

PHYSICS PAPER 2

Question-Answer Book

11:45 am – 12:45 pm (1 hour)

This paper must be answered in English

INSTRUCTIONS

- 1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5 and 7.
- 2) This paper consists of **FOUR** sections, Sections A, B, C and D. Each section contains eight multiple-choice questions and one structured question which carries 10 marks. Attempt **ALL** questions in any **TWO** sections.
- 3) Write your answers to the structured questions in the **ANSWER BOOK** provided. For multiple-choice questions, blacken the appropriate circle with an HB pencil. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
- 4) Graph paper and supplementary answer sheets will be provided on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** the Answer Book.
- 5) The Question-Answer Book and Answer Book will be collected **SEPARATELY** at the end of the examination.
- 6) The diagrams in this paper are **NOT** necessarily drawn to scale.
- 7) The last two pages of this Question-Answer Book contain a list of data, formulae and relationships which you may find useful.
- 8) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

Candidate Number

--	--	--	--	--	--	--	--	--	--	--	--



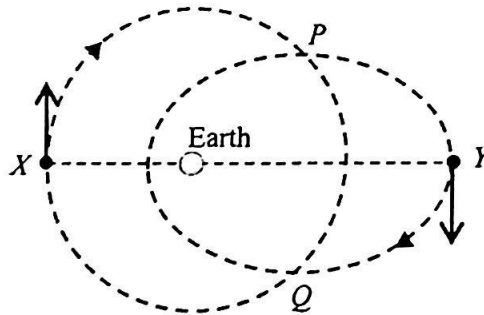
Section A : Astronomy and Space Science

Q.1: Multiple-choice questions

1.1 Which of the following represents the arrangement in descending order of size ?

- | | | | | | |
|----|--|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | star cluster > galaxy > planetary system | A | B | C | D |
| B. | star cluster > planetary system > galaxy | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | galaxy > planetary system > star cluster | | | | |
| D. | galaxy > star cluster > planetary system | | | | |

1.2 Two satellites X and Y are revolving in clockwise direction about the Earth as shown. The diameter of the circular orbit of X equals the length of the major axis of the elliptical orbit of Y . The two orbits intersect at P and Q .



At the instant shown, the two satellites and the Earth are on a straight line. Which deductions are correct ?

- (1) X and Y have the same acceleration when they pass P .
- (2) The speed of X is greater than that of Y at the instant shown.
- (3) The satellites will not meet each other at P or at Q .

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) and (2) only | A | B | C | D |
| B. | (1) and (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (2) and (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

1.3 The mass of Mars is 0.107 times that of the Earth. The radius of Mars is 0.532 times that of the Earth. What is the escape velocity of Mars in terms of the escape velocity of the Earth v_E ?

- | | | | | | |
|----|-------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | $0.201 v_E$ | A | B | C | D |
| B. | $0.378 v_E$ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | $0.449 v_E$ | | | | |
| D. | $0.615 v_E$ | | | | |

1.4 The luminosity of star P is double that of star Q . The brightness of P is eight times that of Q . What can be deduced about the respective distance of stars P and Q from the Earth ?

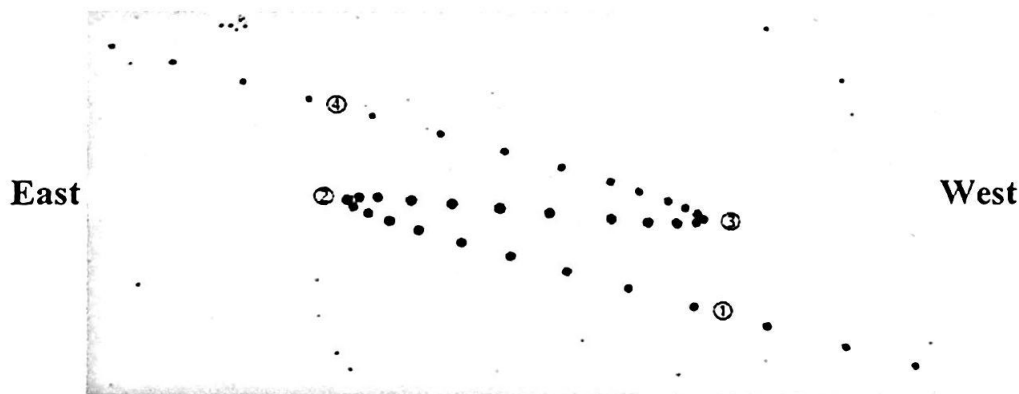
- | | | | | | |
|----|---|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | P 's distance from the Earth is 2 times that of Q . | A | B | C | D |
| B. | Q 's distance from the Earth is 2 times that of P . | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | P 's distance from the Earth is 4 times that of Q . | | | | |
| D. | Q 's distance from the Earth is 4 times that of P . | | | | |

1.5 The edge-on view of a binary system shows that the wavelength of the calcium K spectral line of one of the stars changes by ± 0.3 nm from the same line ($\lambda = 393.4$ nm) obtained in a laboratory. The period of the star is 69 hours. Find the radius of its orbit.

- | | | | | | |
|----|------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | 2.5×10^6 m | A | B | C | D |
| B. | 1.5×10^8 m | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | 9.0×10^9 m | | | | |
| D. | 5.6×10^{10} m | | | | |

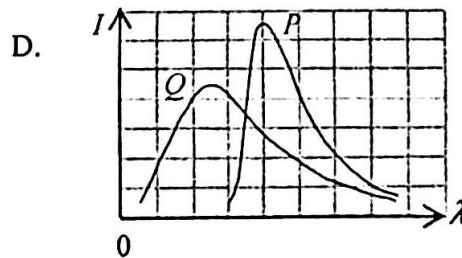
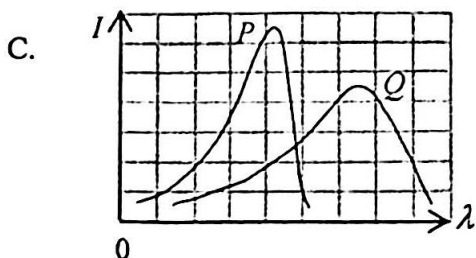
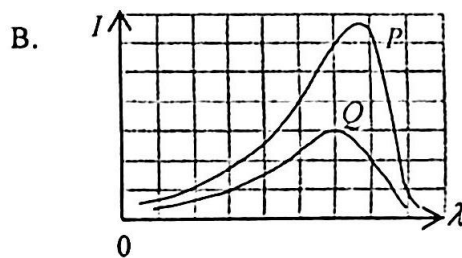
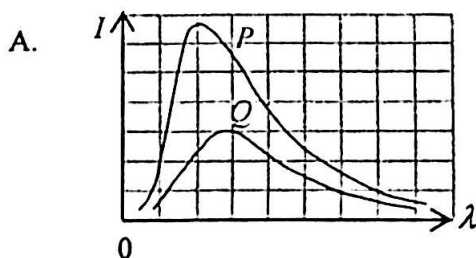
Please stick the barcode label here.

- 1.6 The figure below shows the motion of Mars from bottom right to top left against the background night sky over a period of about 7 months.



At which point along the path was Mars closest to the Earth ?

- A. somewhere between ① and ② A B C D
 B. somewhere between ② and ③ ○ ○ ○ ○
 C. somewhere between ③ and ④
 D. either at turning point ② or at turning point ③
- 1.7 A star, which is 4.2 light years from the Sun, is observed from the Earth 6 months apart. Estimate the maximum angular difference in the observed positions of this star.
- A. 0.8 arc seconds A B C D
 B. 1.3 arc seconds ○ ○ ○ ○
 C. 1.6 arc seconds
 D. 2.6 arc seconds
- 1.8 Star P has a higher surface temperature than star Q . However, star Q has a larger radius. Which graph shows the distribution of spectral intensity I (in W m^{-2} per nm) with the wavelength λ (in nm) of the electromagnetic radiation emitted from the surfaces of P and Q ? Blackbody radiation is assumed for both stars.



- A B C D
 ○ ○ ○ ○

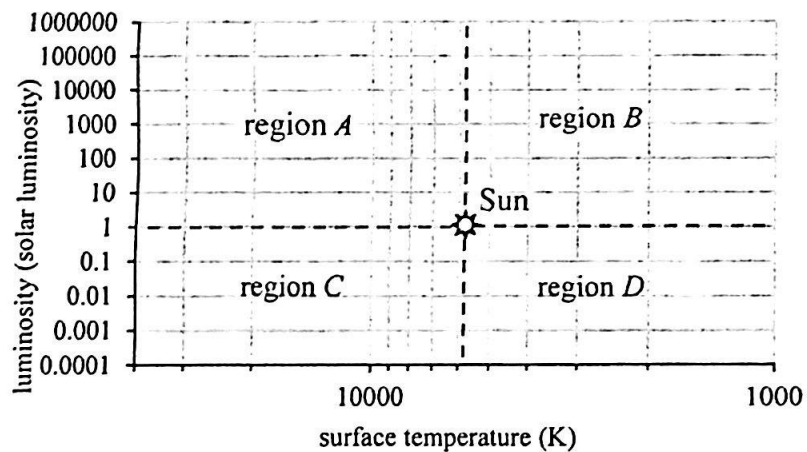
Q.1: Structured question

A certain star X at a distance of about 50 kpc from the Earth exploded a very long time ago and became Supernova 1987A (SN 1987A). The light from this supernova first reached the Earth in 1987.

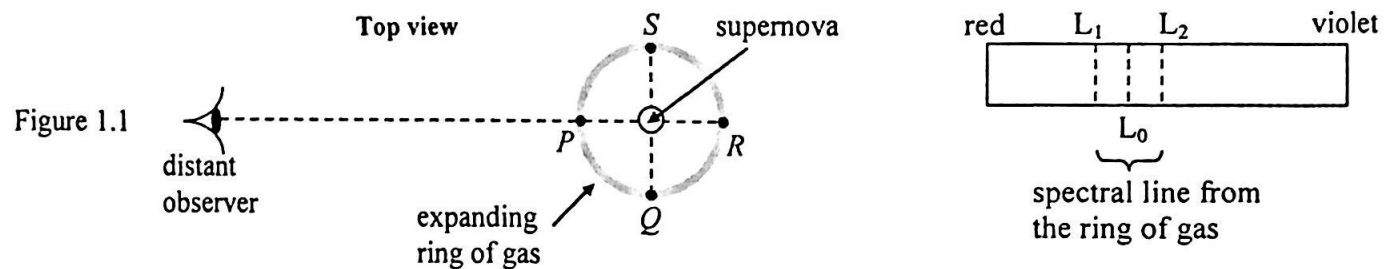
- (a) Estimate how long ago the above explosion took place. (Give your answer in years to 3 sig. fig.) (1 mark)
- (b) At maximum brightness, SN 1987A has an apparent magnitude of +2.9. Is the *absolute magnitude* of SN 1987A at maximum brightness smaller than, larger than or equal to +2.9? Explain your answer. (2 marks)

Before the explosion of star X , its luminosity was about 40000 times that of the Sun and its surface temperature was 3.1 times that of the Sun.

- (c) (i) Use Stefan's law to show that the radius of the star X is about 20 times the Sun's radius. (2 marks)
- (ii) In which region, A , B , C or D , on the Hertzsprung-Russell diagram was star X located? Explain whether or not this star can be classified as a 'red giant'. (2 marks)



- (d) A special feature of SN 1987A is that a circular ring of gas surrounds the supernova. The gas was ejected by the star X some time before it exploded. As shown in Figure 1.1, each point on this ring is expanding outwards at a constant speed from the supernova.



Suppose a distant observer on the plane containing the ring views a certain spectral line from the ring of gas and finds that it covers wavelengths between the limits L_1 and L_2 as shown in Figure 1.1. L_0 is the wavelength of that spectral line when observed in the laboratory. State the respective wavelengths that originate from point Q and point R on the ring. Explain your answer. (3 marks)

Please stick the barcode label here.

Section B : Atomic World

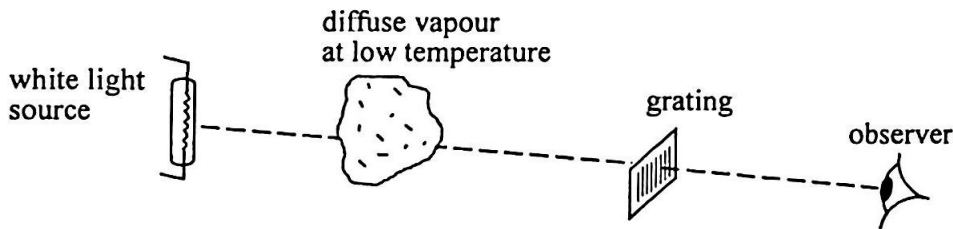
Q.2: Multiple-choice questions

2.1 Which of the following statements about Rutherford's scattering experiment is/are correct ?

- (1) Thin gold foil was used so that each α particle would most likely be scattered by one gold nucleus only.
- (2) If β particles were directed towards the gold foil instead of α particles, they could be deflected by both the gold nuclei and the electrons in the foil.
- (3) Gold foil was used because gold contains free electrons.

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) only | A | B | C | D |
| B. | (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (1) and (2) only | | | | |
| D. | (2) and (3) only | | | | |

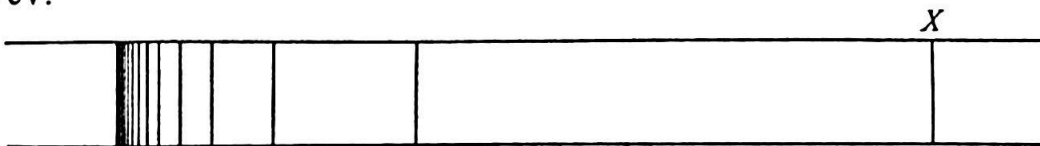
2.2



In the experiment shown above, dark lines are observed on a colour background. Which explanation is correct ?

- | | | | | | |
|----|--|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | No photons corresponding to the dark lines were emitted from the source. | A | B | C | D |
| B. | No photons corresponding to the dark lines were emitted from the vapour. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | Photons corresponding to the dark lines from the source were absorbed by the vapour. | | | | |
| D. | Photons corresponding to the dark lines from the source were scattered back to the source by the vapour. | | | | |

2.3 The figure below shows the emission lines of the hydrogen spectrum associated with electron transitions from excited energy levels to the ground state ($n = 1$). It is known that the energy level of the ground state is $E_1 = -13.6$ eV.



Which statement is correct ?

- | | | | | | |
|----|--|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | Spectral line X has the highest frequency. | A | B | C | D |
| B. | The shortest wavelength of the lines in this spectral series is about 90 nm. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | These spectral lines are in the infra-red region. | | | | |
| D. | Some of these lines also appear in other spectral series of the hydrogen spectrum. | | | | |

2.4 Which statements about the Bohr atom model are correct ?

- (1) It can explain why α particles can be rebounded by a thin gold foil.
- (2) It can give the atomic spectra of a singly ionized helium atom (He^+).
- (3) A postulate of this model is that the angular momentum of the electron in an hydrogen atom is quantized.

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) and (2) only | A | B | C | D |
| B. | (1) and (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (2) and (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

2.5 An atom has three energy levels : X , Y , and Z . When the atom transits from X to Y , it emits a photon of wavelength λ_1 . The atom transits from Y to Z when it absorbs a photon of wavelength λ_2 , with $\lambda_1 > \lambda_2$. These energy levels arranged in descending order is

- | | | | | | |
|----|-----------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | $Z X Y$. | A | B | C | D |
| B. | $Z Y X$. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | $X Z Y$. | | | | |
| D. | $X Y Z$. | | | | |

2.6 An electron beam accelerated through a potential difference of V is directed to a thin crystal layer. The diffraction pattern obtained is similar to that produced by X-rays of wavelength λ . What potential difference should be used for accelerating the electron beam so as to give a diffraction pattern similar to that produced by X-rays of wavelength 2λ ?

- | | | | | | |
|----|---------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | $\frac{V}{4}$ | A | B | C | D |
| B. | $\frac{V}{2}$ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | $2V$ | | | | |
| D. | $4V$ | | | | |

2.7 Which of the following statements about a scanning tunnelling microscope (STM) is/are correct ?

- (1) STM can reveal the internal structure of a specimen as three-dimensional images are produced.
- (2) In STM imaging, the surface of the specimen must be electrically conducting.
- (3) The resolving power of STM is limited by Rayleigh criterion.

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) only | A | B | C | D |
| B. | (2) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

2.8 Which of the following statements about materials in bulk form and in nano size are correct ?

- (1) Most materials exhibit different colour in the states mentioned above.
- (2) Most materials in nano size have lower melting point.
- (3) Materials in nano size are usually more efficient in serving as catalyst.

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) and (2) only | A | B | C | D |
| B. | (1) and (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (2) and (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

Please stick the barcode label here.

Q.2: Structured question

In order to demonstrate photoelectric effect, the electrodes A and C of the photocell in Figure 2.1 are connected to a potential difference V which can be read from the high-resistance voltmeter. This potential difference can vary from 0 V to 2.5 V.

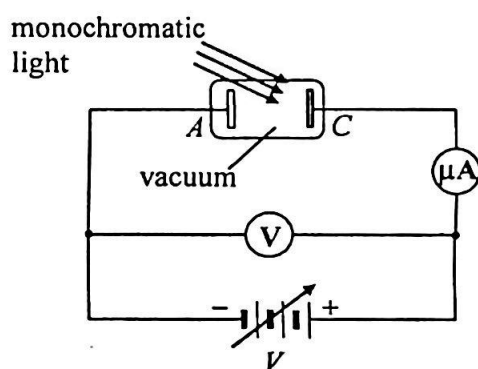


Figure 2.1

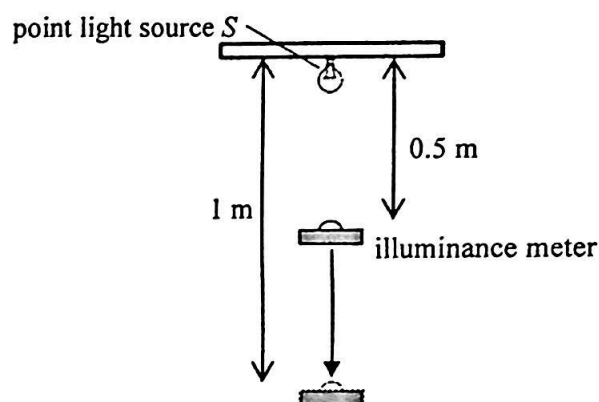
When monochromatic light of wavelength 300 nm is incident on electrode C , the microammeter of negligible internal resistance shows a reading.

- (a) (i) State the part of the electromagnetic spectrum (ultra-violet, blue, green, red or infra-red) that the incident light belongs to. (1 mark)
- (ii) According to wave theory, there should be a 'time delay' for photoelectric emission to occur. However, the experimental result shows that photoelectric emission is immediate. State the implication of such an experimental result. (1 mark)
- (b) The applied potential difference is adjusted until the microammeter reading just falls to zero when $V = 1.7$ V.
- (i) State and explain whether the microammeter reading would change if an incident light of the same wavelength but higher intensity is used. (2 marks)
- (ii) Calculate the work function, in eV, of electrode C . (3 marks)
- (c) Now the applied potential difference is adjusted until $V = 0.8$ V and the microammeter registers $0.4 \mu\text{A}$.
- (i) Estimate the number of photoelectrons reaching electrode A in one second. (1 mark)
- (ii) State the maximum kinetic energy, in eV, of the photoelectrons reaching A . Explain why not all photoelectrons reaching A possess this amount of kinetic energy. (2 marks)

Section C : Energy and Use of Energy

Q.3: Multiple-choice questions

- 3.1 An illuminance meter is placed 0.5 m directly underneath a point light source S emitting a certain luminous flux as shown.



If the luminous flux emitted by S is doubled and the meter is lowered to a position 1 m underneath S , what would be the change in the meter reading ?

- A. decreases by 25% A B C D
- B. decreases by 50% A B C D
- C. remains unchanged A B C D
- D. increases by 50% A B C D
- 3.2 A solar furnace uses a reflector of area 9 m^2 to collect sunlight so as to heat up a piece of iron of mass 2 kg. The efficiency of the furnace is 50%. Estimate the time taken to heat up the piece of iron from 30°C to 90°C .
 Given: specific heat capacity of iron = $450 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$
 solar power per unit area received on the Earth's surface = 1000 W m^{-2}
- A. 12 s A B C D
- B. 24 s A B C D
- C. 48 s A B C D
- D. 96 s A B C D
- 3.3 An electric vehicle's battery of capacity 40 kWh is completely discharged initially. It is charged with a terminal voltage of 220 V at an average current of 32 A. Estimate the time required to fully charge this battery. Assume that 20% energy loss occurs during charging.
- A. 4.6 hours A B C D
- B. 5.7 hours A B C D
- C. 6.8 hours A B C D
- D. 7.1 hours A B C D
- 3.4 What are the reasons for a microwave oven having an 'end-use energy efficiency' of less than 100% ?
- (1) Some energy is lost during the transmission of electrical energy from the power plant to the oven.
 (2) The microwave oven cannot convert all the electrical energy to the energy of microwave.
 (3) Some microwaves are absorbed by the oven's body and does not reach the food.
- A. (1) and (2) only A B C D
- B. (1) and (3) only A B C D
- C. (2) and (3) only A B C D
- D. (1), (2) and (3) A B C D

3.5 During summer time, heat flows into a house through its walls of a certain thickness. The rate of heat flow per unit area of the wall would be reduced if

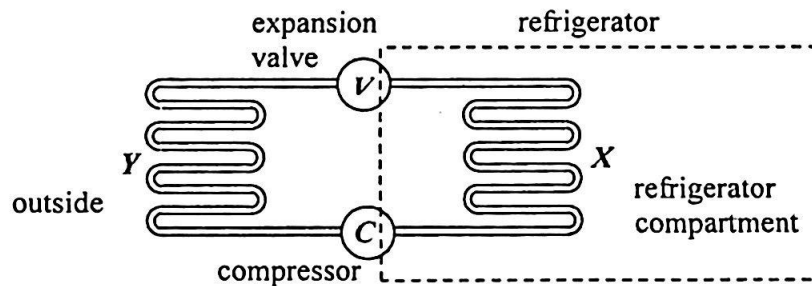
- (1) the temperature difference between the outer and inner surfaces of the wall is smaller.
- (2) the thickness of the wall is increased.
- (3) material of a larger U-value is used for building the wall.

- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) and (2) only | A | B | C | D |
| B. | (1) and (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (2) and (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

3.6 A room is kept cool by an air-conditioner of cooling capacity P . The temperatures inside and outside the room are 27°C and 31°C respectively. The rate of heat flowing into the room by radiation through windows and that by conduction are in the ratio 1:4. If the cooling capacity is raised to $2P$ while the temperature outside the room is still 31°C , estimate the temperature inside the room. Assume that the rate of heat flowing into the room by radiation is unchanged.

- | | | | | | |
|----|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | 21°C | A | B | C | D |
| B. | 22°C | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | 23°C | | | | |
| D. | 25°C | | | | |

3.7 A simplified schematic diagram of a refrigerator is as shown.



What is the direction of flow of the refrigerant through the expansion valve V ? Which component, X or Y , contains refrigerant at a higher temperature?

- | | direction of flow of the refrigerant through the expansion valve | component that contains refrigerant at a higher temperature | A | B | C | D |
|----|--|---|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | $X \rightarrow V \rightarrow Y$ | X | | | | |
| B. | $X \rightarrow V \rightarrow Y$ | Y | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | $Y \rightarrow V \rightarrow X$ | X | | | | |
| D. | $Y \rightarrow V \rightarrow X$ | Y | | | | |

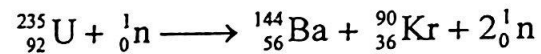
3.8 Which of the following is/are 'renewable energy source(s)'?

- (1) wind power
- (2) natural gas
- (3) nuclear power

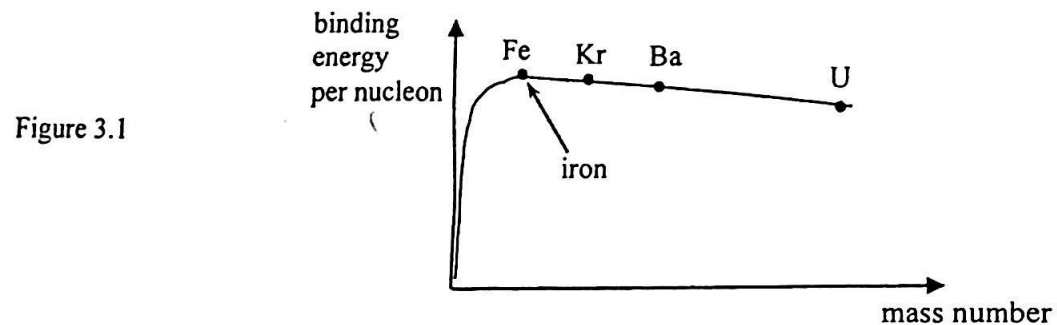
- | | | | | | |
|----|------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A. | (1) only | A | B | C | D |
| B. | (1) and (3) only | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C. | (2) and (3) only | | | | |
| D. | (1), (2) and (3) | | | | |

Q.3: Structured question

Pressurized water reactors constitute the majority of the world's nuclear power plants. In the reactor, energy is produced by the fission of uranium-235 nuclei ($^{235}_{92}\text{U}$). A typical fission reaction is as follows:



- (a) Referring to the binding energy curve in Figure 3.1, explain why uranium-235 nuclei tend to undergo fission. (2 marks)



- (b) The binding energy of a uranium-235 nucleus is 1783 MeV.
- (i) What does the above statement mean? (1 mark)
- (ii) Find the energy released, in MeV, in the fission of a uranium-235 nucleus.
 Given: Binding energy per nucleon of $^{144}_{56}\text{Ba}$ nucleus = 8.27 MeV per nucleon
 Binding energy per nucleon of $^{90}_{36}\text{Kr}$ nucleus = 8.59 MeV per nucleon (2 marks)
- (c) (i) In the reactor of a nuclear power plant, a total energy of 1.30×10^{30} MeV would be released if all uranium-235 nuclei in the fuel rods have undergone fission. Given that the mean power output of the power plant is 500 MW and the efficiency in converting nuclear energy to electrical energy is 40%. Estimate the time, in years, for which the fuel rods can be used. (Take 1 year = 3.15×10^7 s) (2 marks)
- (ii) State a reason why the fuel rods are usually replaced before the time estimated in (c)(i) has elapsed. (1 mark)
- (d) Explain the role of the following in a fission reactor:
- (i) moderator
- (ii) control rods (2 marks)

Section D : Medical Physics

Q.4: Multiple-choice questions

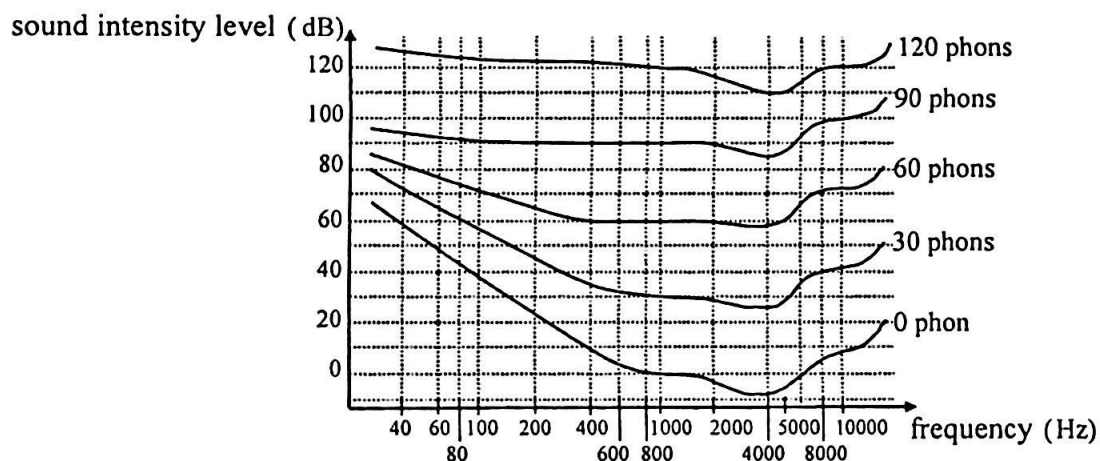
4.1 When the accommodation of an eye changes from looking at a distant object to a near object, which of the following statements is/are correct ?

- (1) The eye lens becomes less 'convex'.
- (2) The optical power of the eye lens increases.
- (3) The ciliary muscles around the lens contract.

- A. (1) only
- B. (3) only
- C. (1) and (2) only
- D. (2) and (3) only

- | | | | |
|-----------------------|-----------------------|-----------------------|-----------------------|
| A | B | C | D |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

4.2 The figure shows the relationship of loudness (in phons) to sound intensity level (in dB) for persons with normal hearing. Which statement CANNOT be deduced from this figure ?



- A. The ear is most sensitive to sounds of frequencies between 2000 Hz and 5000 Hz.
- B. A sound of 60 Hz at 40 dB is inaudible.
- C. Hearing sensitivity always increases with the increase of frequency of sound.
- D. For sounds at frequencies below 1000 Hz, the numerical value of sound intensity level (in dB) is not smaller than its loudness (in phons).

- | | | | |
|-----------------------|-----------------------|-----------------------|-----------------------|
| A | B | C | D |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

4.3 A doctor suspects that a patient has tumours in the liver. Which method(s) below can be used to detect the tumours and measure their size ?

- (1) examining with an endoscope
- (2) taking an ultrasound B-scan
- (3) taking a computed tomography (CT) scan

- A. (1) only
- B. (3) only
- C. (1) and (2) only
- D. (2) and (3) only

- | | | | |
|-----------------------|-----------------------|-----------------------|-----------------------|
| A | B | C | D |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

4.4 Which of the following statements about the piezoelectric crystal inside an ultrasound transducer is/are correct?

- (1) The piezoelectric crystal converts electrical signals into mechanical vibrations and vice versa.
 (2) The thickness of the piezoelectric crystal is arbitrary.

- A. Only (1) is correct. A B C D
 B. Only (2) is correct.
 C. (1) and (2) are correct.
 D. (1) and (2) are incorrect.

4.5 Using the information given below, find the proportion of energy transmitted when ultrasound is incident from air to skin.

	acoustic impedance / $\text{kg m}^{-2} \text{s}^{-1}$
air	430
soft tissue	1.5×10^6

- A. 5.7×10^{-4} A B C D
 B. 1.1×10^{-3}
 C. 2.8×10^{-3}
 D. 1.0×10^{-2}

4.6 Which sequence about the procedure of radionuclide imaging (RNI) is correct?

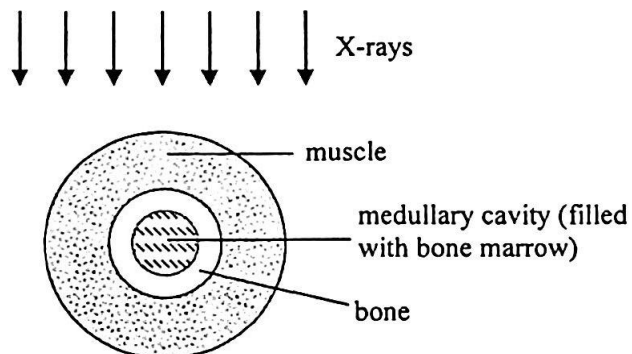
- (1) The drug is moved through bloodstream to the target organ.
 (2) Inject the drug into the patient's body.
 (3) Label the drug with a radioactive isotope.
 (4) Reconstruct the image by a computer.
 (5) Scan the patient with a gamma camera.

- A. (2) → (3) → (1) → (5) → (4) A B C D
 B. (2) → (3) → (1) → (4) → (5)
 C. (3) → (2) → (1) → (5) → (4)
 D. (3) → (2) → (1) → (4) → (5)

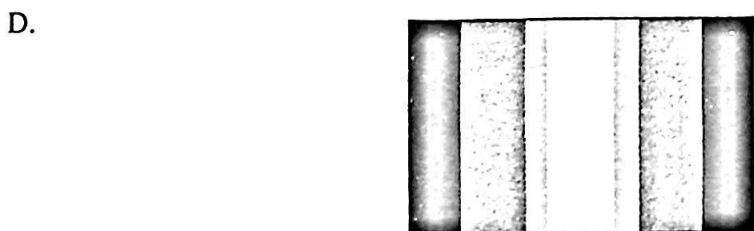
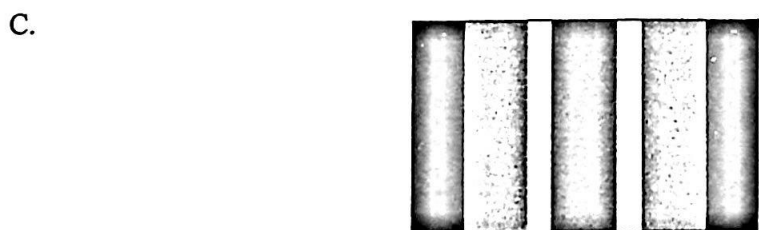
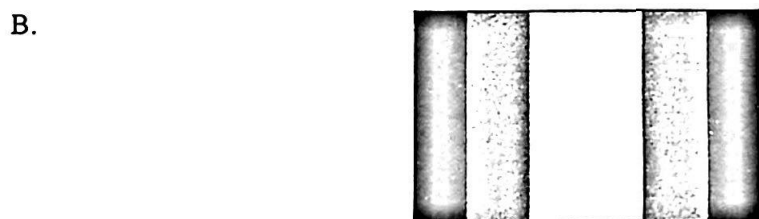
4.7 Radionuclide imaging can be used to study kidney diseases. Which radioactive isotope below would be the most suitable?

radioactive isotope	radiation emitted	half-life	A	B	C	D
A.	γ	20.3 minutes	A	B	C	D
B.	γ	6.0 hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C.	β, γ	2.7 days				
D.	β	3.3 hours				

- 4.8 The figure shows a simplified diagram of the cross-section of human arm. The medullary cavity is the central cavity that is filled with bone marrow. The linear attenuation coefficient of bone marrow is roughly the same as that of muscle.



Which figure below best represents the X-ray radiographic image of the arm ?



- A B C D

Q.4: Structured question

- (a) State briefly how X-rays are produced. (1 mark)
- (b) The table below shows the linear attenuation coefficients of soft tissue and bone for an X-ray beam.

	linear attenuation coefficient
soft tissue	$\mu_s = 0.51 \text{ cm}^{-1}$
bone	$\mu_b = 2.46 \text{ cm}^{-1}$

- (i) State one factor contributing to a higher linear attenuation coefficient of bone compared to soft tissue. (1 mark)
- (ii) X-ray beam of intensity I_0 passes through soft tissue that is 5.6 cm in thickness and is attenuated to intensity I . What thickness of bone would yield the same degree of attenuation of the same X-ray beam? Show your calculation. (2 marks)
- (iii) Explain why X-ray radiographic imaging of the breast usually employs X-rays of lower energy (~20 keV) while examination of bony structures employs X-rays of energy around 100 keV. (2 marks)
- (c) People are often concerned about the radiation exposure during medical examinations like X-ray radiographic imaging and computed tomography (CT) scans. Some information about the radiation dose is given below:

source / item	equivalent dose
Taking an X-ray radiographic image	0.1 – 0.2 mSv
A CT scan	1 – 10 mSv
Average weekly natural background dose for a person	about 0.05 mSv

- (i) State one potential hazard of exposure to ionizing radiation on human bodies. (1 mark)
- (ii) Explain why the equivalent dose of a CT scan is higher than that of taking an X-ray radiographic image. (2 marks)
- (iii) Name one source contributing to the natural background dose. (1 mark)

END OF PAPER

Sources of materials used in this paper will be acknowledged in the *HKDSE Question Papers* booklet published by the Hong Kong Examinations and Assessment Authority at a later stage.