2024-DSE
PHY
PAPER 1A

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2024

PHYSICS PAPER 1

8:30 am – 11:00 am (2½ hours)

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 50 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 the Question-Answer Book. **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 two 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 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.

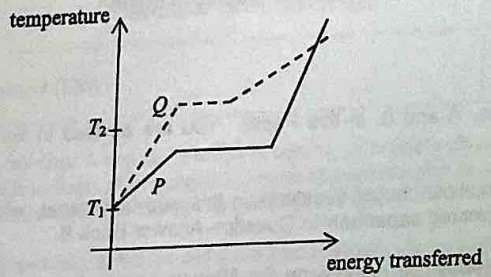
(6) No marks will be deducted for wrong answers.

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

Section A

There are 33 questions. Questions marked with * involve knowledge of the extension component.
Take $g = 9.81\ m\ s^{-2}$.

1. Substance P and Q are of the same mass and both are solids at temperature T_1. The graph below shows the variation of temperature of the substances with energy transferred.



Which statement below is correct ?

A. P has a higher melting point than Q.
B. The specific latent heat of fusion of P is smaller than that of Q.
C. The specific heat capacity of solid P is greater than that of solid Q.
D. At temperature T_2, P is gas while Q is solid.

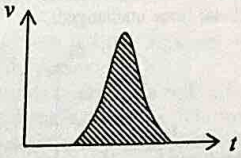
2. If 0.5 kg of water at 50 °C is mixed with 2.0 kg of ice at 0 °C, what is the final temperature of the mixture ?
Given: specific heat capacity of water = 4200 $J\ kg^{-1}\ °C^{-1}$
specific latent heat of fusion of ice = $3.34 \times 10^5\ J\ kg^{-1}$

A. −54 °C
B. 0 °C
C. 10 °C
D. 25 °C

*3. The best vacuum attained in the laboratory has a pressure of about 10^{-8} Pa. Estimate the order of magnitude of the number of air molecules in 1 cm^3 of such 'vacuum' at room temperature.

A. 10^4
B. 10^6
C. 10^8
D. 10^{12}

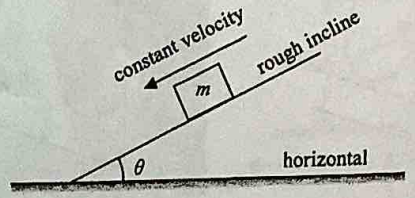
4.



What physical quantity does the shaded area represent in the above velocity-time (v-t) graph ?

A. acceleration
B. change of velocity
C. momentum
D. displacement

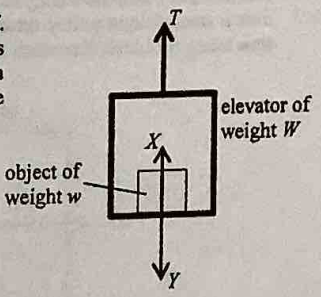
5.



A block of mass m slides down along a fixed rough incline with constant velocity as shown. The incline makes an angle θ with the horizontal. What is the magnitude of the force exerted on the incline by the block ?

A. zero
B. mg
C. $mg \sin\theta$
D. $mg \cos\theta$

6. An object of weight w is placed inside an elevator of weight W. A force T pulls the elevator upward. A **supporting force** X acts on the object while the **floor of the elevator experiences a force** Y due to the presence of the object. Which of the following is an action and reaction pair ?



A. T and $(W + w)$
B. w and X
C. X and Y
D. It cannot be determined as the direction of acceleration of the elevator is unknown.

7. In an experiment, a horizontal force F acts on a block placed on a rough horizontal surface as shown in Figure (a). Figure (b) shows the variation of the block's kinetic energy E_k with the distance s it travelled. Neglect air resistance and assume frictional force unchanged.

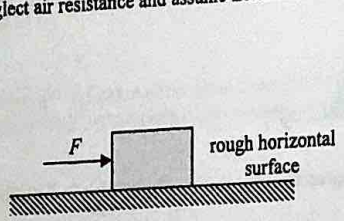


Figure (a)

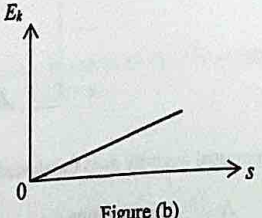
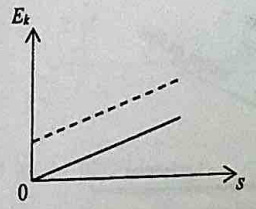


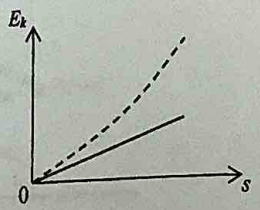
Figure (b)

If the experiment is repeated with force F doubled, which of the following graphs represents the expected result (in dotted line) ?

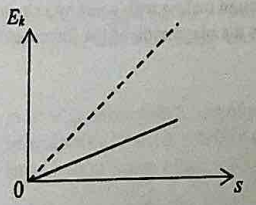
A.



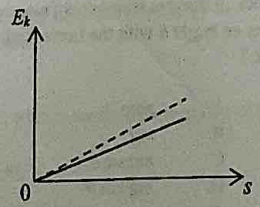
B.



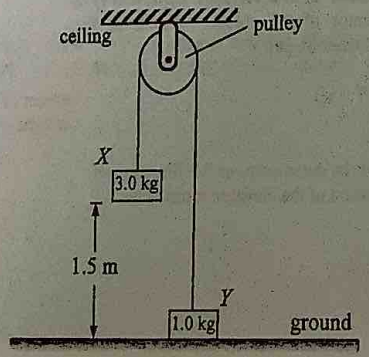
C.



D.



8. Block X and Y of mass 3.0 kg and 1.0 kg respectively are connected by a light inextensible string passing over a smooth light pulley fixed to the ceiling as shown. The blocks are released from rest. Find the time taken for block X to reach the ground. Neglect air resistance.

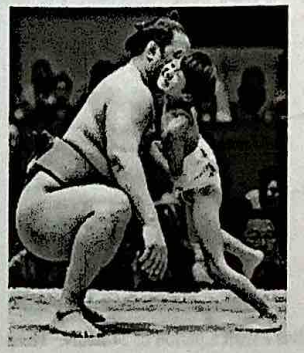


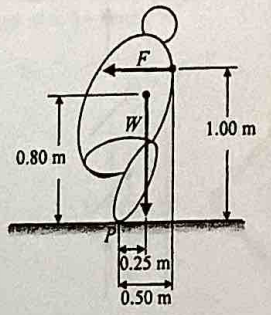
A. 0.55 s
B. 0.64 s
C. 0.68 s
D. 0.78 s

9. A person thought that when he pulls his hair with a large enough force, eventually he will be able to pull himself off the ground. This is a misconception because

A. the pulling force is acting internally within that person but it is not an external force acting on the person.
B. it is impossible to generate a pulling force larger than a person's weight.
C. the pulling force is balanced by the person's weight.
D. it is impossible for the pulling force to overcome the force due to atmospheric pressure.

10. A child tries to push a 150 kg (sumo) wrestler in order to topple him backwards in a game. The simplified diagram indicates the weight W of the wrestler and the horizontal pushing force F acting on the wrestler by the child. P is the wrestler's contact point on the ground.

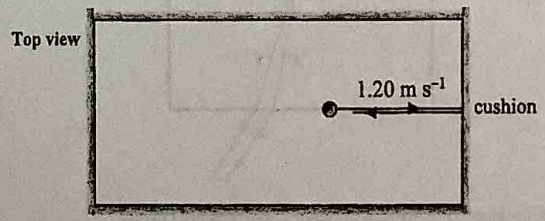




Find the minimum value of F required.

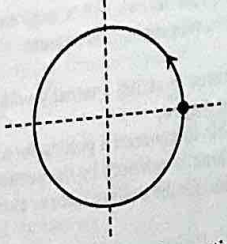
A. 368 N
B. 736 N
C. 1177 N
D. 2354 N

11. On a billiard table, a billiard ball of mass 0.16 kg and moving with a uniform speed of 1.20 m s^{-1} collides elastically with the cushion. It rebounds with the same speed normal to the cushion as shown. If the impact time is 0.0003 s, find the average force acting on the ball by the cushion during collision.

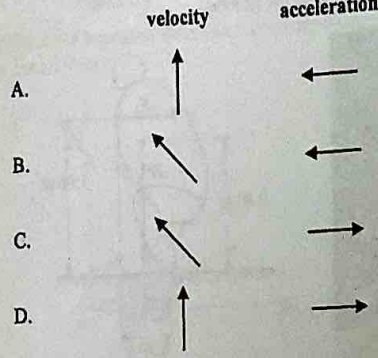


A. 0 N
B. 640 N
C. 1280 N
D. 2560 N

*12.



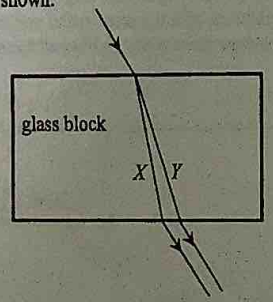
The figure shows a particle performing uniform circular motion. Which of the following correctly indicates the directions of its velocity and acceleration at the instant shown ?



*13. A satellite orbits the Earth in a circular orbit of radius r with a period of 24 hours. The period of another satellite which orbits the Earth in a circular orbit of radius $2r$ is

A. less than 24 hours.
B. 24 hours.
C. between 24 hours and 48 hours.
D. more than 48 hours.

14. A light beam consisting of monochromatic light beam X and Y is incident on a rectangular glass block. It splits into two beams as shown.

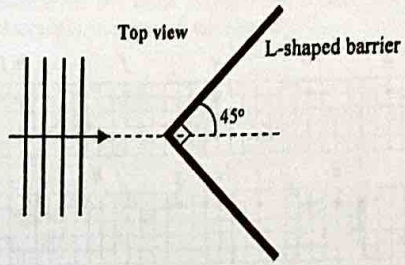


Which of the following comparisons of beam X and Y is/are correct ?

(1) X has a higher frequency.
(2) X has a larger speed in glass.
(3) In the glass block, the critical angle for X is greater.

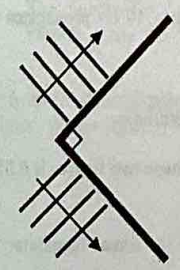
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

15.

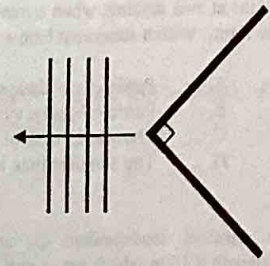


In a ripple tank, a series of plane water waves approach an L-shaped barrier as shown above. Which diagram below best shows the wave pattern reflected from the barrier ?

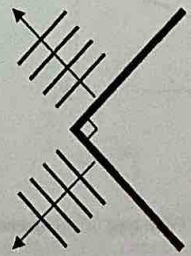
A.



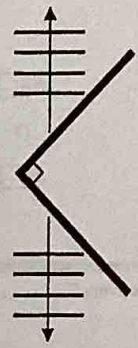
B.



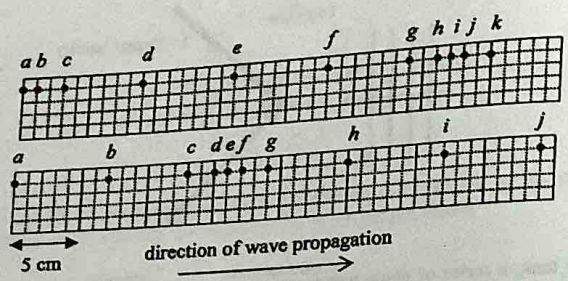
C.



D.



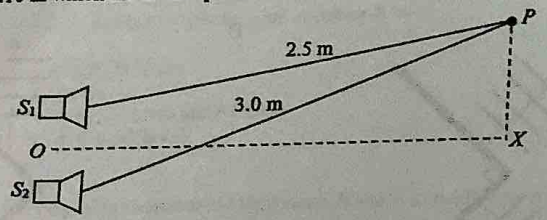
16.



A series of particles is uniformly distributed along a slinky spring initially. Figure (a) and (b) show their positions at two instants when a travelling wave of frequency 10 Hz propagates along the spring from left to right. Which statement below is correct ?

A. Particle *a* is always stationary.
B. Particle *b* and *c* vibrate with different amplitudes.
C. The wavelength of the wave is 16 cm.
D. The smallest time interval for obtaining these two figures is 0.05 s.

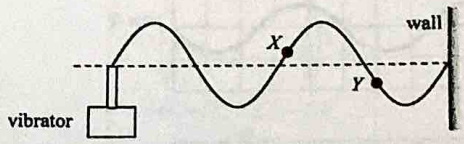
17. Two identical loudspeakers S_1 and S_2 connected to a signal generator produce sounds of wavelength 0.10 m which are in anti-phase.



OX is the perpendicular bisector of the line joining S_1 and S_2. What type of interference occurs at X and P respectively ?

	X	P
A.	destructive	constructive
B.	constructive	constructive
C.	destructive	destructive
D.	constructive	destructive

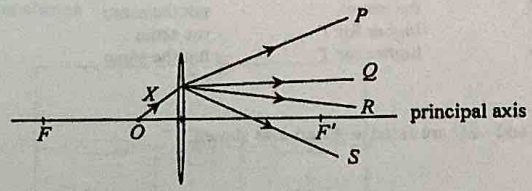
18. A string is tied to a vibrator at one end while the other end is fixed to a wall. The figure shows the stationary wave formed at a certain frequency of the vibrator.



Which statement is correct when the frequency is doubled ?

A. The amplitude of the wave will double.
B. The wavelength will double.
C. The speed of the wave will double.
D. Particle X and Y will become in phase.

19. X is a light ray from an object O placed on the principal axis of a convex lens as shown. F and F' are the foci of the lens. Which light ray best represents the emergent ray ?



A. P
B. Q
C. R
D. S

*20. An object of height 10 cm placed at 20 cm in front of a concave lens forms an image of height 8 cm. Find the focal length of the concave lens.

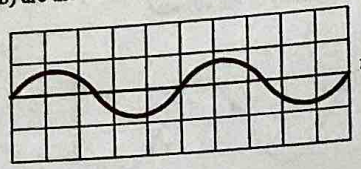
A. 4.4 cm
B. 8.9 cm
C. 40 cm
D. 80 cm

21. Which description below is **INCORRECT** ?

A. Microwaves are a kind of electromagnetic waves.
B. Microwaves can be observed with the naked eye.
C. Microwaves propagate with the speed of light in a vacuum.
D. Microwaves are used in radar to detect the position of an aeroplane.

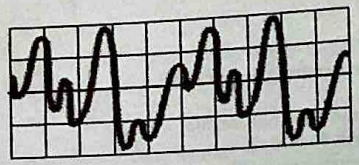
22. Figure (a) and (b) are the CRO displays of musical note X and Y using the same time axis and intensity axis.

Figure (a)



note X

Figure (b)

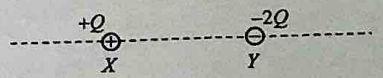


note Y

Which comparison of these two notes must be correct ?

	pitch	loudness
A.	the same	the same
B.	the same	not the same
C.	higher for Y	the same
D.	higher for Y	not the same

23. Charges $+Q$ and $-2Q$ are fixed at X and Y as shown.

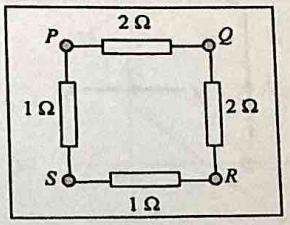


Which description(s) about the electric field along the dotted line is/are correct ?

(1) Between X and Y, the respective electric fields due to the two charges are in the same direction.
(2) To the right of Y, the resultant electric field is always directed to the left.
(3) On the dotted line, there exist two points where the resultant electric field is zero.

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

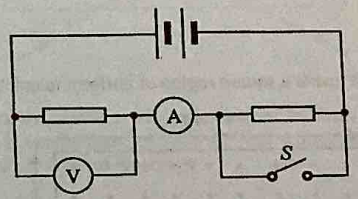
24.



Four resistors are connected to terminals $PQRS$ of a circuit board as shown. Across which pair of terminals below is the equivalent resistance smallest ?

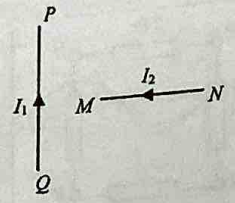
A. PQ
B. PR
C. PS
D. QS

25. In the circuit below, the two resistors are identical. When S is closed, how would the readings of the ammeter and voltmeter change ?



	ammeter reading	voltmeter reading
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

26.



PQ in the figure is a section of a fixed long straight wire carrying a current I_1. MN is a section of another long straight wire carrying a current I_2. MN is perpendicular to PQ and both wires are in the same plane. What is the direction of the magnetic force acting on MN due to PQ ? Neglect the effects of the Earth's magnetic field.

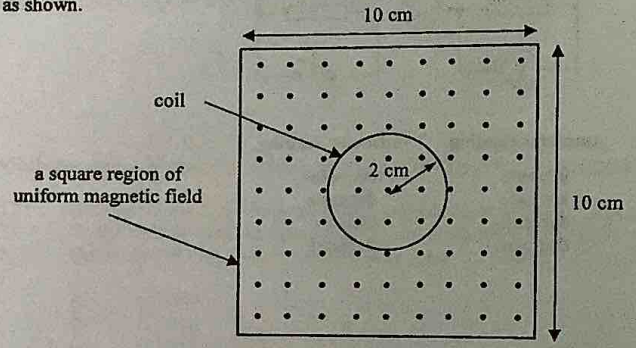
A. pointing out of the paper

B. ↓

C. pointing into the paper

D. ↑

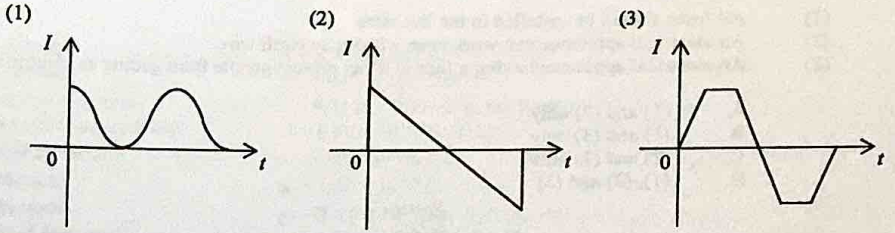
*27. A coil of radius 2 cm is placed inside a square region of uniform magnetic field pointing out of the paper as shown.



The magnetic field decreases uniformly from a strength of 5.0 T to 3.0 T in 0.8 s. What is the magnitude of the e.m.f. induced in the coil ?

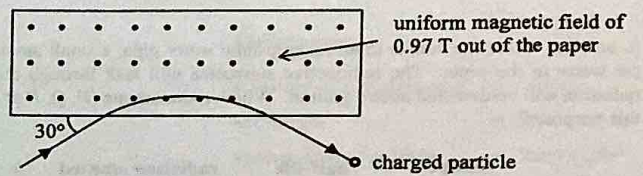
A. 2.5×10^{-2} V
B. 3.1×10^{-2} V
C. 3.1×10^{-3} V
D. 6.2×10^{-3} V

*28. Which of the following current against time (I- t) graphs represent an a.c. ?



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

*29.



A charged particle enters and leaves a magnetic field of uniform flux density 0.97 T along the path as shown. It experiences a magnetic force of 5.9×10^{-12} N within the magnetic field. Given that the speed of the particle is 1.9×10^{7} m s^{-1}, find its charge.

A. -3.2×10^{-19} C
B. $+3.2 \times 10^{-19}$ C
C. -6.4×10^{-19} C
D. $+6.4 \times 10^{-19}$ C

*30. A power station generates 217 MW of power for transmission to downtown under a voltage of 132 kV via a transmission cable which has an effective resistance of 0.02 Ω km^{-1}. The power loss for a total cable length of 40 km is about

A. 2.16 MW.
B. 6.49 MW.
C. 13.0 MW.
D. 21.6 MW.

31. Which statements about domestic electricity are correct ?

(1) All fuses should be installed in the live wire.
(2) An electrical appliance can work even without an earth wire.
(3) An electrical appliance having a fuse in it can protect people from getting an electric shock.

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

*32. It takes 2.0 years for the activity of a sample containing a radioactive nuclide to drop from 800 Bq to 600 Bq. How long will it take for the activity of the sample to drop from 600 Bq to 300 Bq ?

A. 2.0 years
B. 2.5 years
C. 3.0 years
D. 4.8 years

33. In order to locate the cracks in an underground water pipe, a small amount of a radioisotope is added to the water in the pipe. The radioactive substance will leak through the crack to the soil nearby, thus radiation will be detected above ground. Which radioisotope (*P*, *Q*, *R* or *S*) below is the most suitable for this purpose ?

	isotope	half-life	radiation emitted
A.	*P*	66 hours	β
B.	*Q*	36 hours	γ
C.	*R*	7.2 hours	α
D.	*S*	45 minutes	α, β

END OF SECTION A

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	$q_e = 1.60 \times 10^{-19}\ \text{C}$
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	$u = 1.661 \times 10^{-27}\ \text{kg}$ (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
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	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
$P = \frac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e q_e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}\ \text{eV}$	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)
$\text{power} = \frac{1}{f}$	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.	$pV = \frac{1}{3}Nmc^{\overline{2}}$	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 separation 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

2024-DSE
PHY
PAPER 1B

B

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2024

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 and 9.

(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.

Please stick the barcode label here.

Candidate Number									

Short Questions Question No.	Marks
1	6
2	6
3	6
4	6
5	4
6	5
7	6
8	6
9	6
Long Questions Question No.	**Marks**
10	10
11	7
12	8
13	8

Section B: Answer ALL questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided. Take $g = 9.81\ m\ s^{-2}$.

1. A bottle of water of temperature 4 °C is taken out from a refrigerator and placed on a table. The room temperature is 30 °C.

Figure 1.1

(a) State one way of heat transfer from the surroundings to the bottle of water. (1 mark)

(b) Explain whether wrapping the bottle with an aluminum foil will speed up the rate of temperature increase. (2 marks)

(c) After a period of time, water droplets form on the surface of the bottle.

(i) State the source of the water droplets. (1 mark)

(ii) Suppose 0.40 g of water droplets are collected on the surface of the bottle. Estimate the latent heat released from these droplets. (2 marks)
Given: specific latent heat of vaporization of water = $2.26 \times 10^6\ J\ kg^{-1}$

*2. Figure 2.1 shows a closed vessel of a fixed volume containing argon, a monatomic gas, maintained at temperature T_0. The root-mean-square speed ($c_{r.m.s.}$) of the argon atoms inside is 500 $m\ s^{-1}$.

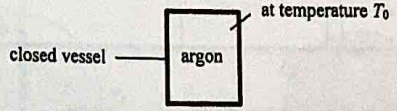


Figure 2.1

(a) (i) Calculate the average kinetic energy of the argon atoms, E_K. Given that the mass of an argon atom is 6.63×10^{-26} kg. (2 marks)

(ii) Hence, or otherwise, find T_0 (in K). (2 marks)

(b) If some of the argon has been leaked from the vessel while the temperature remains at T_0, state and explain the change, if any, in the root-mean-square speed of the argon atoms inside the vessel. (2 marks)

3. A small block P of mass 0.20 kg rests on side A of a horizontal table as shown. The surface of the table is smooth from A to B but is rough from B to C. Neglect air resistance.

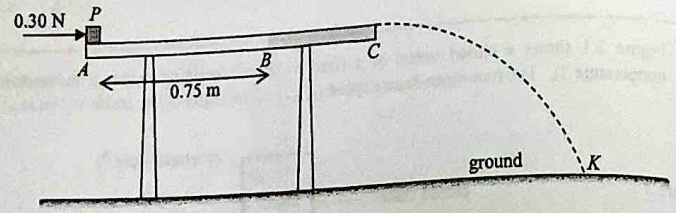


Figure 3.1

A horizontal force of 0.30 N acts on the block as shown.

(a) Find the speed of the block after it travels 0.75 m to point B. (2 marks)

(b) The horizontal force is removed when block P just reaches B. When the block continues to travel from B to C, on the free-body diagram below indicate and name the force(s) acting on the block. (2 marks)

P

*(c) The block leaves side C of the table and takes 0.35 s to reach point K on the ground. Estimate the height of the table. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

*4. A sphere of radius 0.50 m rotates about a vertical axis ACB with a constant angular speed of 6 rad s^{-1}, with C being the sphere's centre. A small plasticine P of mass 0.020 kg is stuck on the surface of the sphere such that it rotates on a horizontal plane containing C as shown in Figure 4.1(a).

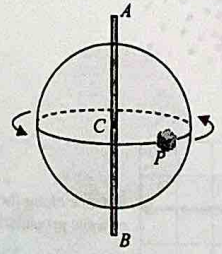


Figure 4.1(a)

Top view from A

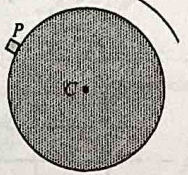


Figure 4.1(b)

(a) (i) Find the magnitude of the centripetal force acting on P. (2 marks)

(ii) The sphere's angular speed is increasing. If P finally leaves the sphere at the position shown in Figure 4.1(b) (Top view from A). Indicate on Figure 4.1(b) the direction of motion of P when it just leaves the sphere. (1 mark)

(b) Another plasticine Q is stuck on the sphere's surface as shown in Figure 4.2.

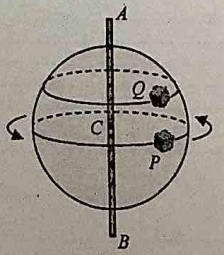


Figure 4.2

(i) State whether P and Q have the same angular speed. (1 mark)

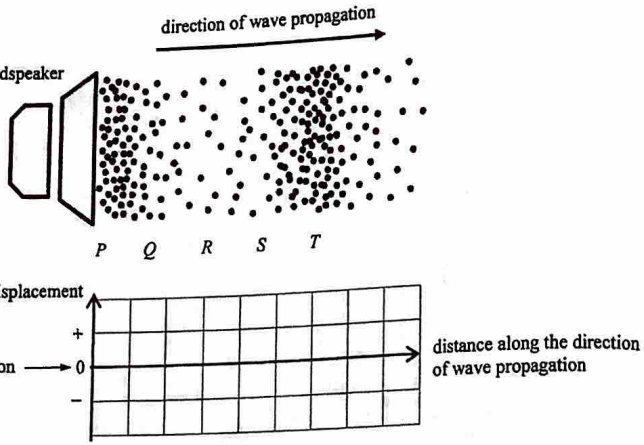
(ii) Explain whether P and Q have the same magnitude of centripetal acceleration. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

5. Figure 5.1 represents the distribution of air particles at a certain instant in a sound wave produced by a loudspeaker.

Figure 5.1



(a) Sketch the displacement-distance graph of the air particles at that instant in the grid provided. Take the displacement to the right as positive (+). (2 marks)

(b) At the instant shown, state a region (*P*, *Q*, *R*, *S* or *T*) in which

(i) the air particles are moving with the highest speed; (1 mark)

(ii) the air pressure is the lowest. (1 mark)

Answers written in the margins will not be marked.

Please stick the barcode label here.

*6. After removing the protective coating and the reflective layer of a compact disc (CD), the CD becomes a diffraction grating with evenly spaced parallel slits (Figure 6.1(a)). The set-up in Figure 6.1(b) employs a laser beam which can be used to measure the slit separation *d*.

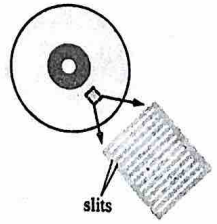


Figure 6.1(a)

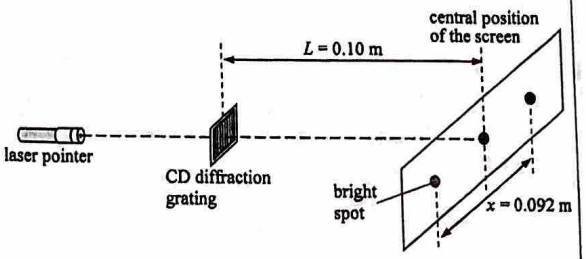


Figure 6.1(b)

Given that the separation between the CD diffraction grating and the screen, *L*, is 0.10 m, the separation between the first-order maxima, *x*, is 0.092 m and the wavelength λ of the red laser light beam used is 650 nm.

(a) Estimate *d*. (3 marks)

(b) State and explain the change in *x* if green laser light is used. (2 marks)

Answers written in the margins will not be marked.

7. The graph below shows the speed of sound at different air temperatures.

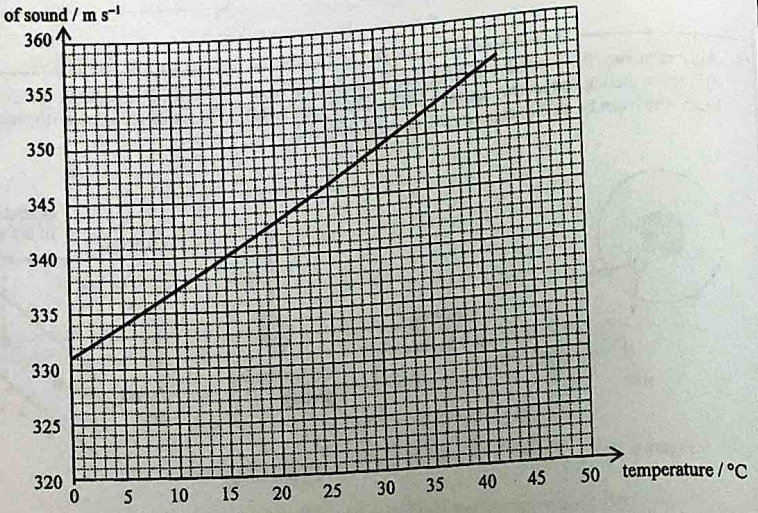


Figure 7.1

(a) With reference to the graph, state the relationship between the speed of sound and the air temperature. (1 mark)

(b) Figure 7.2 shows sound travelling from a distant tower clock to an observer at night when the ground cools.

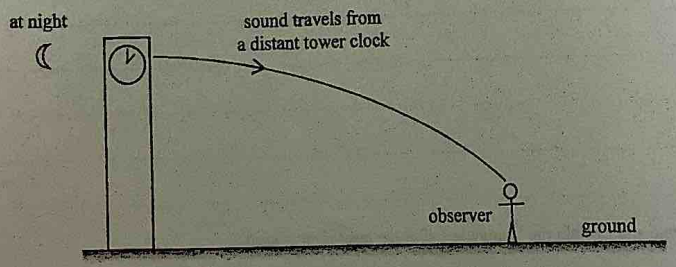


Figure 7.2

How does the temperature difference between air layers above the ground explain the situation in Figure 7.2 ? (2 marks)

(c) It is known that the air temperature is 10 °C. Referring to the graph in Figure 7.1:

(i) estimate the ratio of speed of light to the speed of sound; (1 mark)

(ii) estimate the distance of a thunderstorm from an observer *O* if thunder is heard 3.0 s after lightning is seen by *O*. (2 marks)

Please stick the barcode label here.

8. Figure 8.1 shows a pencil in a glass of water with an observer viewing vertically downwards. Given that the refractive index of water is 1.33.

Figure 8.1

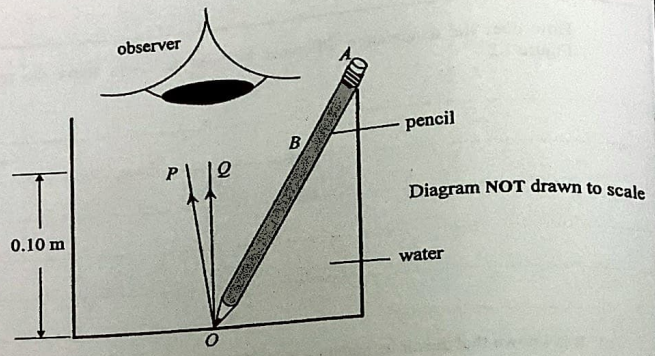


Diagram NOT drawn to scale

Light rays P and Q come from the tip O of the pencil, with Q along the vertical.

(a) On Figure 8.1, complete the paths of these light rays and indicate the image of O seen by the observer (label this as I). (2 marks)

(b) The angle between ray P and ray Q is 1.5°. Find the angle of refraction of ray P. (2 marks)

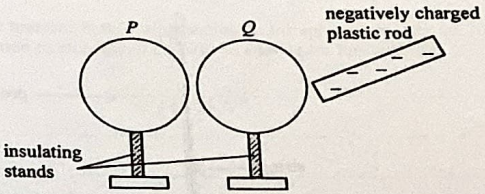
(c) Hence, or otherwise, find the distance between image I and the water surface if the depth of water is 0.10 m. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

9. Figure 9.1 shows two identical conducting light spheres P and Q placed close to each other without touching.

Figure 9.1



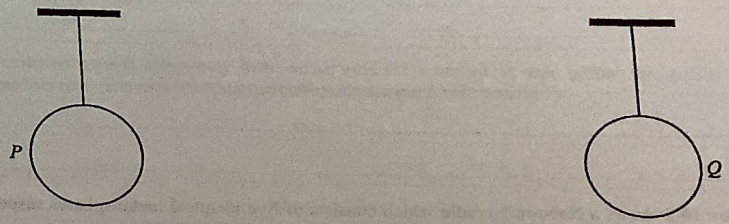
Both spheres are uncharged initially. A negatively charged plastic rod is brought close to Q but without touching the sphere.

(a) On Figure 9.1, sketch the distribution of charges on P and on Q. (2 marks)

A student touches sphere P momentarily with his finger while the plastic rod is in the position as shown. The plastic rod is removed afterwards.

(b) Explain whether the amount of charges on the plastic rod would decrease. (2 marks)

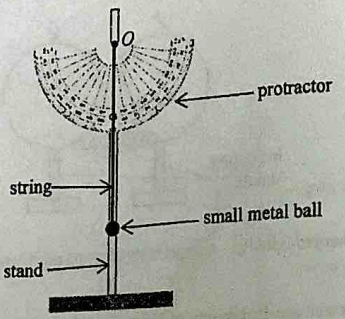
(c) The two light spheres are now suspended by nylon threads from fixed supports such that the spheres are far apart from each other. Explain how you would use one of the spheres to test for the unknown polarity of another charged rod. (2 marks)



Answers written in the margins will not be marked.

10. (a) As shown in Figure 10.1, one end of an inextensible string is attached to a small metal ball while its upper end O is fixed to a stand. A protractor is fixed onto the stand behind the string.

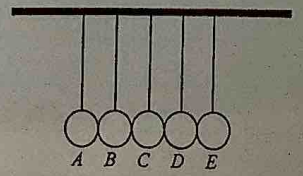
Figure 10.1



Write down the steps that you would take to demonstrate the conservation of energy using the set-up given. (4 marks)

(b) Figure 10.2 shows a Newton's cradle which consists of five identical metal spheres suspended in a row by inextensible light strings of equal length from a fixed horizontal support.

Figure 10.2



Answers written in the margins will not be marked.

Sphere A and B together are displaced slightly to the left and then released from rest. Just after collision, both A and B come to rest while sphere D and E swing together to the right slightly. Neglect air resistance.

(i) (I) Even though the tensions in the strings acting on the spheres are external forces, explain why the law of conservation of momentum can still be applied for this collision. (1 mark)

(II) Suppose that only one sphere (E) swings to the right with speed v_E just after collision. By finding v_E and hence explain why it is not possible for **only one sphere** to swing to the right. Given that the speed of sphere A and B just before collision is 0.50 m s^{-1}. The mass of each sphere is 0.020 kg. (3 marks)

(ii) The collision repeats alternately from either side for a period of time before the system eventually returns to a rest. Discuss whether the collisions are **perfectly elastic**. (2 marks)

Answers written in the margins will not be marked.

11. Read the following passage about **deformation sensors** and answer the questions that follow.

Figure 11.1(a) shows a simple sensing device consisting of a thin, flat rectangular metal foil attached to a plastic backing plate. When this foil, length l and width w, is stretched to deform as shown in Figure 11.1(b), its resistance will change.

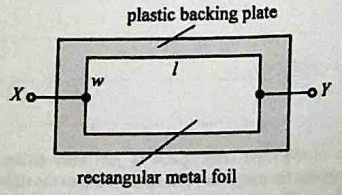


Figure 11.1(a)

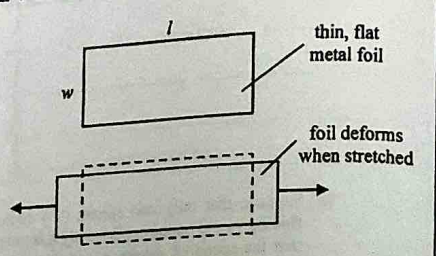


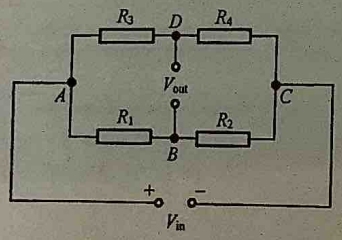
Figure 11.1(b)

When this device is connected to a suitable circuit, it can serve as a sensor to monitor deformation which results in a change in parameters of the circuit (such as voltage).

(a) Referring to Figure 11.1(a) and (b), state and explain how the metal foil's resistance across XY changes when the foil is stretched. Assume that the thickness and resistivity of the foil remain unchanged. (2 marks)

(b) Figure 11.2 shows a circuit with four resistors of resistance R_1, R_2, R_3 and R_4 connected to an input voltage V_{in}. V_{out} is the voltage across DB.

Figure 11.2



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Answers written in the margins will not be marked.

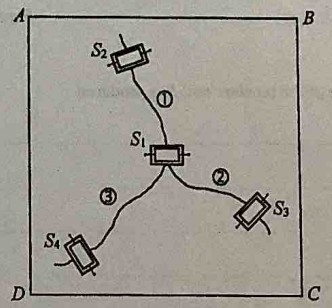
(i) Current I_1 flows through branch ABC. Write an equation relating V_{in}, I_1, R_1 and R_2. (1 mark)

(ii) R_4 in the circuit is the sensing device described in the passage, with unstretched resistance 500 Ω. Find the corresponding percentage change in V_{out}/V_{in} when R_4 increases 0.2% (i.e. becomes 501 Ω).

Given: $\frac{V_{out}}{V_{in}} = \frac{R_4}{R_3 + R_4} - \frac{R_2}{R_1 + R_2}$; $R_1 = R_2 = R_3 = 470\ \Omega$. (2 marks)

(iii) Sensing devices S_1, S_2, S_3 and S_4 connected to a suitable circuit are attached to ceiling $ABCD$ as shown in Figure 11.3 in order to monitor the growth of the cracks ①, ② and ③. After a few weeks, the extent of deformation detected is in the order $S_1 > S_2 > S_3 > S_4$.

Figure 11.3



(I) Deduce which crack (①, ② or ③) has grown the most. (1 mark)

(II) Deduce the most probable stretching direction (AB, BC or AC) along the ceiling. (1 mark)

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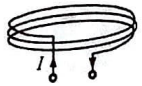
Answers written in the margins will not be marked.

12. Figure 12.1 shows a coil of several turns.

Figure 12.1



(a) Sketch the magnetic field pattern produced by the coil when it carries a current I as shown. (2 marks)

(b) As shown in Figure 12.2(a), this coil is now connected to an a.c. source to serve as a transmitter coil (T). A receiver coil (R) connected to a CRO is placed directly above T. The time variation of the voltage of coil R is displayed on the CRO (Figure 12.2(b)).

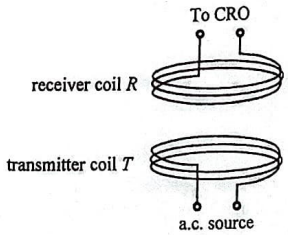


Figure 12.2(a)

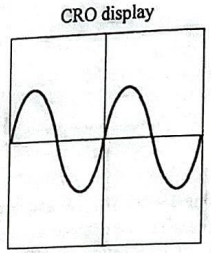


Figure 12.2(b)

(i) Explain how the voltage of the receiver coil R is produced. (2 marks)

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*(ii) On Figure 12.2(b), sketch the CRO display when the frequency of the a.c. source is doubled. (2 marks)

Answers written in the margins will not be marked.

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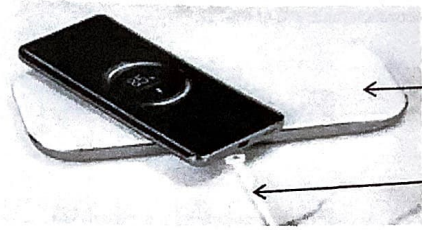
(c) A mobile phone with a receiver coil inside can be charged wirelessly by placing it on a charging pad equipped with a built-in transmitter coil, which is connected to a power source.



Explain why wirelessly charging of phones need phone cases with non-metallic back covers. (2 marks)

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Answers written in the margins will not be marked.

13. Radon (Rn-222) is a radioactive gas with no colour, no smell and no taste. It is released from bedrock material underground or from concrete composed of granite. Rn-222 decays with a half-life of 3.82 days by giving out α particles. (2 marks)

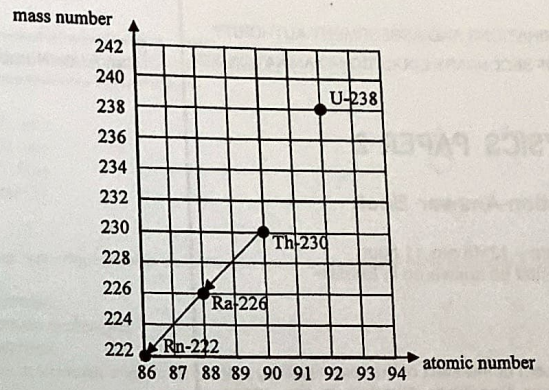
(a) *(i) Find the decay constant (unit: s^{-1}) of Rn-222.

(ii) Inside buildings, the average activity due to radon in 1 m^3 of air is about 48 Bq. Estimate the average number of radon atoms in 1 m^3 of air inside buildings. (2 marks)

(iii) Why is indoor radon considered harmful to human although α particles have limited penetrating power ? (2 marks)

Answers written in the margins will not be marked.

(b) Rn-222 belongs to a decay series starting from uranium-238 (U-238). It is known that U-238 undergoes decay in the sequence α-β-β-α to become thorium-230 (Th-230). Complete the decay series below from U-238 to Th-230 using arrows. (2 marks)



END OF PAPER

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

Answers written in the margins will not be marked.