Please stick the barcode label here.

Candidate Number ☐☐☐☐☐☐

	Marker's Use Only	Examiner's Use Only
	Marker No.	Examiner No.
Question No.	Marks	Marks
Section A 1-8		
Section A 9		
Section B 1-8		
Section B 9		
Section C 1-8		
Section C 9		
Section D 1-8		
Section D 9		

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION

PHYSICS   PAPER 2 (Sample Paper)

Question-Answer Book

Time allowed : 1 hour
This paper must be answered in English

INSTRUCTIONS

(1) Write your Candidate Number in the space provided on Page 1.

(2) Stick barcode labels in the spaces provided on Pages 1, 3, 5 and 7.

(3) Answer the questions from any **TWO** sections of this paper.

(4) Write your answers in the spaces provided in this Question-Answer Book.   Do not write in the margins. Answers written in the margins will not be marked.

(5) 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.   Tie them loosely but securely with a string INSIDE this Question-Answer Book.

(6) The diagrams in this section are **NOT** necessarily drawn to scale.

Section A : Astronomy and Space Science

Given :   1 astronomical unit = 1.50×10^{11} m
          1 parsec = 3.08×10^{16} m = 3.26 ly
          1 light year = 9.46×10^{15} m

A1.   Which of the following is **NOT** contained in the astronomical object shown in the figure ?

      A.   Cluster of galaxies
      B.   Nebula
      C.   Star
      D.   Star cluster

Answer : _____

A2.   Hong Kong's longitude and latitude are 114.1°E and 22.3°N respectively.   What is the altitude of the north celestial pole when observed in Hong Kong ?

      A.   22.3°
      B.   65.9°
      C.   67.7°
      D.   114.1°

Answer : _____

A3.   Which of the following statements concerning the celestial sphere model can be used to explain why stars in the east are rising and stars in the west are setting ?

      A.   The celestial sphere rotates from west to east with a period of a day.
      B.   The celestial sphere rotates from east to west with a period of a day.
      C.   Stars move on the celestial sphere from west to east with a period of a year.
      D.   Stars move on the celestial sphere from east to west with a period of a year.

Answer : _____

A4.   According to the Ptolemy's geocentric model,

      A.   Jupiter moves in a circular orbit around the Earth.
      B.   The Earth-Venus distance is always smaller than the Earth-Sun distance.
      C.   The Earth-Mars distance is always smaller than the Earth-Sun distance.
      D.   It is not possible to observe Jupiter at mid-night.

Answer : _____

A5.   Which statement is **INCORRECT** ?

     A.   Planets move around stars in elliptical orbits.
     B.   Comets move around the Sun in elliptical orbits.
     C.   The cube of the orbital period of a planet is proportional to the square of the length of its semi-major axis around the Sun.
     D.   For a given planet orbiting around the Sun, the speed of the planet increases as its distance from the Sun decreases.

Answer : _____

A6.   The average of the closest and farthest distances of a comet from the Sun is 18 AU.   What is its orbital period ?

     A.   6.9 yr
     B.   18 yr
     C.   76 yr
     D.   200 yr

Answer : _____

(For Questions 7 and 8) A star has a luminosity 1000 times that of the Sun and its surface temperature is 3900 K.

A7.   The star is a

     A.   supernova.
     B.   white dwarf.
     C.   blue giant star.
     D.   red giant star.

Answer : _____

A8.   What is the radius of the star ? (Assume that the surface temperature of the Sun is 5800 K and that all stars are blackbody emitters.)

     A.   14 times the radius of the Sun
     B.   21 times the radius of the Sun
     C.   70 times the radius of the Sun
   D.   4900 times the radius of the Sun

Answer : _____

A9. The Crab Nebula is an expanding, roughly spherical shell of gas in the constellation Taurus. Acc____ a recent study, its average apparent angular size is 5.8 arc minute. The whole nebula has neg____ velocity relative to the Earth, and the nebula is at a distance of 2000 pc from the Earth. The wavelength____ an O III spectral line found in the spectrum of the light emitted by the gas moving towards the Earth fro____ around the middle part of the Crab Nebula is 374.13 nm along the line of sight of an observer on the Earth. The wavelength of the same spectral line observed in the laboratory is 375.99 nm.

core of the nebula
at the start

direction towards
the Earth

expanding spherical
shell of gas
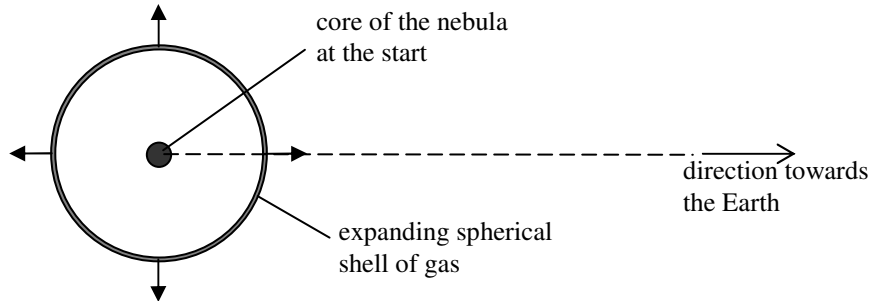
(a) What is the radius of the Crab Nebula ? Give your answer to two significant figures in parsecs.

(2 marks)

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(b) Calculate the speed of that gas which is moving towards the Earth. Give your answer in km s^{-1} to two significant figures. (3 marks)

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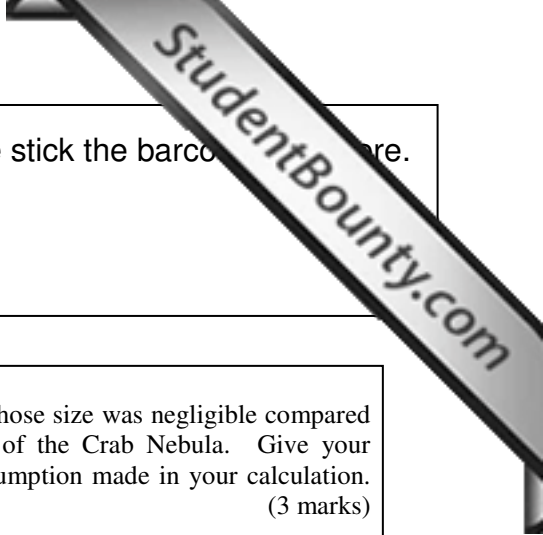
A9. (c) (i) The Crab Nebula was formed by the explosion of a star whose size was negligible compared with the present size of the nebula. Estimate the age of the Crab Nebula. Give your answer to two significant figures in years. State the assumption made in your calculation.

(3 marks)

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(ii) Actually, the Chinese observed the stellar explosion which created the Crab Nebula in 1054 A.D. and so we know that its age is about 950 years. Give a possible reason to explain why the Crab Nebula's age estimated in (c)(i) is longer than 950 years. (2 marks)

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Section B : Atomic World

B1.   Which of these conclusions could **NOT** be deduced from Rutherford's scattering experiment ?

    (1)   Alpha particles are helium nuclei.
    (2)   There are discrete energy levels in an atom.
    (3)   The positive charge in an atom is confined to a very small region.

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

                                            Answer : _____

B2.   The equivalent wavelength of a photon of energy 10 eV is

        A.   213 nm
        B.   124 nm
        C.   25.6 nm
        D.   19.7 nm

                                            Answer : _____

B3.   The ionization potential of a hydrogen atom is 13.6 V.   How much energy is required to excite an electron from the ground state to the first excited state in a hydrogen atom ?

        A.   10.2 eV
        B.   6.8 eV
        C.   3.4 eV
        D.   1.9 eV

                                            Answer : _____

B4.

Energy

    0 ────────────

    $-4E$ ────────

    $-6E$ ──────────
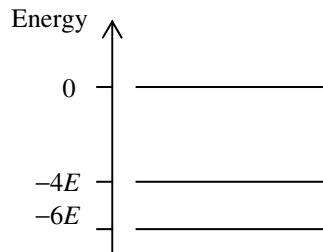
    The energy levels of a certain atom are as shown.   Which of these may undergo an inelastic collision with the atom ?

    (1)   an electron with kinetic energy $3E$
    (2)   a photon with energy $2E$
    (3)   a photon with energy $3E$

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

                                            Answer : _____

Answers written in the margins will not be marked.

B5.   In an experiment on the photoelectric effect, a beam of monochromatic light is directed onto a metal plate to liberate electrons.   The velocity of the fastest photoelectrons emitted is

A.   directly proportional to the frequency of the incident light.
B.   directly proportional to the intensity of the incident light.
C.   independent of the nature of metal.
D.   independent of the intensity of the incident light.

Answer : _____

B6.   The work function W of five metals are tabulated below.

Metal	Caesium	Barium	Calcium	Magnesium	Beryllium
$W/10^{-19}$ J	3.4	4.0	4.6	5.9	8.0

When monochromatic light of wavelength 400 nm is incident on each of the metals, how many of them would exhibit photoelectric emission ?

A.   1
B.   2
C.   3
D.   4

Answer : _____

B7.   Which of the following statements is/are correct ?

(1)   Photoelectric effect is an evidence that light possesses particle nature.
(2)   Electron diffraction suggests that electrons can behave like waves.
(3)   The line spectrum of atomic hydrogen suggests that the atom has discrete energy levels.

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

Answer : _____

B8.   Graphite is a conductor because of the 'delocalization' of electrons.   Where are these delocalized electrons ?

A.   formed on the surface of graphite.
B.   formed within the carbon layers of graphite.
C.   formed homogeneously within graphite.
D.   formed in a 'sea' of positive ions.

Answer : _____

B9. (a) An electron is accelerated from rest through a potential difference V (in V). Show that the de Broglie wavelength λ (in nm) is given by $\lambda \approx \dfrac{1.23}{\sqrt{V}}$. (2 marks)

(b) In a transmission electron microscope (TEM), electrons are accelerated by a potential difference of 50 kV.

(i) Estimate the final de Broglie wavelength of the electrons. (1 mark)

(ii) Describe how the electrons are focused in the TEM and explain how the image of the sample is formed. (3 marks)

(iii) Suggest **ONE** method to increase the resolving power of the TEM. Explain. (2 marks)

(c) State **ONE** daily life application of nanotechnology and discuss any potential health risks associated with it. (2 marks)

Section C : Energy and Use of Energy

C1.   The Coefficient of Performance (COP) of a heat pump is

        A.   the ratio of energy absorbed from the cold reservoir to the energy rejected to the hot reservoir.
        B.   the heat energy rejected to the hot reservoir per unit work input.
        C.   the ratio between the total energy input to the useful work done.
        D.   the ratio between the extra work input to the total energy input.

Answer : _____

C2.   In the figure, a light source is a perpendicular distance h above a horizontal surface.   The amount of illuminance (unit: lux) of a point on the surface at a distance R from the source is directly proportional to

light source

θ

R

h

×
point of
measurement
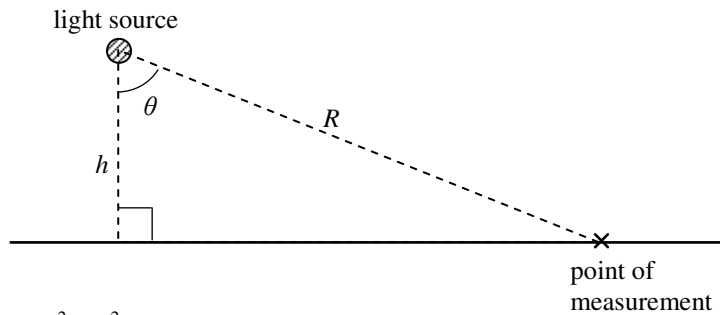
        A. $\cos^2\theta/R^2$
        B. $\cos^2\theta/h^2$
        C. $\cos^3\theta/h^2$
        D. $\cos^3\theta/R^2$

Answer : _____

C3.   If each fission of uranium-235 liberates 200 MeV of energy, how much uranium-235 must undergo fission per second to generate a power of 1000 MW ?

        A. 2.0×10^{-24} kg
        B. 2.2×10^{-10} kg
        C. 5.2×10^{-8} kg
        D. 1.2×10^{-5} kg

Answer : _____

C4.   Which of these is **NOT** an advantage of Battery Electric Vehicle ?

        A.   zero emission
        B.   low energy cost per kilometre covered
        C.   long mileage range
        D.   energy security by diversifying energy sources

Answer : _____

C5. Which of these actions reduces the heat gained in the summer by buildings in Hong Kong ?

      A.   Increase the OTTV values of the building envelope
      B.   Apply solar films on windows to reduce solar heat gain
      C.   Minimise internal heat gain from indoor activities
      D.   Improve the air-tightness of the building envelope

Answer : _____

C6. The solar constant is 1367 W m^{-2} (power per unit area from the Sun reaching the outer atmosphere) and the Earth-Sun distance is 1.50×10^{11} m (i.e. 1 AU), estimate the total radiation power of the Sun.

      A. 3.9×10^{26} W
      B. 3.2×10^{25} W
      C. 2.3×10^{25} W
      D. 7.7×10^{24} W

Answer : _____

C7. In estimating the maximum power available from a wind turbine, what is assumed to true ?

(1)   The density of air is constant.
(2)   The direction of wind relative to the orientation of the turbine is unchanged.
(3)   The area swept by the turbine is constant.

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

Answer : _____

C8. A fuel cell cannot be classified as a Renewable Energy Source because

      A.   it is a secondary energy source.
      B.   its supply is limited.
      C.   it is from fossil sources.
      D.   the time scale for regeneration is too long.

Answer : _____

C9. (a) Gas cookers and induction cookers are common domestic cooking devices. The conversion efficiencies and costs are tabulated below:

Cooking device	Conversion efficiency	Cost
Gas cooker	40%	$0.25 per MJ
Induction cooker	75%	$0.90 per kW h

(i) Explain how an induction cooker generates heat in a cooking vessel placed on it. (2 marks)

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(ii) Give a reason why the conversion efficiency of gas cookers is much lower than that of induction cookers. (1 mark)

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(iii) If a gas cooker and an induction cooker are used to heat up 1 kg of water at room temperature of 25°C to boiling. Calculate the cost of doing this for each cooker. (4 marks)
Given : specific heat capacity of water = 4200 J kg^{-1}°C^{-1}.

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(b) The European Commission is preparing to replace incandescent light bulbs across most of Europe by compact fluorescent light bulbs (CFLs) or light emitting diodes (LEDs). State **TWO** advantages and **TWO** disadvantages of such a move. (3 marks)

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Answers written in the margins will not be marked.

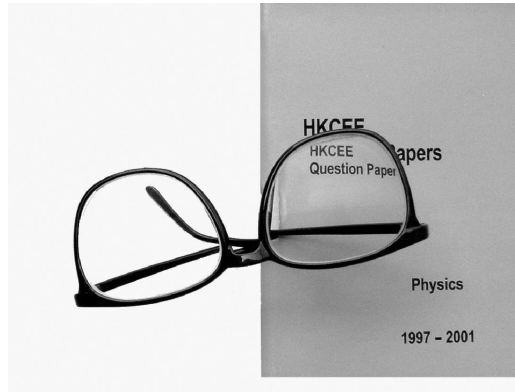Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Section D : Medical Physics

The table shows the speed of sound in, and density of, different tissues.

Tissue	Speed of sound in tissue / m s^{-1}	Density / kg m^{-3}
Fat	1450	952
Blood	1570	1025
Muscle	1580	1076
Bone	3050	2560

D1.

A man places his spectacles on a book as shown above.   What kind of lenses does he wear and what defect of vision does he have ?

	Lenses	**Defect of vision**
A.	converging lenses	long-sightedness
B.	converging lenses	short-sightedness
C.	diverging lenses	long-sightedness
D.	diverging lenses	short-sightedness

Answer : _____

D2.   Which of these contribute to the attenuation of ultrasound when it passes through body tissues ?

(1)   interference
(2)   scattering
(3)   absorption

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

Answer : _____

D3.   Which part of the body is most clearly imaged with ultrasound ?

A.   lung
B.   bone
C.   liver
D.   intestine

Answer : _____
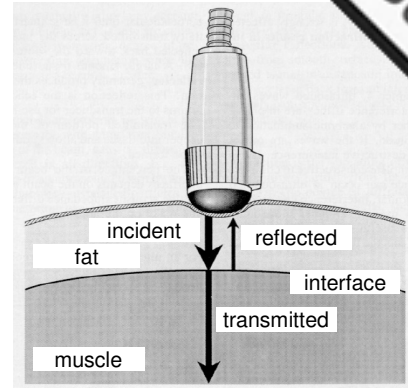
D4.   Ultrasound of intensity 10 mW cm^{-2} is incident normally at a fat-muscle interface as shown.   What is the intensity of the ultrasound reflected from the interface ?

A.   0.11 mW cm^{-2}
B.   0.33 mW cm^{-2}
C.   0.67 mW cm^{-2}
D.   0.89 mW cm^{-2}

incident   reflected
fat
interface
transmitted
muscle

Answer : _____

D5.   Which statements about Radionuclide Imaging (RNI) are correct ?

(1)   The image resolution of a radionuclide image is far worse than that of an X-ray image.
(2)   RNI relies on its ability for the study of function rather than structure.
(3)   A bone scan that shows a hot spot (i.e. intense increase uptake of tracer) in the bone reveals the existence of a tumour.

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

Answer : _____

D6.   Why is a rotating anode used in an X-ray tube ?

A.   To save energy
B.   To dissipate heat more efficiently
C.   To produce better image resolution
D.   To produce a more intense X-ray beam

Answer : _____

D7.   Which criteria are essential when choosing radioactive sources as medical tracers in human bodies ?

(1)   The sources should have a short half-life.
(2)   The radiation emitted should have a weak ionizing power.
(3)   The radiation emitted should not be deflected by an electric field.

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

Answer : _____

D8.   The half-life of Tc-99m is 6 hours.   A patient is given an injection containing 5.7×10^{-18} kg of Tc-99m and the scan is taken 4 hours after the injection.   Calculate how much Tc-99m remains undecayed when the scan is taken.

A. 2.9×10^{-18} kg
B. 3.3×10^{-18} kg
C. 3.6×10^{-18} kg
D. 3.8×10^{-18} kg

Answer : _____

D9. (a)

The figure shows the cross-section of an optical fibre in an endoscope. Rays incident with angle θ smaller than a certain value θ_{max} will fall into the range of guided modes, i.e. they can be transmitted to the far end of the optical fibre.

(i) Complete the light ray in the figure and explain why it will be guided through the optical fibre. (3 marks)

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(ii) Show that $\sin \theta_{max} = \dfrac{1}{n_{air}} (n_{core}^2 - n_{clad}^2)^{\frac{1}{2}}$. (3 marks)

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(b) Briefly describe how an endoscope could be used to obtain tissue samples from inside the trachea of the lung, and explain why the endoscope is of particular use in this procedure. (4 marks)

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END OF PAPER