education

MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2024

MARKS: 150

TIME: 3 HOURS

This question paper consists of 19 pages including data sheets.

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INSTRUCTIONS AND INFORMATION

1 Write your name on the FOLIO PAPERS.

2 This question paper consists of TEN questions. Answer ALL the questions on the FOLIO PAPERS.

3 Start EACH question on a NEW page on the FOLIO PAPERS.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

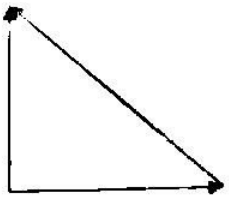
12. Write neatly and legibly.

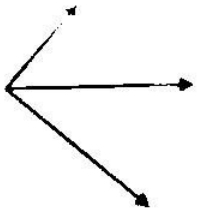
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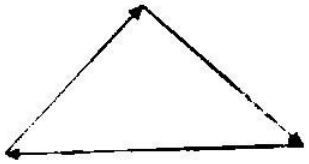
QUESTION 1: MULTIPLE CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1 to 1.10) on the FOLIO PAPERS, e.g. 1.11 D.

1.1 Consider the following vector diagrams. Which one of these vector diagrams represents a zero resultant?

A 

B 

C 

D 

(2)

1.2 How far above the earth's surface will an object, mass **m** be, if the weight is nine times smaller than on the earth's surface? (**r** represents the radius of the earth)

A ½ **r**

B 2**r**

C **r**

D 3**r**

(2)

1.3 Two objects with equal masses are dropped from different heights. When they are both 1 m above the ground, they have ...

A the same kinetic energy.

B the same acceleration and velocity.

C different velocities and the same potential energy.

D the same velocity and different acceleration.

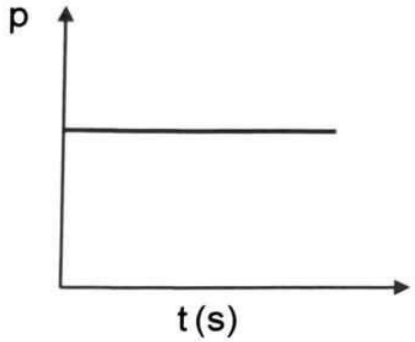
(2)

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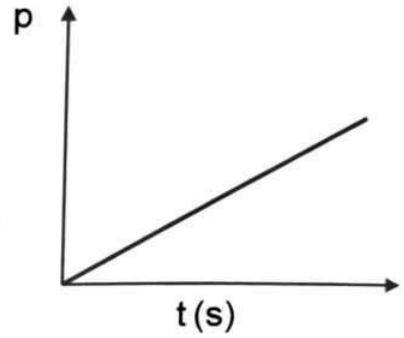
1.4 Which one of the following momentum versus time graphs best represents the motion of an object moving from rest in a straight line under the influence of a constant net force?

(2)

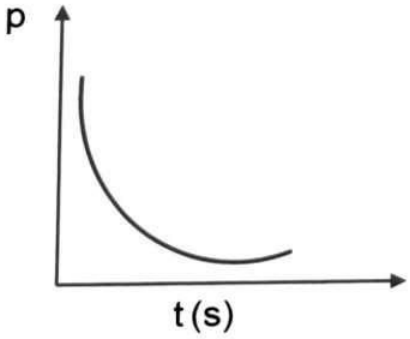
A



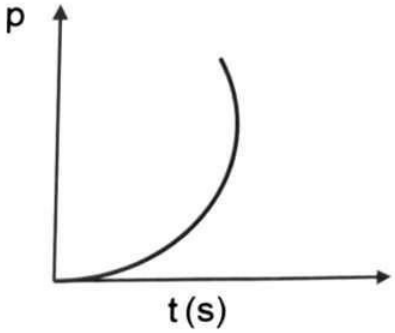
B



C



D



1.5 Which one of the following is a conservative force?

A Gravitational force

B Frictional force

C Applied force

D Tension in a rope

(2)

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1.6 A stationary person listens to the siren of an approaching ambulance.

Which ONE of the following characteristics associated with the sound of the siren, as heard by the person, is/are CORRECT?

(i) The pitch increases
(ii) The wavelength increases
(iii) The frequency increases
(iv) The wavelength decreases

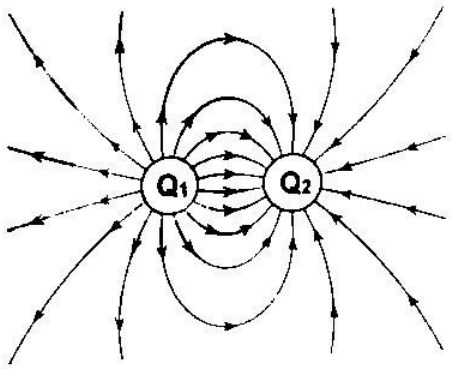
A (iii) and (iv) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (iii) and (iv) only (2)

1.7 The electric field pattern between two **charged** spheres Q_1 and Q_2 is shown below.



Which ONE of the following statements regarding the charge on sphere Q_1 and Q_2 is CORRECT?

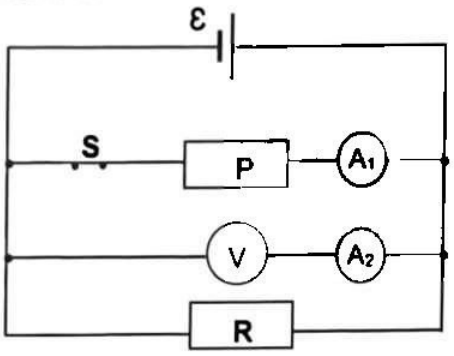
	Charge on sphere Q_1	**Charge on sphere Q_2**
A	Negative	Negative
B	Positive	Negative
C	Negative	Positive
D	Positive	Positive

(2)

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1.8 Two identical resistors **P** and **R** are connected in the circuit as shown below. The cell has an emf ε and negligible internal resistance. The switch is initially CLOSED.

Switch S is now OPENED. Which ONE of the following combinations of changes will occur in **P**, **R** and **V**?



	CURRENT IN P	CURRENT IN R	VOLTMETER V
A	Decreases	Increases	Increases
B	Decreases	Remains the same	Remains the same
C	Decreases	Decreases	Remains the same
D	Increases	Remains the same	Decreases

(2)

1.9 The component of an AC generator that maintains electrical contact between the rotating part/parts and the external circuit is/are the...

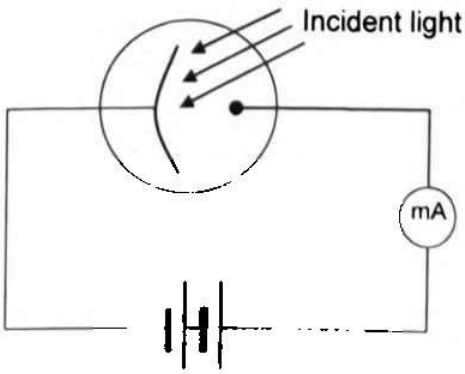
A carbon brushes.

B battery.

C split rings.

D slip rings. (2)

1.10 YELLOW light shines on the cathode of a photo-electric cell. A milli-ammeter in the circuit registers a reading.



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How does the velocity of the photo-electrons and the number of photo-electrons released per second change when the yellow light is replaced by a GREEN light of HIGHER intensity?

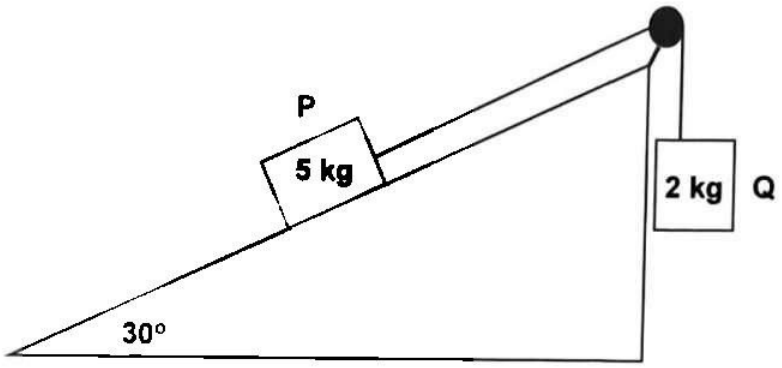
	VELOCITY OF PHOTO-ELECTRONS	NUMBER OF PHOTO-ELECTRONS PER SECOND
A	Increases	Increases
B	Stays the same	Decreases
C	Decreases	Stays the same
D	Increases	Decreases

(2)
[20]

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QUESTION 2 (Start on a new page.)

Block **P**, of mass 5 kg, is placed on a rough surface that is inclined at an angle of 30° to the horizontal. It is connected to a second block **Q**, of mass 2 kg, by a light inextensible string passing over a light frictionless pulley. An average constant frictional force of 2,5 N acts on block **P** as it moves on the incline, as shown in the diagram below. Ignore the effects of air resistance



2.1 State Newton's second law of motion in words. (2)

2.2 In which direction will the system move? Choose from DOWN THE INCLINE or UP THE INCLINE. (1)

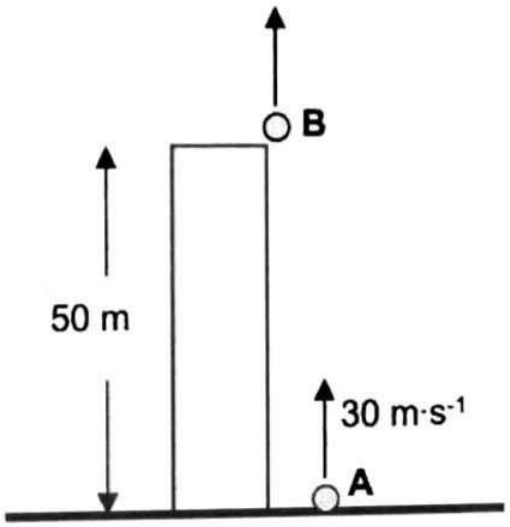
2.3 Draw a labelled free-body diagram for block **P** as it is moving on the incline. (4)

2.4 Apply Newton's second law to each of the blocks and calculate the magnitude of the acceleration of block **P** while moving on the incline. (5)

2.5 If the string between block **P** and **Q** now breaks, how will block **P**'s acceleration compare to that calculated in QUESTION 2.4?
Choose from GREATER THAN, SMALLER THAN or EQUAL TO.
Give a reason for the answer. (2)
[14]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards from the ground, near a tall building, with a speed of 30 $m \cdot s^{-1}$. Ignore the effects of air friction.



3.1 Explain what is meant by a projectile. (2)

3.2 Calculate the:

3.2.1 total time that ball **A** will be in the air. (4)

3.2.2 magnitude of the displacement of ball **A** during the last second before reaching maximum height. (4)

Two seconds after ball **A** is projected upwards, ball **B** is projected vertically upwards from the roof of the same building. The roof of the building is 50 m above the ground. Both balls **A** and **B** reach the ground at the same time. Refer to the diagram above. Ignore the effects of air friction.

3.3 Calculate the velocity at which ball **B** was projected upwards from the roof. (4)

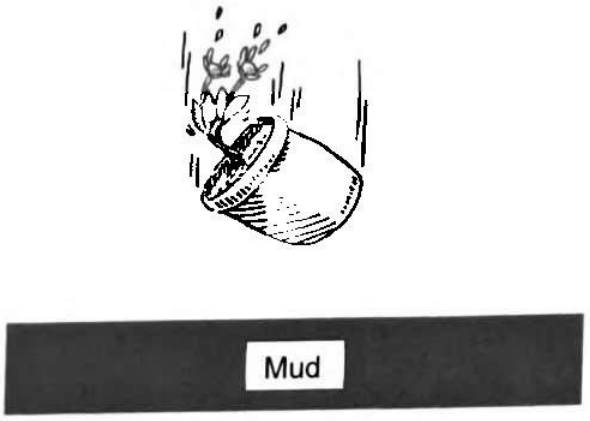
3.4 Sketch velocity-time graphs for the motion of both balls **A** and **B on the same set of axes**. Clearly label the graphs for balls **A** and **B** respectively.
Indicate the following on the graphs:
(a) Time taken by both balls **A** and **B** to reach the ground
(b) Time taken by ball **A** to reach its maximum height (4)

[18]

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QUESTION 4 (Start on a new page.)

A flower pot falls from an apartment balcony. The height of the balcony above the mud is 15 m and the mass of the flower pot is 1.5 kg.
Ignore air resistance and frictional force of the mud.



4.1 Calculate the velocity with which the flower pot hits the mud. (3)

The flower pot falls into the mud and comes to rest within 0.5 s.



4.2 Define the term *impulse* in words. (2)

4.3 Calculate the magnitude of the:

4.3.1 Net force on the flower pot as it falls into the mud (3)

4.3.2 Force of the mud on the flower pot (3)

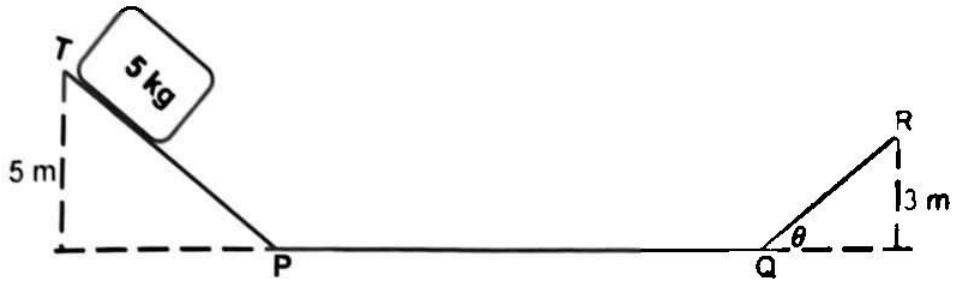
4.4 How will the force be influenced if the time taken for the flower pot to come to rest is longer?
Choose from INCREASE, DECREASE or STAY THE SAME.
Explain the answer. (3)

[14]

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QUESTION 5 (Start on a new page.)

A 5 kg block is released from rest at point T, from a height of 5 m and slides down a frictionless incline to **P**. It then moves along a frictionless horizontal surface **PQ** and finally moves up a rough inclined plane **QR**. It comes to rest 3 m above the horizontal at point **R**. The frictional force between the surface **QR** and the block is 18 N, as shown in the diagram below.



5.1 Define the term *non-conservative force*. (2)

5.2 Using conservation of mechanical energy only to calculate the speed of the block at point **P**. (4)

5.3 Draw a free-body diagram for the block as it is sliding between **TP**. (2)

5.4 Explain why the kinetic energy at point **P** is the same as that at point **Q**. (1)

5.5 State the work-energy theorem in words. (2)

5.6 Calculate the angle (θ) of the slope **QR**. (6)

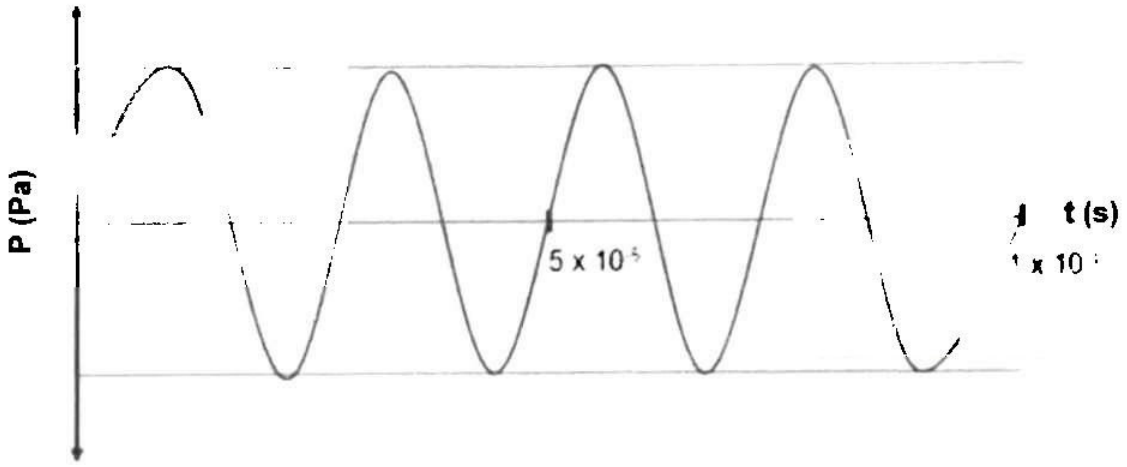
[17]

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QUESTION 6 (Start on a new page.)

Scientists studying the social interaction of dolphins in captivity connected an underwater sound recorder to an oscilloscope and immersed it in the dolphin tank at an aquarium.

They recorded the sound waves emitted by a dolphin as it approached the microphone. The waves recorded on the oscilloscope are represented in the diagram below.



6.1 State the Doppler effect in words. (2)

6.2 The average frequency of the social vocalisations of dolphins is 39 kHz. Proof by means of calculation that the frequency recorded is 1 kHz higher than the actual frequency. (2)

6.3 Explain why the recorded frequency is higher than the actual frequency. (2)

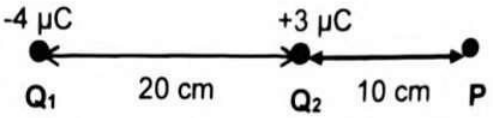
6.4 Calculate the speed at which the dolphin is approaching the recorder. The speed of sound in sea water is 1500 $m \cdot s^{-1}$. (5)

[11]

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QUESTION 7 (Start on a new page.)

Two point charges Q_1 en Q_2 are placed 20 cm apart as shown in the diagram below. Point **P** is 10 cm to the right of charge Q_2.



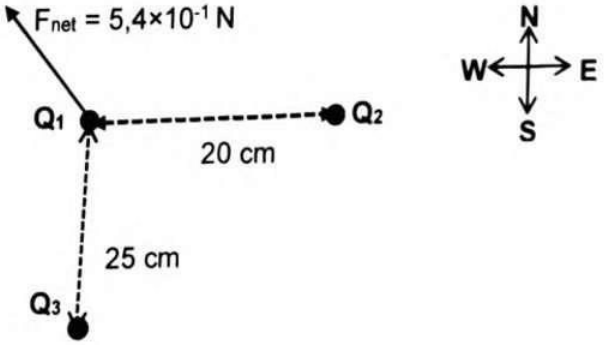
7.1 Define the term *electric field at a point.* (2)

7.2 Calculate the magnitude and direction of the net electric field at point **P**. (6)

The two charges are brought into contact with each other and placed back at their original positions.

7.3 Calculate the charge on each of the point charges after contact. (2)

After Q_1 and Q_2 were brought into contact and placed at their original positions, a charge Q_3 is placed 25 cm south of Q_1.
Charge Q_1 experiences a net force of $5{,}4 \times 10^{-1}$ N due to the other two charges as shown in the diagram below.



7.4 Calculate the magnitude and nature of the charge on Q_3. (6)

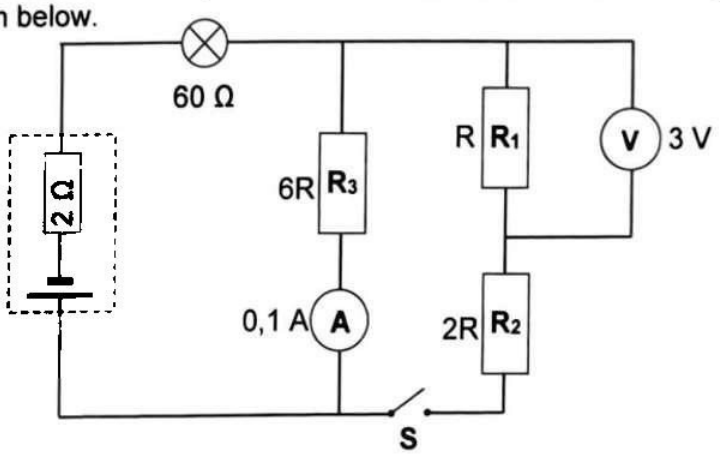
[16]

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QUESTION 8 (Start on a new page.)

The circuit diagram below shows a cell with an internal resistance 2 Ω, connected to three resistors, a light bulb, a switch, an ammeter and connecting wires. The resistance of the three resistors are R, 2R and 6R respectively and the resistance of the bulb is 60 Ω.

When switch **S** is CLOSED, the voltmeter and ammeter have readings as shown in the diagram below.



8.1 Write down the value of the:

8.1.1 Potential difference across resistor R_2 (1)

8.1.2 Current through R_2 (1)

8.2 Calculate the:

8.2.1 Resistance of resistor R_1 (3)

8.2.2 Emf of the cell (5)

8.2.3 Power dissipated in the light bulb (3)

Switch **S** is now OPENED.

8.3 Write down the reading on voltmeter **V**. (1)

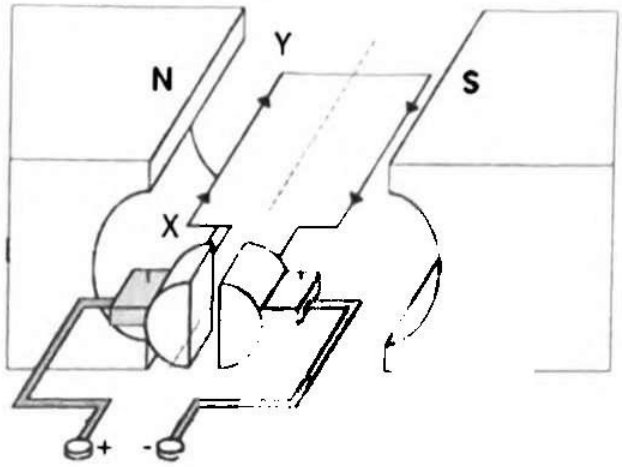
8.4 What will happen to the 'lost volts'?
Choose from INCREASES, DECREASES, REMAINS THE SAME.
Explain the answer with reference to total resistance and current. (3)

[17]

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QUESTION 9 (Start on a new page.)

9.1 The simplified diagram of a DC motor is shown below.
The current in the coil is in the direction **XY**.



9.1.1 In which direction will the above coil rotate?
Choose from CLOCKWISE or ANTI-CLOCKWISE. (1)

9.1.2 Write down the energy conversion that takes place in a motor. (1)

9.1.3 Sketch an emf versus time graph for two complete rotations of the coil, starting from the position of the coil as shown in the simplified diagram above. (2)

9.2 The specifications of an electric drill are as follows:

2100 W; 230 V

9.2.1 Define the term *root mean square potential difference* (2)

9.2.2 Calculate the maximum value of the current that can flow through the drill. (4)

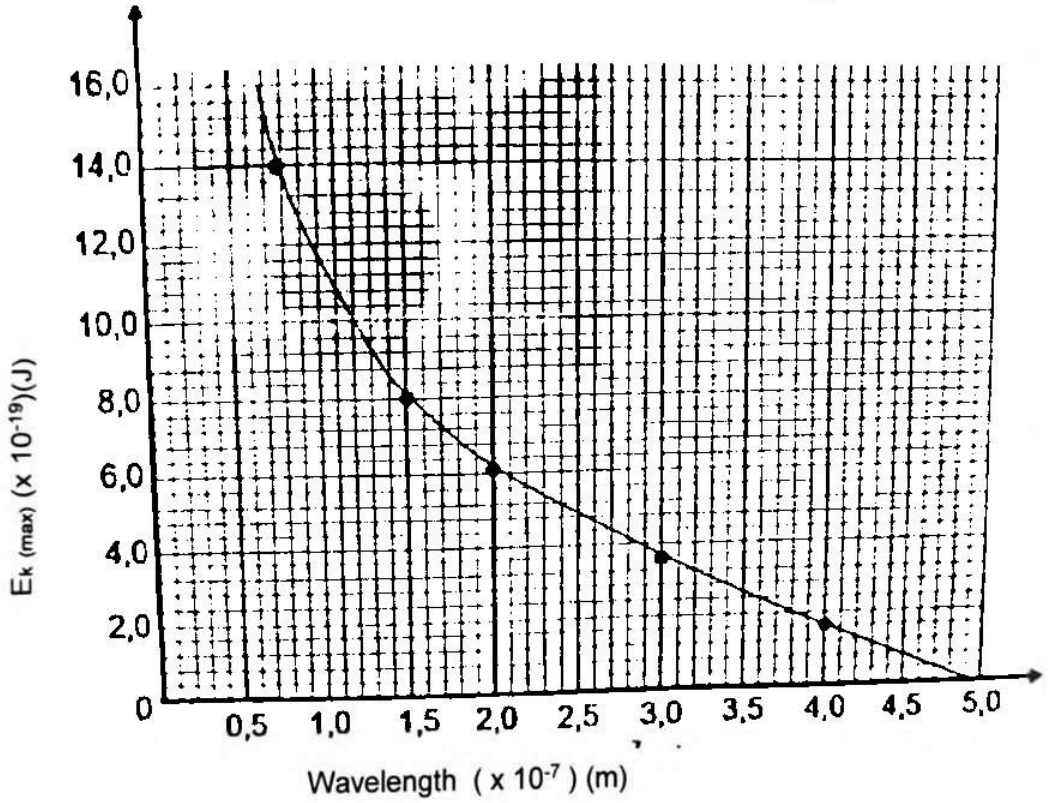
[10]

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QUESTION 10 (Start on a new page.)

When light of different frequencies shines on the metal cathode of a photo-cell, photo-electrons are released from the surface of the cathode. The graph below shows the relationship between the maximum kinetic energy ($Ek_{(max)}$) of a released photo-electron and the wavelength of the incident light.

GRAPH of $Ek_{(max)}$ versus WAVELENGTH



10.1 Determine, by using the graph, the maximum kinetic energy of the released photo-electron if the wavelength of the incident light is 3×10^{-7} m. (1)

10.2 What is the relationship, deducted from the graph, between the wavelength of the incident light and the maximum kinetic kinetic energy of the released photo-electron? (2)

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

10.4 Use the graph and calculate the work function of the metal that is used as a cathode for this photo-cell. (3)

10.5 The velocity of the released photo-electron is $2,6 \times 10^{6}$ m·s^{-1}. Calculate the wavelength of the incident light. (5)

[13]

TOTAL: 150