Physics Higher Level
Radiation and Matter
Practice Unit Assessment

Time 45 minutes

Read Carefully

1 All questions should be attempted.

2 Enter the question number clearly beside the answer to each question.

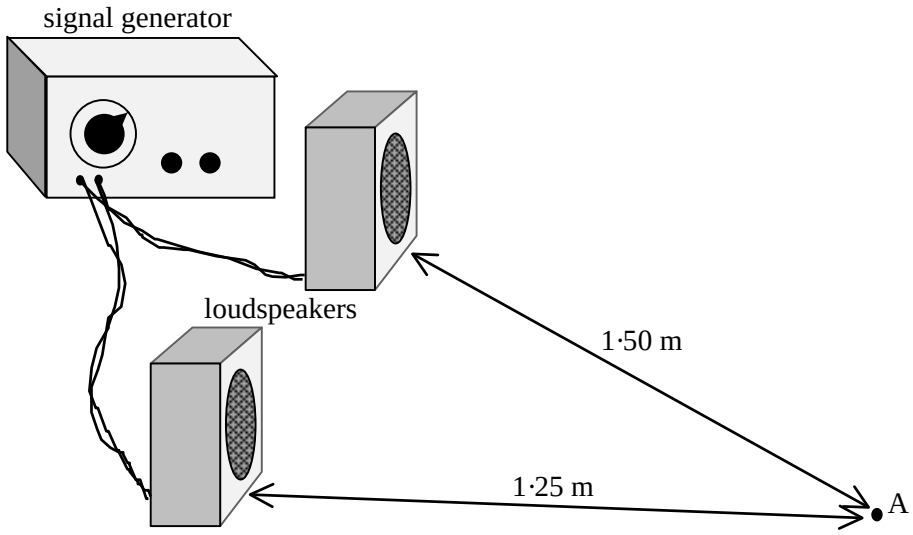
3 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

4 The following data should be used when required.

Speed of light in vacuum c	$3{\cdot}00 \times 10^{8}$ m s^{-1}	Planck's constant h	$6{\cdot}63 \times 10^{-34}$ J s
Magnitude of the charge on electron e	$1{\cdot}60 \times 10^{-19}$ C	Mass of electron m_e	$9{\cdot}11 \times 10^{-31}$ kg
Acceleration due to gravity g	$9{\cdot}8$ m s^{-2}	Mass of proton m_p	$1{\cdot}67 \times 10^{-27}$ kg

NOTE: This is a **trial paper** and contains questions **of the type** that will be encountered in the actual unit assessment. The threshold of attainment of the unit assessment (pass mark) is 18 marks.

1. Two loudspeakers are connected to a signal generator which produces a steady note with a frequency of 3400 Hz.



(*a*) Calculate the wavelength of the sound waves being produced by the loudspeakers given that the speed of sound in air is 340 m s^{-1}. **2**

(*b*) A microphone is placed at position A which is 1·25 m from one loudspeaker and 1·50 m from the other. State, providing evidence for your answer, whether constructive or destructive interference will be found at this point. **2**

(*c*) The experiment is moved from a large open space to a small room in which there are many reflections of sound from the walls. Why would this make it very hard to detect accurately the position of a maxima or minima of sound? **1**

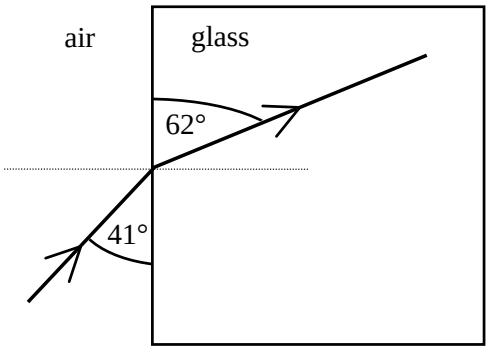
(5)

2. (*a*) What is the velocity of light in air? **2**

(*b*) What will be the velocity of light within a lens made of glass with a refractive index of 1·48? **1**

(3)

3. Find the refractive index of the glass block shown below.



2

(2)

4. A photographic light meter indicates a light intensity of 4 W m^{-2} at a distance of 2·0 m from a light source. What separation from the light source would be required to produce a light intensity of 0·25 W m^{-2}? **2**

(2)

5. The work function of a metal is $6{\cdot}4 \times 10^{-19}$ J.

(*a*) Explain what is meant by the term 'work function'. **1**

(*b*) Light with a frequency of $1{\cdot}2 \times 10^{15}$ Hz. is shone onto the metal surface.

Find whether or not the photons of this light will cause the photoelectric effect to take place. **2**

(*c*) The light source is now replaced with a light source which produces light with a frequency of $1{\cdot}5 \times 10^{15}$ Hz.

(i) The photons from this source contain more energy than is required to release the electrons. How much extra energy is available after the electron has been released? **2**

(ii) Into what energy type will this extra energy be converted? **1**

(iii) Photons come from three lamps that emit red, green and blue light. Which of these lamps produces photons with the highest energy? **1**

(7)

6. The equation for a nuclear reaction is given below.

$$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{140}_{58}\text{Ce} + {}^{94}_{40}\text{Zr} + {}^{1}_{0}\text{n} + {}^{1}_{0}\text{n} + \text{energy}$$

(*a*) State whether this is a fission or fusion reaction. **1**

(*b*) Explain the difference between a spontaneous fission reaction and an induced fission reaction. **2**

(*c*) (i) Explain, using $E = mc^2$, how this nuclear reaction results in the production of energy. **2**

(ii) Using the information given below, and any other data required from the front cover, calculate the energy released in the above nuclear reaction. **2**

mass of $^{235}_{92}\text{U}$ = 390·173 x 10^{-27} kg

mass of $^{140}_{58}\text{Ce}$ = 232·242 x 10^{-27} kg

mass of $^{94}_{40}\text{Zr}$ = 155·883 x 10^{-27} kg

mass of $^{1}_{0}\text{n}$ = 1·675 x 10^{-27} kg

(7)

7. (*a*) State **two** factors that determine the risk of biological harm from ionising radiation. **2**

(*b*) A welder uses radioactive materials to help detect welding faults in a pipeline. Over a period of a year he receives 6 mGy of gamma radiation and 0·5 mGy of alpha radiation. Use the table below to calculate the total dose equivalent he receives for the year? **2**

(4)

Type of radiation	*Quality factor, Q*
X-rays	1
gamma rays	1
beta particles	1
slow neutrons	5
fast neutrons	10
alpha particles	20