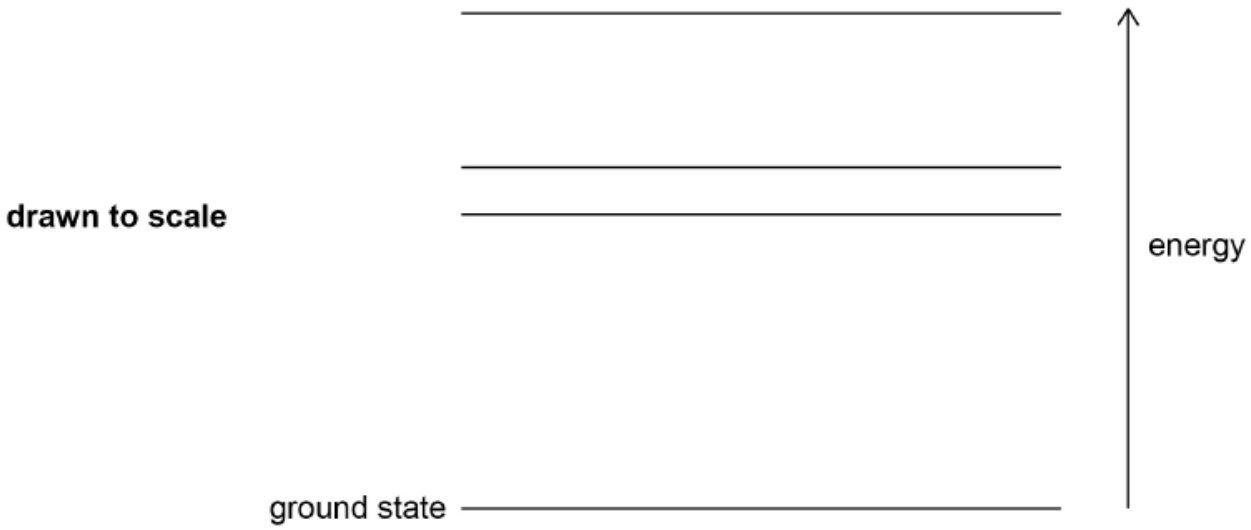
B $K^+ \rightarrow p + \nu_\mu$ ⬭

C $K^+ \rightarrow \pi^+ + \pi^+ + \pi^0$ ⬭

D $K^+ \rightarrow \mu^+ + \nu_\mu$ ⬭

15. June/2020/Paper_7407_02/No.10

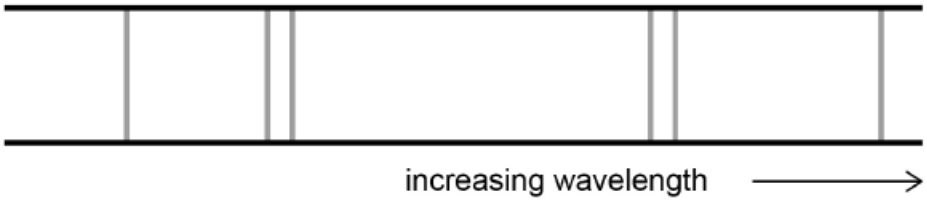
The diagram shows four energy levels of an atom drawn to scale.
These energy levels give rise to part of an emission spectrum.



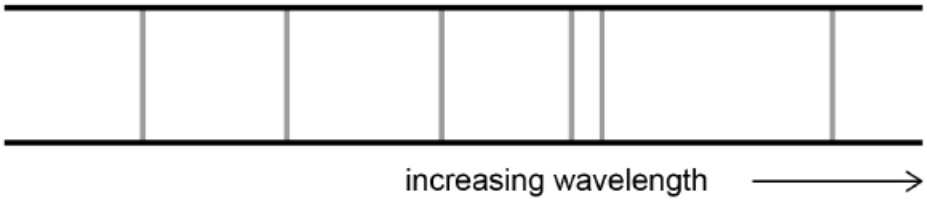
Which pattern of lines will be observed from these energy levels?

[1 mark]

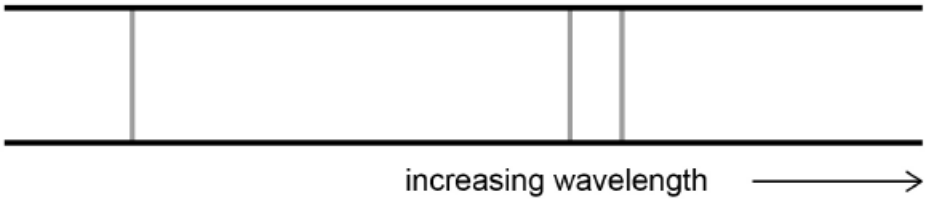
A



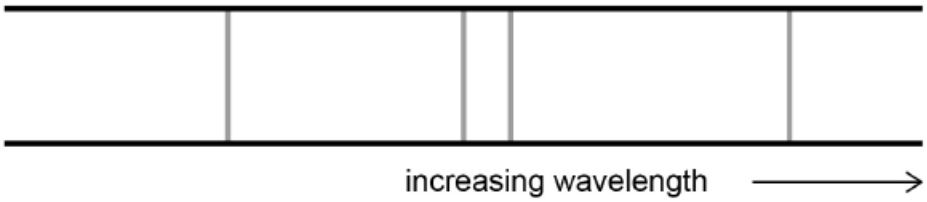
B

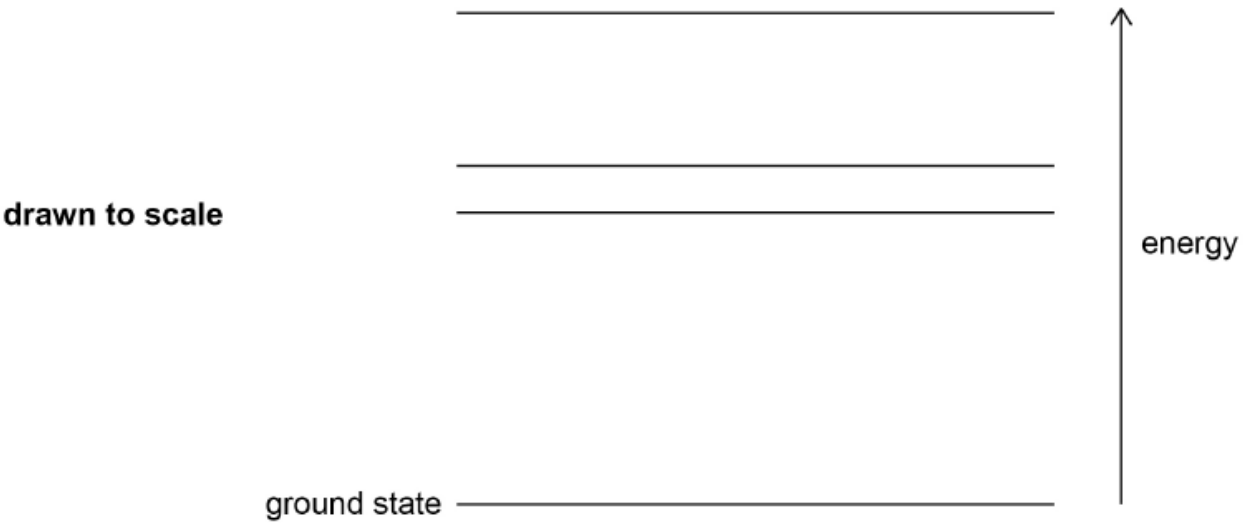


C



D

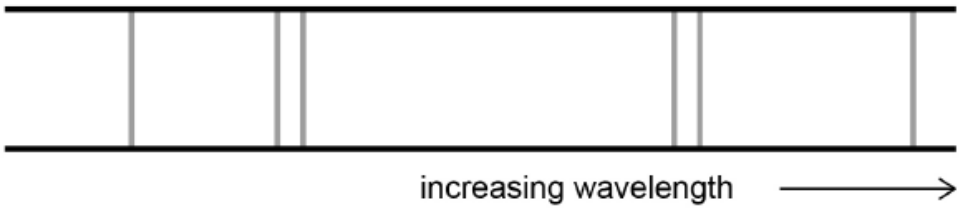




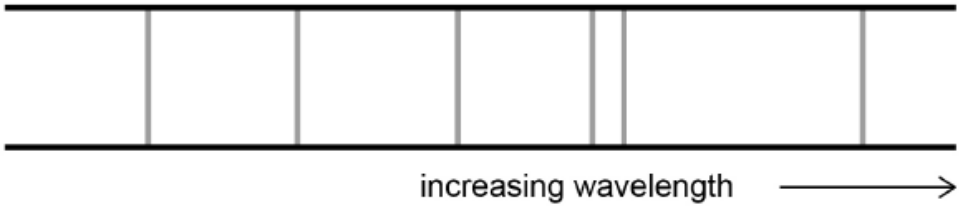
Which pattern of lines will be observed from these energy levels?

[1 mark]

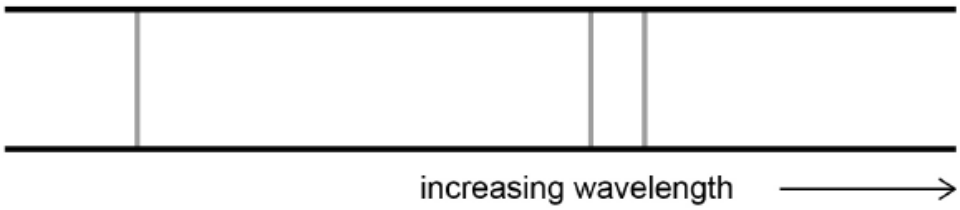
A



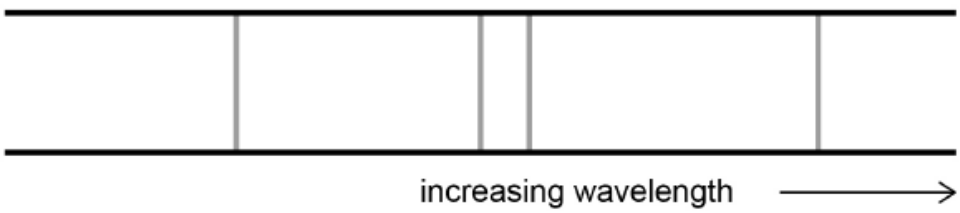
B



C



D



16. June/2020/Paper_7407_02/No.11

A particle has a kinetic energy of E_k and a de Broglie wavelength of λ.

What is the de Broglie wavelength when the particle has a kinetic energy of $4E_k$?

[1 mark]

A $\frac{\lambda}{2}$ ⬭

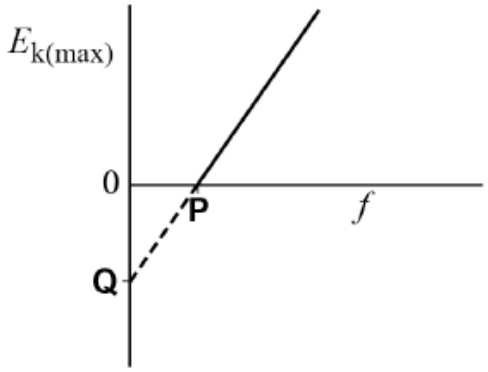
B $\frac{\lambda}{\sqrt{2}}$ ⬭

C $\sqrt{2}\lambda$ ⬭

D 2λ ⬭

17. June/2021/Paper_7407_02/No. 21

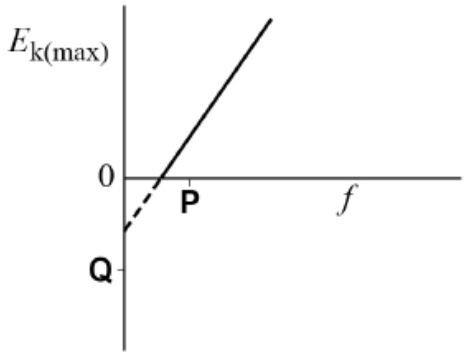
The graph shows how the maximum kinetic energy $E_{k(max)}$ of photoelectrons emitted from a metal surface varies with the frequency f of the incident radiation.
P is the intercept on the f axis. **Q** is the intercept on the $E_{k(max)}$ axis.



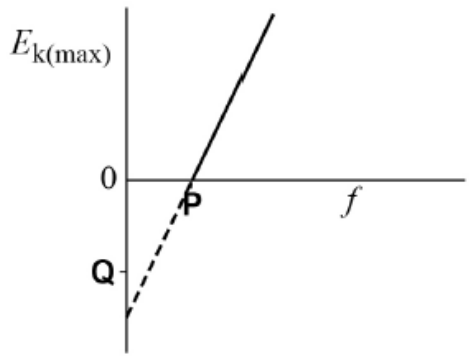
Which graph shows the variation of $E_{k(max)}$ with f for a metal with a greater work function?

[1 mark]

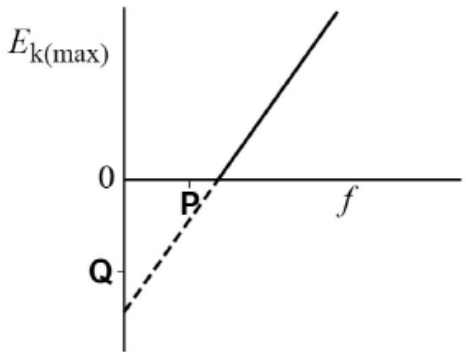
A



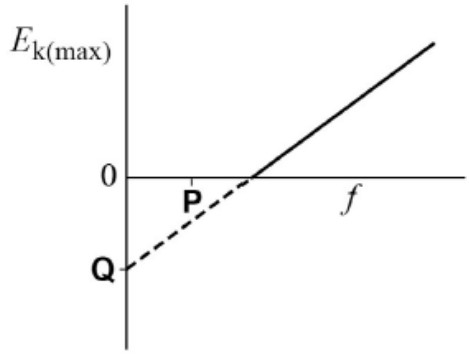
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

18. June/2021/Paper_7407_02/No.05

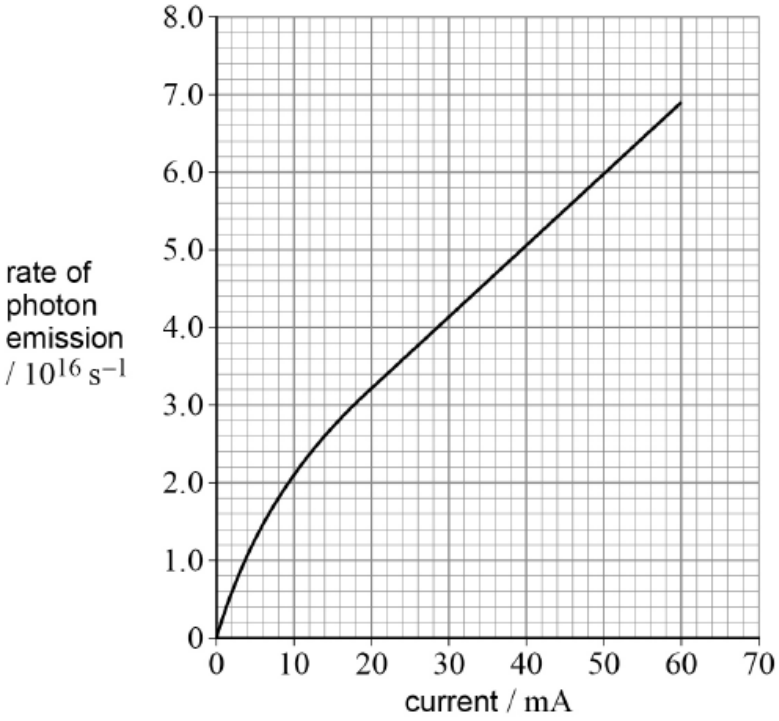
0 5 . 1 A light emitting diode (LED) emits blue light with a wavelength of $440\ \text{nm}$.
The rate of photon emission is $3.0 \times 10^{16}\ \text{s}^{-1}$.

Show that the power output of the LED is approximately $0.014\ \text{W}$.

[2 marks]

0 5 . 2 A different LED emits red light with a wavelength of 660 nm.
Figure 12 shows how the rate of photon emission varies with current up to the maximum operating current of this LED.

Figure 12



A student claims that the red LED can have twice the power output of the blue LED.

Deduce whether the student's claim is correct.

[3 marks]

0 5 . 3 The student has paint that fluoresces when light of any wavelength is incident on it. She coats the blue LED and the red LED with the paint.

Compare the wavelengths of light emitted by the paint on each LED.

In your answer you should also explain the processes that cause the paint to fluoresce.

[6 marks]