PP-DSE
PHY
PAPER 1A

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

PRACTICE PAPER

PHYSICS PAPER 1

(2 hours 30 minutes)

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 60 minutes.

2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book **B**.

3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book **B**. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**

4. The diagrams in this paper are **NOT** necessarily drawn to scale.

5. The last pages of this question paper contain a list of data, formulae and relationships which you may find useful.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.

2. When told to open this book, you should check that all the questions are there. Look for the words **'END OF SECTION A'** after the last question.

3. All questions carry equal marks.

4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.

5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

6. No marks will be deducted for wrong answers.

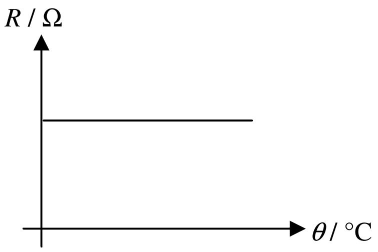
Not to be taken away before the end of the examination session

There are 36 questions. Questions marked with "*" involve knowledge of the extension component.

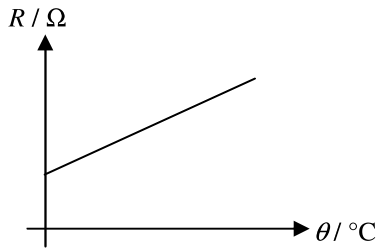
Section A

1. The graphs below show how the electrical resistances R of three different circuit elements change with temperature θ. Which of the circuit elements can be used to measure temperature ?

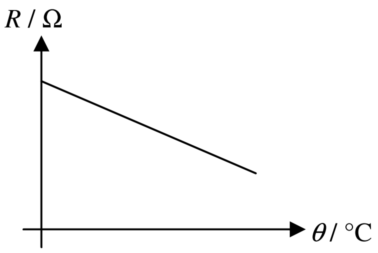
(1)



(2)

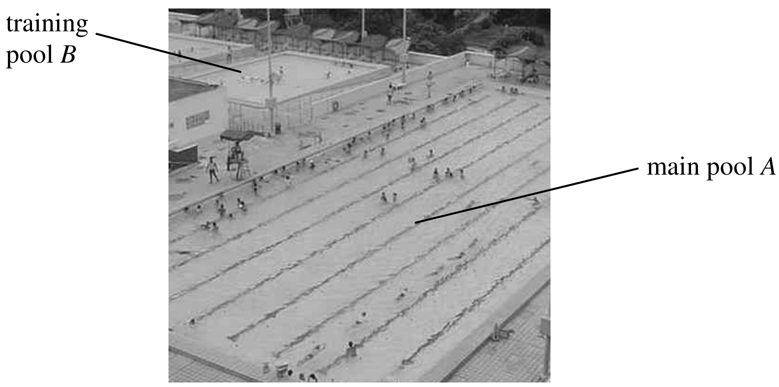


(3)



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

2. In the figure below, a training pool B is located next to the main pool A. The training pool B has a smaller area and is shallower. If the pools are under the sunlight at the same time, which of the following statements about the rise in the water temperature of the two pools is correct ? Assume that the initial water temperatures of the pools are the same.



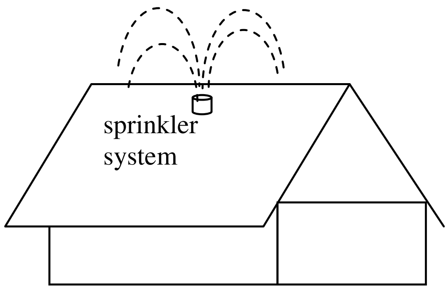
A. The water temperature of training pool B rises faster because it is shallower.
B. The water temperature of training pool B rises faster because it has a smaller surface area.
C. The water temperature of main pool A rises faster because it is deeper.
D. The water temperature of main pool A rises faster because it has a larger surface area.

3. Peter adds 50 g of milk at 20°C to 350 g of tea at 80°C, what is the final temperature of the mixt

Given : Specific heat capacity of milk = 3800 J kg^{-1} $°C^{-1}$
Specific heat capacity of tea = 4200 J kg^{-1} $°C^{-1}$

A. 50.0°C
B. 72.5°C
C. 73.1°C
D. 77.4°C

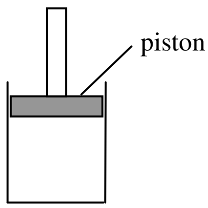
4. The sprinkler system on a rooftop is able to spray small water droplets onto the rooftop which can lower the temperature of the rooftop on hot sunny days. Which of the following explanations about the sprinkler system is/are reasonable ?



(1) Water is a good conductor, which conducts heat quickly.
(2) Water has a high specific heat capacity, absorbing a lot of energy when its temperature rises.
(3) Water has a high specific latent heat of vaporization, absorbing a lot of energy when it evaporates.

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

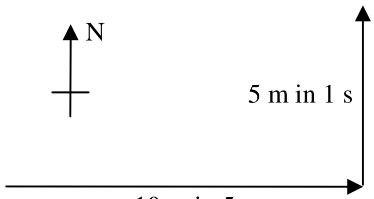
*5. A fixed mass of an ideal gas is contained in a cylinder fitted with a frictionless piston as shown in the figure below. If the gas is cooled under constant pressure,



(1) the average separation of the gas molecules will decrease.
(2) the r.m.s. speed of the gas molecules will decrease.
(3) the number of collisions per second of the gas molecules on the piston will decrease.

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

6.



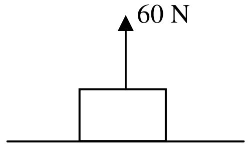
A toy car travelled due east for 10 m in 5 s, then immediately turned north and travelled 5 m for 1 s. What was the average speed of the car ?

A. 1.9 m s^{-1}
B. 2.2 m s^{-1}
C. 2.5 m s^{-1}
D. 3.5 m s^{-1}

7. A stone falls from rest. Neglecting air resistance, the ratio of the distance travelled by the stone in the 1^{st} second to that travelled in the 2^{nd} second is

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

8.

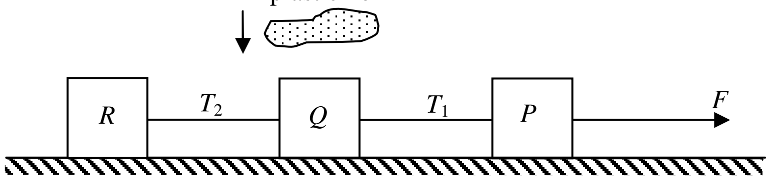


A block of weight 100 N is placed on a horizontal table and a vertical force of 60 N is exerted on the block as shown in the figure above. Which of the following statements is/are correct ?

(1) The weight of the block is balanced by the force exerted on the block by the table.
(2) The weight of the block and the force exerted on the table by the block are equal in magnitude.
(3) The force exerted on the table by the block and the force exerted on the block by the table are an action-reaction pair.

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

9. Blocks, P, Q and R, connected by light inextensible threads, are placed on a smooth horizonta[l] ... shown. A constant force F is applied to P so that the whole system travels to the right with accele[ration] ...



A lump of plasticine is placed on Q and it moves together with Q. If the applied force F remains unchanged, how would the tensions T_1 and T_2 in the two threads change ?

	Tension T_1	Tension T_2
A.	increase	decrease
B.	increase	increase
C.	decrease	decrease
D.	decrease	increase

10.

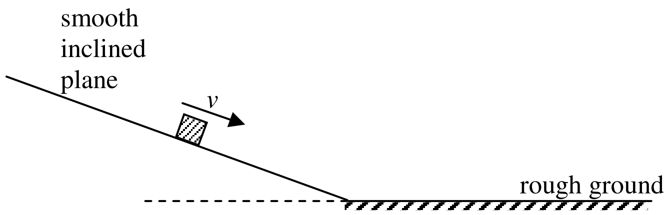


Figure (a)

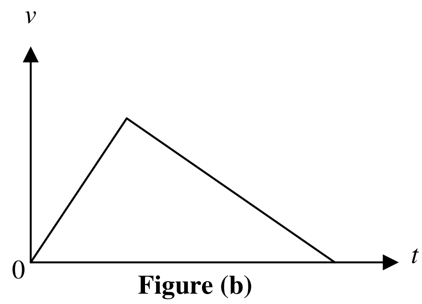
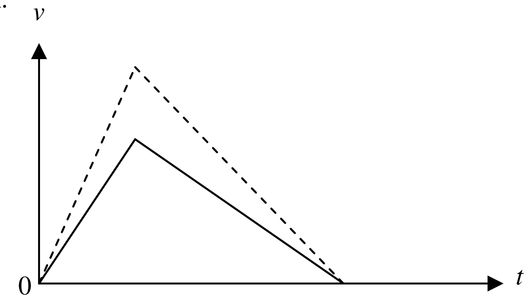


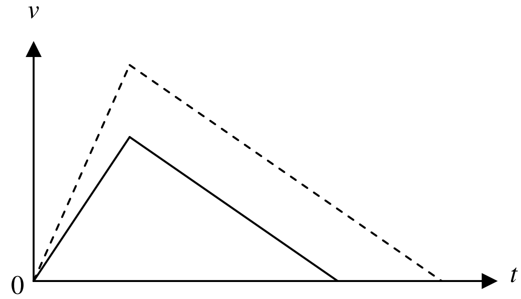
Figure (b)

As shown in Figure (a), a block slides down along a smooth inclined plane from rest. The corresponding speed-time graph of its motion is shown in Figure (b). Which of the following speed-time graphs (in dotted lines) best represents the motion of the block if it is released at a higher position on the plane instead ? Assume that the friction between the ground and the block remains unchanged.

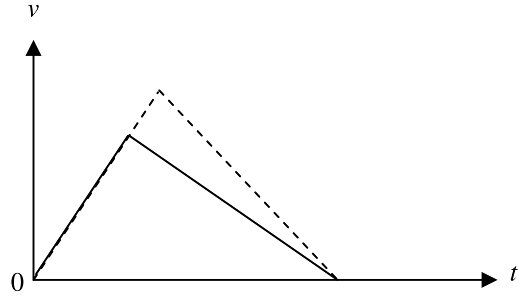
A.



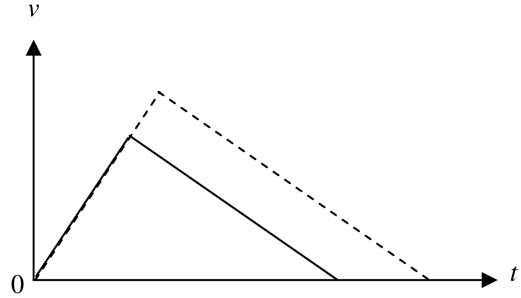
B.



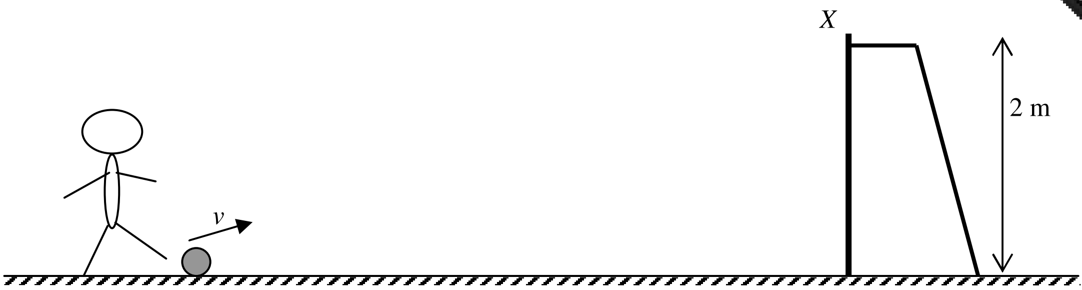
C.



D.



11.

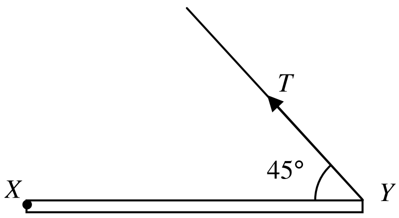


A football player kicks a ball on the ground. The ball leaves the ground with speed v and hits the bar at X with a speed of 17 m s^{-1}. X is 2 m above the ground. Neglecting air resistance, what is the value of v ?

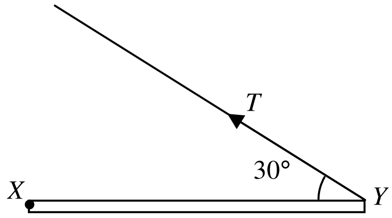
A. 15.8 m s^{-1}
B. 18.1 m s^{-1}
C. 19.0 m s^{-1}
D. 23.3 m s^{-1}

12. A rod XY hinged at X is kept horizontal by a light string. M is the midpoint of XY. In which of the following arrangements will the tension T in the string be the smallest ?

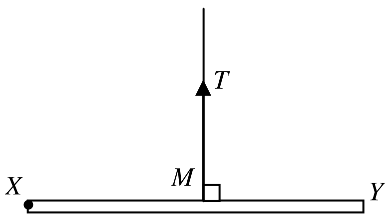
A.



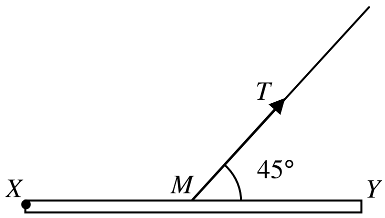
B.



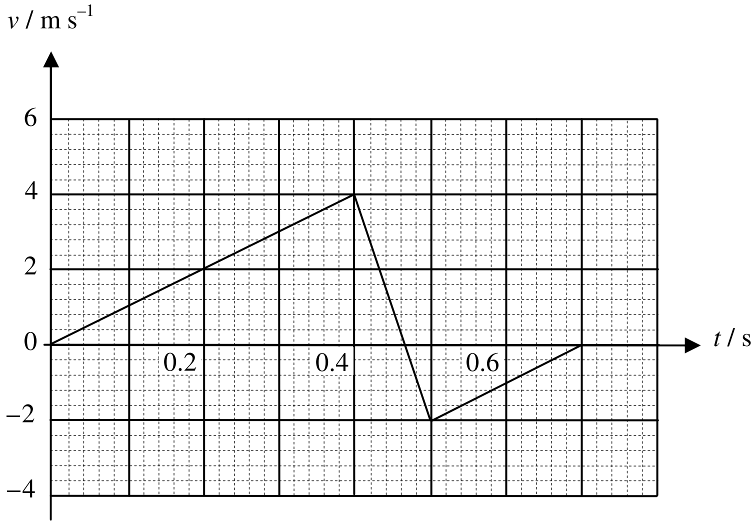
C.



D.



13.

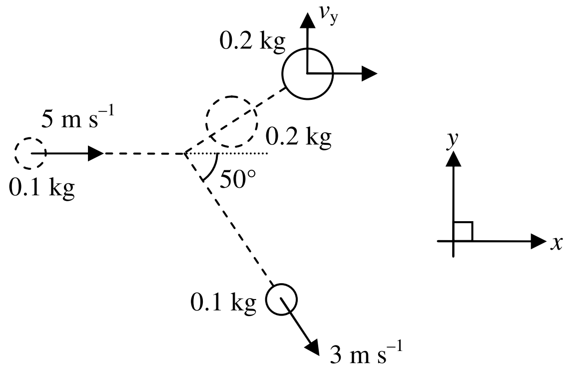


A ball of mass 0.2 kg is released from rest. It hits the ground and rebounds. The velocity-time graph of the ball is shown above. Which of the following statements are correct ?

(1) The magnitude of the change in momentum of the ball during the collision is 1.2 kg m s^{-1}.
(2) The magnitude of the average force acting on the ball by the ground during the collision is 12 N.
(3) There is mechanical energy loss during the collision.

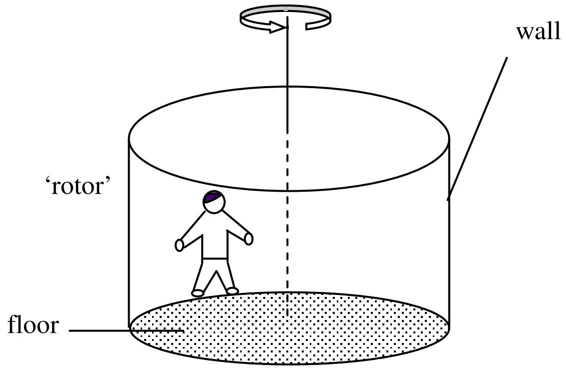
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

*14. A disc of mass 0.1 kg and velocity 5 m s^{-1} strikes a stationary disc of mass 0.2 kg on a smooth table. After the collision, the 0.1 kg disc moves with a speed of 3 m s^{-1} at 50° to the x direction. Find the component of the velocity of the 0.2 kg disc in y direction, v_y, after the collision.



A. 1.15 m s^{-1}
B. 1.54 m s^{-1}
C. 1.92 m s^{-1}
D. 2.01 m s^{-1}

*15.



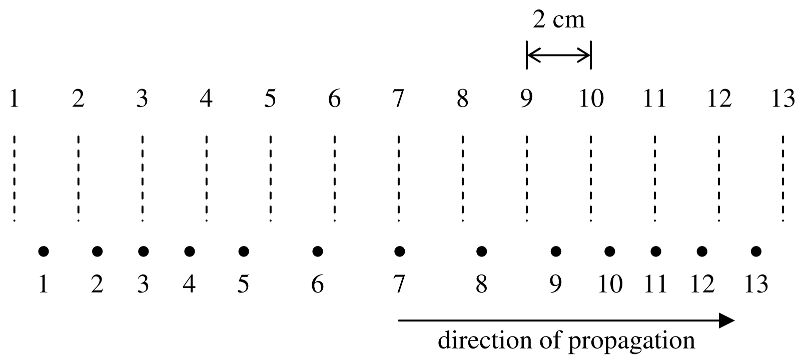
A man is rotating with constant speed inside a cylindrical 'rotor' and he remains pressed against the wall. The floor of the 'rotor' is smooth. Which of the following forces provides the centripetal force for the man ?

A. the weight of the man
B. the frictional force from the wall
C. the normal reaction from the wall
D. the supporting force from the floor

16. Which of the following phenomena demonstrates that light is an electromagnetic wave ?

A. Light carries energy.
B. Light reflects when it meets a polished metal surface.
C. Light bends when it travels across a boundary from one medium into another.
D. Light can travel from the Sun to the Earth.

17.

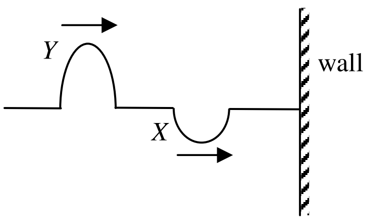


A longitudinal wave travels to the right through a medium containing a series of particles. The figure above shows the positions of the particles at a certain instant. The dotted lines indicate the equilibrium positions of the particles. Which of the following statements about the wave at the instant shown is/are correct ?

(1) The wavelength of the longitudinal wave is 16 cm.
(2) Particles 8 and 10 are moving in the same direction.
(3) Particle 3 is momentarily at rest.

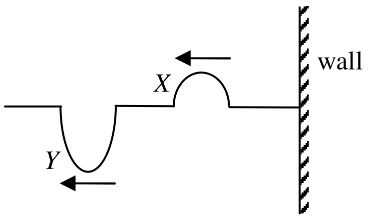
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

18.

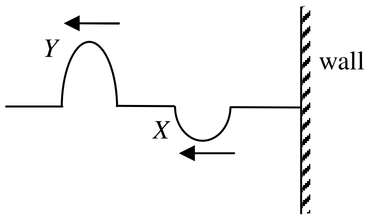


Two pulses, *X* and *Y*, are travelling along a string which is fixed at one end to the wall as shown in the figure above. Which of the following is a possible waveform of the string after the two pulses reflect ?

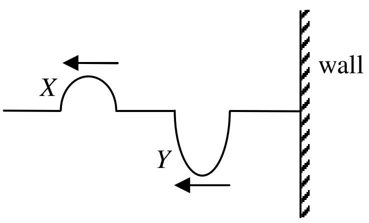
A.



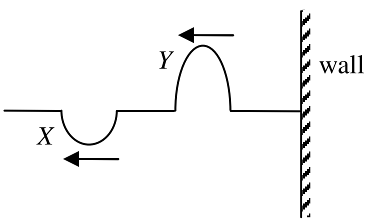
B.



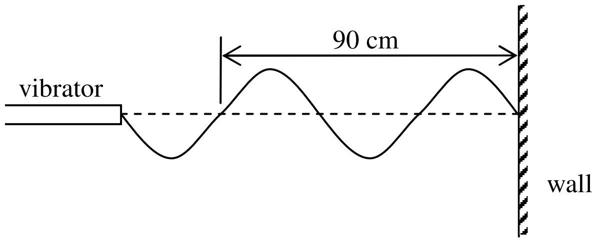
C.



D.



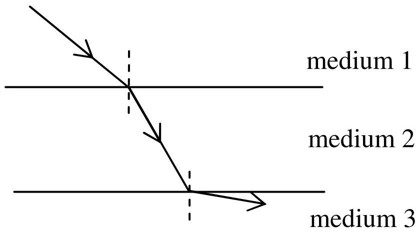
19.



A stationary wave is set up along a string by a vibrator. The waveform at a certain instant is shown above. If the frequency of the vibrator is 50 Hz, what is the wave speed along the string ?

A. 15 m s^{-1}
B. 30 m s^{-1}
C. 45 m s^{-1}
D. 55 m s^{-1}

20.



As shown above, a ray of light travels from medium 1 to medium 2, and then enters medium 3. The boundaries are parallel to each other. Arrange the speed of light, c, in the three media in **ascending** order.

A. $c_3 < c_2 < c_1$
B. $c_3 < c_1 < c_2$
C. $c_2 < c_3 < c_1$
D. $c_2 < c_1 < c_3$

*21.

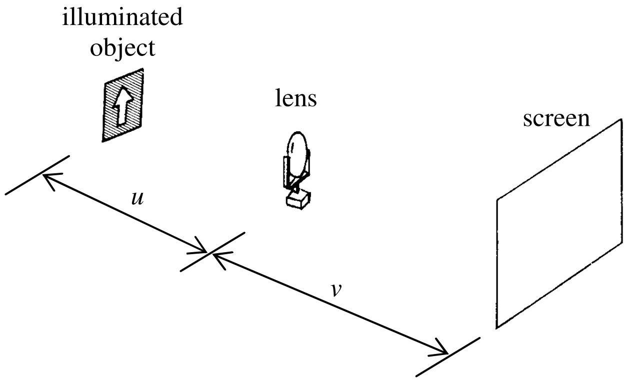


Figure (a)

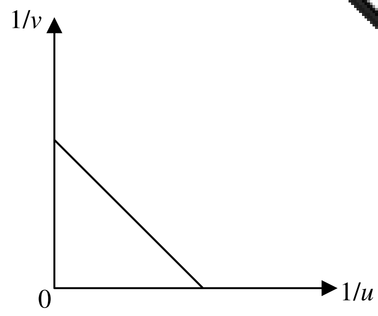
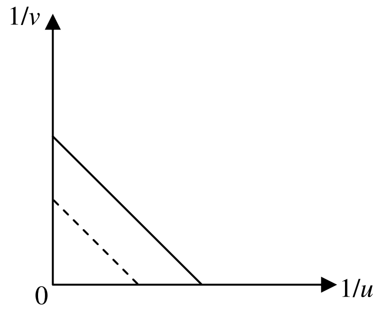


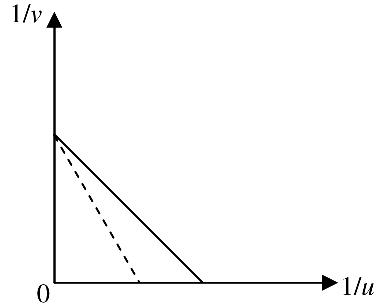
Figure (b)

A student uses the set-up in Figure (a) to study the relationship between the object distance u and the image distance v of a convex lens. A graph of $1/v$ against $1/u$ is plotted in Figure (b). If the lens is replaced by another convex lens of shorter focal length, which of the following graphs (in dotted lines) would be obtained ?

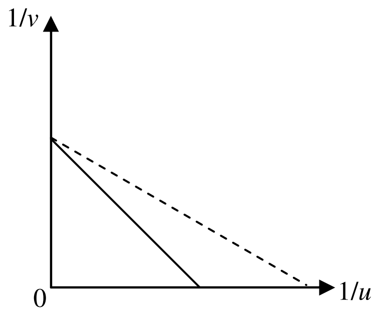
A.



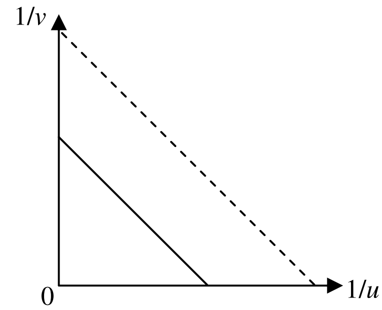
B.



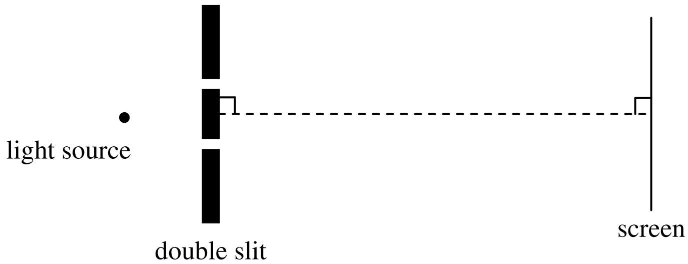
C.



D.



*22.



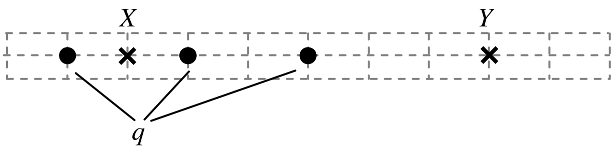
In a Young's double slit experiment, a monochromatic light source of wavelength 600 nm is used. The fringe separation is 5 mm on the screen. If the slit separation is halved and a monochromatic light source of wavelength 450 nm is used instead, what is the new fringe separation ?

A. 1.9 mm
B. 3.3 mm
C. 7.5 mm
D. 13.3 mm

*23. Yellow light of wavelength 590 nm is incident normally on a diffraction grating with 400 lines per mm. Find the difference in angular positions for the third order and the fourth order bright fringes.

A. 13.7°
B. 25.7°
C. 45.1°
D. 70.7°

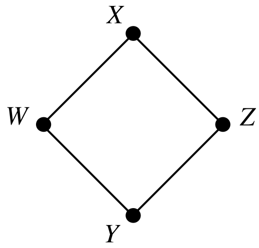
24.



Three identical point charges q (represented by dots) are situated in the space as shown. Which of the following descriptions about the direction and magnitude of the electric field E at X and at Y is correct ?

	Direction	Magnitude
A.	Same	$E_X > E_Y$
B.	Same	$E_X < E_Y$
C.	Opposite	$E_X > E_Y$
D.	Opposite	$E_X < E_Y$

*25.



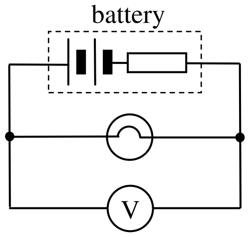
The figure above shows four points *W*, *X*, *Y* and *Z* in a uniform electric field. *WXZY* is a square. The electric potential at *W*, *X* and *Y* are 1 V, 5 V and 5 V respectively. What is the electric potential at *Z* ?

A. 1 V
B. 6 V
C. 9 V
D. 11 V

26. Two metal rods, *X* and *Y*, of uniform cross-sectional area are made of the same material and have the same volume. The length and resistance of *X* are *l* and *R* respectively. What is the resistance of *Y* if it has a length of 2*l* ?

A. *R*/4
B. *R*/2
C. 2*R*
D. 4*R*

27. The figure below shows a battery of e.m.f. 3.0 V and internal resistance 2.0 Ω is connected to a light bulb of resistance 10.0 Ω. A voltmeter of internal resistance 10 kΩ is connected in parallel with the light bulb. What is the reading of the voltmeter ?



A. 2.4 V
B. 2.5 V
C. 2.9 V
D. 3.0 V

28. In Figure (a), two identical resistors are connected in series to a cell of e.m.f. V and negligible resistance. The power dissipated by each resistor is P. If the two resistors are now connected in parallel as shown in Figure (b), what is the power dissipated by each resistor ?

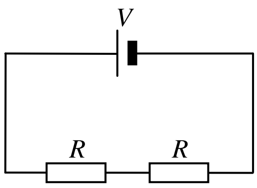


Figure (a)

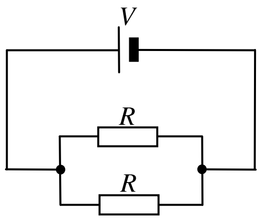
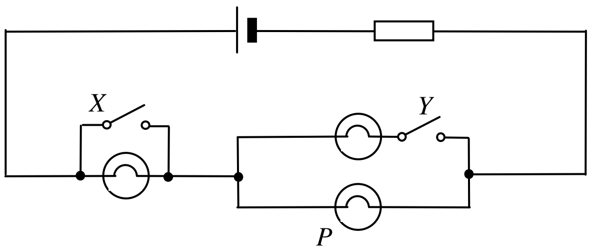


Figure (b)

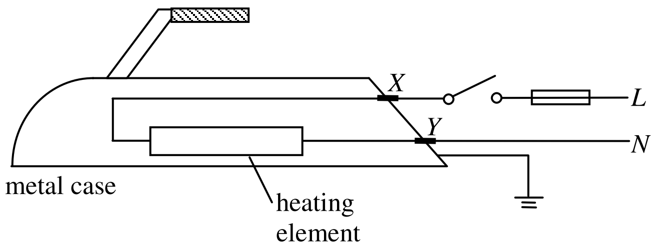
A. 2P
B. 4P
C. 8P
D. 16P

29. In the circuit below, three identical light bulbs are connected to a cell. Under what conditions will light bulb P have the maximum brightness ?



	Switch *X*	**Switch *Y***
A.	closed	open
B.	closed	closed
C.	open	open
D.	open	closed

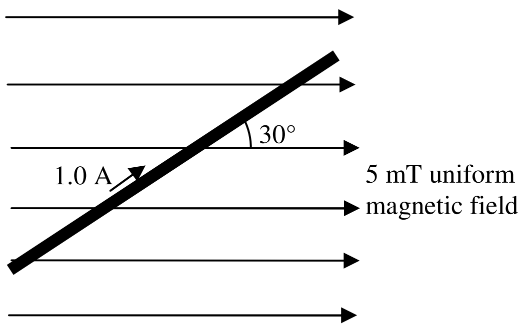
30.



The figure above shows the main parts of an electric iron. In which of the following situations will the fuse blow when the switch is closed ?

A. The heating element is broken and becomes an open circuit.
B. The earth wire is worn out and becomes disconnected.
C. The insulation at contact point X is worn out so that the wire touches the metal case.
D. The insulation at contact point Y is worn out so that the wire touches the metal case.

31. The figure below shows a current of 1.0 A flowing in a metal rod of length 0.5 m. The ro inside a region with a uniform magnetic field of strength 5 mT. What is the direction and the m of the magnetic force acting on the rod ?

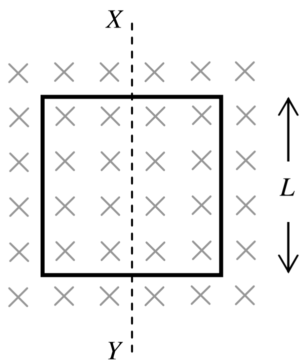


	Direction	**Magnitude**
A.	into the paper	1.25×10^{-3} N
B.	out of the paper	1.25×10^{-3} N
C.	into the paper	2.17×10^{-3} N
D.	out of the paper	2.17×10^{-3} N

*32. A Hall probe is placed in a uniform magnetic field. The slice of semiconductor inside the Hall probe is 1.3×10^{-3} m thick and has 10^{25} charge carriers per cubic metre. When a steady current of 0.4 A passes through the slice, a Hall voltage of 2×10^{-5} V is set up. What is the magnetic field strength detected by the probe ? Assume that the magnitude of the charge of each charge carrier is 1.6×10^{-19} C.

A. 0.104 T
B. 0.962 T
C. 1.04 T
D. 9.62 T

*33.



A square metal frame of side length L is placed inside a uniform magnetic field B as shown. What is the change in magnetic flux through the frame when it is rotated about the axis XY by 90° and 180° respectively ?

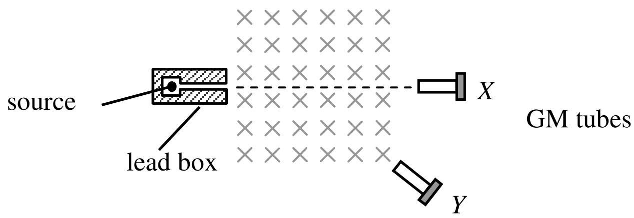
	90°	**180°**
A.	0	0
B.	0	$2BL^2$
C.	BL^2	0
D.	BL^2	$2BL^2$

34. Which of the following statements about α and β particles is/are correct ?

(1) The mass of an α particle is greater than that of a β particle.
(2) α particles have a stronger penetrating power than β particles.
(3) An α source can discharge a positively charged metal sphere nearby.

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

35.



A radioactive source is placed in front of a uniform magnetic field pointing into the paper as shown above. The count rates recorded by the GM tubes at X and Y are 101 counts per minute and 400 counts per minute respectively. Which of the following deductions must be correct ?

A. The source does not emit α radiation.
B. The source emits β radiations.
C. The source emits γ radiations.
D. The background count rate is about 100 counts per minute.

*36. For the following nuclear reaction, state the type of reaction and determine the energy released.

$${}^{2}_{1}\text{H} + {}^{3}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + {}^{1}_{0}\text{n}$$

Given: mass of ${}^{2}_{1}\text{H}$ = 2.014 u
mass of ${}^{3}_{1}\text{H}$ = 3.016 u
mass of ${}^{4}_{2}\text{He}$ = 4.003 u
mass of ${}^{1}_{0}\text{n}$ = 1.009 u

	Type of reaction	**Energy released**
A.	fusion	0.018 MeV
B.	fusion	16.76 MeV
C.	fission	0.018 MeV
D.	fission	16.76 MeV

END OF SECTION A

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List of data, formulae and relationships

Data

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

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
$P = \sigma A T^4$	Stefan's law
$\left\lvert\frac{\Delta f}{f_0}\right\rvert \approx \frac{v}{c} \approx \left\lvert\frac{\Delta\lambda}{\lambda_0}\right\rvert$	Doppler effect

Energy and Use of Energy

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

Atomic World

$\frac{1}{2}m_e {v_{max}}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}\ \text{eV}$	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	D1.	$F = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
A2.	$E = l\,\Delta m$	energy transfer during change of state	D2.	$E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
A3.	$pV = nRT$	equation of state for an ideal gas	D3.	$V = \dfrac{Q}{4\pi\varepsilon_0 r}$	electric potential due to a point charge
A4.	$pV = \dfrac{1}{3}Nm\overline{c^2}$	kinetic theory equation	D4.	$E = \dfrac{V}{d}$	electric field between parallel plates (numerically)
A5.	$E_K = \dfrac{3RT}{2N_A}$	molecular kinetic energy	D5.	$I = nAvQ$	general current flow equation
			D6.	$R = \dfrac{\rho l}{A}$	resistance and resistivity
B1.	$F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$	Force	D7.	$R = R_1 + R_2$	resistors in series
B2.	moment = $F \times d$	moment of a force	D8.	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$	resistors in parallel
B3.	$E_P = mgh$	gravitational potential energy	D9.	$P = IV = I^2R$	power in a circuit
B4.	$E_K = \dfrac{1}{2}mv^2$	kinetic energy	D10.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
B5.	$P = Fv = \dfrac{W}{t}$	mechanical power	D11.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
B6.	$a = \dfrac{v^2}{r} = \omega^2 r$	centripetal acceleration	D12.	$V = \dfrac{BI}{nQt}$	Hall voltage
B7.	$F = \dfrac{Gm_1 m_2}{r^2}$	Newton's law of gravitation	D13.	$B = \dfrac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
			D14.	$B = \dfrac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
C1.	$\Delta y = \dfrac{\lambda D}{a}$	fringe width in double-slit interference	D15.	$\varepsilon = N\dfrac{\Delta\Phi}{\Delta t}$	induced e.m.f.
C2.	$d\sin\theta = n\lambda$	diffraction grating equation	D16.	$\dfrac{V_s}{V_p} \approx \dfrac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
C3.	$\dfrac{1}{u} + \dfrac{1}{v} = \dfrac{1}{f}$	equation for a single lens			
			E1.	$N = N_0 e^{-kt}$	law of radioactive decay
			E2.	$t_{\frac{1}{2}} = \dfrac{\ln 2}{k}$	half-life and decay constant
			E3.	$A = kN$	activity and the number of undecayed nuclei
			E4.	$E = mc^2$	mass-energy relationship

PP-DSE
PHY
PAPER 1B

B

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Candidate Number | | | | | | | | |

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

PRACTICE PAPER

PHYSICS PAPER 1

SECTION B: Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

(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, 7, 9 and 11.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) Answer **ALL** questions.

(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) 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** this Question-Answer Book.

(6) 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.

Answer **ALL** questions. Parts marked with "*" involve knowledge of the extension component. W[...] answers in the spaces provided.

1.

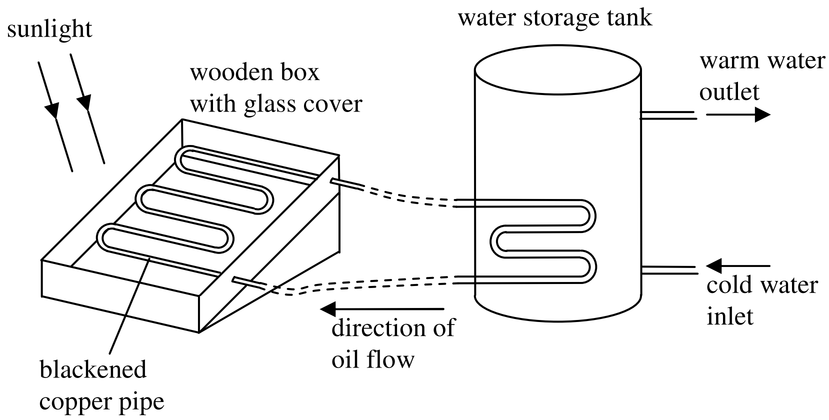

Figure 1.1

Figure 1.1 shows a solar water heating system. The heater is made from a glass-covered wooden box and the copper pipe inside is painted black. The heater is put on an inclined surface. Oil circulates between the heater and the water storage tank via the copper pipe.

(a) (i) Explain why the copper pipe inside the box is painted black.

(1 mark)

(ii) Explain why the wooden box is covered by a sheet of glass.

(1 mark)

(iii) Explain why the oil circulates in the system in the direction as indicated in Figure 1.1.

(2 marks)

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(b) When the oil flows through the pipe in the heater at a rate of 0.3 kg per minute, the temperature of the oil rises from 25°C to 37°C. Determine the power absorbed by the oil.

Given : specific heat capacity of oil = 2500 J kg^{-1} $°C^{-1}$

(3 marks)

*(c) If the wooden box is sealed and made air-tight, how would the air pressure inside change when temperature increases ? Explain briefly in terms of kinetic theory. No mathematical derivation is required.

(3 marks)

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2.

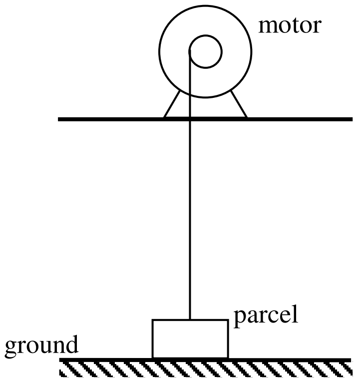

Figure 2.1

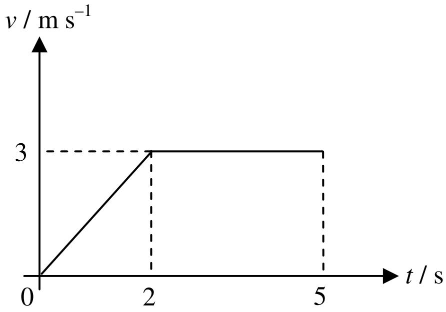

Figure 2.2

A parcel of mass 4 kg is being raised from the ground by a light string connected to a motor at the rooftop of a building as shown in Figure 2.1. The speed-time graph of the parcel for the first 5 s is shown in Figure 2.2. Neglect air resistance.

(a) Find the tension in the string at time $t = 1$ s.

(3 marks)

(b) Calculate the output power of the motor between $t = 2$ s and 5 s.

(2 marks)

(c) At $t = 5$ s, the string suddenly breaks. Describe the subsequent motion of the parcel.

(2 marks)

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3. A smooth curved rail PQR is fixed on a horizontal bench as shown in Figure 3.1. P is at a height [obscured] the bench surface. A small metal ball X of mass 0.03 kg is released from rest at P.

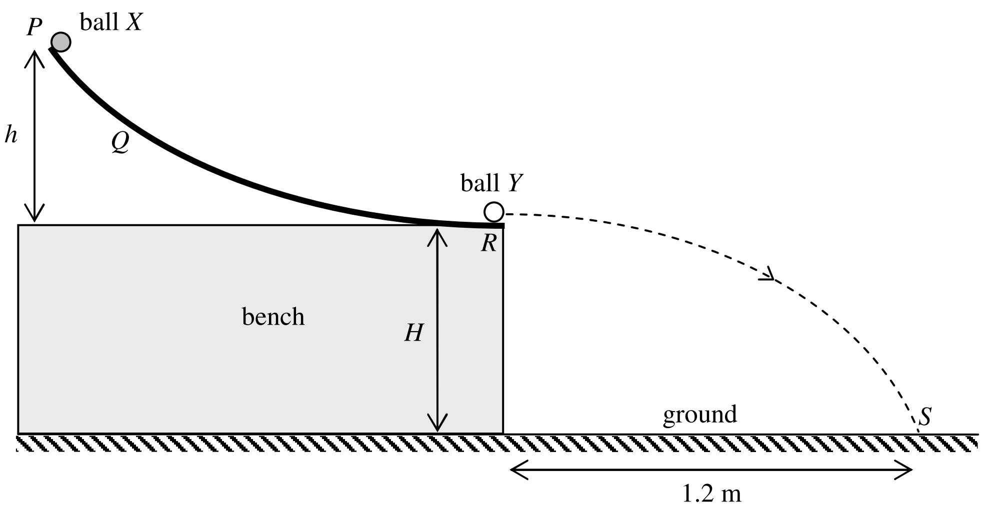

Figure 3.1

When ball X reaches R, it moves horizontally and collides head-on with another metal ball Y of mass 0.04 kg which is initially at rest on the rail. Immediately after the collision, ball X comes to rest while ball Y moves off the bench horizontally with a speed of 3 m s^{-1}. Neglect air resistance.

(a) What is the speed of ball X just before it collides with ball Y ?

(1 mark)

(b) Find the value of h.

(2 marks)

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*(c) Ball *Y* lands on the ground at *S* which is at a horizontal distance of 1.2 m from the bench. Find the height *H* of the bench.

(3 marks)

*(d) Ball *X* is now released at *Q* such that ball *Y* moves off the bench horizontally with a smaller speed after collision. Would the time of flight of ball *Y* change ? Explain briefly.

(2 marks)

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4. A communications satellite moves in a circular orbit around the Earth with a period of 24 ho[urs] remains above a certain place on the equator.

Given : radius of the Earth $r_E = 6400$ km

*(a) (i) Find the orbital radius of the communications satellite.

(3 marks)

*(ii) Determine the orbital speed of the communications satellite.

(2 marks)

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(b) In Figure 4.1, *X* is a point in space and *O* is the centre of the Earth.

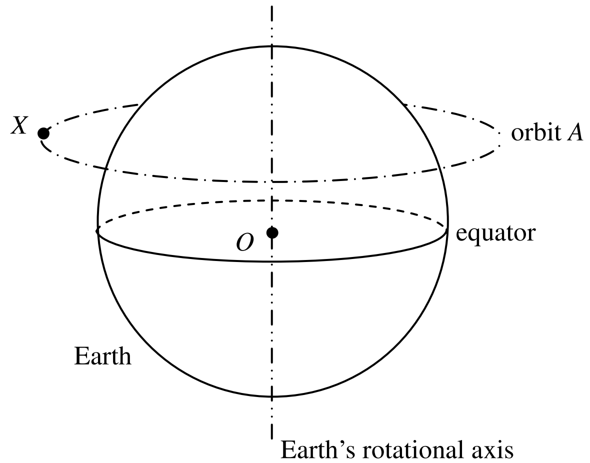

Figure 4.1

*(i) A satellite is at *X*. In Figure 4.1, draw the gravitational force acting on the satellite due to the Earth.

(1 mark)

*(ii) Briefly explain why the satellite cannot move in a circular orbit *A* as shown in Figure 4.1 under the influence of the Earth's gravitational force only.

(1 mark)

---

5. (a) Two rectangular barriers are put into a ripple tank. A vibrator vibrating at 25 Hz pr[...] water waves with straight wavefronts. The wavelength of the water waves is 0.8 cm. Cir[...] wavefronts are observed after the water waves pass through the opening between the tw[...] barriers. Figure 5.1 shows the top view of the set-up.

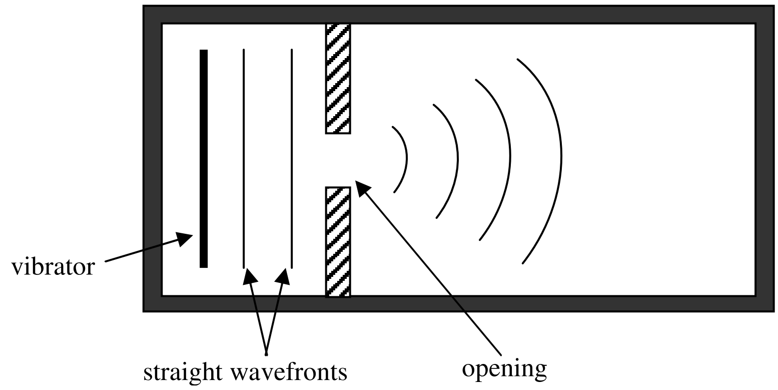

Figure 5.1

(i) Name the wave phenomenon that takes place when the water waves pass through the opening.

(1 mark)

(ii) Calculate the speed of the water waves in the ripple tank.

(2 marks)

(iii) If the experiment is repeated using a higher vibrator frequency, describe the changes, if any, in the wave pattern shown in Figure 5.1.

(2 marks)

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(b) Figure 5.2 shows three points, P, Q and R, in a ripple tank such that $PR = 8$ cm and $QR = 10$ cm. A dipper is put at P to produce circular water waves of wavelength 0.8 cm.

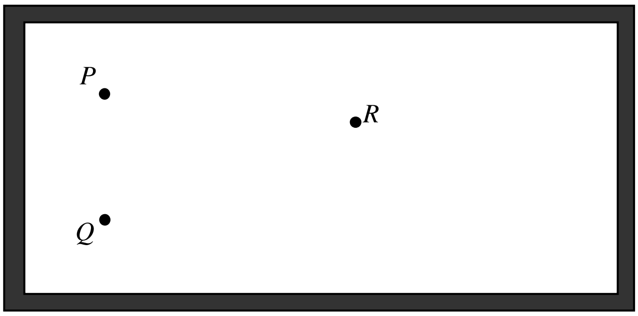

Figure 5.2

Another identical dipper, vibrating in phase with the one at P, is later put at Q. Explain the change, if any, in the amplitude of the water wave at R.

(3 marks)

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6. Figure 6.1 shows the following apparatus:

A low voltage power supply, a ray box with a single slit, a full circle protractor and a semi-circular gla[ss] block.

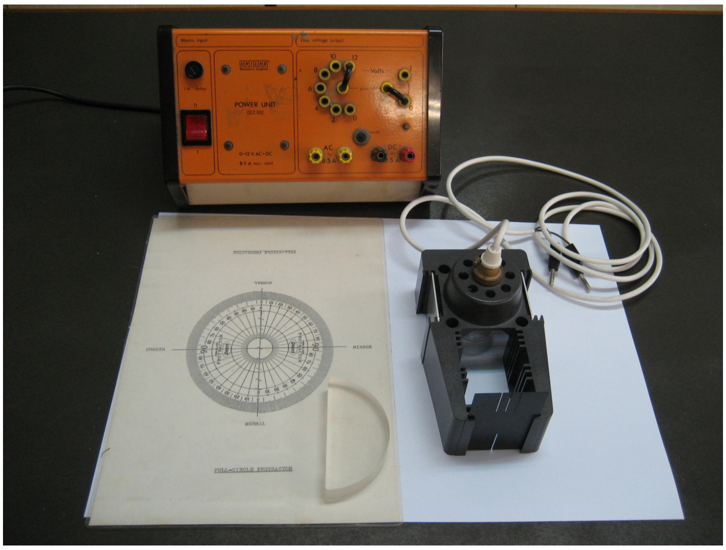

Figure 6.1

Describe how to use the above apparatus to measure the critical angle of the semi-circular glass block.

(5 marks)

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7. A drop of liquid is placed on a thin glass slide above a plastic ruler. The side view of the set-up i[illegible] in Figure 7.1. Looking through the liquid drop, a magnified image of the number '9' on the ruler is [illegible] as shown in Figure 7.2.

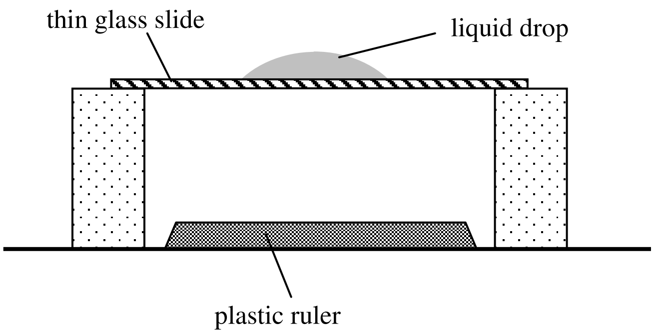


Figure 7.1

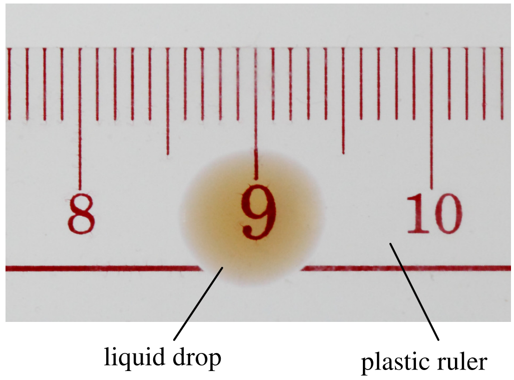


Figure 7.2

(a) A lens can be used to produce an image with the same nature as that produced by the liquid drop. State the type of lens and explain your answer.

(2 marks)

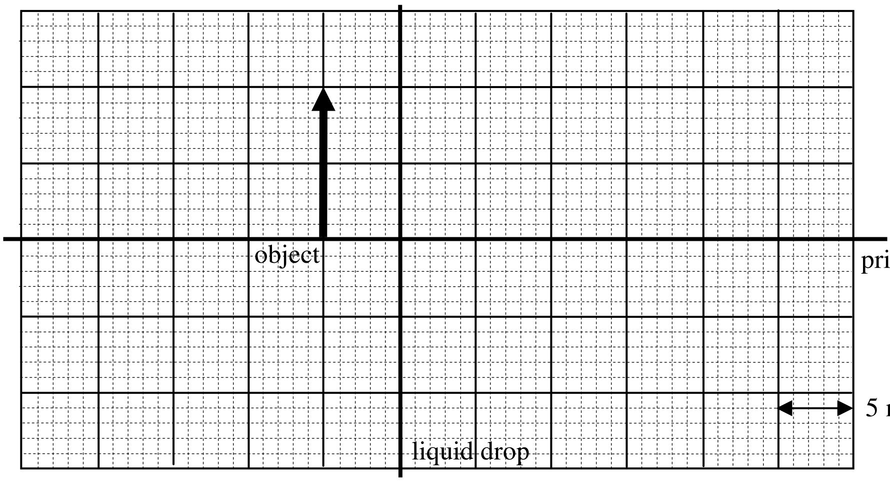
(b) The linear magnification of the number '9' is 1.4. Take the number '9' as the object, [use the] graph paper below to

(i) draw the image of the object, and

(ii) draw **one** light ray to find the focal length of the liquid drop.

You may neglect the effect due to the thin glass slide.

(3 marks)



Focal length of the liquid drop = _______ mm

(c) If the refractive index of the liquid becomes smaller, explain the change, if any, in the focal length of the liquid drop.

(2 marks)

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8. As shown in Figure 8.1, two large vertical parallel metal plates, each in a slotted base, are placed polystyrene tile. The plates are connected to the positive and negative terminals of an EHT supply respectively. The plates' separation d = 10 cm.

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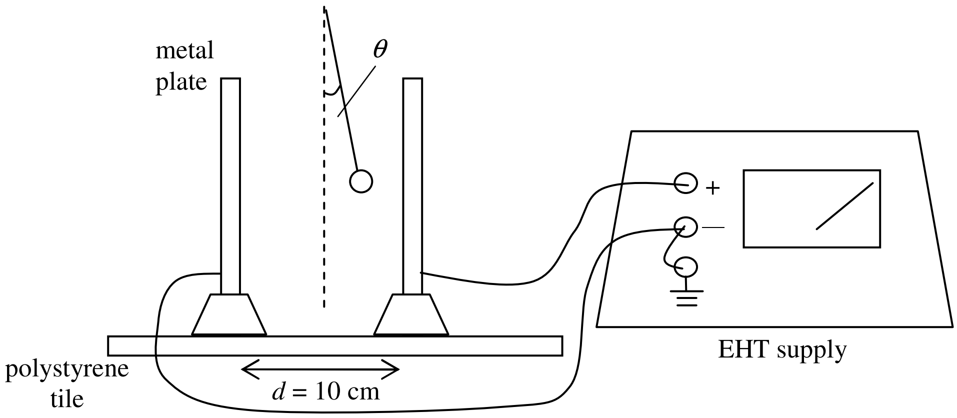

Figure 8.1

A small charged ball is suspended by a nylon thread and is placed midway between the plates. The thread makes an angle θ to the vertical when the ball is in equilibrium.

(a) Draw a free-body diagram to show the forces acting on the charged ball. Also indicate in your diagram the direction of the electric field between the plates.

(3 marks)

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(b) (i) Express tan θ in terms of the electric force F acting on the ball and the weight W of the ball.

(1 mark)

*(ii) Given that the mass of the ball is 0.07 g. When the voltage between the plates is 4000 V, $\theta = 2°$. Estimate the magnitude of the charge carried by the ball. Assume that the electric field between the plates is uniform.

(3 marks)

(c) Using the setup in Figure 8.1, suggest a simple method to test whether the electric field between the plates is uniform.

(3 marks)

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9.

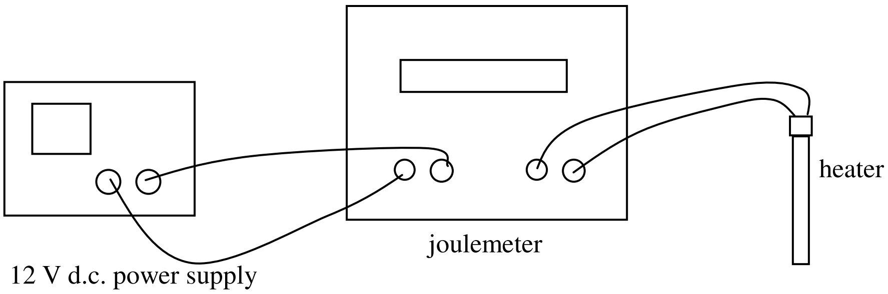

Figure 9.1

(a) A 12 V heater is operated under a steady d.c. voltage of 12 V. The energy consumed by the heater in 2 minutes is measured by a joulemeter as shown in Figure 9.1. The initial and final readings of the joulemeter are 126 J and 2526 J respectively.

(i) Estimate the electrical power of the heater.

(2 marks)

(ii) Hence, find the current through the heater.

(2 marks)

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(a) (iii) A 5 A fuse is installed in the power supply. Explain whether the fuse will [illegible] another identical heater is connected in parallel with the original heater.

(2 marks)

*(b) The heater is now connected to a sinusoidal a.c. power supply. The peak value of the voltage of the a.c. power supply is 15 V. How would the output power of the heater change ?

(2 marks)

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10. Read the following passage about ignition coils and answer the questions that follow.

Ignition coil

An ignition coil is used to produce sparks from the battery of a car to ignite the fuel in the engine. It is used to produce high-voltage pulses from a low-voltage d.c. supply.

An ignition coil consists of two coils of insulated copper wire that are wound around a common iron core. One coil, called the primary coil, is made from relatively few (tens or hundreds) turns of thick copper wire. The other coil, called the secondary coil, typically consists of many (thousands) turns of thin copper wire.

When an electric current is passed through the primary coil, a magnetic field is created. The iron core guides most of the primary coil's magnetic field to the secondary coil. When the current in the primary coil is suddenly interrupted, a high voltage pulse of many thousand volts is developed across the secondary coil. This voltage is often sufficient to cause an electrical discharge to produce a spark.

(a) Explain why a voltage is developed across the secondary coil when the current in the primary coil is suddenly interrupted.

(2 marks)

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....

(b) Suggest **two** reasons why the voltage developed across the secondary coil is very large.

(2 marks)

....

....

....

....

....

(c) Explain why thick wire should be used to construct the primary coil.

(3 ma

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11. The decay of radioactive isotope protactinium-238 (^{238}Pa) has a half-life of approximately 136 sample of ^{238}Pa is put in front of a GM tube and the initial count rate is 1000 counts per minute. background count rate is 50 counts per minute.

(a) It is known that the decay of ^{238}Pa does not emit γ radiation. Suggest a simple test to verify the radiation from ^{238}Pa is β radiation but not α radiation.

(3 marks)

----

*(b) Estimate the decay constant of ^{238}Pa.

(1 mark)

----

*(c) Hence, or otherwise, estimate the time taken for the count rate to drop to 250 counts per minute.

(3 marks)

END OF PAPER

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

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PP-DSE
PHY

PAPER 2

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

PRACTICE PAPER

PHYSICS PAPER 2

Question-Answer Book

(1 hour)
This paper must be answered in English

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Candidate Number									

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, 7, 9 and 11.

(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 in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked. 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** this Question-Answer Book.

(5) The diagrams in this paper are **NOT** necessarily drawn to scale.

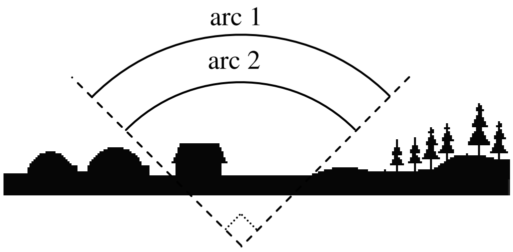
(6) The last pages of this Question-Answer Book contain a list of data, formulae and relationships which you may find useful.

(7) 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.

Section A : Astronomy and Space Science

Q.1: Multiple-choice questions

1.1 The figure below shows the view facing the south horizon in Hong Kong.



The two arcs represent the tracks of stars. Which of the following statements is/are **incorrect** ?

(1) The stars move clockwise along the arcs.
(2) The stars move anticlockwise along the arcs.
(3) The time taken for a star to follow path arc 1 is longer than that of path arc 2.

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

A ○ B ○ C ○ D ○

1.2 In 1838, German astronomer Bessel announced that the parallax of 61 Cygni is 0.314 arcseconds. What is the distance of 61 Cygni from the Earth according to Bessel's measurement ?

A. 0.98 ly
B. 1.02 ly
C. 3.18 ly
D. 10.38 ly

A ○ B ○ C ○ D ○

1.3 Which of the following statements about retrograde motion of planets is correct ?

A. Retrograde motion can only be observed at locations near the equator.
B. Only planets closer to the Sun than the Earth exhibit retrograde motion.
C. During retrograde motion, an observer on Earth sees the planet move from east to west over the course of several weeks or months.
D. The geocentric model cannot explain the retrograde motion of planets.

A ○ B ○ C ○ D ○

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1.4 If the acceleration due to gravity on the Moon's surface is 1/6 of that on the Earth's surface, what is the gravitational potential energy with respect to the surface of the Moon for an object of mass m which is 1 m above the Moon's surface ?

Given : R = radius of the Moon (>> 1 m)
M = mass of the Moon
G = the universal gravitational constant
g = acceleration due to gravity (close to the Earth)

A. $-mg/6$
B. $mg/6$
C. $-GMm/R$
D. GMm/R

A B C D
○ ○ ○ ○

1.5 A satellite of mass m is in a circular orbit of radius r around a planet of mass M and radius R. What is the extra kinetic energy required by the satellite to escape the gravitational attraction of the planet ?

Given : G = the universal gravitational constant

A. $\dfrac{GMm}{2r}$
B. $\dfrac{GMm}{r}$
C. $\dfrac{GMm}{2R}$
D. $\dfrac{GMm}{R}$

A B C D
○ ○ ○ ○

1.6 American astronomer Hubble discovered that the recession velocities v of galaxies are proportional to their distances d from the Earth, $v = Hd$, where H is the Hubble constant. Which of the following is **not** a unit of the Hubble constant ?

A. km s^{-1} Mpc^{-1}
B. m s^{-1} ly^{-1}
C. s
D. s^{-1}

A B C D
○ ○ ○ ○

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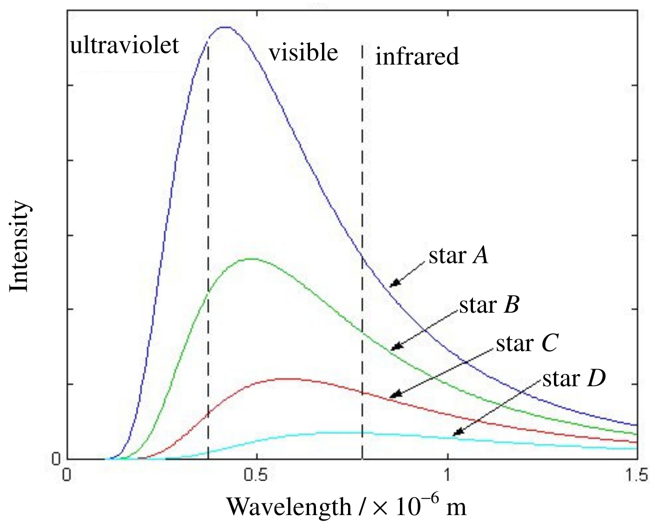
(For questions 1.7 and 1.8) The figure below shows the radiation curves of four stars.



1.7 Which star has the highest surface temperature ?

A. star *A*
B. star *B*
C. star *C*
D. star *D*

A B C D

1.8 Which of the following statements about the stars are correct ?

(1) The area under the curve is proportional to the surface temperature of that star.
(2) The colours of the four stars are different.
(3) If stars *C* and *D* have the same luminosity, star *D* has a larger radius.

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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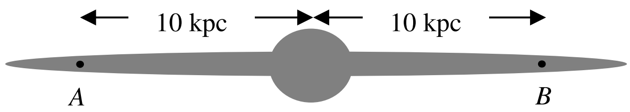
Q.1: Structured question

(a) We observe a galaxy *X* as shown in Figure 1.1. *X* has negligible velocity relative to the Ear[th]. Points *A* and *B* are both 10 kpc from the centre. The wavelengths of the H-alpha lines from the hydrogen gas at points *A* and *B* are 656.83 nm and 655.73 nm respectively. The wavelength of the H-alpha line measured in the laboratory is 656.28 nm.



edge-on view of galaxy *X*

Figure 1.1

(i) Determine the speed of the hydrogen gas at point *A* along the line of sight of an observer on the Earth.

(1 mark)

(ii) Briefly explain at which point, *A* or *B*, the hydrogen gas is moving towards the Earth.

(2 marks)

(iii) Assuming that the hydrogen gas at points *A* and *B* are moving in a circular path around the centre of *X*, and that the mass of *X* is concentrated at its centre, estimate the mass of *X*.

(2 marks)

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(b) Observations were made on another galaxy *Y*, as shown in Figure 1.2.

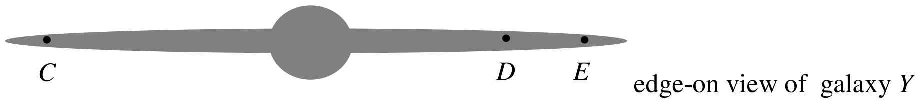

Figure 1.2

(i) The angular separation between points *C* and *E* is 1.6°. Given that *Y* is 950 kpc from the Earth, express the separation between *C* and *E* in kpc.

(2 marks)

(ii) Further observations show that the velocities of hydrogen gas at points *D* and *E* along the line of sight of an observer on the Earth are about the same. What could be inferred about the mass distribution of *Y* ? Assume that the hydrogen gas at points *D* and *E* are moving in circular paths around the centre of *Y*.

(1 mark)

(c) Briefly explain how we can estimate the surface temperature of a star by analyzing its radiation.

(2 marks)

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Section B : Atomic World

Q.2: Multiple-choice questions

2.1 Which of the following can be concluded from the Rutherford scattering experiment ?

(1) The nucleus of an atom consists of protons and neutrons.
(2) The nucleus of an atom is very small compared to the size of the atom.
(3) Electromagnetic waves emitted from atoms of gases are of specific frequencies.

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

A ○ B ○ C ○ D ○

2.2 The ionization energy for a hydrogen atom in ground state is 13.6 eV. A photon of energy 4.53 eV strikes a hydrogen atom in ground state. The hydrogen atom will

A. not be excited to a higher energy level.
B. be excited to the first excited state.
C. be excited to the third excited state.
D. be ionized.

A ○ B ○ C ○ D ○

2.3 The wavelength of the radiation emitted when an electron of an atom drops from the j^{th} excited state of energy E_j to a lower k^{th} excited state of energy E_k is

A. $\frac{E_j - E_k}{h}$

B. $\frac{E_j - E_k}{hc}$

C. $\frac{hc}{E_j - E_k}$

D. $\frac{hc}{E_j} - \frac{hc}{E_k}$

A ○ B ○ C ○ D ○

2.4 The de Broglie wavelength of a particle at speed v is λ. If the speed of the particle is doubled, the de Broglie wavelength is

A. $\lambda / 4$
B. $\lambda / 2$
C. λ
D. 2λ

A ○ B ○ C ○ D ○

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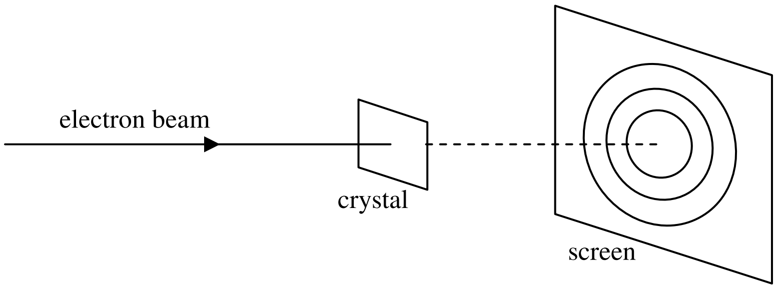
2.5 A beam of electrons is incident on a thin film of crystal. A pattern of bright and dark rings is observed on a fluorescent screen. Which physical phenomenon explains the formation of the pattern ?



A. Photoelectric effect
B. Electron diffraction
C. Ionization of atoms
D. Lotus effect

A B C D

2.6 Which of the following statements about different microscopes is/are correct ?

(1) The resolution of an optical microscope will increase if red light instead of blue light is used to illuminate the specimen.
(2) A transmission electron microscope (TEM) uses magnetic field to focus the electron beam.
(3) Only specimens that conduct electricity can be studied by a scanning tunnelling microscope (STM).

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

A B C D

2.7 Estimate the wavelength of electrons when they are accelerated in a transmission electron microscope (TEM) with a voltage of 76 kV.

A. 2.4×10^{-12} m
B. 4.5×10^{-12} m
C. 1.4×10^{-10} m
D. 9.6×10^{-9} m

A B C D

2.8 Which of the following are possible means by which nano particles could get into the human body?

(1) The skin having direct contact with nano particles.
(2) Inhaling nano particles into the lungs while breathing.
(3) Ingesting food containing nano particles.

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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Q.2: Structured question

(a) In studying the photoelectrons emitted from sodium, it was found that no photoelectrons were emitted when the wavelength of the incident light was longer than 5.27×10^{-7} m.

(i) Explain why the wave model of light **cannot** account for this phenomenon.

(2 marks)

(ii) Determine the work function for sodium. Express your answer in electron-volts.

(3 marks)

(iii) What is the physical meaning of work function ?

(1 mark)

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Answers written in the margins will not be marked.

(b) Figure 2.1 shows a photoelectric smoke detector Peter made for a science project competition. It consists of a light source *S*, a photocell *C* and an alarm circuit. When smoke enters the detector, light from *S* is scattered by the smoke particles and enters *C* as shown in Figure 2.2. Photoelectrons are produced in *C* when light is incident on its sodium surface. The alarm is triggered when the photoelectric current is larger than 1×10^{-8} A.

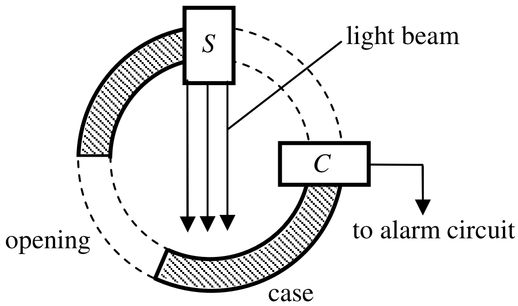

Figure 2.1

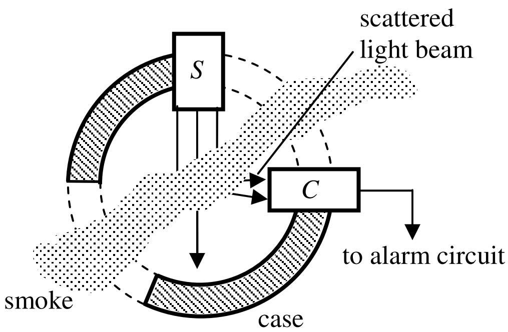

Figure 2.2

(i) If 5% of the photons incident on the sodium surface of *C* emit photoelectrons, what is the minimum number of photons incident on the sodium surface of *C* in 1 s when the alarm is triggered ?

(2 marks)

(ii) Peter claimed that the detector will become more sensitive if a light source of the same type as *S* but of higher intensity is used. Comment on his suggestion.

(2 marks)

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Section C : Energy and Use of Energy

Q.3: Multiple-choice questions

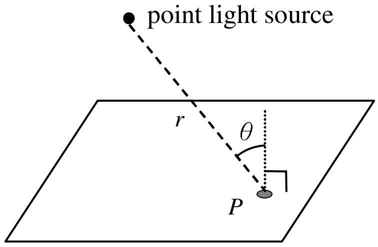
3.1 A 100 W filament light bulb and a 22 W compact fluorescent lamp both produce a luminous flux of 1600 lm. Which of the following statements about the two light sources is/are correct ?

(1) Both light sources give out the same amount of energy in the form of electromagnetic waves in 1 s.
(2) 78 J of electrical energy is converted to heat in the filament light bulb in 1 s.
(3) Both light sources have the same brightness to the human eye when observed from the same distance.

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

A B C D
○ ○ ○ ○

3.2 A point light source with luminous flux *F* is illuminating a point *P* on a table surface as shown in the figure below. The illuminance at point *P* is



A. $\dfrac{F\cos\theta}{4\pi r^2}$

B. $\dfrac{F\cos^2\theta}{4\pi r^2}$

C. $\dfrac{F\cos(90^\circ-\theta)}{4\pi r^2}$

D. $\dfrac{F\cos^2(90^\circ-\theta)}{4\pi r^2}$

A B C D
○ ○ ○ ○

3.3 Which of the following statements about an electric hotplate and an induction cooker is/are correct ?

(1) Both cookers make use of the heating effect of a current.
(2) Only metal cooking pots can be used for both cookers.
(3) In general, an induction cooker has a higher energy efficiency than an electric hotplate.

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

A B C D
○ ○ ○ ○

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Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

3.4 The table below shows the data of a house. Calculate the Overall Thermal Transfer Value of the h

	Windows	Walls	Roof
Rate of heat transfer / W	6200	4400	8600
Total area / m^2	20	480	140

A. 30 W m^{-2}
B. 127 W m^{-2}
C. 310 W m^{-2}
D. 381 W m^{-2}

A B C D
○ ○ ○ ○

3.5 A wind turbine has an overall efficiency of 30% and its output power is 360 kW when the wind blows normally at the turbine with a constant velocity of 10 m s^{-1}. Find the length of the blades of the wind turbine.
Given: density of air = 1.2 kg m^{-3}

A. 4.1 m
B. 7.6 m
C. 13.8 m
D. 25.2 m

A B C D
○ ○ ○ ○

3.6 The difference in mass between a uranium-238 nucleus and its constituent nucleons is 1.88482 u. Determine the binding energy per nucleon of a uranium-238 nucleus.

A. 2.08 MeV
B. 7.37 MeV
C. 448.59 MeV
D. 1754.77 MeV

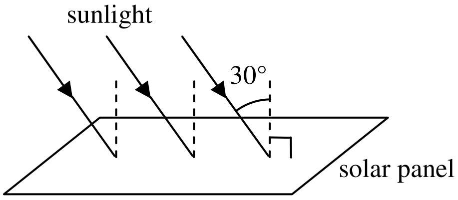
A B C D
○ ○ ○ ○

3.7 Which of the following is the function of the control rods in a fission reactor ?

A. They slow down neutrons.
B. They absorb neutrons.
C. They absorb heat from the reactor.
D. They transfer heat to the generator.

A B C D
○ ○ ○ ○

3.8 Estimate the electrical power output of a 20 m^2 solar panel when it is illuminated with sunlight of intensity 1 kW m^{-2} at an angle of 30° to the vertical.



Given: efficiency of the solar panel = 12%

A. 1200 W
B. 1386 W
C. 2078 W
D. 2400 W

A B C D
○ ○ ○ ○

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Answers written in the margins will not be marked.

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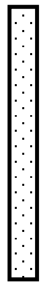
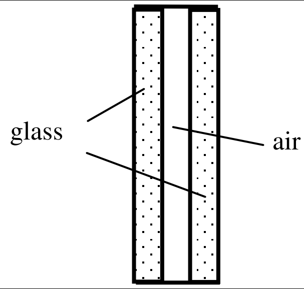
Q.3: Structured question

(a) The heat transfer through a window can be reduced by using double-glazed glass. The table belo[w] shows some information of two types of windows, both made from the same type of glass.

		
Type	Single layer	Double-glazed
Thickness	0.01 m	0.03 m (0.01 m for each layer)
Thermal transmittance U-value	5.7 W m^{-2} K^{-1}	2.8 W m^{-2} K^{-1}

(i) Suggest **two** reasons why the thermal transmittance of the double-glazed window is smaller than that of the single layer window.

(2 marks)

(ii) On a hot sunny afternoon, the temperatures outside and inside a room are 36°C and 24°C respectively.

(1) If the double-glazed window is used in the room and the area of the window is 2 m^2, estimate the rate of heat transfer due to conduction through this window.

(1 mark)

(2) Briefly explain whether the actual rate of heat transfer will be higher or lower than your answer in part (1).

(2 marks)

(a) (iii) Other than using double-glazed windows, suggest one method to reduce the he[...] through windows.

(1 ma[...]

(b) An air-conditioner is installed in a room to keep the room cool.

(i) Briefly explain how the refrigerant in an air-conditioner absorbs heat from the room.

(2 marks)

(ii) The energy label of the air-conditioner is shown in Figure 3.1.

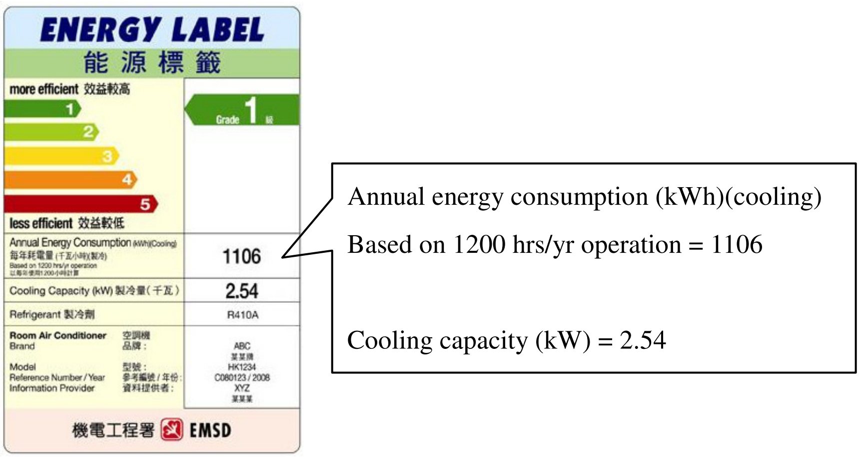


Figure 3.1

Estimate the amount of heat that can be removed from the room by the air-conditioner in 5 minutes.

(2 marks)

Section D : Medical Physics

Q.4: Multiple-choice questions

4.1 The far point of Phoebe's eye is at 60 cm and its lens-to-retina distance is 2.5 cm. What is the power of the corrective lens that she should wear ?

A. − 2.0 D
B. − 1.7 D
C. 1.7 D
D. 2.0 D

A ○ B ○ C ○ D ○

4.2 Which of the following features of the middle ear amplify the pressure ?

(1) The middle ear is filled with air.
(2) The ear bones form a lever system.
(3) The area of the ear drum is larger than that of the oval window.

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

A ○ B ○ C ○ D ○

4.3 The sound intensity of a machine is 0.01 W m^{-2}. By adding a noise barrier, the sound intensity is reduced to 6×10^{-6} W m^{-2}. Find the reduction in the sound intensity level.
Given : threshold of hearing = 1×10^{-12} W m^{-2}

A. 32 dB
B. 68 dB
C. 88 dB
D. 100 dB

A ○ B ○ C ○ D ○

(For questions 4.4 and 4.5) The following table shows the acoustic impedances and the densities of three different media *X*, *Y* and *Z*.

Medium	Acoustic impedance / $\times 10^6$ Rayl	Density / kg m^{-3}
X	1.48	1000
Y	1.63	1058
Z	1.66	1060

4.4 Arrange the speed of sound in the three media, v_X, v_Y and v_Z, in **descending** order.

A. $v_X > v_Y > v_Z$
B. $v_Y > v_X > v_Z$
C. $v_Z > v_X > v_Y$
D. $v_Z > v_Y > v_X$

A ○ B ○ C ○ D ○

4.5 What is the intensity reflection coefficient between medium *X* and medium *Z* for normal incidence ?

A. 7.97×10^{-4}
B. 8.48×10^{-4}
C. 3.29×10^{-3}
D. 5.73×10^{-2}

A ○ B ○ C ○ D ○

4.6 Which of the following statements about a fibre optic endoscope is **incorrect** ?

A. Tissue samples can be obtained at the same time for further examination.
B. Coherent bundle fibres are used for image transport.
C. The cladding of the optical fibre must have a smaller refractive index than the glass fibre inside.
D. The critical angle of the optical fibre should be as large as possible.

A B C D
○ ○ ○ ○

4.7 Which of the following statements about radionuclide planar imaging is/are **incorrect** ?

(1) Radionuclide planar images provide functional information about the organ.
(2) Radiation of radionuclide planar imaging stays shorter inside our body than that of X-ray radiographic imaging.
(3) Tracers are used to absorb radiation.

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

A B C D
○ ○ ○ ○

4.8 Technetium-99m has a half-life of 6 hours, and a biological half-life of 3 hours. A patient is given an injection of technetium-99m at 12:00 noon. Which of the following statements is/are correct ?

(1) At 3:00 pm, the number of undecayed technetium nuclei in the patient's body is less than half of the initial value.
(2) All the technetium nuclei will be removed from the body by biological processes by 6:00 pm.
(3) All the technetium nuclei removed from the body by biological processes are decayed.

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

A B C D
○ ○ ○ ○

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Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Q.4: Structured question

The table below shows the linear attenuation coefficient, μ, of X-rays for different tissues.

Tissue	bone	liver	muscle	lung	air
Linear attenuation coefficient/cm^{-1}	4.00	0.85	0.84	0.20	0.10

(a) Suggest one reason to explain why the linear attenuation coefficient of the lung is smaller than that of the liver.

(1 mark)

(b) Show that the half-value thickness = $\dfrac{\ln 2}{\mu}$.

(2 marks)

(c) The intensity of a beam of X-ray drops to 1/8 of its initial value after passing through a lung. Estimate the thickness of the lung.

(2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(d) Figure 4.1 shows an X-ray radiographic image of a patient's chest. Explain why th[...] appear white in colour.

(2 mar[...])

Figure 4.1

(e) Artificial contrast medium is sometimes used to highlight an organ in X-ray radiographic imaging. Suggest **two** properties that an artificial contrast medium should have.

(2 marks)

(f) Suggest one advantage of X-ray radiographic imaging over CT scan.

(1 mark)

END OF PAPER

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

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List of data, formulae and relationships

Data

molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
acceleration due to gravity	$g = 9.81 \text{ m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
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	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
atomic mass unit	$\text{u} = 1.661 \times 10^{-27}$ kg (1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11}$ m
light year	$\text{ly} = 9.46 \times 10^{15}$ m
parsec	$\text{pc} = 3.09 \times 10^{16} \text{ m} = 3.26 \text{ ly} = 206265 \text{ AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
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
$P = \sigma A T^4$	Stefan's law
$\left\lvert\frac{\Delta f}{f_0}\right\rvert \approx \frac{v}{c} \approx \left\lvert\frac{\Delta\lambda}{\lambda_0}\right\rvert$	Doppler effect

Energy and Use of Energy

$\frac{Q}{t} = k\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{k}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho A v^3$	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)
$\text{power} = \frac{1}{f}$	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.	$P = Fv = \frac{W}{t}$	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.	$V = \frac{Q}{4\pi\varepsilon_0 r}$	electric potential due to a point charge
D4.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D5.	$I = nAvQ$	general current flow equation
D6.	$R = \frac{\rho l}{A}$	resistance and resistivity
D7.	$R = R_1 + R_2$	resistors in series
D8.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D9.	$P = IV = I^2R$	power in a circuit
D10.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D11.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D12.	$V = \frac{BI}{nQt}$	Hall voltage
D13.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D14.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D15.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D16.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0 e^{-kt}$	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.	$E = mc^2$	mass-energy relationship

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本專輯的試題曾引用下列刊物的資料：
Material from the following publications has been used in question papers in this volume:

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