

Physics II

030

27/07/2022 08:30 AM - 11:30 AM



NESA NATIONAL EXAMINATION AND
SCHOOL INSPECTION
AUTHORITY

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2021-2022

SUBJECT: PHYSICS II

PAPER II : THEORY

COMBINATIONS:

PHYSICS - CHEMISTRY- MATHEMATICS (PCM)

PHYSICS - CHEMISTRY- BIOLOGY (PCB)

MATHEMATICS - PHYSICS - GEOGRAPHY (MPG)

MATHEMATICS - PHYSICS - COMPUTER SCIENCE (MPC)

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as written on your registration form and **DO NOT** write your names and index number on additional answer sheets if provided.
- 2) Do not open this question paper until you are told to do so.
- 3) This paper consists of **two** sections **A** and **B**.

Section A: Attempt **ALL** questions.

(55 marks)

Section B: Attempt any **THREE** questions.

(45 marks)

- 4) Non- programmable scientific calculator and mathematical set may be used.

5) Useful constants

Acceleration due to gravity $g=9.81 \text{ m/s}^2$

Planck's constant $h=6.63 \times 10^{-34} \text{ J.s}$

Speed of light in vacuum $C= 3 \times 10^8 \text{ m/s}$

The rest mass of the electron $m_e= 9.1 \times 10^{-31} \text{ kg}$

The magnitude of the charge of an electron $e = 1.6 \times 10^{-19} \text{ C}$

SECTION A: ATTEMPT ALL QUESTIONS (55 marks)

- 1) a) State the cause of each of the following phenomena: (1 mark)
 i) Earthquakes. (1 mark)
 ii) Tsunami. (1 mark)
- b) i) State any one way of preventing landslides. (1 mark)
 ii) Identify one effect of cyclones on environment. (1 mark)
- 2) a) What does acronym LASER stand for? (1 mark)
 b) State one property of LASER. (1 mark)
 c) Identify any one real life application of LASER. (1 mark)
- 3) Match each of elementary particles (**Column A**) with its description (**Column B**). (4marks)

Column A	Column B
a) Fermions	i) Carry strong nuclear forces between matter particles
b) Quarks	ii) Antiparticle of electron
c) Positron	iii) Have half integer spins
d) Gluons	iv) Make up hadrons such as protons and neutrons

- 4) State whether each of the following statements is **TRUE** or **FALSE**: (1mark)
 a) Troposphere is a layer of Sun's atmosphere. (1mark)
 b) Red giant stars are hotter than white dwarf stars. (1mark)
 c) Luminosity is the total energy that a star emits per second. (1mark)
- 5) Complete each of the following statements using only 4 appropriate terms from the box.

Distance between charged objects	Electric force
Electric field	Lightning
	Electric potential

- a) The electric force per electric charge unit is called (1mark)
- b) One of the factors that affect the electric force between two charged objects is (1mark)
- c) Lightning arresters help prevent damage to the apparatus because of high voltages. (1mark)
- d) The electric field is equal to divided by the the distance between the plates of a capacitor. (1mark)

- 6) a) When is the work done by a force negative? (1 mark)
 b) Explain how an object can have mechanical energy even if its momentum is zero. (1 mark)
 c) Describe a perfectly inelastic collision. (1 mark)
- 7) a) A glass of cold water is placed in a sealed room containing air at room temperature. After an infinite amount of time, what will happen? (1 mark)
 b) What happens to internal energy when the work is done by the system on surroundings? (1 mark)
 c) Why is the efficiency of Carnot engine less than 100%? (1 mark)
- 8) a) Observe the following sound waves marked **A**, **B**, **C** and **D** (*figure 1*) and answer the questions that follow.

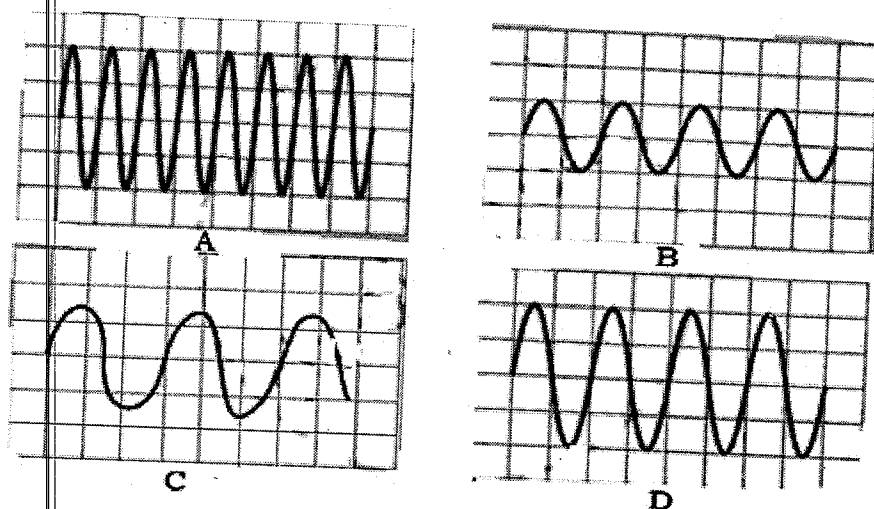


Figure 1

- i) Select two waves that represent sounds of the same loudness but different pitch. (1 mark)
 ii) Select two waves representing sounds of the same frequency but different loudness. (1 mark)
- b) Does sound travel faster in solids, liquid or in gas? Explain your answer. (2 marks)

- 9) a) State Newton's law of universal gravitation. (1 mark)
 b) **Figure 2** shows an orbit of a planet around the Sun.

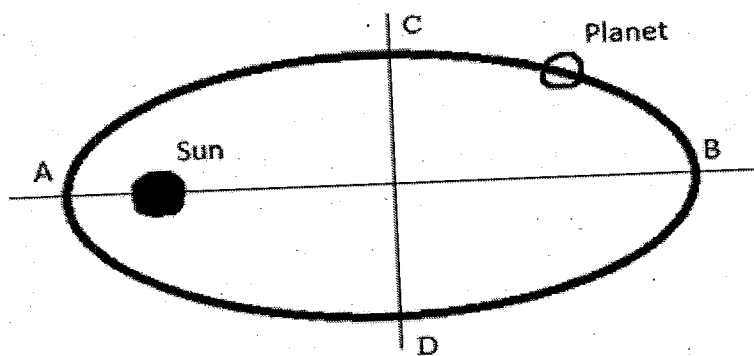


Figure 2

- i) What is the planet's orbit around the Sun called? (1mark)
 ii) Where does the planet move slowest in its orbit? (1mark)
 Use one of the letters **A, B, C, D** to answer this question.

- 10) Classify each of the following statements as advantage of analog signal or advantage of digital signal. You may use a table.

- a) It conveys information with less noise, distortion and interference. (1mark)
 b) It uses less bandwidth. (1mark)
 c) It offers a lot of editing tools. (1mark)

- 11) A hydrogen atom initially in a state with energy -3.4 eV makes a transition to a state with energy -0.85 eV .

- a) Show that the atom absorbs or emits a photon in this process. (2 marks)
 b) Find the wavelength of the photon involved in this process. (2 marks)

- 12) Analyze the following electric circuit (**figure3**) then answer related sub-questions.

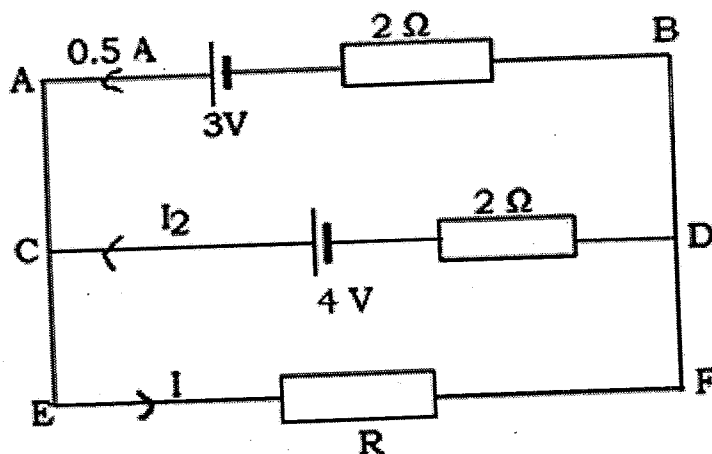


Figure 3

Determine:

- a) The electric current I_2 in the arm CD. (2 marks)
- b) The potential difference V_R across the unknown resistor R. (2 marks)
- c) The electric current I. (1 mark)

13) During assessment, a teacher asked learners to use ray diagram to complete the following diagram (figure 4)

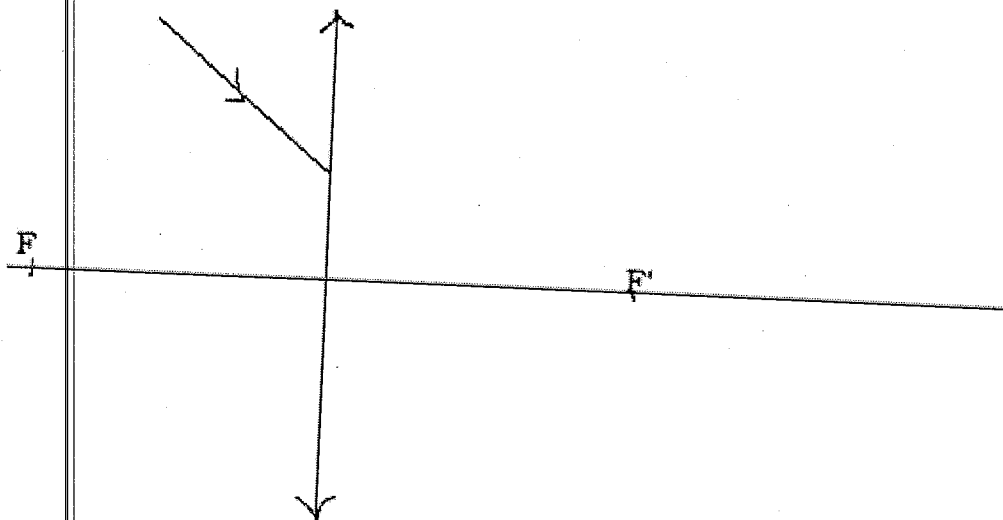


Figure 4

A learner gave the following answer (figure 5)

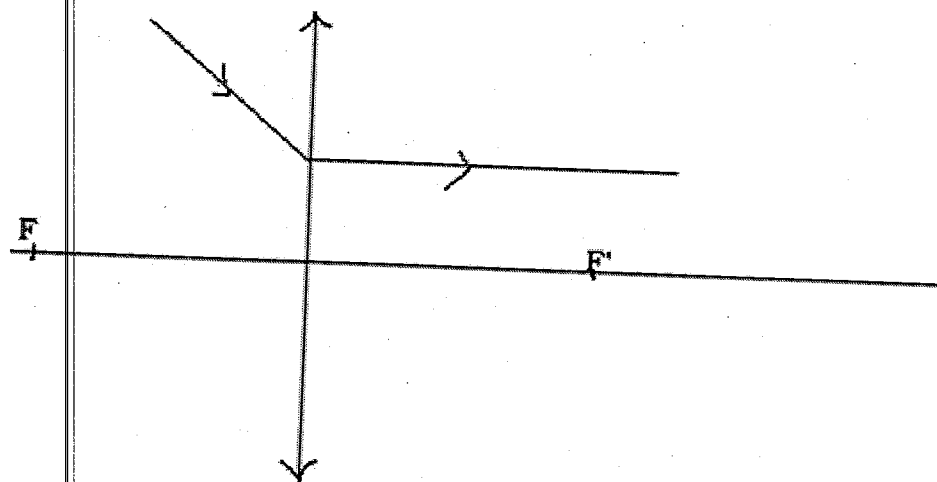


Figure 5

- a) Is this ray diagram given by the learner, correct? If yes, explain your answer, if no transform the diagram so that it corresponds to a right answer. (4 marks)

- 14) You are given 4 lenses having powers as $P_1=2$ dioptries, $P_2=3$ dioptries, $P_3=6$ dioptries and $P_4=14$ dioptries.
Indicate two lenses that you can select so that one is an objective lens and another is eyepiece lens to construct a microscope. Justify your answer. **(4 marks)**

- 15) Russia state-owned nuclear company Rosatom Global reached an agreement to set up in Rwanda the nuclear power plant by 2024. After signing this agreement on the use of nuclear energy, the Rwandan cabinet approved the establishment of the Rwanda Atomic Energy Board, an institution to coordinate nuclear science and technology activities in the country.

Formulate any four recommendations to Rwanda Atomic Energy Board on the safety measures associated with the production and use of nuclear energy that will be taken. **(4 marks)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (45 marks)

- 16) **Read carefully the extract below and answer related questions.**

Climate change is the defining global challenge of our time. Rapid changes to the global climate over the past several decades have already resulted in widespread impacts across human societies and natural systems. Continued changes of this magnitude will have severe and irreversible planetary impacts lasting hundreds of thousands of years, further threatening people and communities everywhere. Lessening the worst of climate impacts requires a substantial push to limit global temperature changes over the course of this century. This in turn depends on humankind's ability to achieve rapid and sustained reduction in greenhouse gas emissions over the next several decades. Doing so, demands a transformation of our economy and our systems of production and consumption, from changing how we generate energy and produce food to how we consume goods and services. While the focus for most of this change often rests at the scale of government and industry, changes at the level of individuals, households and communities are profoundly of greater importance than most people appreciate.

Reference: Williamson, K., Satre- Meloy, A., Velasco, K.& Green, K. (2018), *Climate change needs behaviour change*, pp. 5

Questions

- a) What do you understand by the term climate change? **(1 mark)**
b) i) Imagine three greenhouse gases that the authors could mention. **(3 marks)**
ii) Explain how greenhouse gases contribute to the climate change according to the authors. **(2 marks)**

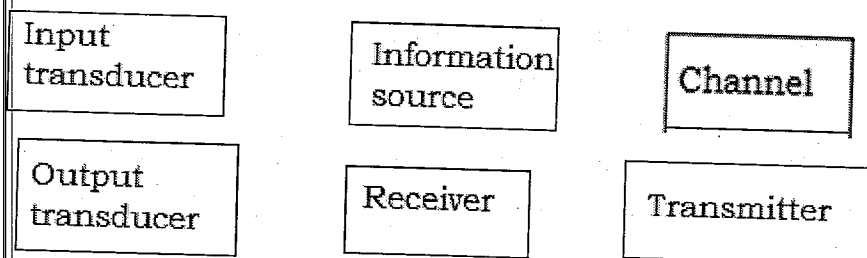
- c) The authors mentioned the facts related to climate change in their research topic "climate change needs behaviour change". Formulate what the authors wrote to confirm that the negative effects of climate change are real. **(3 marks)**

- d) i) The main way to lessen climate change is given in this extract. Which one? **(1 mark)**

- ii) How does the Government of Rwandan support practically the strategies to reduce climate change proposed by the authors? Identify any three strategies. **(3 marks)**

- e) Evaluate the extent to which Rwanda is being affected by climate change. **(2 marks)**

- 17) You are given 6 elements/blocks of telecommunication system



- a) Construct a meaningful block diagram of telecommunication system using the given elements. Two successive elements must be linked by an arrow. **(6 marks)**

- b) Explain in details the principle of functioning of your block diagram of telecommunication system. **(6 marks)**

- c) Give a device that works as each of the following elements:
i) Input transducer **(1 mark)**
ii) Output transducer **(1 mark)**

- d) Where is noise added to a signal in the given block diagram of telecommunication system? **(1 mark)**

- 18) a) What do you understand by the term uniform circular motion? **(1 mark)**

- b) How is projectile motion used in real life? **(1 mark)**

- c) A car is travelling at uniform velocity 52.5 km/h. The wheels roll along the road without sliding. There is a white dot on the tyre.
i) Use SI unit to find the angular frequency/angular velocity ω for the tyre, given that the diameter of the wheel is 60.0 cm. **(2 marks)**

- ii) **Figure 6** below shows the position of the white dot at $t=0\text{s}$, where the angular displacement $\theta=0^\circ$.

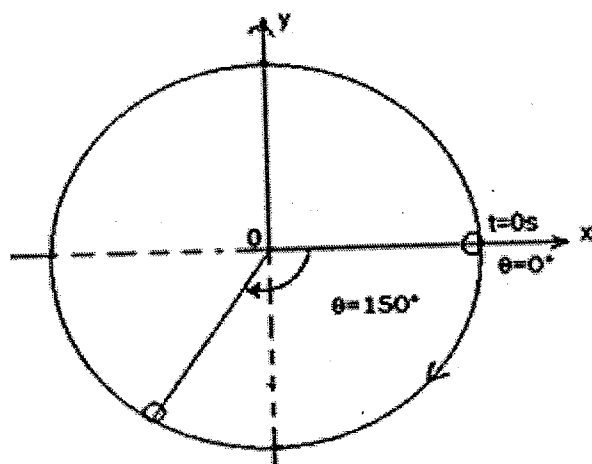


Figure 6

At what time will the white dot first pass through $\theta=150^\circ$?
Hint: Convert $\theta=150^\circ$ into radians before finding the time.

(3 marks)

- d) An object is launched at a velocity of 20 m/s in a direction making an angle of 25° upward with the horizontal plane as shown, not to scale, in **figure 7**.

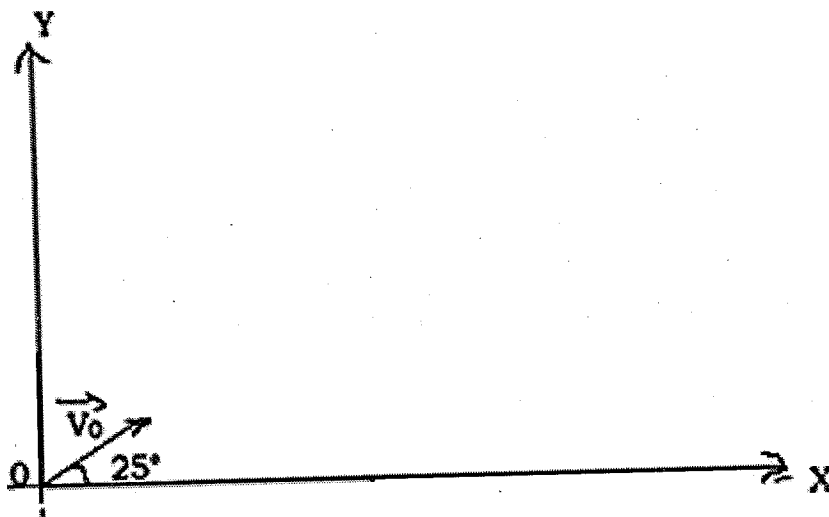


Figure 7

- Find the maximum height reached by the object. **(2 marks)**
- What is the total flight time (between launch and touching the ground) of the object? **(2 marks)**
- Calculate the horizontal range R (maximum x) of the object. **(2 marks)**
- With a justification, sketch the path followed by the projectile. **(2 marks)**

- 19) a) A mass m attached to a spring is displaced from its equilibrium position and allowed to oscillate vertically (**figure 8**). Air resistance is negligible.

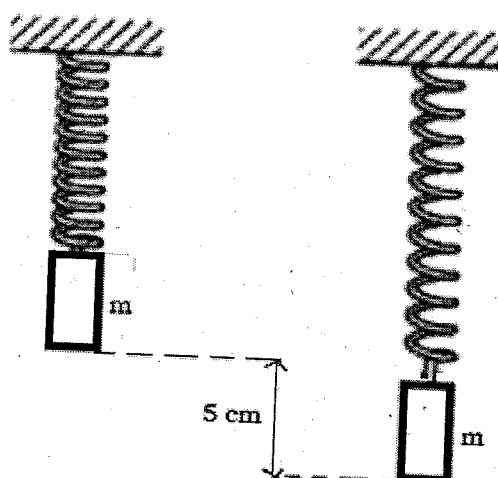


Figure 8

Figure 9 shows the graph of displacement from equilibrium position against time for the mass.

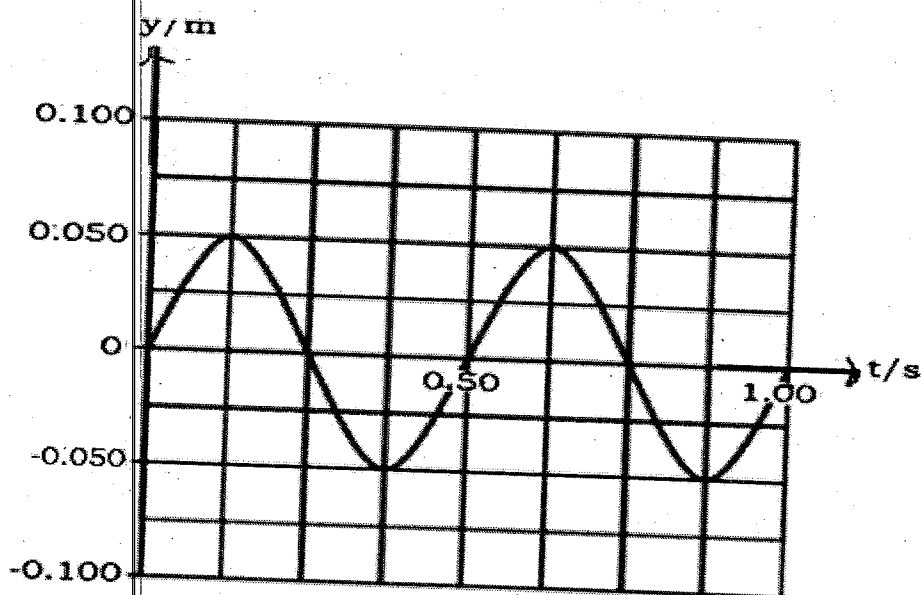


Figure 9

- From the graph, find:
 - The amplitude A of oscillation. (1 mark)
 - The period T of oscillations. (1 mark)
- Determine the angular frequency/velocity ω of the motion. (2 marks)
- Write an expression for the displacement Y of the mass as function of time. Include appropriate numerical values.
The initial condition can help you find the initial phase ϕ_0 of the motion. (3 marks)
- The system is now modified so that a damping force acts on oscillating mass. Propose how this modification may be achieved. (1 mark)

- b) A 0.5 kg mass is attached to a horizontal spring which undergoes simple harmonic motion. The graph of potential energy as a function of position is shown below (**figure 10**). The total energy of the oscillating system is 3 J.

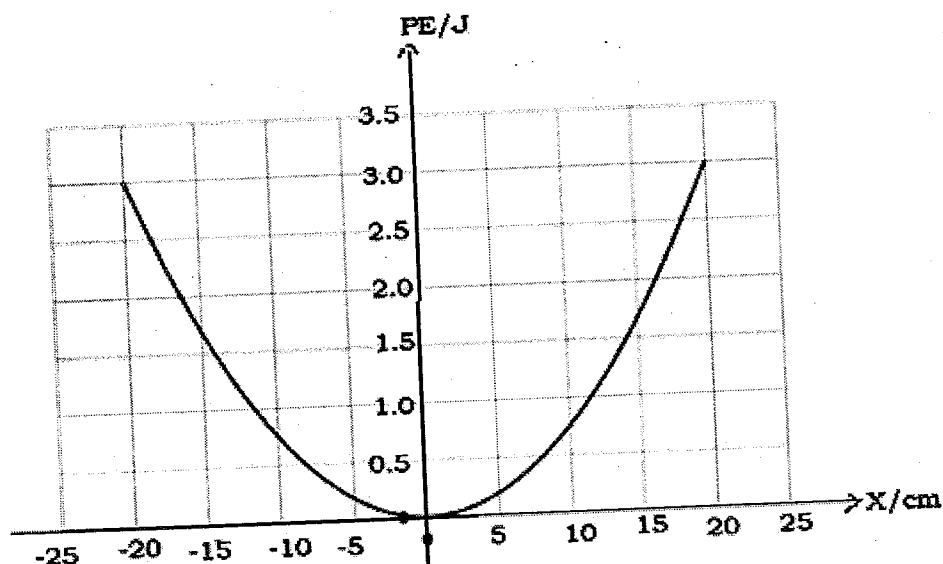


Figure 10

- i) Sketch on the same set of axes a labelled graph showing the variation of potential energy, kinetic energy and total energy with displacement of a particle executing a simple harmonic motion. Numerical values are not required. **(2 marks)**
- ii) Estimate the following energies of the system when the displacement $x=10$ cm. **(1 mark)**
 - The potential energy. **(2 marks)**
 - The kinetic energy. **(2 marks)**
- iii) Calculate the period of oscillation. **(2 marks)**

- 20) **Figure 11** shows wavefronts incident on and emerging from a double slit arrangement.

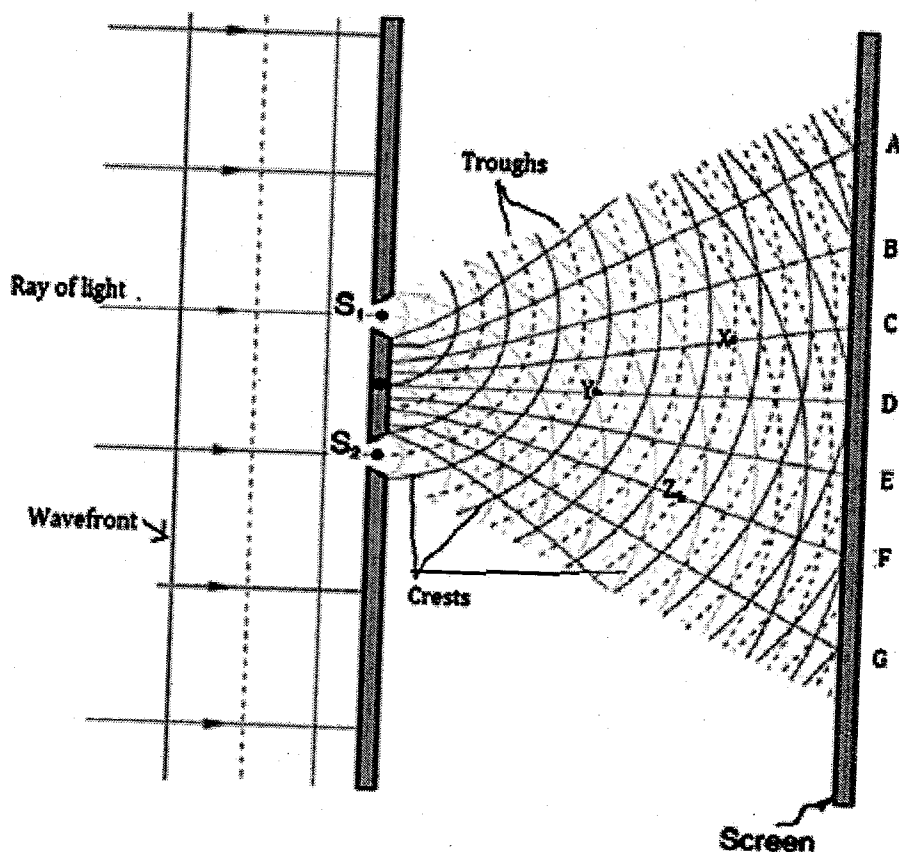


Figure 11

The above wavefronts represent successive crests and troughs of light waves. The directions along which destructive interference and constructive interference are represented by the letters on the screen.

- a) (i) State three conditions that must be satisfied so that two waves may interfere. **(3 marks)**
(ii) State the principle of superposition of waves. **(1 mark)**
- b) Copy the table and tick the appropriate boxes in the table to show what is observed at the points marked **X**, **Y** and **Z** in the diagram.

	Point	i. What is observed		
		Constructive interference	Destructive interference	Neither
	X			
	Y			
	Z			

(3 marks)

- c) Select the directions **A, B, C, D, E, F, G** to answer the following and use the value of the path difference or the value of the phase difference between two interfering waves to justify your answer.
- (i) Select any one direction along which constructive interference may be observed. Justify your answer. **(2 marks)**
- (ii) Determine any one direction along which destructive interference may be observed. Justify your answer. **(2 marks)**
- d) Light of wavelength 650 nm is incident normally on a double slit arrangement. The interference fringes formed are viewed on a screen parallel to and 1.2 m from the plane of the double slit. The fringe separation/width is 0.750 mm
- i) Calculate the separation of the slits. **(2 marks)**
- ii) The separation between the two slits is slightly increased without changing other parameters.
State the effects, if any, that this change has on:
- The separation of the fringes. **(1 mark)**
 - The frequency of the light. **(1 mark)**

- END -