2016-DSE
PHY
PAPER 2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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Candidate Number									

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.

* A 1 5 0 E 2 M C *

Section A : Astronomy and Space Science

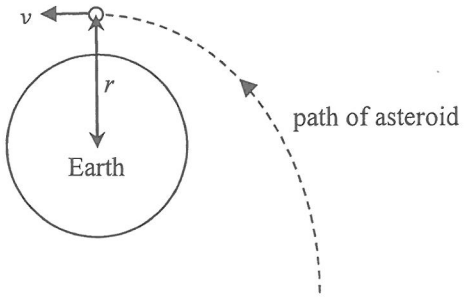
Q.1: Multiple-choice questions

1.1 A spacecraft is orbiting the Earth (mass M) in a circular orbit of radius r. Inside the spacecraft, a spring balance is used to measure the weight of an object (mass m). Which of the following is correct ?

	reading of the spring balance	force acting on the object due to gravity
A.	0	0
B.	0	$\frac{GMm}{r^2}$
C.	$\frac{GMm}{r^2}$	0
D.	$\frac{GMm}{r^2}$	$\frac{GMm}{r^2}$

A ○ B ○ C ○ D ○

1.2 An asteroid (mass m) approaches the Earth (mass $M >> m$) as shown. The velocity at the closest approach is v and the corresponding distance from the Earth's centre is r. Assuming no energy is lost during the asteroid's journey, what is its kinetic energy when it is very far away from the Earth ?



A. 0

B. $\frac{1}{2}mv^2$

C. $\frac{1}{2}mv^2 - \frac{GMm}{r}$

D. $\frac{1}{2}mv^2 + \frac{GMm}{r}$

A ○ B ○ C ○ D ○

1.3 Which of the following comparisons about the typical size of various celestial bodies are correct ?

(1) A star cluster is smaller than a galaxy.
(2) A cluster of galaxies is larger than a galaxy.
(3) A nebula is larger than a galaxy.

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

A ○ B ○ C ○ D ○

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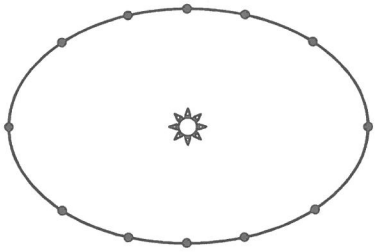
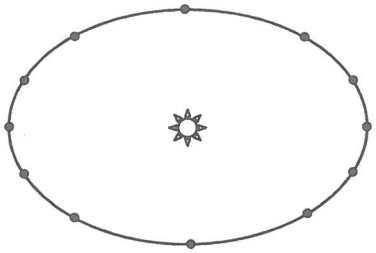
1.4 Which diagram below best shows the positions of a planet orbiting a star at equal time intervals ?

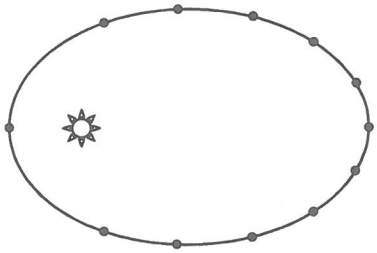
A.



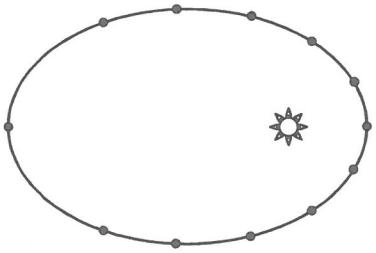
B.



C.



D.



A	B	C	D
○	○	○	○

1.5 A spacecraft sends a radio signal back to the Earth from 130 AU away. How long will it take for the signal to arrive at the Earth ?

A. 500 s
B. 650 s
C. 43333 s
D. 65000 s

A	B	C	D
○	○	○	○

1.6 The explosion of a massive star towards the end of its life results in a supernova which appears extremely bright in the sky for some time. In 1987, a supernova (SN1987A) appeared and was visible to the naked eye in the Large Magellanic Cloud which is 163000 light years away. In 1054, Chinese astronomers observed another supernova (SN1054) that appeared in the constellation of Taurus which is 6500 light years away. SN1987A happened about

A. 933 years after SN1054.
B. 155567 years before SN1054.
C. 156500 years before SN1054.
D. 162067 years before SN1054.

A	B	C	D
○	○	○	○

Go on to the next page

1.7 Stars X and Y are of equal brightness to the naked eye. The measured parallax of star X is twice that of star Y. What is the ratio $\frac{\text{luminosity of star } X}{\text{luminosity of star } Y}$?

A. $\frac{1}{4}$

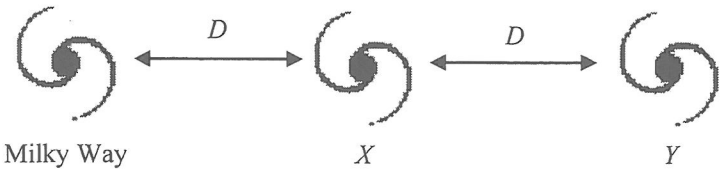
B. $\frac{1}{2}$

C. 2

D. 4

A	B	C	D
○	○	○	○

1.8 Three galaxies are separated by distance D as shown below. The H_α line of Galaxy X when observed from the Milky Way shows a red shift of $\Delta\lambda$.



Which of the following statements is/are correct ?

(1) The H_α line of Galaxy Y when observed from the Milky Way shows a red shift greater than $\Delta\lambda$.
(2) The H_α line of the Milky Way when observed from Galaxy X shows no red shift.
(3) The speed at which Galaxy X is moving away from Galaxy Y equals the speed of which Galaxy X is moving away from the Milky Way.

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

A	B	C	D
○	○	○	○

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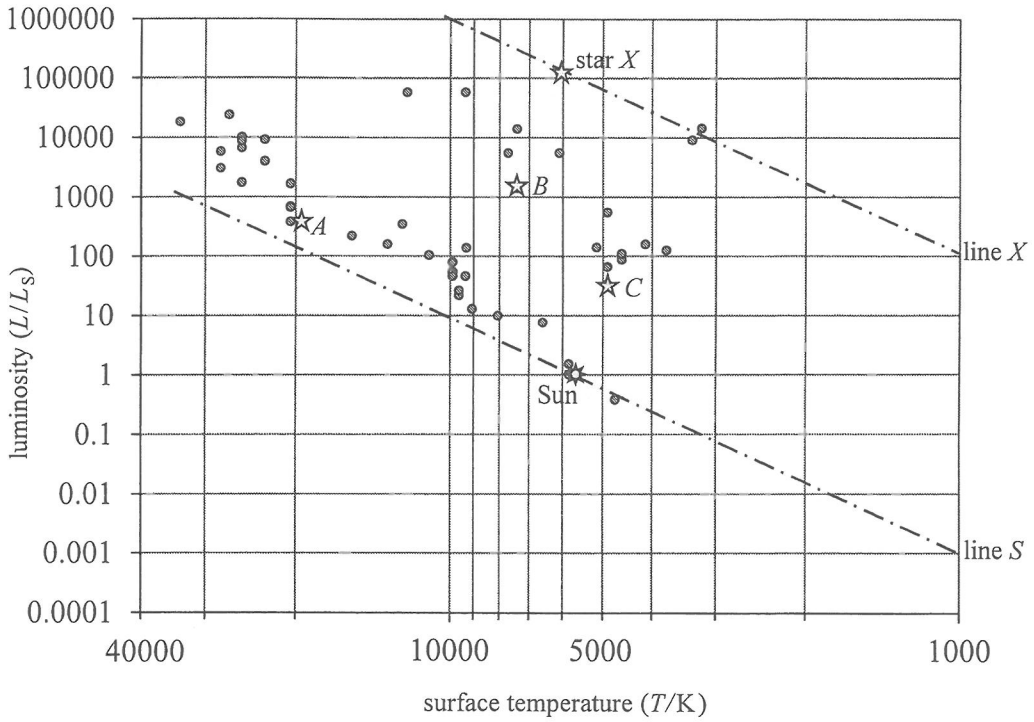
Q.1: Structured question

(a) Explain qualitatively how **absolute magnitude**, **apparent magnitude** and **luminosity** of a star are related. (2 marks)

The Hertzsprung-Russell diagram (HR diagram) below shows the 50 brightest stars as seen from the Earth.



(b) (i) L, R and T are the luminosity, radius and surface temperature of a star. Use Stefan's law to show that

$$\frac{L}{L_S} = \left(\frac{R}{R_S}\right)^2 \left(\frac{T}{T_S}\right)^4$$

where L_S, R_S and T_S are the luminosity, radius and surface temperature of the Sun. State an assumption you made. (2 marks)

(ii) Star X in the HR diagram has surface temperature $T = 6100$ K and luminosity $L = 126000\ L_S$. Find the radius R of star X in terms of the Sun's radius R_S. Hence name the type of star that it belongs to. Given: surface temperature of the Sun $T_S = 5840$ K. (3 marks)

(c) (i) Taking the logarithm of the equation in (b)(i) yields the following equation:

$$\log\left(\frac{L}{L_S}\right) = 4\log T + 2\log\left(\frac{R}{R_S}\right) - 4\log T_S$$

Show that it represents *a straight line* in the HR diagram and all stars on the line are of *the same size*. The scales on both axes of the HR diagram are logarithmic and the x-axis indicates a higher temperature towards the left. R_S and T_S are constants. [Note: Line S and line X in the diagram are two such straight lines running from upper left to lower right containing the Sun and star X respectively.] (2 marks)

(ii) For stars A, B and C in the HR diagram, deduce which one is the largest. (1 mark)

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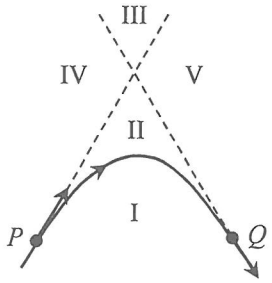
Section B : Atomic World

Q.2: Multiple-choice questions

2.1



In the above figure, the solid line is the trajectory of an α-particle scattered by a gold nucleus (not shown in figure). The dotted lines are tangents to the trajectory at points P and Q. The two dotted lines together with the trajectory divide the plane into five regions (I – V). In which region(s) can the gold nucleus be situated ?

A. I
B. II
C. III
D. IV or V

A B C D

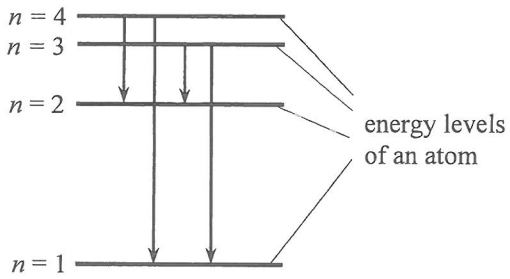
2.2 Which statements about *wave-particle duality* are correct ?

(1) Interference of light is evidence that light behaves as a wave.
(2) Photoelectric effect is evidence that light behaves as a particle.
(3) Electron diffraction by a crystal shows that electrons behave as a wave.

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

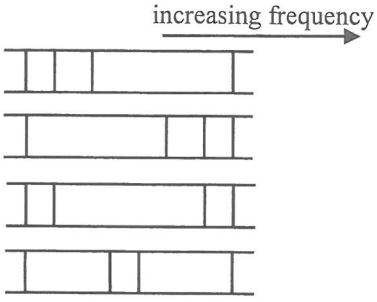
A B C D

2.3



The above figure shows four energy levels of an atom drawn approximately to scale. Which emission spectrum below best corresponds to the four electron transitions indicated ?

A.
B.
C.
D.



A B C D

Please stick the barcode label here.

2.4 Which of the following electron transitions between energy levels in a hydrogen atom will emit electromagnetic radiation of the longest wavelength ?

A. $n = 2$ to $n = 1$
B. $n = 3$ to $n = 2$
C. $n = 4$ to $n = 2$
D. $n = 5$ to $n = 2$

A ○ B ○ C ○ D ○

2.5 If the de Broglie waves associated with a proton and an α-particle have the same wavelength, what is the ratio of the kinetic energy of the proton to that of the α-particle ?

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

A ○ B ○ C ○ D ○

2.6 The minimum angular separation between two points which can be resolved by the human eye (pupil diameter 4 mm) under normal lighting has the order of magnitude of

A. 10^{-1} rad.
B. 10^{-2} rad.
C. 10^{-3} rad.
D. 10^{-4} rad.

A ○ B ○ C ○ D ○

2.7 Transmission electron microscope (TEM) is used to observe structures of nano-scale instead of an optical microscope. This is because electron wave compared to visible light can have

A. shorter wavelength so that its diffraction is less significant.
B. shorter wavelength so that its diffraction is more significant.
C. longer wavelength so that its diffraction is less significant.
D. longer wavelength so that its diffraction is more significant.

A ○ B ○ C ○ D ○

2.8 Which of the following applications in nanotechnology utilize(s) **Lotus effect** ?

(1) Water-repelling fabric used in swimming suits is manufactured by nano-coating.
(2) Glass is made self-cleaning by coating it with a water-attracting material in nanoscale.
(3) Nano-sized zinc oxide is added to fabric as a photocatalyst for protection from dirt.

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

A ○ B ○ C ○ D ○

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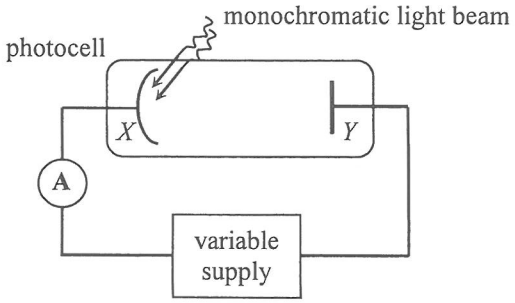
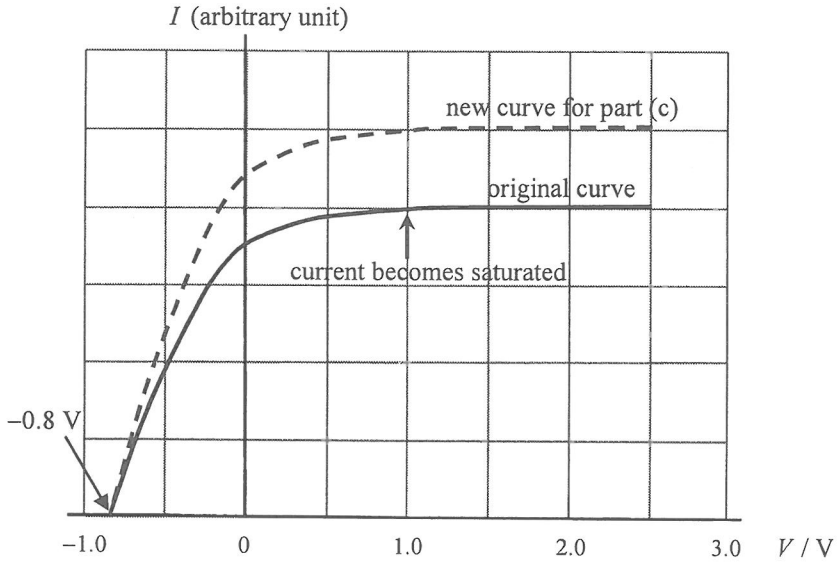
Q.2: Structured question

Figure 2.1



The set-up in Figure 2.1 is for the study of the photoelectric effect. A monochromatic light beam with each photon of energy 3.4 eV is directed towards the photo-sensitive cathode X of a photocell. The potential difference V across anode Y and cathode X can be changed by adjusting the variable supply. The graph shows how the photoelectric current I varies with the potential difference V.



(a) (i) The photoelectric current I becomes saturated after V reaches a certain value. Explain why this is so. (1 mark)

(ii) Hence deduce the *maximum kinetic energy*, in eV, of the photoelectrons reaching anode Y when I is just saturated. (2 marks)

(b) (i) Find the work function, in eV, of the metal of cathode X and calculate the threshold wavelength for this metal. (3 marks)

(ii) Hence explain whether yellow light of wavelength 576 nm can have photoelectric effect on cathode X. (2 marks)

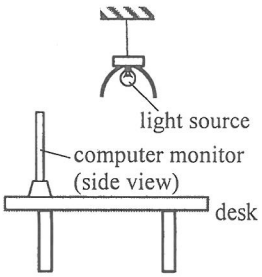
(c) If the experiment is repeated with another light beam using the same photocell, a new curve (in dotted line) is obtained as shown. What can be said about this light beam's *frequency* and *intensity* ? (2 marks)

Section C : Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 In a computer room, there is a light source installed directly above each desk such that a concave reflector encloses most of the source as shown. The purpose(s) of such arrangement is/are to

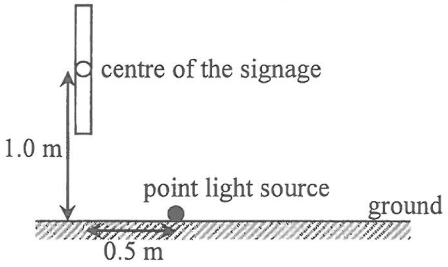
(1) maximize the amount of light reaching the desk's surface.
(2) reduce the amount of light reaching the computer monitor so that glare can be minimized.
(3) increase the luminous flux of the light source.



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

A B C D

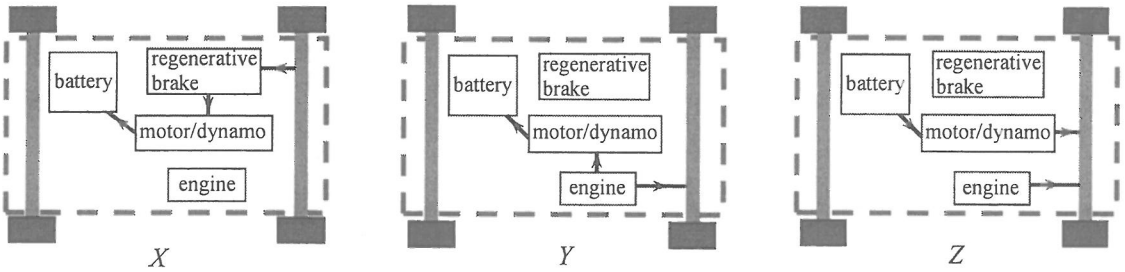
3.2 The signage below is to be illuminated by a point light source from the ground as shown. What is the luminous flux of the source required for producing an illuminance of 200 lux at the centre of the signage ? Assume that the source emits light uniformly in all directions and neglect any reflection from the ground.



A. 7025 lm
B. 3512 lm
C. 3142 lm
D. 560 lm

A B C D

3.3 Figures *X*, *Y* and *Z* below show the energy flow of a hybrid car in three different situations.



Which of the following correctly matches the figures with these situations ?

	braking	**accelerating with full power**	**cruising at a constant speed**
A.	*X*	*Y*	*Z*
B.	*Y*	*X*	*Z*
C.	*X*	*Z*	*Y*
D.	*Y*	*Z*	*X*

A B C D

Go on to the next page

3.4 Which statement about a solar cell is **INCORRECT** ?

A. When sunlight shines on a solar cell, some electrons in the semiconductor are excited to be free electrons.
B. When a solar cell delivers power, current only flows in the interface at the p-n junction.
C. The output voltage of a solar cell remains more or less unchanged when the incident light intensity increases.
D. The efficiency of typical solar cells is about 10% to 20%.

A ○ B ○ C ○ D ○

3.5 A room is cooled down by an air-conditioner and maintained a steady temperature which is ΔT below the temperature outside. Which of the factors below would affect ΔT ?

(1) thermal conductivity of the wall material of the room
(2) cooling capacity of the air-conditioner
(3) specific heat capacity of air

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

A ○ B ○ C ○ D ○

3.6 Which of the following expressions take(s) the unit watt (W) ?

(1) luminous flux × area
(2) solar constant × area
(3) thermal transmittance × area × temperature difference

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

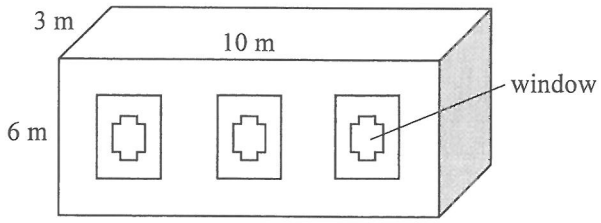
A ○ B ○ C ○ D ○

3.7 An air-conditioner can remove 1 J of heat from a room to the exterior for every 0.5 J it consumes. Estimate the total thermal energy released to the exterior when the air-conditioner removes 1500 J of heat from the room.

A. 750 J
B. 1000 J
C. 2250 J
D. 4500 J

A ○ B ○ C ○ D ○

3.8 The Overall Thermal Transfer Value (OTTV) of the house shown is 25 W m^{-2} and the rate of heat generated due to human activities inside is 2000 W. Which cooling capacity below for an air-conditioning system is the **most appropriate** choice for the house ?



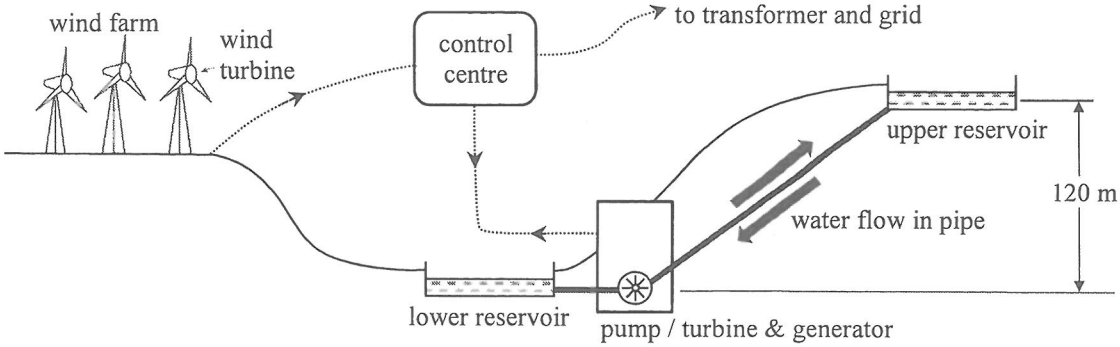
A. 2 kW
B. 5 kW
C. 10 kW
D. 15 kW

A ○ B ○ C ○ D ○

Q.3: Structured question

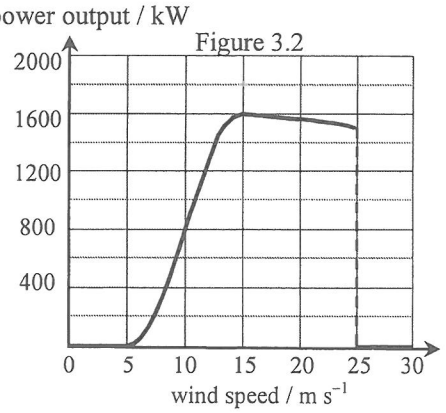
Figure 3.1 shows a wind power station backed up by a pumped hydroelectric storage system via a control centre. Excess electrical power from the wind farm can be used to pump water from the lower reservoir to the upper one during off-peak hours. During peak hours, water runs down from the upper reservoir to drive the turbine and generator to produce electricity.

Figure 3.1



A rotor blade of each wind turbine is 30 m long. Each turbine can be automatically controlled so that the blades' rotational plane is always normal to the wind direction. The graph in Figure 3.2 shows how the electrical power output from each turbine varies with wind speed.

Figure 3.2

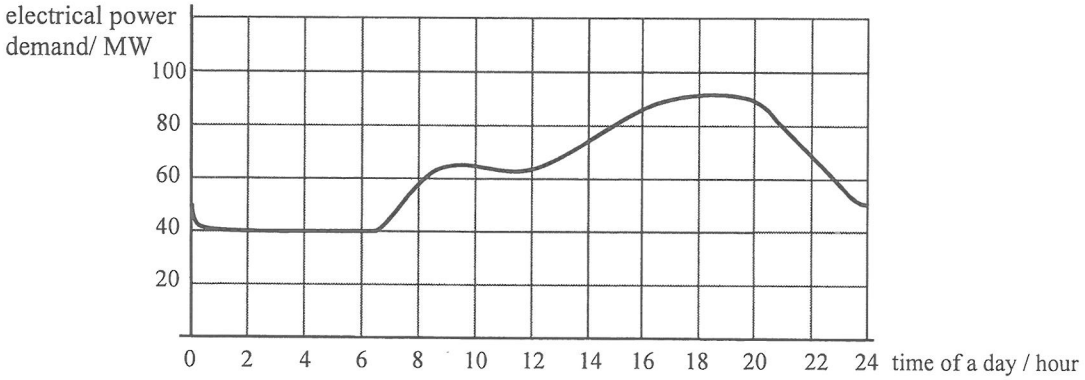


(a) (i) State the reason why practically there is no power output from the turbine when the wind speed is (I) lower than 5 m s^{-1}; and (II) higher than 25 m s^{-1}. (2 marks)

(ii) The turbine attains maximum power output when the wind speed is 15 m s^{-1}. Find the efficiency of the wind turbine in converting wind energy to electrical energy at such wind speed. Given: density of air = 1.23 kg m^{-3} (2 marks)

(b) There are 50 wind turbines in the wind farm for supplying electricity to a town. Figure 3.3 shows the variation of the town's electrical power demand with time of a day.

Figure 3.3



(i) Using the two graphs given, find the lowest wind speed needed to meet the town's minimum demand of electrical power in a day without using the pumped hydroelectric storage system. (2 marks)

(ii) Suppose that on a certain day the wind speed is always 15 m s^{-1}.

(I) Estimate the total power output of the wind farm. Hence state the time period within which the pumped hydroelectric storage system needs to generate electricity for the town. (2 marks)

(II) During the period of minimum demand of electrical power by the town, at what flow rate, in kg s^{-1}, is water in the lower reservoir pumped back to the upper one at a vertical height of 120 m ? The overall efficiency of the pump is 80%. (g = 9.81 m s^{-2}) (2 marks)

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Section D : Medical Physics

Q.4: Multiple-choice questions

4.1 The retina contains two types of light sensitive cells, namely, rods and cones. Which of the following statements about rods and cones is/are correct ?

(1) Rods are responsible for vision at low light levels.
(2) Rods are less numerous than cones.
(3) Both rods and cones are capable of colour vision.

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

A B C D
○ ○ ○ ○

4.2 Tom suffers from an eye defect such that his near point of accommodation is 2 m from his eyes. Spectacle lens of what power is needed to correct his near point to 0.25 m ?

A. + 3.5 D
B. – 3.5 D
C. + 4.5 D
D. – 4.5 D

A B C D
○ ○ ○ ○

4.3 When an aircraft takes off, some people suffer from ear pain or temporary loss of hearing. Which of the following could be the cause ?

A. The pressure on the eardrum increases drastically such that the three ear bones in middle ear cannot move.
B. The pressure on the eardrum increases drastically such that the oval window closes.
C. The pressure between the outer ear and middle ear is suddenly imbalanced and consequently the cochlea cannot function.
D. The pressure between the outer ear and middle ear is suddenly imbalanced and the eardrum cannot vibrate freely.

A B C D
○ ○ ○ ○

4.4 Endoscopes are widely used in the diagnosis of colon diseases rather than other medical imaging methods because

(1) it can provide a direct picture with fairly good resolution and clarity.
(2) tools can be inserted through the duct in the endoscope to obtain tissue for further tests.
(3) its risk is lower than that of other imaging methods.

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

A B C D
○ ○ ○ ○

4.5 A student measures the sound intensity level in dB at a distance of x from a small sound source. Estimate how far the student should be from the sound source in order to reduce the measured sound intensity level by 20 dB.

A. $5x$
B. $10x$
C. $20x$
D. $40x$

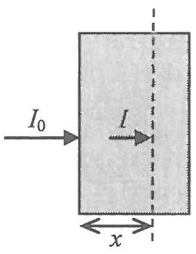
A	B	C	D
○	○	○	○

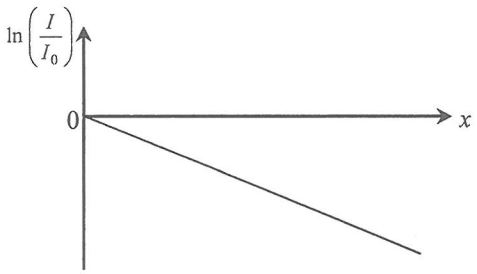
4.6 For scanning the liver which is located inside the body, which of the following choices of ultrasound, with a reason, is correct ?

A. 3 MHz ultrasound, as the image is of a higher resolution.
B. 3 MHz ultrasound, as it can travel deeper inside the body.
C. 12 MHz ultrasound, as the image is of a higher resolution.
D. 12 MHz ultrasound, as it can travel deeper inside the body.

A	B	C	D
○	○	○	○

4.7 An X-ray beam of intensity I_0 is incident on a medium of linear attenuation coefficient μ. After travelling a distance x in that medium as shown, the intensity of the beam becomes I. A graph of $\ln\left(\frac{I}{I_0}\right)$ is plotted against x. What does the **magnitude** of the slope of the graph represent ?





A. $\frac{\mu}{2}$
B. $\frac{\ln 2}{\mu}$
C. $\frac{1}{\mu}$
D. μ

A	B	C	D
○	○	○	○

4.8 Which of the following statements about computed tomography (CT) scan is/are correct ?

(1) The grey levels in CT images correspond to X-ray attenuation coefficient of the body tissue.
(2) CT image reconstruction involves back projecting the intensity readings of the X-ray beam across an image plane viewed at different angles.
(3) The radiation dose received by a patient taking a CT scan is much higher than that received in conventional X-ray imaging.

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

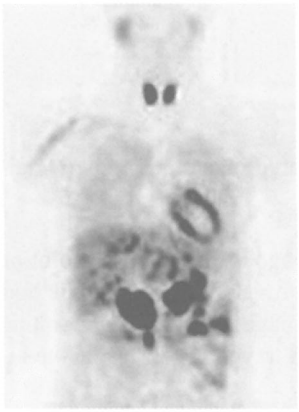
A	B	C	D
○	○	○	○

Go on to the next page

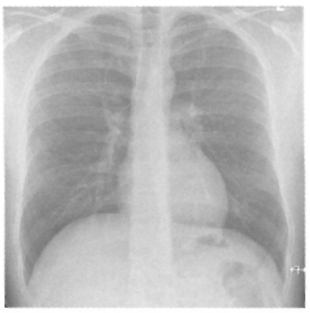
Q.4: Structured question

(a) Images *A*, *B* and *C* below were obtained by different medical imaging methods.

A **(kidney)**



B **(body)**

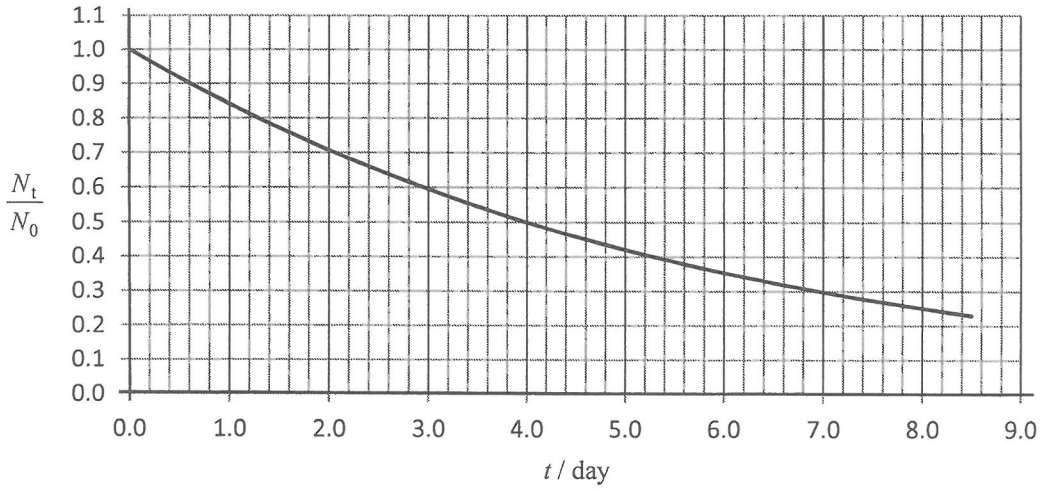


C **(chest)**

(i) Which one is produced by *radionuclide imaging* ? Explain how this image is formed. No need to describe the structure and mechanism of the detecting instrument used. (4 marks)

(ii) State **ONE** advantage of radionuclide imaging over the other two imaging methods. (1 mark)

(b) A radioactive isotope of initial amount N_0 decays to become N_t after time t. The graph below shows the variation of the ratio $\frac{N_t}{N_0}$ with time t.



(i) Use the graph to find the half-life of the radioactive isotope. (1 mark)

A chemical compound containing this radioactive isotope is used as a 'tracer' for injecting into a patient to study a physiological process. The biological half-life of this 'tracer' is 2 days.

(ii) What is meant by the **biological half-life** of the 'tracer' ? (1 mark)

(iii) If 50 mg of this 'tracer' is injected initially, estimate the time taken for the amount of this *radioactive* chemical compound *remaining* in the body to drop to 10 mg. (3 marks)

END OF PAPER

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

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31$ J mol^{-1} K^{-1}	
Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}	
acceleration due to gravity	$g = 9.81$ m s^{-2} (close to the Earth)	
universal gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}	
speed of light in vacuum	$c = 3.00 \times 10^8$ m s^{-1}	
charge of electron	$e = 1.60 \times 10^{-19}$ C	
electron rest mass	$m_e = 9.11 \times 10^{-31}$ kg	
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}	
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}	
atomic mass unit	u $= 1.661 \times 10^{-27}$ kg	(1 u is equivalent to 931 MeV)
astronomical unit	AU $= 1.50 \times 10^{11}$ m	
light year	ly $= 9.46 \times 10^{15}$ m	
parsec	pc $= 3.09 \times 10^{16}$ m $= 3.26$ ly $= 206265$ AU	
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}	
Planck constant	$h = 6.63 \times 10^{-34}$ J s	

Rectilinear motion

For uniformly accelerated motion :

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

Astronomy and Space Science

$U = -\frac{GMm}{r}$	gravitational potential energy
$P = \sigma AT^4$	Stefan's law
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	Doppler effect

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{\kappa}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho Av^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}{}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ eV	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
power $= \frac{1}{f}$	power of a lens
$L = 10\log\frac{I}{I_0}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_0 e^{-\mu x}$	transmitted intensity through a medium

A1.	$E = mc\,\Delta T$	energy transfer during heating and cooling
A2.	$E = l\,\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy
B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment $= F \times d$	moment of a force
B3.	$E_P = mgh$	gravitational potential energy
B4.	$E_K = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation
C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d\sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens
D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$\Delta E = \Delta mc^2$	mass-energy relationship