Anglo-Chinese Junior College

Physics Preliminary Examination
Higher 1

A Methodist Institution
(Founded 1886)

CANDIDATE NAME		CLASS	
CENTRE NUMBER		INDEX NUMBER	

PHYSICS — **8866/02**

Paper 2 Structured questions

26 Aug 2009
2 hours

Candidates answer on the Question Paper
No additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your Name and Index number in the spaces provided at the boxes above and on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **any two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For examiners' use only	
Section A	
1	/ 9
2	/ 8
3	/ 7
4	/ 5
5	/ 11
Section B	
6	/ 20
7	/ 20
8	/ 20
Total	/ 80

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\,\Delta V$
hydrostatic pressure,	p	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \dots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \dots$

For Examiner's Use

Section A

Answer **all** the questions in the spaces provided.

1 A 20.0 cm length of thin metal rod with a mass of 5.0×10^{-3} kg is placed on a smooth inclined plane in a region of uniform horizontal magnetic field (See Fig 1.1). The magnitude of the magnetic flux density, B is 4.0×10^{-3} T.

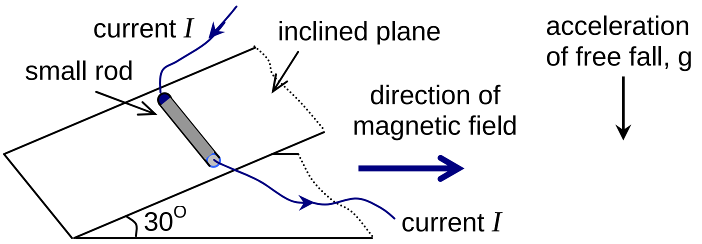


Fig 1.1

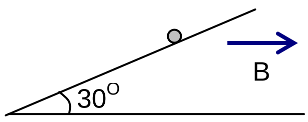


Fig 1.2

(a)(i) Fig 1.2 shows the side view of the arrangement of Fig 1.1. Sketch in Fig 1.2, the forces (in appropriate directions) acting on the small rod when the electric current is switched on. [2]

(ii) Explain a method that could be used to apply a horizontal uniform magnetic field to the inclined plane and metal rod setup shown in Fig 1.1. You may sketch a diagram to aid in the explanation.

....

....

.... [1]

(iii) If the electric current flowing through the small metal rod is 4.0 A, find the initial magnitude of the acceleration of the rod.

acceleration, *a* = ... [4]

(b) The direction of the magnetic field is now shifted such that the small rod has no resultant force acting on it. The rest of the apparatus setup remains the same.

In the space provided (Fig 1.3), draw a force-vector diagram to show how the forces act on the metal rod.

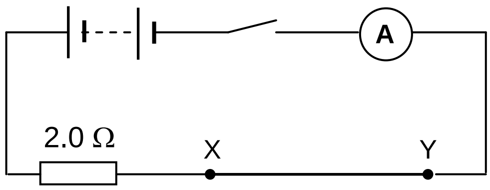
Indicate the new direction of the magnetic field with reference to the direction of the force due to the field. [2]

Fig 1.3

For Examiner's Use

2 A uniform wire, XY, of resistivity $4.9 \times 10^{-7}\ \Omega$ m is connected in series to a $2.0\ \Omega$ resistor and a 6.0 V d.c. power supply.

Fig 2.1

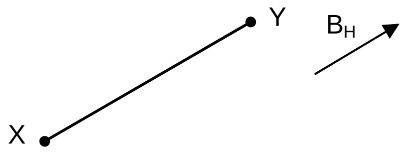


With the switch open, the setup in Fig 2.1 is placed such that wire XY is arranged parallel to the direction of the horizontal component of the Earth's magnetic field, B_H of magnitude 2.2×10^{-5} T.
A small compass is placed 1.2 cm directly beneath wire XY such that the magnetic flux density, B experienced by the compass at a distance d is given by

$$B = \left(\frac{2.0 \times 10^{-7}\ I}{d}\right) \text{ tesla}$$ when a current, I, is flowing through the wire.

(a)(i) When the switch in Fig 2.1 is closed, indicate in Fig 2.2, the direction of the magnetic field due to the current in wire XY at the location of the compass.

Fig 2.2



[1]

(ii) If the compass points at an angle of 45° from the wire XY, calculate the current flowing through the circuit.

current, I = ________________ A [2]

(b)(i) Wire XY has a diameter of 0.4 mm. Show that its resistance per unit length is $3.9\ \Omega\ m^{-1}$.

[2]

(ii) In Fig 2.1, the wire XY is 0.40 m long. Find the internal resistance, r, of the d.c. power supply.

resistance, r = ________________ Ω [3]

For Examiner's Use

3 Two transverse sources S_1 and S_2 are 2.0 m apart with wave amplitudes A and $2A$ respectively (Fig 3.1). They emit waves which are in phase and polarized in the same plane and direction. A detector is placed on a line XY which is parallel to the line joining S_1 and S_2. M is the midpoint between S_1 and S_2. There is maximum intensity at P, and is no maximum intensity between O and P. The distance between S_1 and P is 12.0 m, and distance between S_2 and P is 13.0 m.

Fig 3.1

(a) Explain the meaning of coherent sources in relation to the superposition of two waves.

....

.... [1]

(b) Can the distance OP be found accurately using the relationship, $y = \dfrac{\lambda D}{d}$?

Give your reasoning.

....

.... [1]

(c) If the detector at P detects a maximum intensity, and there is no maximum between O and P, calculate the
(i) distance OP
(ii) distance OM

distance OP = ...

distance OM = ... [3]

(d) The individual intensities of S_1 and S_2 at P are I_1 and I_2 respectively. Determine the ratio of $\dfrac{I_1}{I_2}$

ratio = ... [2]

For Examiner's Use

4 Fig 4.1 shows some of the energy levels (measured in electron-volts) of the hydrogen atom.

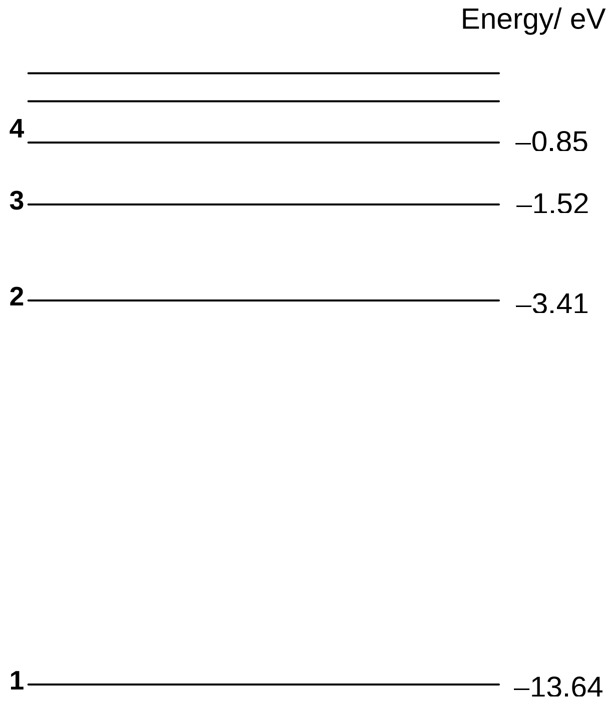


Fig. 4.1

(a) The electron of the hydrogen atom is in the lowest energy level. How much energy is required to remove this electron from the atom?

energy required = ... eV [1]

(b) State and explain which transitions would be observed if cool hydrogen vapour is bombarded with

(i) electrons of kinetic energy 12.2 eV,

....

....

.... [2]

(ii) photons of energy 12.2 eV.

....

....

....

energy = ... J [2]

For Examiner's Use

5 A small metal object travelling horizontally at a speed of 200 m s^{-1} strikes a block of wood that is at rest on top of a smooth thin 6.50 m tall vertical pole. The object enters the block and is embedded in the block.
During the collision of the object and block, some kinetic energy is converted into internal energy which results in a temperature rise of the object.
The block with the metal object embedded subsequently moves off from the vertical pole in a horizontal direction and eventually strikes the ground.

The amount of energy, Q, needed to increase the temperature by ΔT, of the object is given by $Q = m\,c\,\Delta T$ m is the mass of the object
c is the specific heat capacity of the material

The following are some of the data of the collision :

mass of object	=	0.010 kg
initial speed of object before impact	=	200 m s^{-1}
mass of block of wood	=	0.390 kg
specific heat capacity of the material of the object	=	250 J kg^{-1} K^{-1}

(a)(i) State the Principle of Conservation of Linear Momentum for two colliding bodies.

....

....

.... [1]

(ii) Calculate the initial speed with which the combined block and object first move from rest after the object hits the block.

initial speed = ... [2]

(b)(i) Show that the kinetic energy of the combined block and object immediately after the object has lodged in the block is 5.0 J.

[2]

(ii) Assuming that all the kinetic energy lost during the collision becomes the internal energy in the object, calculate the object's rise in temperature during the collision.

[2]

(c) Find the velocity of the object and block system when it hits the ground.

velocity = ______________ [4]

For Examiner's Use

Section B

Answer **two** the questions for this section.

6 (a) (i) State the important difference between a vector and a scalar.

....

.... [1]

(ii) Put the following quantities into a list of vectors and a list of scalars.

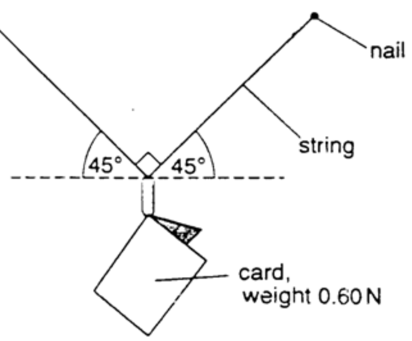
work , pressure, electric current, magnetic flux density

SCALARS :	
VECTORS :	

[2]

(iii) In order to display greeting cards, a student fixes a length of string between two nails and then suspends the cards from the string. Fig 1.1 shows the string with one card of weight 0.60 N suspended by a light clip at the centre of the string.

Fig. 1.1



1 On Fig 1.1, mark the forces on the clip due to the tension in the string. [2]

2 The resultant of the forces due to the tension in the string is 0.60 N.
In the space below, draw a vector triangle for the forces in the string and their resultant. Use a scale of 1.0 cm to represent 0.10 N. [3]

3 Use your completed vector diagram to determine the magnitude of the tension in the string.

tension = ______________ N [1]

4 The student decides that she would like as little sag as possible in the string when it is loaded with cards. To achieve this, she tightens the string. State, with a reason, whether the string, loaded with cards, could ever be horizontal.

....

....

....

....

.... [2]

(b) State the conditions for the equilibrium of a body which is acted upon by a number of forces.

....

....

....

....

....

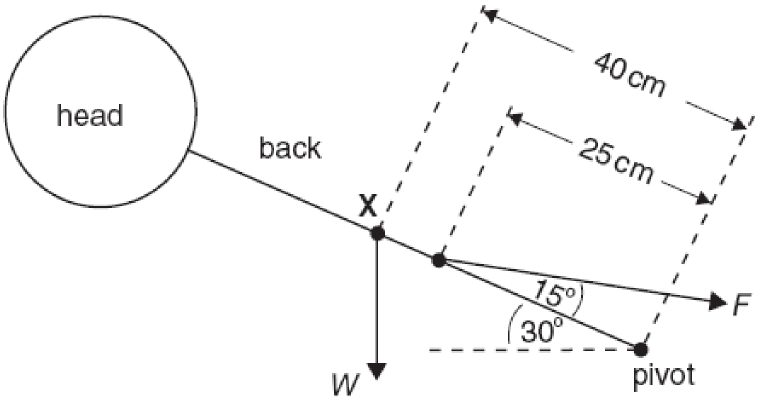
.... [2]

[Question to continue on next page …

For Examiner's Use

(c) Fig 1.2 shows a simple model to demonstrate the forces exerted by back muscles for a person bending over at an angle of 30° to the horizontal.

Fig 1.2



The back muscles may be considered to act as a single force *F* through a point on the back situated 25 cm from the pivot and making a **constant** angle of 15° with the back. The weight *W* of the upper body acts through a point **X**, situated a distance of 40 cm from the pivot.

(i) Calculate for an upper body weight *W* of 450 N, the size of the force *F* needed by the back muscles to keep the back at an angle of

1 30^{o} to the horizontal

F = ... N [2]

2 70^{o} to the horizontal

F = ... N [1]

(ii) Explain including reference to your answers to (c)(i), the body position which should be adopted when lifting heavy loads from the ground.

....

....

....

....

....

....

....

....

....

[4]

For Examiner's Use

7 (a) Fig 7.1 below shows a stretched string driven by a vibrator. The right-hand end of the string is fixed to a wall. A stationary wave is produced on the string; the string vibrates in two loops.

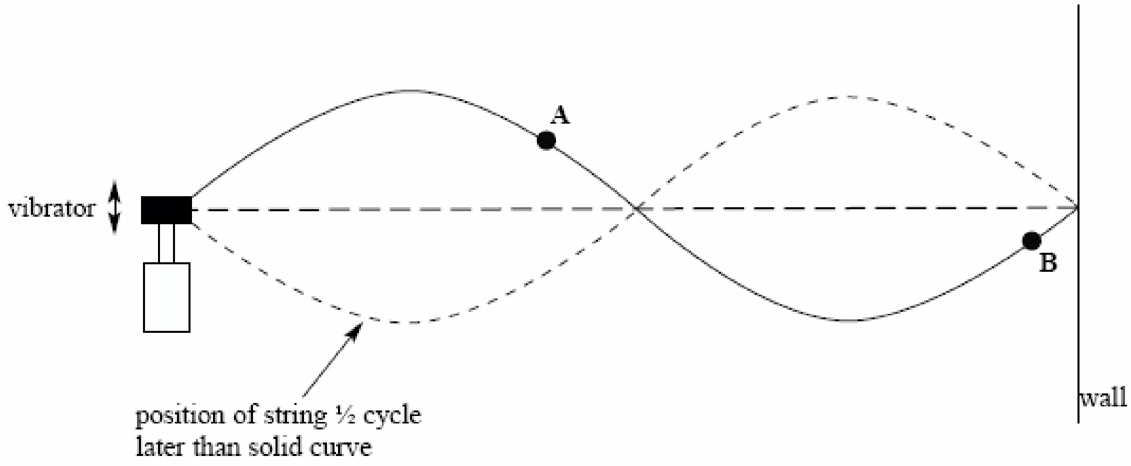


Fig 7.1

(i) State the physical conditions that are necessary for a stationary wave to form on the string.

[3]

(ii) Explain how you know that the wave on the string is transverse.

[1]

(iii) Compare the amplitude and phase of the oscillations of points A and B on the string.

Amplitude : [1]

Phase : [1]

(iv) The length of the string is 1.2 m and the speed of the transverse wave on the string is 6.2 m s^{-1}. Calculate the vibration frequency of the vibrator.

frequency = [3]

For Examiner's Use

(v) The frequency of the vibrator is tripled. Sketch the new shape of the stationary wave in Fig 7.2 below. [1]

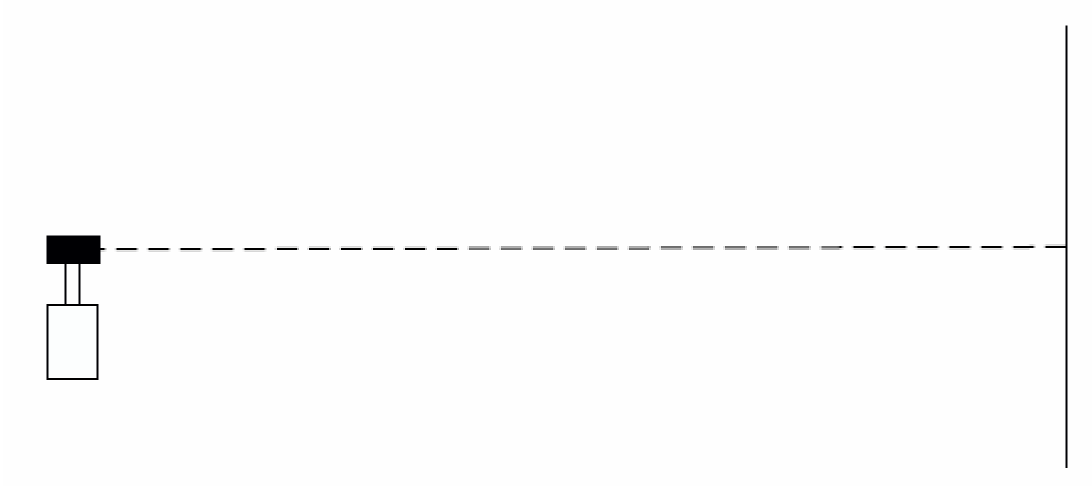
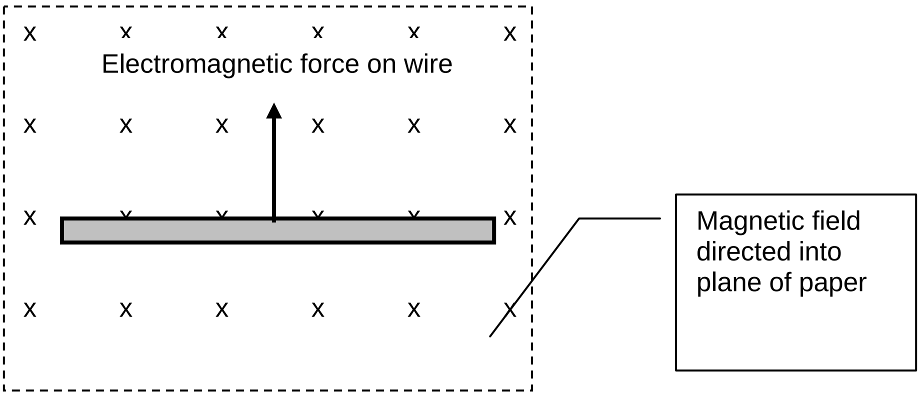


Fig 7.2

(b) A metal wire of length 0.57 m and cross–sectional area 1.0 x 10^{-6} m^2 is situated at right angles to a uniform magnetic field of flux density 1.8 x 10^{-3} T, as illustrated in the Fig 7.3 below.

Fig 7.3



The metal of the wire has density 7.9 x 10^3 kg m^{-3} and resistivity 8.8 x 10^{-8} Ω m. A potential difference is applied between the ends of the wire so that there is an electromagnetic force acting on the wire.

(i) In Fig 7.3, mark the direction of the current in the wire. [1]

For Examiner's Use

(ii) For the wire, calculate
1 its weight
2 its resistance

weight = ______________ N

resistance = ______________ Ω [5]

(iii) Calculate the potential difference required between the ends of the wire for the electromagnetic force on wire to equal its weight.

potential difference = ______________ V [4]

For Examiner's Use

8 (a) In each case below, name the phenomenon which leads to the belief that light behaves like

(i) a wave

[1]

(ii) a stream of particles (photons)

[1]

(b) A hydrogen lamp emits light of frequency 6.8×10^{14} Hz at a rate of 0.10 W. Of the photons given out, 0.15 % fall on the cathode of a photocell which gives a current of 6.0 μA in an external circuit. You may assume this current consists of all the photoelectrons emitted from the cathode of the photocell.

(i) Calculate

1 the energy of the photon

Energy of photon = ... J [1]

2 the number of photons leaving the source per second

Number of photons = ... s^{-1} [2]

(ii) What percentage of the photons falling on the cathode produces photoelectrons?

Percentage = ... [4]

(iii) Suggest a possible reason why it is not possible for every photon received by the photocathode to cause an electron emission?

[1]

For Examiner's Use

(iv) The cathode of the photocell has a *work function* of 2.0 eV

1 Explain what is meant by the term *work function*.

....

....

.... [1]

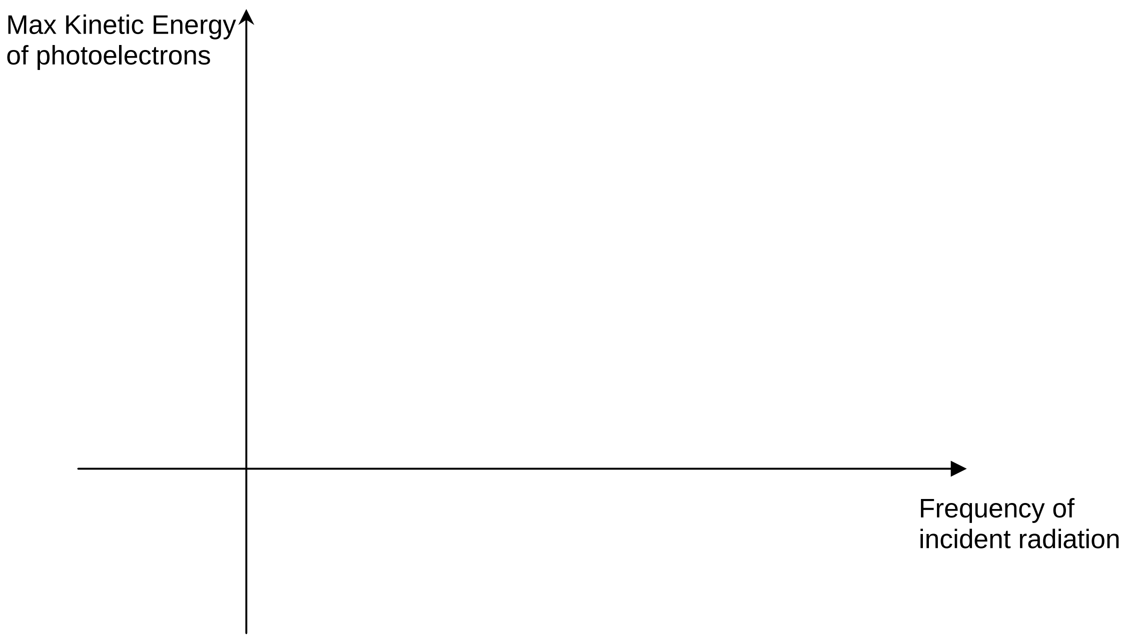
2 Calculate the maximum kinetic energy of electrons emitted from the photocathode of the cell.

Maximum kinetic energy = ... J [2]

3 Hence calculate the minimum de Broglie wavelength associated with the photoelectrons that leave the surface of the photocathode?

Minimum de Broglie wavelength = ... m [3]

(v) Sketch a well-labeled graph to show how the maximum kinetic energy of photoelectrons depends on the frequency of the incident radiation. [2]



For Examiner's Use

(vi) Fig 8.1 shows some of the energy levels in an isolated atom of lithium. Three transitions, A, B and C are drawn between these levels.

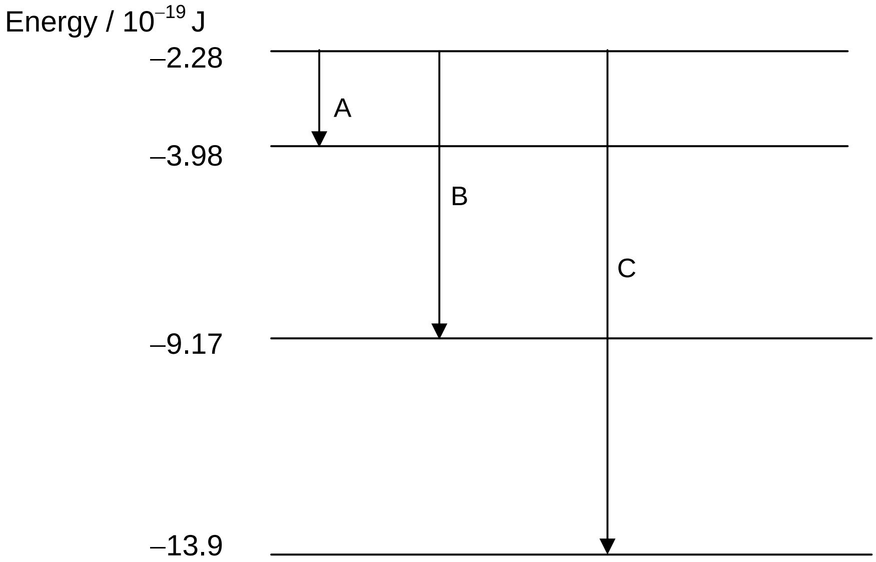


Fig 8.1

Describe and explain what would be observed if the same photocell of part (iv) is irradiated with the radiation associated with transition A.

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....

....

....

.... [2]

End of Paper