SA-STUDENT

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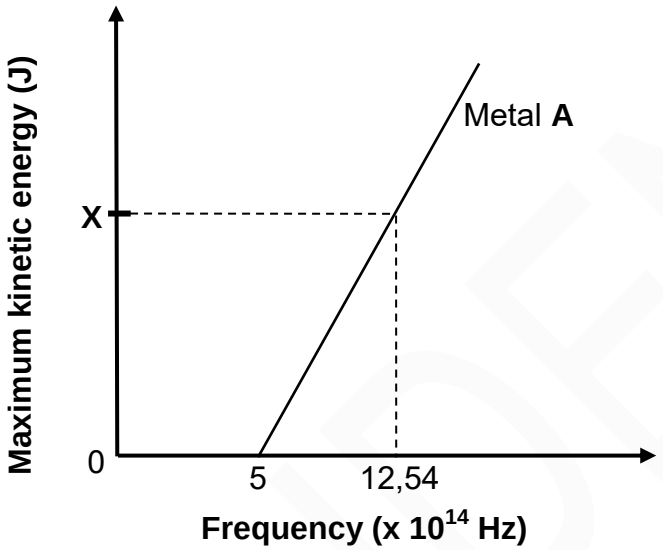
QUESTION 10 (Start on a new page.)

In a photoelectric investigation, light of different frequencies was radiated on each of two metals, **A** and **B**. The graph of maximum kinetic energy of the ejected electrons from metal **A** and the frequency of the incident photons is shown below.

Point **X** on the graph represents an unknown maximum kinetic energy.



10.1 Write down the numerical value of the gradient of the graph. (1)

10.2 Define the term *work function*. (2)

10.3 Calculate the:

10.3.1 Work function of metal **A** (3)

10.3.2 Value of **X** shown on the graph (4)

10.4 How will EACH of the following be affected if light of frequency 12,54 x 10^{14} Hz, but of higher intensity, is used?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The value of **X** (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

Metal **B** has a larger work function than metal **A**.

10.5 Redraw the graph above in your ANSWER BOOK. (Do NOT include values on the axes.) Label this graph as **A**.

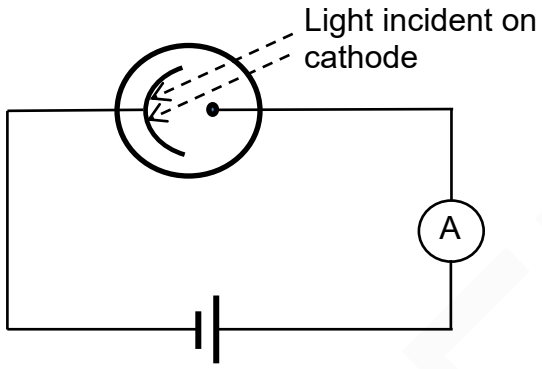
On the SAME set of axes, sketch the graph for metal **B**. Label this graph as **B**. (2)

[14]

TOTAL: 150

QUESTION 10 (Start on a new page.)

Light is incident on the cathode of a photoelectric cell connected to a battery and a sensitive ammeter, as shown below.



10.1 What conclusive evidence about the nature of light is provided by the photoelectric effect? (1)

The cathode has a work function of $3,42 \times 10^{-19}$ J.

10.2 Define the term *work function*. (2)

Light of frequency $5,96 \times 10^{14}$ Hz is shone onto the cathode.

10.3 Calculate the maximum kinetic energy of an electron ejected from the cathode. (4)

10.4 The ammeter registers a constant current of 0,012 A.

Calculate the minimum number of photons of light that strike the cathode in a 10 s period. (4)

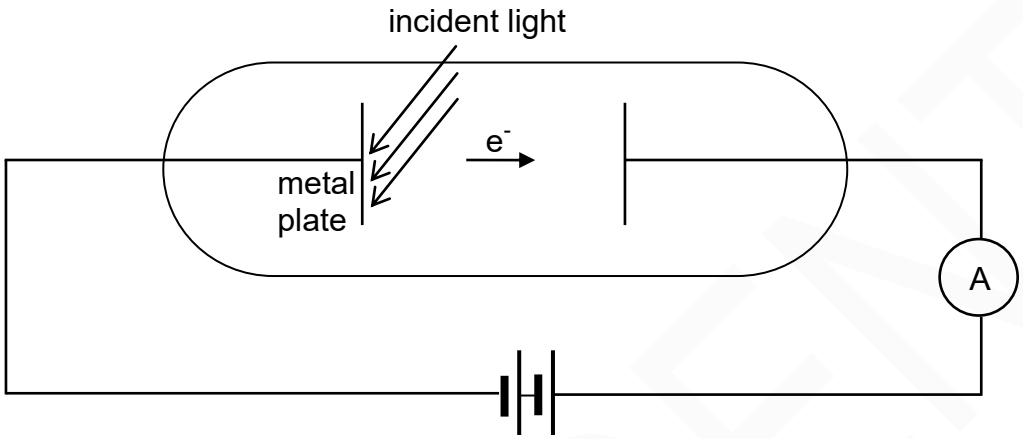
10.5 The intensity of the incident light is now INCREASED. How will this change affect the reading on the ammeter?

Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)
[14]

TOTAL: 150

QUESTION 10 (Start on a new page.)

10.1 The apparatus illustrated in the simplified diagram below is used to demonstrate the photoelectric effect.



10.1.1 Define the term *photoelectric effect*. (2)

Incident light of frequency 1,2 x 10^{15} Hz is shone onto the metal plate and electrons are emitted.

Calculate the:

10.1.2 Number of photoelectrons emitted in one second if the total energy transferred by the light to the metal plate per second is 1,75 x 10^{-9} J (4)

10.1.3 Maximum speed of a photoelectron if the threshold frequency of the metal plate is 9,09 x 10^{14} Hz (5)

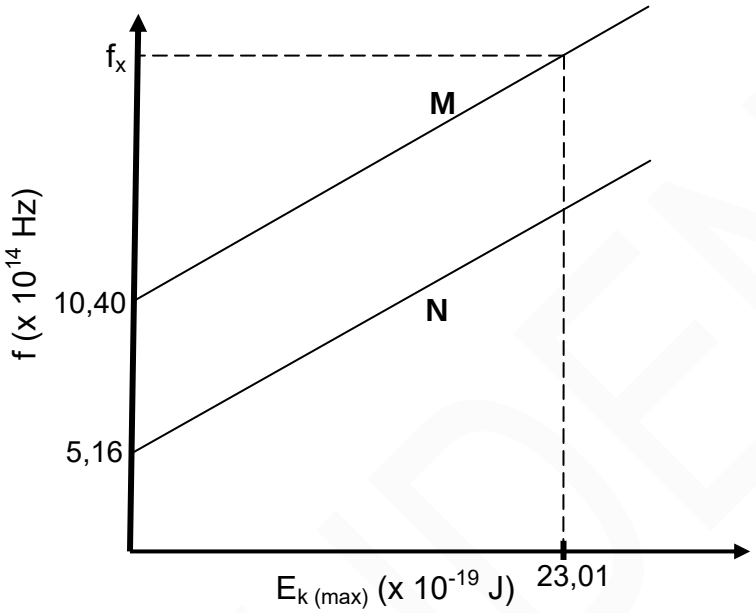
10.2 Briefly explain how an emission spectrum is formed in terms of energy transitions. (2)

[13]

TOTAL: 150

QUESTION 10 (Start on a new page.)

The relationship between frequency (f) and maximum kinetic energy ($E_{k(max)}$) of photoelectrons emitted from two cathodes, **M** and **N**, of different photoelectric cells is investigated. The graphs below have been obtained from the results.



10.1 Define the term *threshold frequency*. (2)

10.2 How does the maximum kinetic energy of photoelectrons emitted from cathode **N** compare to the maximum kinetic energy of those emitted from cathode **M** when light of a frequency greater than 10,40 x 10^{14} Hz is shone on each of the cathodes?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (2)

10.3 Calculate the value of frequency f_x indicated on the graph. (5)

10.4 The experiment is now repeated for cathode **M** using light of frequency f_x, but of higher intensity. How will EACH of the following be affected?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The y-intercept of the graph (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

10.4.3 The maximum kinetic energy of the emitted photoelectrons (1)

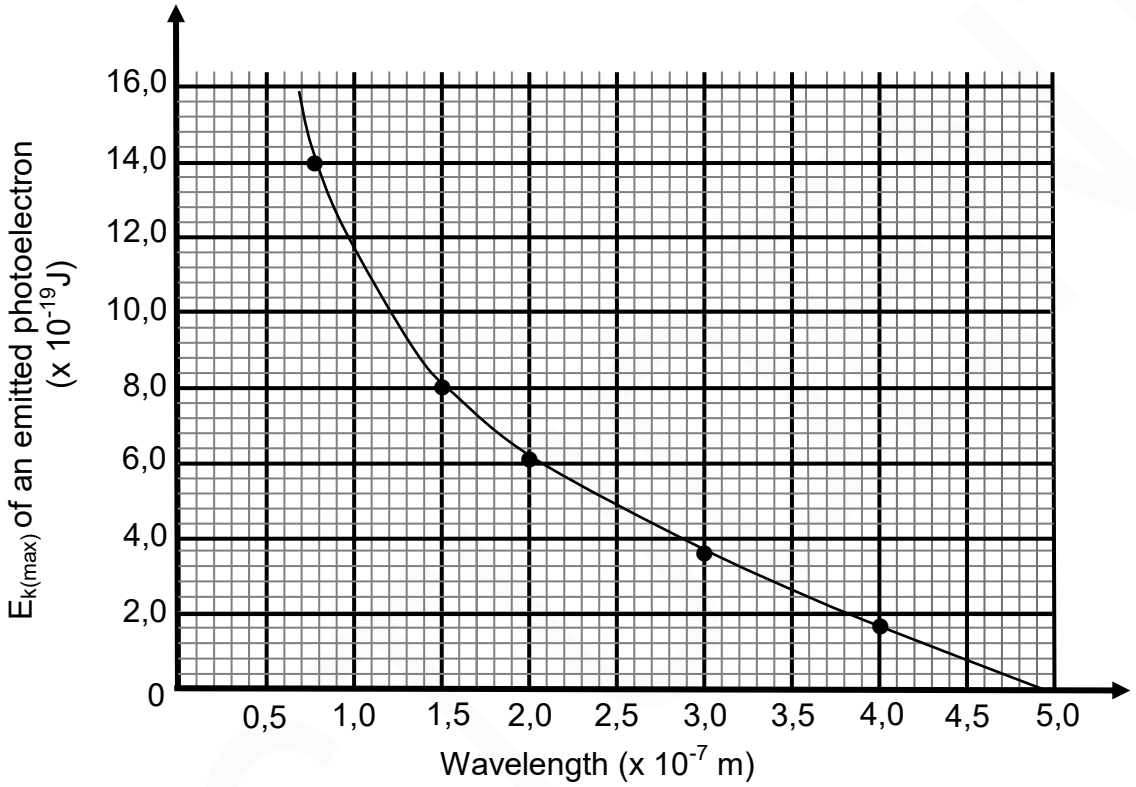
[12]

TOTAL: 150

QUESTION 10 (Start on a new page.)

When light of various frequencies is incident on the metal cathode of a photocell, photoelectrons are emitted from the surface of the cathode.

The graph below shows the relationship between the maximum kinetic energy ($E_{k(max)}$) of an emitted photoelectron and the wavelength of the incident light.



10.1 Use the graph to determine the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is 1,0 x 10^{-7} m. (1)

10.2 What relationship between the maximum kinetic energy of the emitted photoelectron and the wavelength of the incident light can be deduced from the graph? (2)

10.3 Define the term *work function* in words. (2)

10.4 Use the graph to calculate the work function of the metal used as cathode of this photocell. (4)

10.5 Calculate the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is 0,5 x 10^{-7} m. (4)

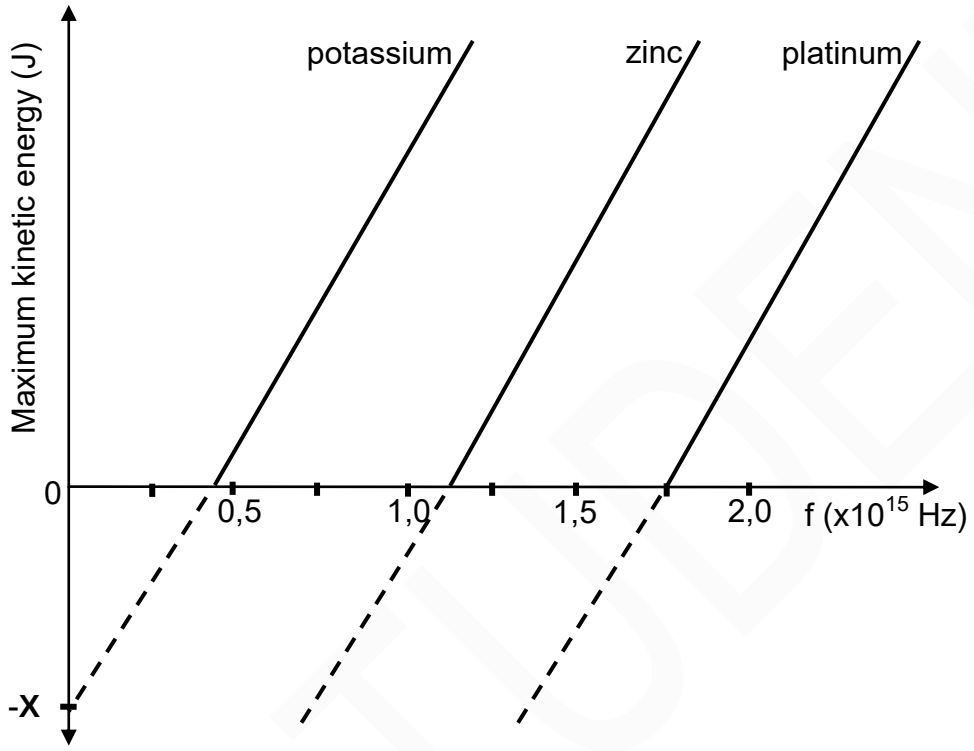
[13]

TOTAL: 150

QUESTION 10 (Start on a new page.)

An experiment is conducted to investigate the relationship between the frequency of light incident on a metal and the maximum kinetic energy of the emitted electrons from the surface of the metal. This experiment is conducted for three different metals.

The graph below represents the results obtained.



10.1 Name the phenomenon on which this experiment is based. (1)

10.2 Name the physical quantity represented by **X** on the graph. (1)

10.3 Which ONE of the three metals needs incident light with the *largest wavelength* for the emission of electrons?

Give a reason for the answer. (2)

10.4 Define the term *work function* in words. (2)

10.5 Calculate the:

10.5.1 Work function of **platinum** (3)

10.5.2 Frequency of the incident light that will emit electrons from the surface of **platinum** with a maximum velocity of 5,60 x 10^5 m·s^{-1} (4)

[13]

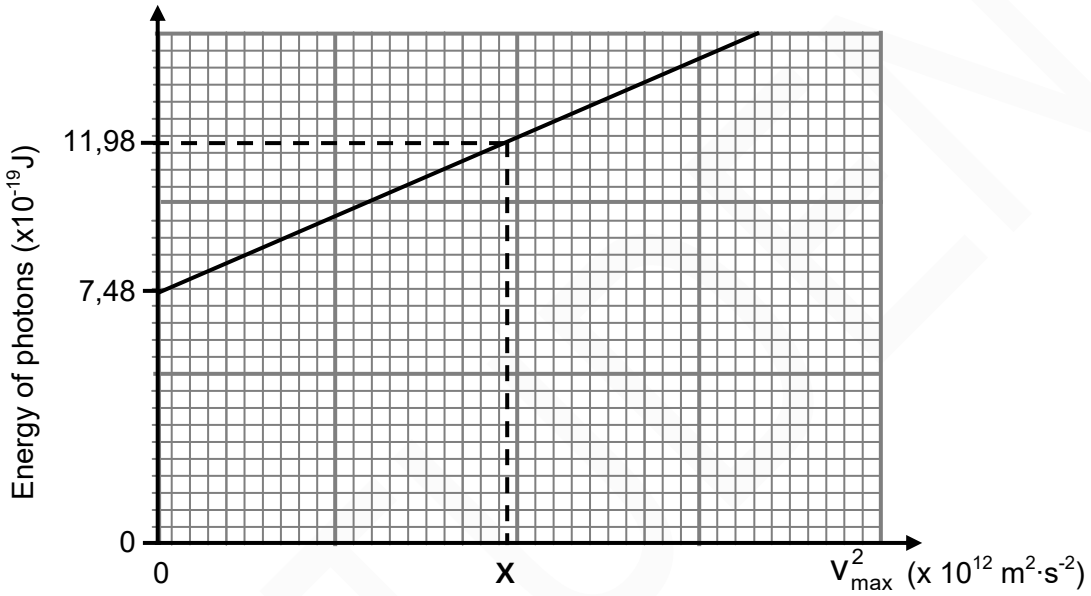
TOTAL: 150

QUESTION 10 (Start on a new page.)

During an experiment, light of different frequencies is radiated onto a silver cathode of a photocell and the corresponding maximum speed of the ejected photoelectrons are measured.

A graph of the energy of the incident photons versus the square of the maximum speed of the ejected photoelectrons is shown below.

Graph of energy of photons versus square of maximum speed of photoelectrons



10.1 Define the term *photoelectric effect*. (2)

Use the graph to answer the following questions.

10.2 Write down the value of the work function of silver.

Use a relevant equation to justify the answer. (3)

10.3 Which physical quantity can be determined from the gradient of the graph? (1)

10.4 Calculate the value of **X** as shown on the graph. (5)

The experiment above is now repeated using light of higher intensity.

10.5 How will EACH of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.5.1 The gradient of the graph (1)

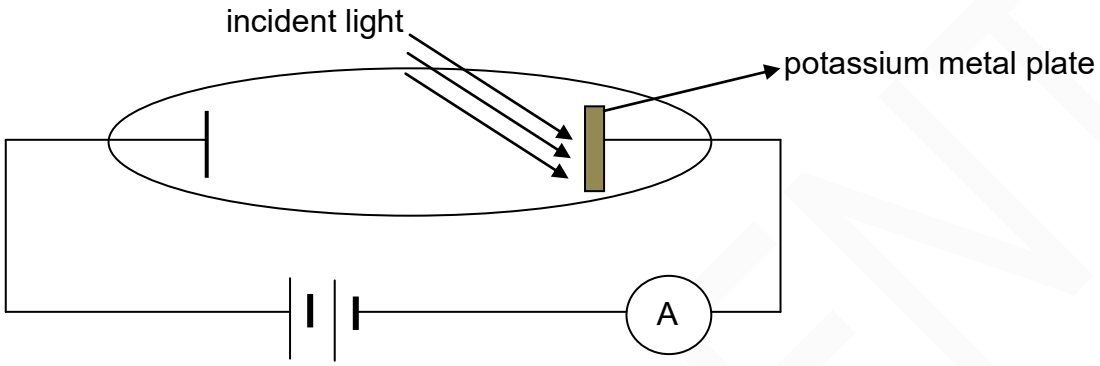
10.5.2 The number of photoelectrons emitted per unit time (1)

[13]

TOTAL: 150

QUESTION 10 (Start on a new page.)

A potassium metal plate is irradiated with light of wavelength 5×10^{-7} m in an arrangement, as shown below. The threshold frequency of potassium is $5{,}55 \times 10^{14}$ Hz.



10.1 Define the term *threshold frequency*. (2)

10.2 Calculate the energy of a photon incident on the metal plate. (3)

10.3 Using a suitable calculation, prove that the ammeter will show a reading. (4)

10.4 The intensity of the light is now increased. Explain why this change causes an increase in the ammeter reading. (3)

[12]

TOTAL: 150

QUESTION 11 (Start on a new page.)

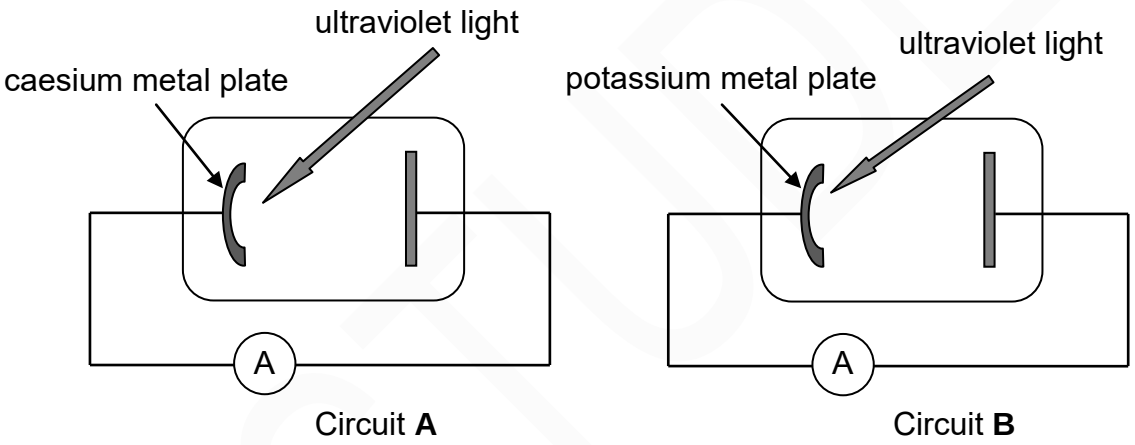
The threshold frequencies of caesium and potassium metals are given in the table below.

METAL	THRESHOLD FREQUENCY
Caesium	$5,07 \times 10^{14}$ Hz
Potassium	$5,55 \times 10^{14}$ Hz

11.1 Define the term *work function* in words. (2)

11.2 Which ONE of the two metals in the table has the higher work function? Give a reason for the answer by referring to the information in the table. (2)

The simplified diagrams below show two circuits, **A** and **B**, containing photocells. The photocell in circuit **A** contains a caesium metal plate, while the photocell in circuit **B** contains a potassium metal plate.



Ultraviolet light with the same intensity and wavelength of $5,5 \times 10^{-7}$ m is incident on the metal plate in EACH of the photocells and the ammeter in circuit **A** registers a current.

11.3 By means of a calculation, determine whether the ammeter in circuit **B** will also register a current. (3)

11.4 Calculate the maximum kinetic energy of an ejected electron in circuit **A**. (5)

11.5 How will the maximum kinetic energy of the ejected electron, calculated in QUESTION 11.4, change when the intensity of the incident light increases?

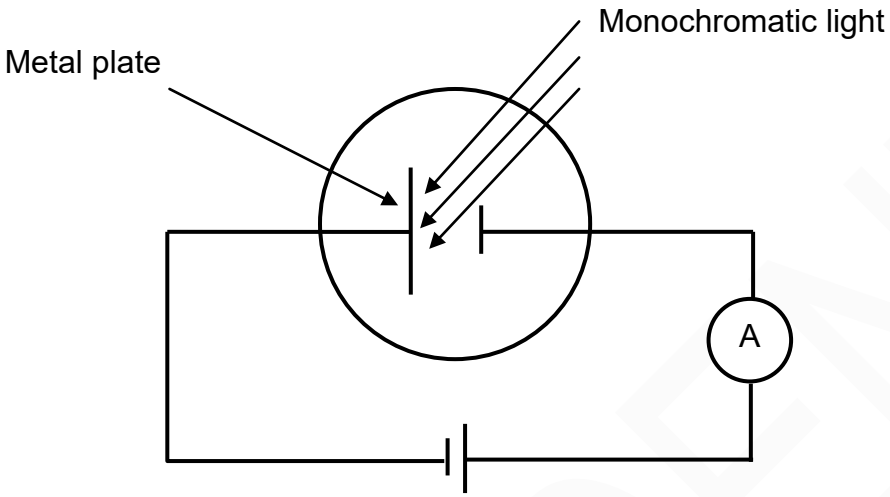
Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)

[13]

TOTAL: 150

QUESTION 11 (Start on a new page.)

11.1 In the diagram below, monochromatic light is incident on the metal plate of a photocell. A sensitive ammeter shows a reading.



11.1.1 How does the energy of the photons of the incident light compare to the work function of the metal plate?
Choose from GREATER THAN, LESS THAN or EQUAL TO.

Give a reason for the answer. (2)

11.1.2 When a change is made to the monochromatic light, the reading on the ammeter increases.

A learner makes the following statement with regard to this change:

The increase in the ammeter reading is due to an increase in the energy of the incident photons.

Give a reason why this statement is INCORRECT. (2)

11.1.3 What does the photoelectric effect tell us about the nature of light? (1)

11.2 Ultraviolet radiation is incident on the surface of sodium metal. The threshold frequency (f_0) for sodium is 5,73 x 10^{14} Hz. The maximum speed of an electron emitted from the metal surface is 4,19 x10^5 m·s^{-1}.

11.2.1 Define or explain the term *threshold frequency*. (2)

Calculate the:

11.2.2 Work function of sodium (3)

11.2.3 Frequency of the incident photon (3)
[13]

TOTAL: 150

QUESTION 11 (Start on a new page.)

A group of students investigates the relationship between the work function of different metals and the maximum kinetic energy of the ejected electrons when the metals are irradiated with light of suitable frequency.

11.1 Define the term *work function*. (2)

During the investigation ultraviolet rays of wavelength 2×10^{-8} m are allowed to fall on different metal plates. The corresponding maximum kinetic energies of ejected electrons are measured.

The data obtained is displayed in the table below.

METAL PLATE USED	**MAXIMUM KINETIC ENERGY ($E_{k(max)}$) ($\times 10^{-18}$ J)**
Lead	9,28
Potassium	9,58
Silver	9,19

11.2 Write down the dependent variable for this investigation. (1)

11.3 Write down ONE control variable for this investigation. (1)

11.4 Using the information in the table, and without any calculation, identify the metal with the largest work function.

Explain the answer. (3)

11.5 Use information in the table to calculate the work function of potassium. (4)

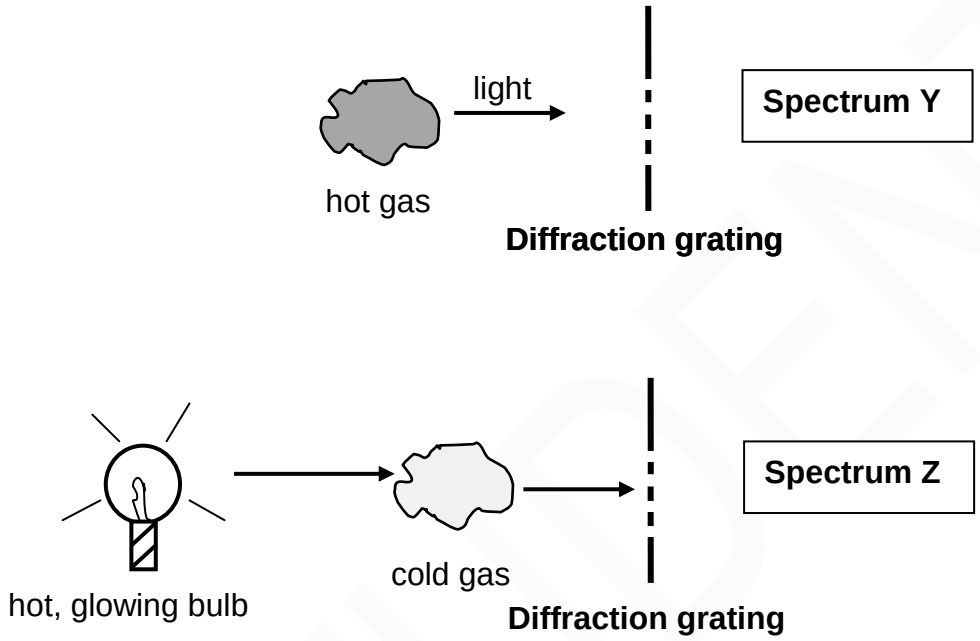
11.6 State how an increase in the intensity of the ultraviolet light affects the maximum kinetic energy of the photoelectrons. Choose from: INCREASES, DECREASES, REMAINS THE SAME.

Explain the answer. (3)
[14]

TOTAL: 150

QUESTION 11 (Start on a new page.)

11.1 A teacher in a science class explains how different types of spectra are obtained. The teacher uses the simplified diagrams shown below for the explanation.



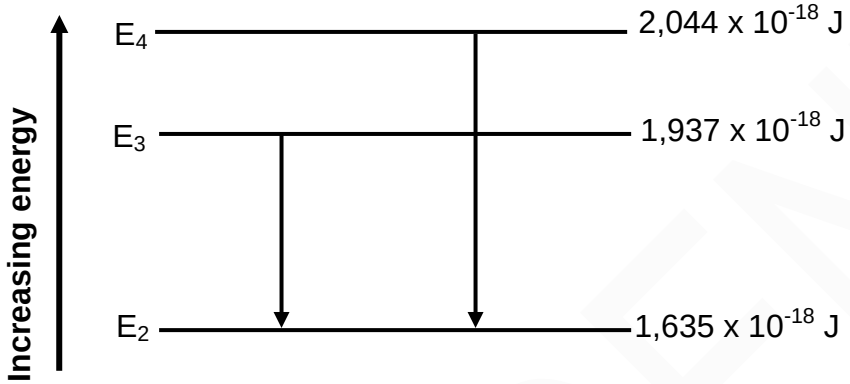
Name the type of spectrum of:

11.1.1 **Y** (1)

11.1.2 **Z** (1)

11.2 In an excited atom, electrons can 'jump' from lower energy levels to higher energy levels. They can also 'drop' from higher energy levels to lower energy levels.

The diagram below (not drawn to scale) shows some of the transitions for electrons in an excited atom.



11.2.1 Do the transitions indicated in the diagram lead to ABSORPTION or EMISSION spectra? (1)

11.2.2 Calculate the frequency of the photon produced when an electron in an excited atom makes a transition from $\mathbf{E_4}$ to $\mathbf{E_2}$, as shown in the diagram. (4)

The threshold frequency of a metal, Q, is 4,4 x 10^{14} Hz.

11.2.3 Calculate the kinetic energy of the most energetic electron ejected when the photon produced in QUESTION 11.2.2 is incident on the surface of metal Q. (4)

Another metal, R, has a threshhold frequency of 7,5 x 10^{14} Hz.

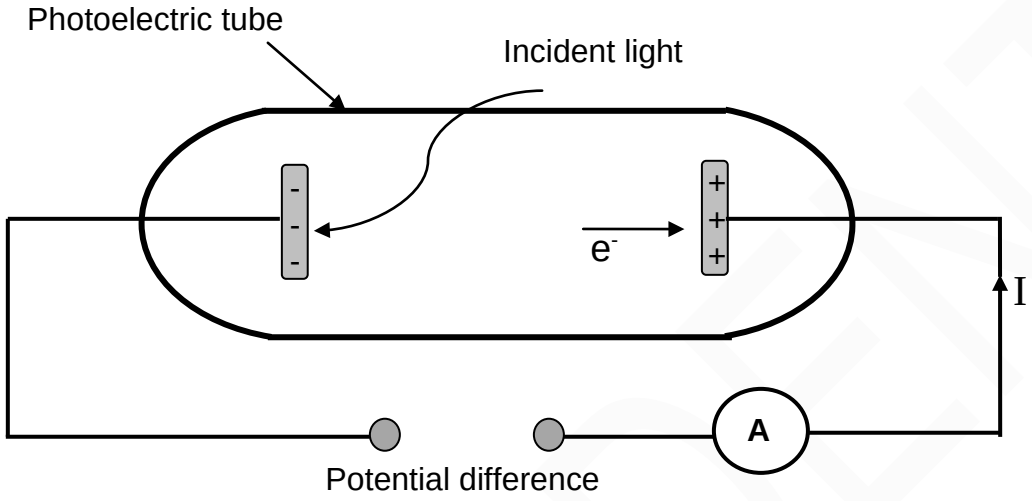
11.2.4 Will the photon produced in QUESTION 11.2.2 be able to eject electrons from the surface of metal R? Write down only YES or NO.

Give a reason for the answer. (2)
[13]

TOTAL: 150

QUESTION 11 (Start on a new page.)

A simplified diagram of an apparatus for an experiment to investigate the photoelectric effect is shown below. Light of a fixed frequency is incident on the cathode of a photoelectric tube. During the experiment the ammeter (**A**) registers the photocurrent.



11.1 Define the term *photoelectric effect.* (2)

The intensity of the incident light is now increased.

11.2 State how this increase in intensity will affect the reading on the ammeter. Choose from INCREASE, DECREASE or REMAIN THE SAME.

Give a reason for the answer. (3)

When the frequency of the incident light is $5,9 \times 10^{14}$ Hz, the maximum recorded kinetic energy of photoelectrons is $2,9 \times 10^{-19}$ J.

11.3 Calculate the maximum wavelength (threshold wavelength) of the incident light that will emit an electron from the cathode of the photo-electric tube. (5)

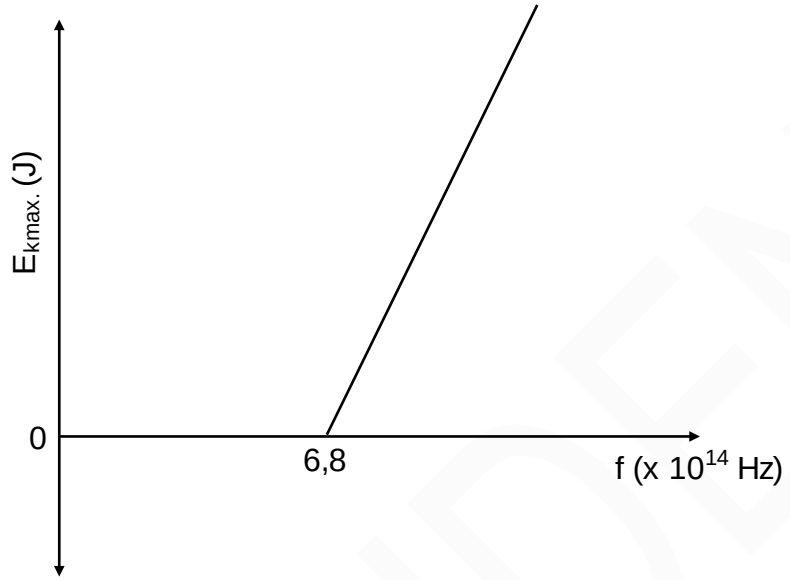
The maximum kinetic energy of the photoelectrons ejected increases when light of a higher frequency is used.

11.4 Use the photoelectric equation to explain this observation. (2)
[12]

TOTAL: 150

QUESTION 10 (Start on a new page.)

The graph below is obtained for an experiment on the photoelectric effect using different frequencies of light and a given metal plate.



The threshold frequency for the metal is 6,8 x 10^{14} Hz.

10.1 Define the term *threshold frequency*. (2)

In the experiment, the brightness of the light incident on the metal surface is increased.

10.2 State how this change will influence the speed of the photoelectrons emitted.

Choose from INCREASES, DECREASES or REMAINS UNCHANGED. (1)

10.3 Show by means of a calculation whether the photoelectric effect will be OBSERVED or NOT OBSERVED, if monochromatic light with a wavelength of 6 x 10^{-7} m is used in this experiment. (5)

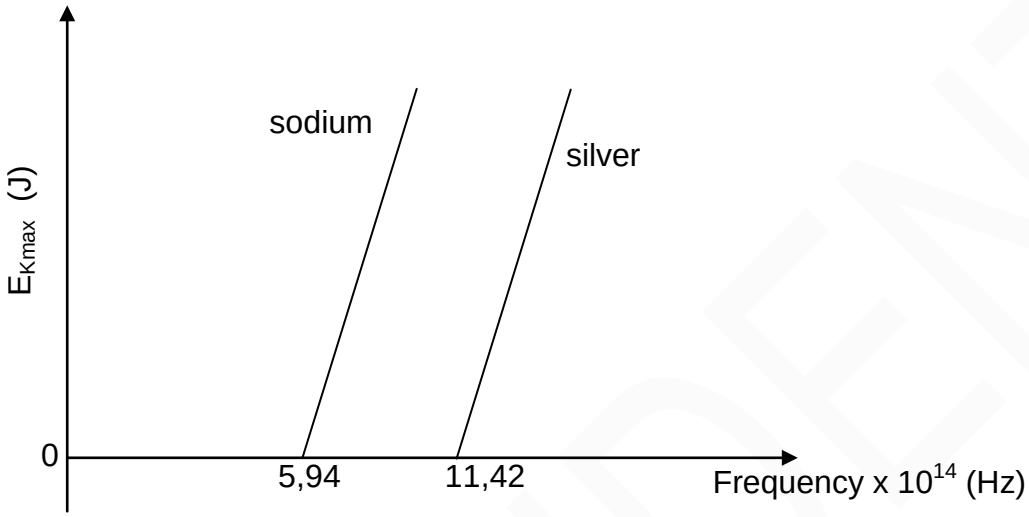
One of the radiations used in this experiment has a frequency of 7,8 x 10^{14} Hz.

10.4 Calculate the maximum speed of an ejected photoelectron. (5)
[13]

TOTAL: 150

QUESTION 10 (Start on a new page.)

10.1 A learner is investigating the photoelectric effect for two different metals, silver and sodium, using light of different frequencies. The maximum kinetic energy of the emitted photoelectrons is plotted against the frequency of the light for each of the metals, as shown in the graphs below.



10.1.1 Define the term *threshold frequency*. (2)

10.1.2 Which metal, sodium or silver, has the larger work function? Explain the answer. (3)

10.1.3 Name the physical constant represented by the slopes of the graphs. (1)

10.1.4 If light of the same frequency is shone on each of the metals, in which metal will the ejected photoelectrons have a larger maximum kinetic energy? (1)

10.2 In a different photoelectric experiment blue light obtained from a light bulb is shone onto a metal plate and electrons are released.

The wavelength of the blue light is 470 x 10^{-9} m and the bulb is rated at 60 mW. The bulb is only 5% efficient.

10.2.1 Calculate the number of photons that will be incident on the metal plate per second, assuming all the light from the bulb is incident on the metal plate. (5)

10.2.2 **Without any further calculation**, write down the number of electrons emitted per second from the metal. (1)

[13]

TOTAL: 150

QUESTION 11 (Start on a new page.)

11.1 In an experiment on the photoelectric effect, light is incident on the surface of a metal and electrons are ejected.

11.1.1 What does the photoelectric effect indicate about the nature of light? (1)

11.1.2 The intensity of the light is increased. Will the maximum speed of the ejected electrons INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)

The wavelength corresponding with the threshold frequency is referred to as *threshold wavelength.*

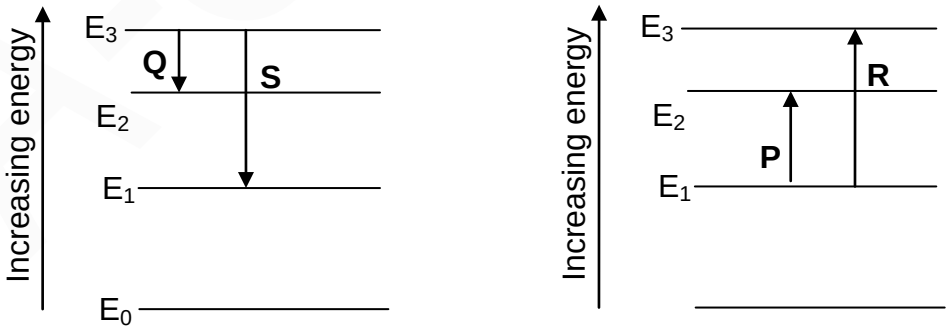
The table below gives the values of threshold wavelengths for three different metals.

METAL	THRESHOLD WAVELENGTH (λ_0) IN METRES
Silver	$2,88 \times 10^{-7}$
Calcium	$4,32 \times 10^{-7}$
Sodium	$5,37 \times 10^{-7}$

In the experiment using one of the metals above, the maximum speed of the ejected electrons was recorded as $4,76 \times 10^5$ $m \cdot s^{-1}$ for light of wavelength 420 nm.

11.1.3 Identify the metal used in the experiment by means of suitable calculations. (5)

11.2 The simplified energy diagrams showing the possible electron transitions in an atom are shown below.



Using the letters **P**, **Q**, **R** and **S**, identify the lines that CORRECTLY show transitions that will result in the atom giving off an EMISSION SPECTRUM. Give a reason for the answer. (4)

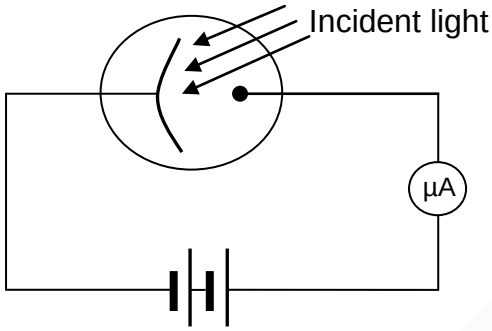
[12]

TOTAL: 150

QUESTION 11 (Start on a new page.)

An investigation was conducted to determine the effects of changes in frequency AND intensity on the current generated in a photoelectric cell when light is incident on it.

The apparatus used in the investigation is shown in the simplified diagram below.



The results of the experiment are shown in the table below.

EXPERIMENT	FREQUENCY (Hz)	INTENSITY (Cd)	CURRENT (μA)
A	$4{,}00 \times 10^{14}$	10	0
B	$4{,}50 \times 10^{14}$	10	0
C	$5{,}00 \times 10^{14}$	10	0
D	$5{,}01 \times 10^{14}$	10	20
E	$5{,}01 \times 10^{14}$	20	40
F	$6{,}50 \times 10^{14}$	10	30

11.1 Define the term *work function*. (2)

11.2 Identify an independent variable. (1)

The threshold frequency for the metal used in the photocell is $5{,}001 \times 10^{14}$ Hz.

11.3 Define the term *threshold frequency.* (2)

11.4 Calculate the maximum speed of an emitted electron in experiment **F**. (5)

In experiments **D** and **E**, the current doubled when the intensity was doubled at the same frequency.

11.5 What conclusion can be made from this observation? (2)
[12]

TOTAL: 150

QUESTION 11 (Start on a new page.)

In an experiment to demonstrate the photoelectric effect, light of different wavelengths was shone onto a metal surface of a photoelectric cell. The maximum kinetic energy of the emitted electrons was determined for the various wavelengths and recorded in the table below.

INVERSE OF WAVELENGTH $\frac{1}{\lambda}$ **(× 10^6 m^{-1})**	**MAXIMUM KINETIC ENERGY** $E_{k(max)}$ **(× 10^{-19} J)**
5,00	6,60
3,30	3,30
2,50	1,70
2,00	0,70

11.1 What is meant by the term *photoelectric effect?* (2)

11.2 Draw a graph of $E_{k(max)}$ (y-axis) versus $\frac{1}{\lambda}$ (x-axis) ON THE ATTACHED ANSWER SHEET. (3)

11.3 USE THE GRAPH to determine:

11.3.1 The threshold frequency of the metal in the photoelectric cell (4)

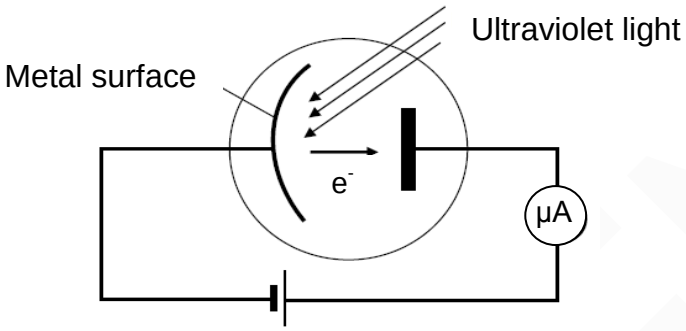
11.3.2 Planck's constant (4)

[13]

TOTAL: 150

QUESTION 10 (Start on a new page.)

A learner uses photocells to determine the maximum kinetic energy of ejected photoelectrons. One photocell has a caesium cathode and the other has a sodium cathode. Each photocell is radiated by ultraviolet light from the same source as shown below.



The incomplete results obtained are shown in the table below.

NAME OF THE METAL	WORK FUNCTION OF THE METAL (J)	MAXIMUM KINETIC ENERGY OF PHOTOELECTRONS (J)
Caesium	$3,36 \times 10^{-19}$	$2,32 \times 10^{-19}$
Sodium	$3,65 \times 10^{-19}$	**E_K**

10.1 Define the term *work function of a metal*. (2)

10.2 Use the information in the table to calculate the wavelength of the ultraviolet light used in the experiment. (4)

10.3 Calculate the maximum kinetic energy, E_K, of an electron ejected from the sodium metal. (4)

10.4 The intensity of the incident ultraviolet light was then increased.

10.4.1 Give a reason why this change does NOT affect the maximum kinetic energy of the ejected photoelectrons. (1)

10.4.2 How does the increased intensity affect the reading on the ammeter? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

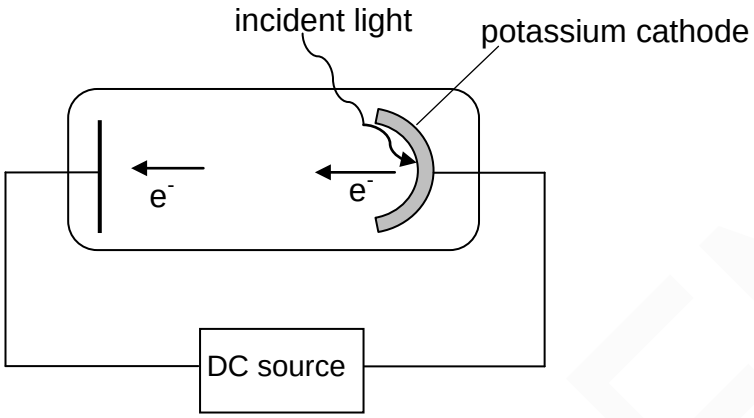
10.4.3 Explain the answer to QUESTION 10.4.2. (2)

[14]

TOTAL: 150

QUESTION 10 (Start on a new page.)

Ultraviolet light is incident onto a photocell with a potassium cathode as shown below. The threshold frequency of potassium is 5,548 x 10^{14} Hz.



10.1 Define the term *threshold frequency (cut-off frequency)*. (2)

The maximum speed of an ejected photoelectron is 5,33 x 10^5 m·s^{-1}.

10.2 Calculate the wavelength of the ultraviolet light used. (5)

The photocell is now replaced by another photocell with a rubidium cathode. The maximum speed of the ejected photoelectron is 6,10 x 10^5 m·s^{-1} when the same ultraviolet light source is used.

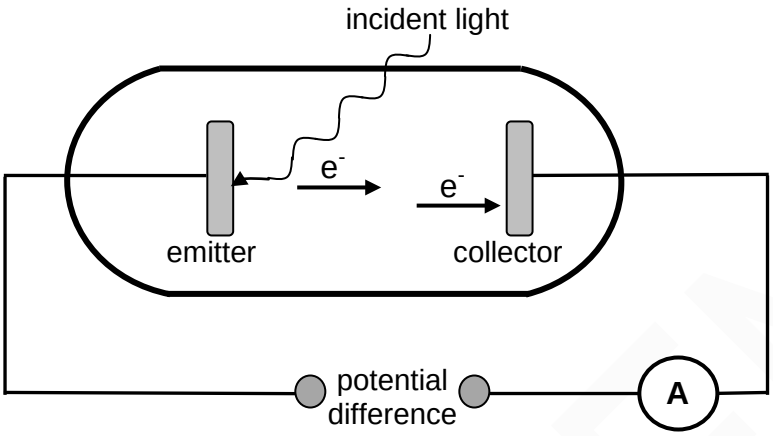
10.3 How does the work function of rubidium compare to that of potassium? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

10.4 Explain the answer to QUESTION 10.3. (3)
[11]

TOTAL: 150

QUESTION 11 (Start on a new page.)

11.1 The apparatus below is used to demonstrate the photoelectric effect.



11.1.1 Define, in words, the *photoelectric effect*. (2)

The incident monochromatic light transfers $1,8 \times 10^{-9}$ J of energy in one second to a certain area of the emitter. The wavelength of a photon in the incident light is 260 nm.

If one photon releases one electron, calculate the:

11.1.2 Number of electrons released from the surface of that area of the emitter in one second (5)

11.1.3 Current produced, in amperes (4)

11.2 The sketch below shows an example of a line emission spectrum.

11.2.1 Briefly explain how this type of spectrum is formed by referring to electron transitions in atoms. (2)

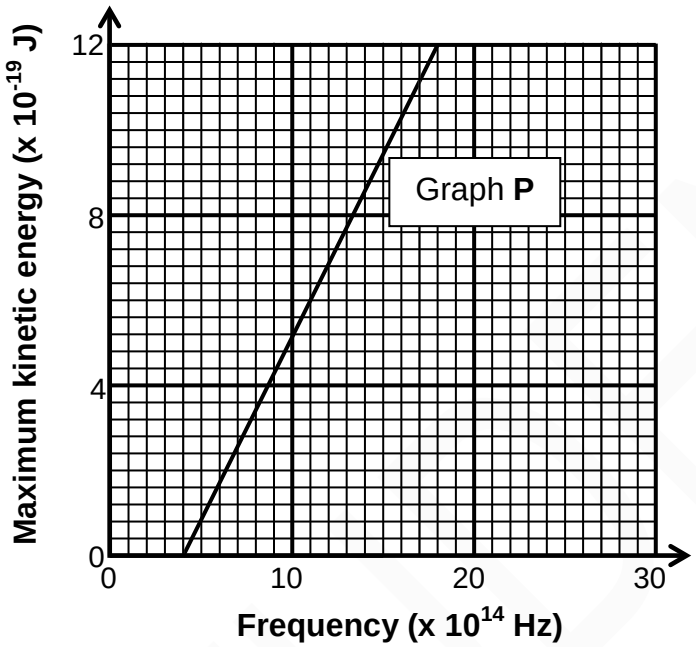
11.2.2 Write down ONE important use of line emission spectra. (1)
[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 11 (Start on a new page.)

Graph **P** below shows how the maximum kinetic energy of electrons emitted from the cathode of a photoelectric cell varies with the frequency of the incident radiation.

Graph of maximum kinetic energy versus frequency



11.1 Define the term *work function*. (2)

11.2 Calculate the:

11.2.1 Work function of the metal used as cathode in the photocell (3)

11.2.2 Velocity of photoelectrons emitted when the frequency of the incident light is 8×10^{14} Hz (5)

11.3 The photocell is now replaced with another one in which the work function of the cathode is TWICE that of the metal in the first cell.

The maximum kinetic energy versus frequency graph, **Q**, for this cathode is now drawn on the same set of axes as graph **P**.

11.3.1 How will the gradient of graph **Q** compare to that of graph **P**? Write down GREATER THAN, SMALLER THAN or EQUAL TO. Explain the answer. (2)

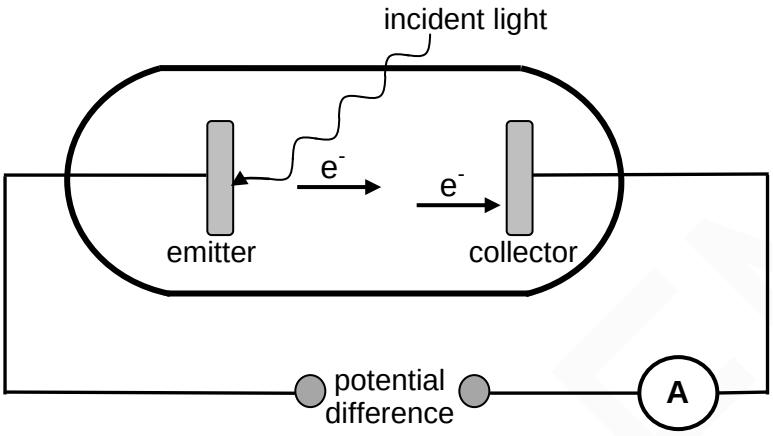
11.3.2 What will the value of the x-intercept of graph **Q** be? Explain how you arrived at the answer. (2)

[14]

TOTAL: 150

QUESTION 11 (Start on a new page.)

11.1 In the simplified diagram below, light is incident on the emitter of a photocell. The emitted photoelectrons move towards the collector and the ammeter registers a reading.



11.1.1 Name the phenomenon illustrated above. (1)

11.1.2 The work function of the metal used as emitter is $8,0 \times 10^{-19}$ J. The incident light has a wavelength of 200 nm.

Calculate the maximum speed at which an electron can be emitted. (5)

11.1.3 Incident light of a higher frequency is now used.

How will this change affect the maximum kinetic energy of the electron emitted in QUESTION 11.1.2? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.1.4 The intensity of the incident light is now increased.

How will this change affect the speed of the electron calculated in QUESTION 11.1.2? Write down INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

11.2 A metal worker places two iron rods, **A** and **B**, in a furnace. After a while he observes that **A** glows deep red while **B** glows orange.

Which ONE of the rods (**A** or **B**) radiates more energy? Give a reason for the answer. (2)

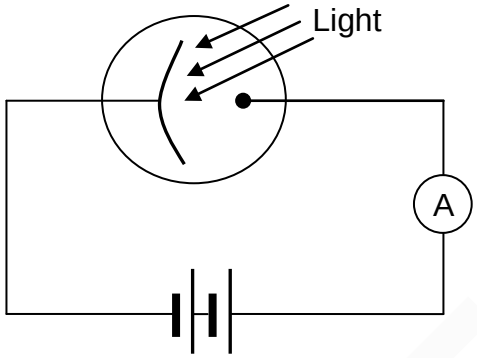
11.3 Neon signs illuminate many buildings. What type of spectrum is produced by neon signs? (1)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 11 (Start on a new page.)

Light shines onto the cathode of a photocell as shown below. The ammeter registers a reading.



11.1 Define the term *photon*. (2)

11.2 Each photon of light has an energy of $6,9 \times 10^{-19}$ J. The cathode has a work function of $6,4 \times 10^{-19}$ J.

Calculate the:

11.2.1 Wavelength of the light (5)

11.2.2 Kinetic energy of the photoelectrons (3)

11.3 How will the reading on the ammeter change if:

11.3.1 Light of the same frequency, but of higher intensity, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)

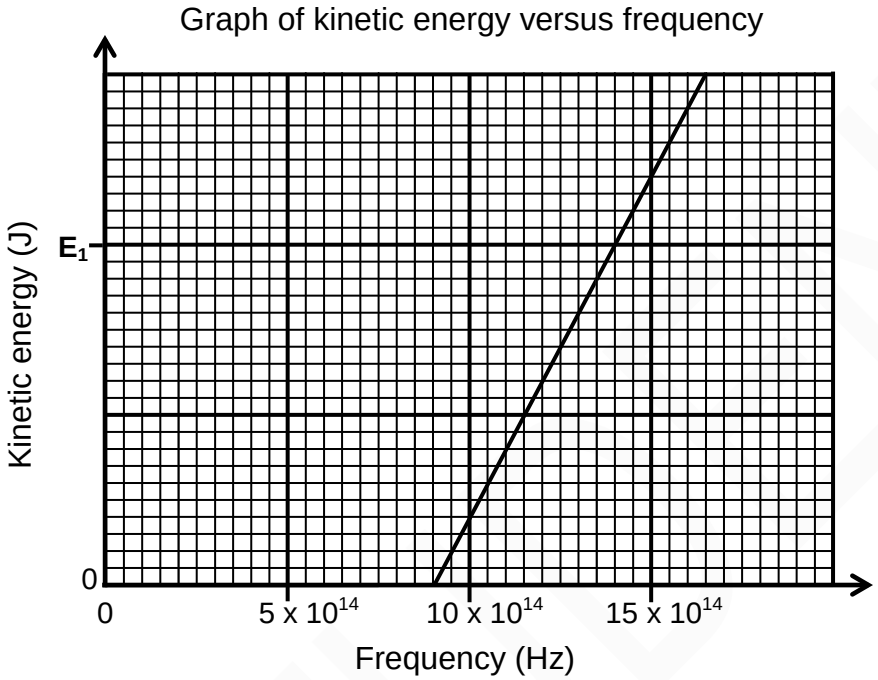
11.3.2 Light of the same intensity, but of higher frequency, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)
[16]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 11 (Start on a new page.)

During an investigation, light of different frequencies is shone onto the metal cathode of a photocell. The kinetic energy of the emitted photoelectrons is measured. The graph below shows the results obtained.



11.1 For this investigation, write down the following:

11.1.1 Dependent variable (1)

11.1.2 Independent variable (1)

11.1.3 Controlled variable (1)

11.2 Define the term *threshold frequency*. (2)

11.3 Use the graph to obtain the threshold frequency of the metal used as cathode in the photocell. (1)

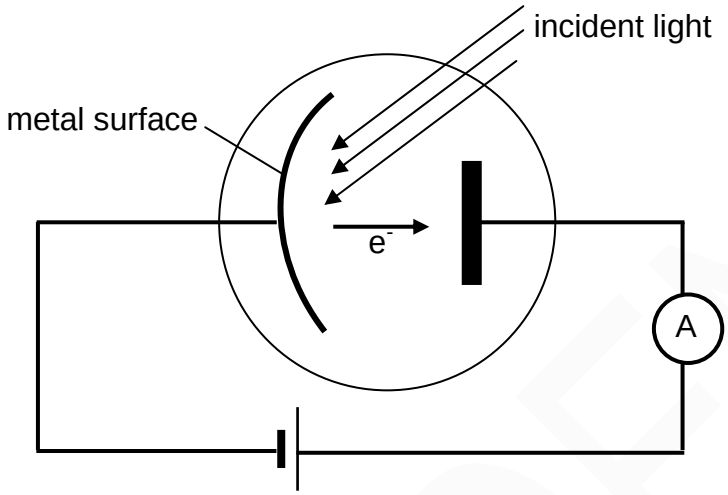
11.4 Calculate the kinetic energy at E_1 shown on the graph. (4)

11.5 How would the kinetic energy calculated in QUESTION 11.4 be affected if light of higher intensity is used? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[11]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 11 (Start on a new page.)

In the diagram shown below, electrons are released from a metal plate when light of a certain frequency is shone on its surface.



11.1 Name the phenomenon described above. (1)

11.2 The frequency of the incident light on the metal plate is $6{,}16 \times 10^{14}$ Hz and electrons are released with a kinetic energy of $5{,}6 \times 10^{-20}$ J.

Calculate the:

11.2.1 Energy of the incident photons (3)

11.2.2 Threshold frequency of the metal plate (5)

11.3 The brightness of the incident light is now increased. What effect will this change have on the following: (Write down only INCREASES, DECREASES or REMAINS THE SAME.)

11.3.1 The reading on the ammeter
Explain the answer. (2)

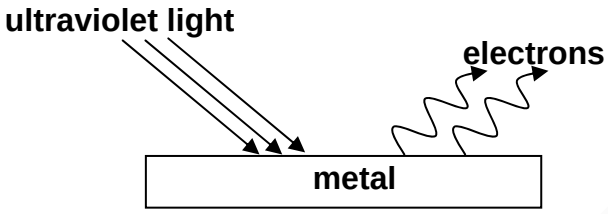
11.3.2 The kinetic energy of the released photoelectrons
Explain the answer. (2)
[13]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 12 (Start on a new page.)

A metal surface is illuminated with ultraviolet light of wavelength 330 nm. Electrons are emitted from the metal surface.

The minimum amount of energy required to emit an electron from the surface of this metal is $3,5 \times 10^{-19}$ J.



12.1 Name the phenomenon illustrated above. (1)

12.2 Give ONE word or term for the underlined sentence in the above paragraph. (1)

12.3 Calculate the frequency of the ultraviolet light. (4)

12.4 Calculate the kinetic energy of a photoelectron emitted from the surface of the metal when the ultraviolet light shines on it. (4)

12.5 The intensity of the ultraviolet light illuminating the metal is now increased. What effect will this change have on the following:

12.5.1 Kinetic energy of the emitted photoelectrons (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

12.5.2 Number of photoelectrons emitted per second (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

12.6 Overexposure to sunlight causes damage to skin cells.

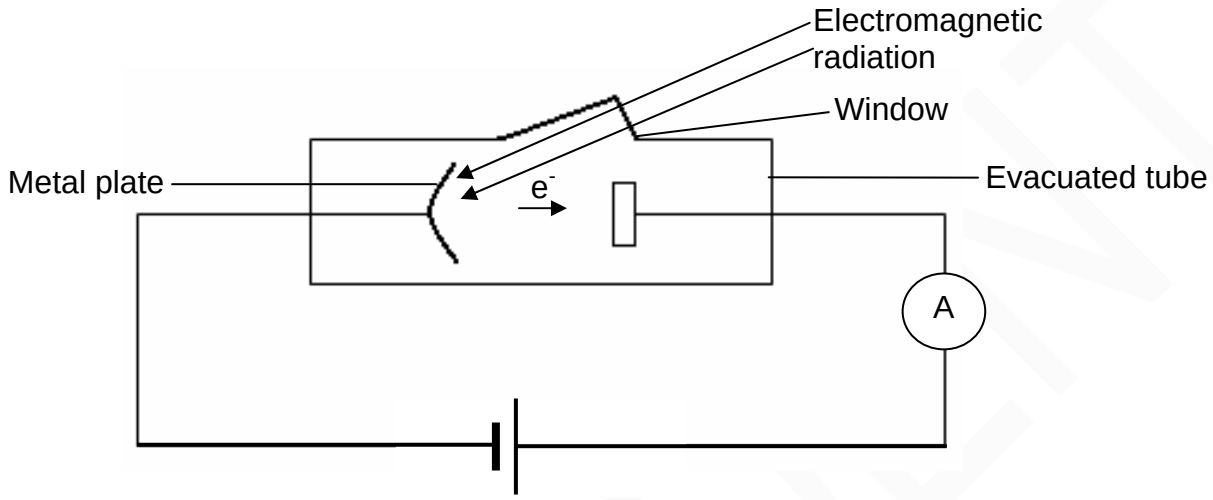
12.6.1 Which type of radiation in sunlight is said to be primarily responsible for this damage? (1)

12.6.2 Name the property of this radiation responsible for the damage. (1)
[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150

QUESTION 14 (Start on a new page.)

The diagram below shows a metal plate that emits electrons when a certain frequency of electromagnetic radiation is incident on it. The plate is connected to a source of potential difference and an ammeter as shown in the circuit below.



14.1 Name the phenomenon described above. (1)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

14.2 Define the term *work function* of a metal. (2)

14.3 Calculate the work function of this metal. (6)

14.4 How will the reading on the ammeter change if the intensity of the electromagnetic radiation is increased? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your answer. (3)

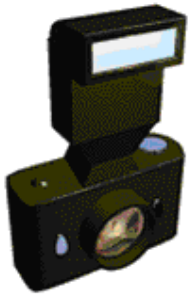
14.5 Incident radiation with a longer wavelength is now used. How will the reading on the ammeter change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

TOTAL SECTION B: 125

GRAND TOTAL: 150

QUESTION 15

A fully automatic camera has a built-in light meter. When light enters the light meter, it strikes a metal object that releases electrons and creates a current.



15.1 What phenomenon is described by the underlined sentence? (1)

15.2 A metal plate is irradiated with electromagnetic radiation of wavelength 200 nm. The metal has a work function of $7,57 \times 10^{-19}$ J.

Show by calculation that the metal plate will emit photo-electrons when irradiated with radiation of this wavelength. (6)

15.3 The intensity of the incident radiation on the metal plate is increased whilst maintaining a constant wavelength of 200 nm. State and explain what effect this change has on the following:

15.3.1 Energy of the emitted photo-electrons (2)

15.3.2 Number of emitted photo-electrons (2)
[11]

TOTAL SECTION B: 115

GRAND TOTAL: 150