HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2017

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 the Question-Answer Book 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

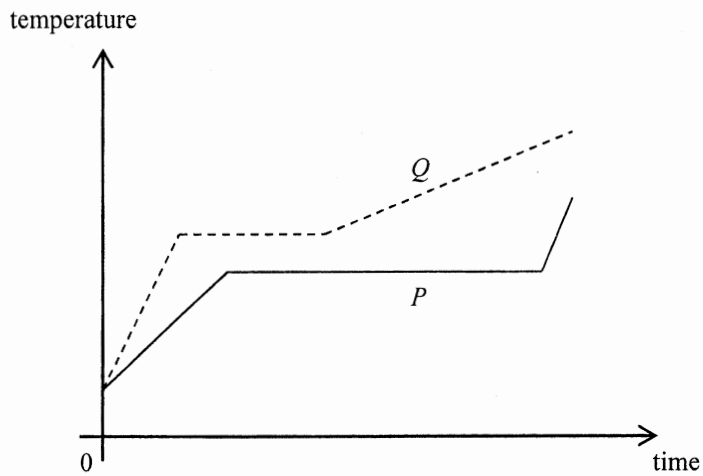
Section A

There are 33 questions. Questions marked with * involve knowledge of the extension component.

1. 30 g of milk at 10°C is added to 120 g of coffee at 80°C. Assuming there is no heat loss to the surroundings, what is the final temperature of the mixture ?
Given: specific heat capacity of milk = 3800 J kg^{-1} $°C^{-1}$
specific heat capacity of coffee = 4200 J kg^{-1} $°C^{-1}$

A. 64.8°C
B. 65.2°C
C. 66.0°C
D. 67.1°C

2. Same mass of solids *P* and *Q* are heated at the same rate. The temperature-time graphs of the two substances are shown below.



Which of the following comparisons about their melting points and specific latent heats of fusion is correct ?

	higher melting point	**larger specific latent heat of fusion**
A.	*P*	*P*
B.	*P*	*Q*
C.	*Q*	*P*
D.	*Q*	*Q*

3. Which of the following statements about the internal energy of a substance are correct ?

(1) When a solid melts, the latent heat of fusion absorbed becomes potential energy of the molecules in the substance.
(2) When a vapour condenses, its internal energy decreases.
(3) When a liquid evaporates, the internal energy of the remaining liquid increases.

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

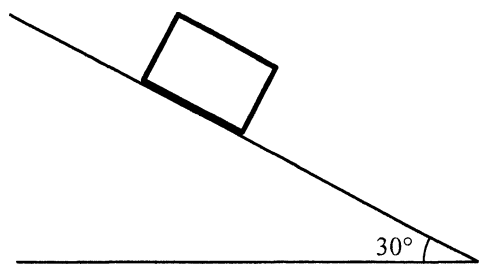
*4. The pressure of a fixed mass of an ideal gas at 10°C is 2×10^5 N m^{-2}. If the volume of the gas is reduced to half of its original volume and its temperature is increased to 100°C, what would the pressure be ?

A. 1.00×10^5 N m^{-2}
B. 1.32×10^5 N m^{-2}
C. 4.00×10^5 N m^{-2}
D. 5.27×10^5 N m^{-2}

5. Which of the following statements about the motion of any two objects is correct ?

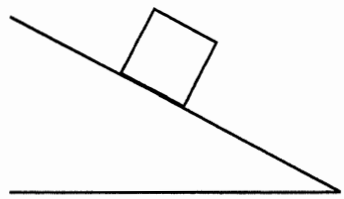
A. The object that takes a shorter time to complete the same path must have greater average speed.
B. The object that travels a greater distance in 1 s must have greater average velocity.
C. The object with greater velocity must have greater acceleration.
D. If the two objects have the same acceleration, they must be moving in the same direction.

6. A block is released from rest on an inclined plane as shown. The inclined plane makes an angle of 30° to the horizontal. The block moves with uniform acceleration, and travels a distance of 1 m in the first 3 s. Determine the acceleration of the block.



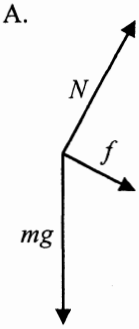
A. 0.22 m s^{-2}
B. 0.33 m s^{-2}
C. 4.91 m s^{-2}
D. Cannot be determined as the frictional force acting on the block is unknown.

7. A block of mass m stays at rest on a rough inclined plane as shown.

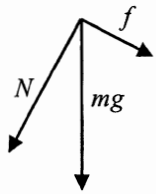


Which of the following diagrams correctly shows the forces acting on the block ?
(N is the normal reaction from the inclined plane, and f is the frictional force between the block and the plane.)

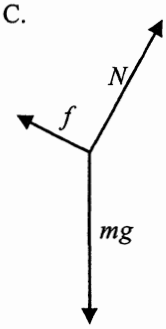
A.



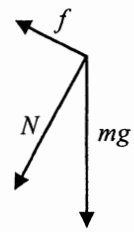
B.



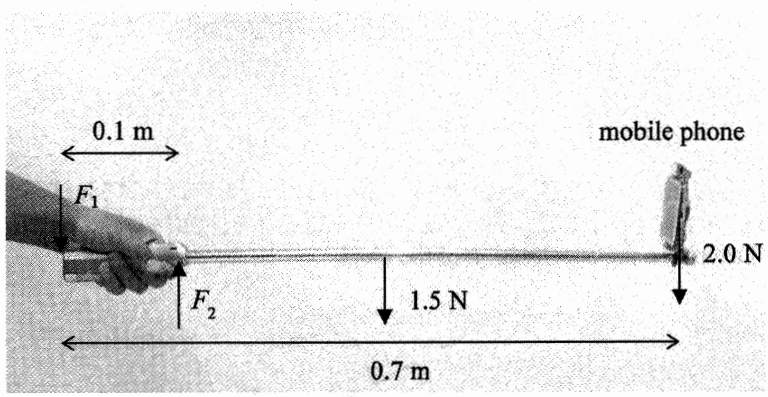
C.



D.



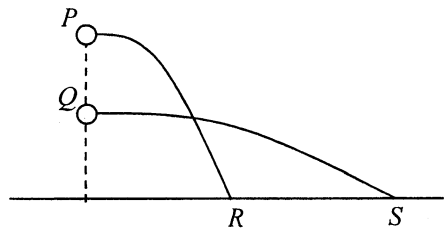
8. Selfie sticks are popular nowadays. A uniform selfie stick of length 0.7 m is held horizontally as shown. Assume that the forces required to hold the selfie stick by the hand are represented by F_1 and F_2 , and F_1 and F_2 are perpendicular to the stick.



It is given that the weight of the selfie stick and the mobile phone are 1.5 N and 2.0 N respectively. Taking the mobile phone as a point mass, estimate the magnitude of F_2 .

A. 3.5 N
B. 19.3 N
C. 35 N
D. Cannot be determined as F_1 is unknown.

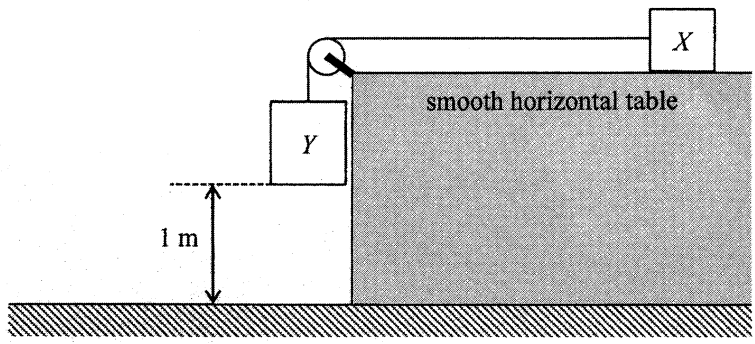
*9. Marbles P and Q of the same mass are shot horizontally. They hit the horizontal ground at points R and S respectively as shown. Neglect air resistance.



Which of the following statements is **INCORRECT** ?

A. The initial speed of marble P is smaller than that of marble Q.
B. The time of flight of marble P is shorter than that of marble Q.
C. The potential energy loss of marble P is greater than that of marble Q.
D. The acceleration of marbles P and Q is the same during the flight.

10. Blocks X and Y are connected by a light inextensible string passing over a fixed frictionless light pulley as shown. The mass of X and Y are 0.5 kg and 1 kg respectively. Initially, Y is 1 m above the ground and the string is taut. The system is then released from rest.

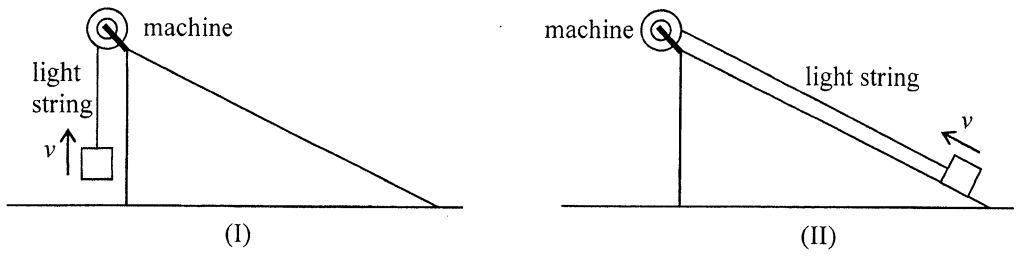


What is the speed of Y just before it reaches the ground ? (Take $g = 9.81\ m\ s^{-2}$)

A. $3.62\ m\ s^{-1}$
B. $4.43\ m\ s^{-1}$
C. $6.26\ m\ s^{-1}$
D. $9.81\ m\ s^{-1}$

11. A machine is fixed at the top of a smooth inclined plane. Two methods, (I) and (II), are used to lift a block from the ground to the top of the inclined plane by the machine.

(I) Pull the block vertically upward at a uniform speed v.
(II) Pull the block up along the inclined plane at the same uniform speed v.



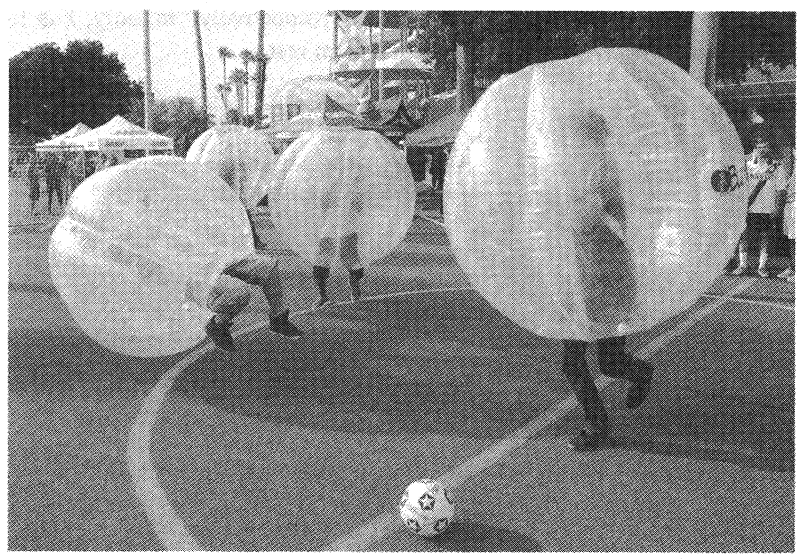
(I) (II)

Which of the following statements correctly compare(s) the two methods ?

(1) The tension in the string is the same.
(2) The average output power of the machine is the same.
(3) The work done by the machine on the block is the same.

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

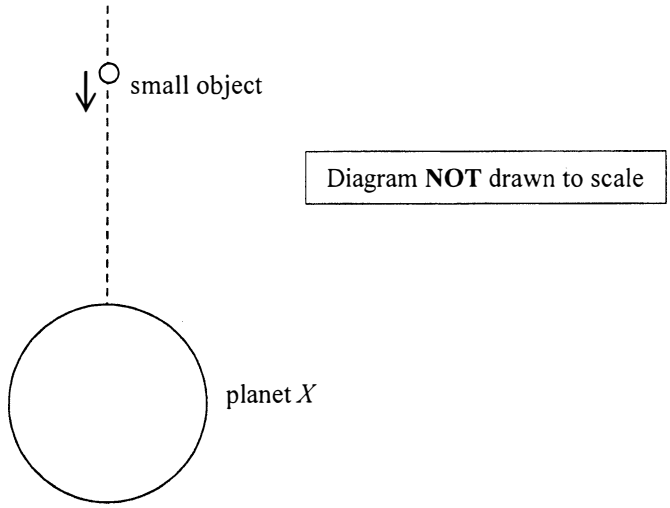
12. Players of "bubble soccer" wear air-filled plastic "bubbles" as shown.



Which of the following statements best explains why the bubble can reduce the chance of injury during a collision ?

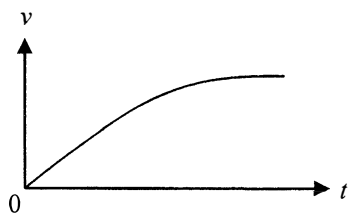
A. The bubble increases the mass of the player, thus the momentum of the player increases.
B. The bubble increases the air resistance acting on the player.
C. The bubble lengthens the impact time during a collision.
D. Like a balloon, the bubble provides a lifting force to the player.

*13. A small object is released from rest at a point very far away from a planet X. The object then starts moving towards X. X does not have an atmosphere. Neglect the effect of other celestial bodies.

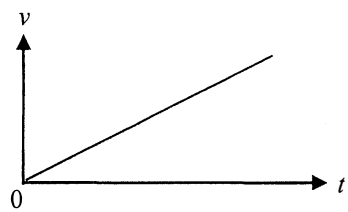


Which of the following graphs best shows the variation of the velocity v of the object with time t before it hits X?

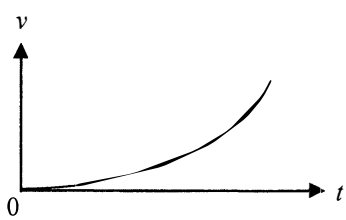
A.



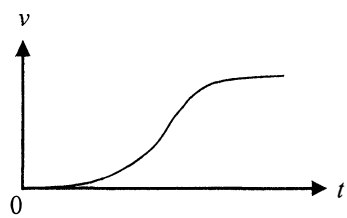
B.



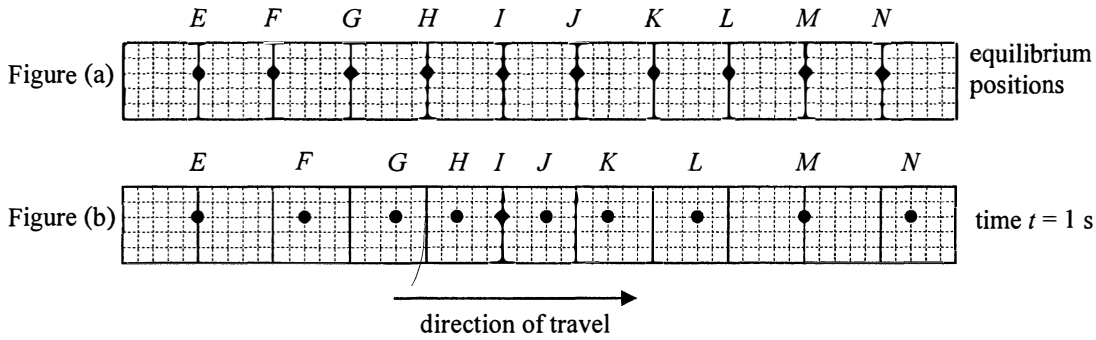
C.



D.



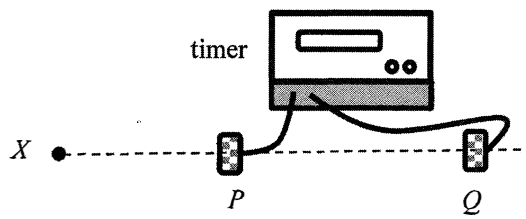
14. Figure (a) shows the equilibrium positions of particles E to N in a medium. At time t = 0, a longitudinal wave starts travelling from left to right. At time t = 1 s, the positions of the particles are shown in Figure (b).



Which of the following statements **MUST BE** correct ?

A. The distance between particles F and N is equal to the wavelength of the wave.
B. The period of the wave is 1 s.
C. Particle E is always at rest.
D. Particle I is momentarily at rest at t = 1 s.

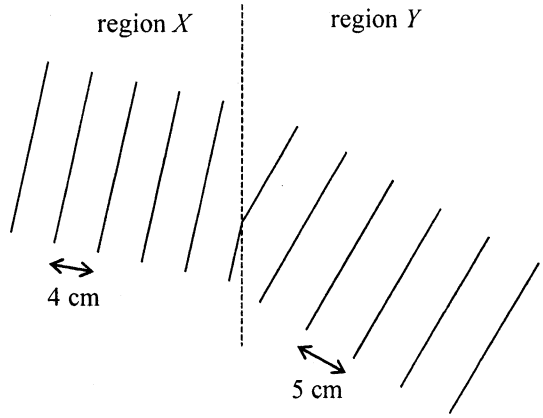
15. An experiment is set up to measure the speed of sound in air as shown. P and Q are two microphones connected to a timer. A sound is produced at X. The timer starts when P receives the sound, and stops when Q receives the sound. The timer shows the time taken for the sound to travel from P to Q. The distance PQ and the time shown can be used to calculate the speed of sound.



Which of the following statements is **INCORRECT** ?

A. X, P and Q must be along the same straight line.
B. The percentage error in the time measured will increase if the distance PQ is reduced.
C. The speed of sound determined should be independent of the distance between X and P.
D. The distance PQ must be equal to an integral multiple of wavelengths of the sound produced at X.

16. The figure shows plane water waves travelling from region X to region Y. The wavelengths of the water waves in regions X and Y are 4 cm and 5 cm respectively.



Which of the following statements is correct ?

A. The speed of the water waves in region X is higher than that in region Y.
B. The direction of travel of the water waves bends towards the normal as they enter region Y.
C. The frequency of the water waves is the same in both regions.
D. If plane water waves of wavelength 5 cm travel from region Y to region X, the wavelength becomes 6 cm after the waves enter region X.

17. In which of the following situations **MUST** the direction of travel of a wave change ?

(1) when a wave is reflected by a barrier
(2) when a wave enters from one medium to another medium
(3) when a wave travels through a gap smaller than its wavelength

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

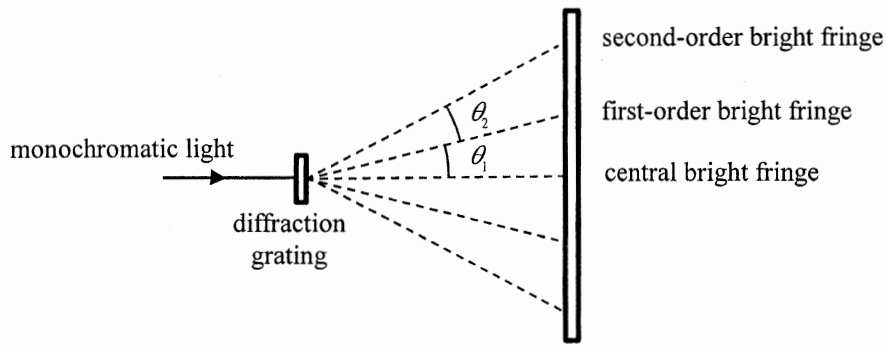
18. Two musical notes of the same pitch and loudness are produced by two different musical instruments. They sound different to the human ears because they have different

A. amplitudes.
B. phases.
C. wave speeds.
D. waveforms.

*19. When an object is placed 30 cm in front of a concave lens, an image is formed 20 cm away from the lens. If the concave lens is replaced by a convex lens of the same focal length and the object distance remains unchanged, which of the following descriptions about the image formed is correct ?

	nature of the image	**image distance**
A.	real	20 cm
B.	real	60 cm
C.	virtual	20 cm
D.	virtual	60 cm

*20. The figure below shows some of the bright fringes formed when monochromatic light passes through a diffraction grating.



Which of the following is/are correct ?

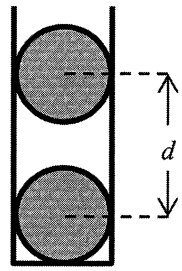
(1) $\theta_1 = \theta_2$
(2) The maximum order of bright fringe is 4 if $\theta_1 = 20°$.
(3) θ_1 will decrease if the experiment is performed in water but not in air.

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

21. If the speed of sound in water is x and the speed of light in water is y, which of the following is correct ?

	speed of sound in air	**speed of light in air**
A.	$> x$	$> y$
B.	$> x$	$< y$
C.	$< x$	$> y$
D.	$< x$	$< y$

22. In the figure, two charged conducting spheres of the same mass m are put in a vertical plastic cylinder. The inner wall of the cylinder is smooth. The spheres are separated by a distance d and remain in equilibrium.

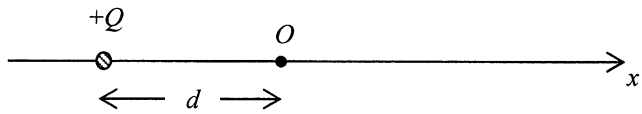


Which of the following statements **MUST BE** correct ?

(1) Both spheres carry positive charges.
(2) The amount of charges on the two spheres is the same.
(3) The separation d depends on m.

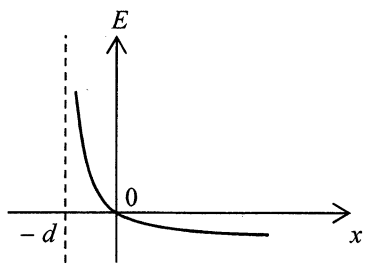
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

*23. A point charge $+Q$ is fixed at a distance d away from the origin O as shown.

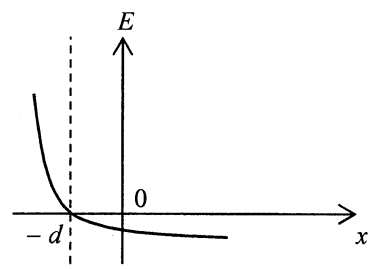


Which of the following graphs best represents the variation of the electric field strength E along the x-axis ? (Take the electric field pointing to the right as positive.)

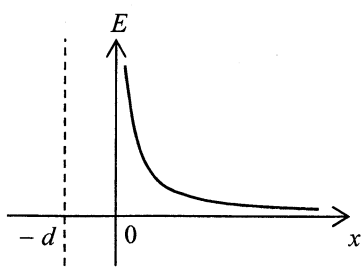
A.



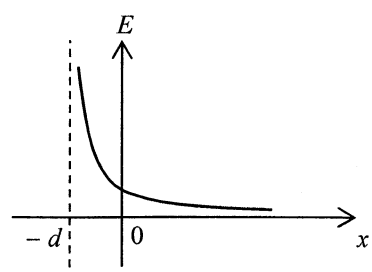
B.



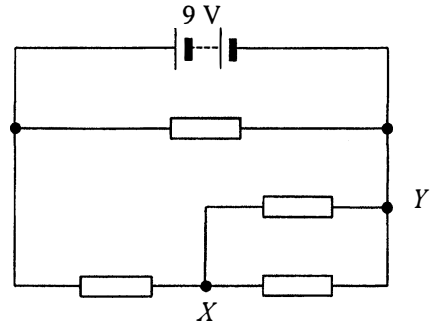
C.



D.



24. In the circuit, all resistors are identical. The internal resistance of the battery can be neglected.



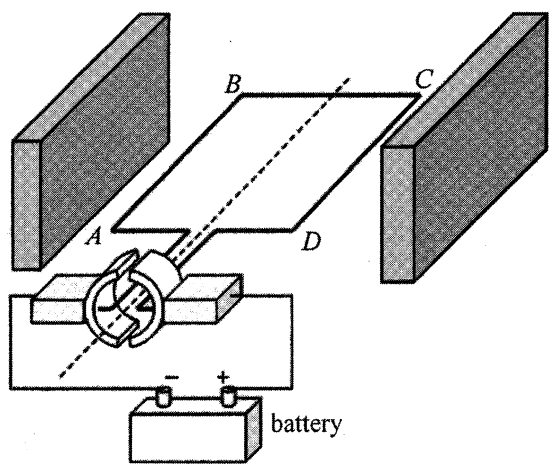
What is the potential difference between X and Y ?

A. 1.5 V
B. 3.0 V
C. 4.5 V
D. 6.0 V

25. Which of the following statements about the use of a fuse is correct ?

A. A fuse should be installed in the neutral wire.
B. A fuse is not required in an electrical appliance with double insulation.
C. A 5A fuse is suitable for a heater of rating '220 V, 1500 W'.
D. The melting point of a fuse should be lower than that of copper.

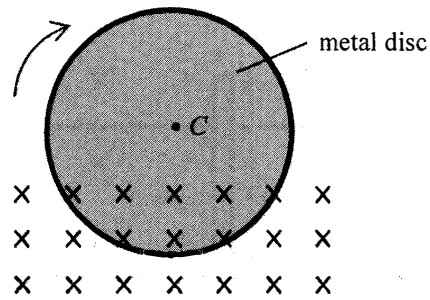
26. The figure shows a simple d.c. motor, the coil $ABCD$ is mounted between the poles of two slab-shaped magnets.



Which of the following statements is correct ?

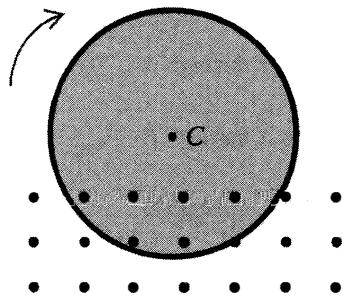
A. The turning effect is zero when the coil is vertical.
B. The magnetic force acting on BC is the greatest when the coil is horizontal.
C. The direction of the magnetic force acting on AB remains constant.
D. The direction of the current in the coil remains unchanged.

27. A metal disc is rotating about its centre C with constant speed. Part of the metal disc is inside a uniform magnetic field pointing into the paper as shown. An eddy current flows in the metal disc.

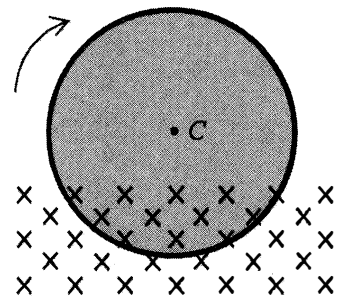


After which of the following changes will the eddy current increase ?

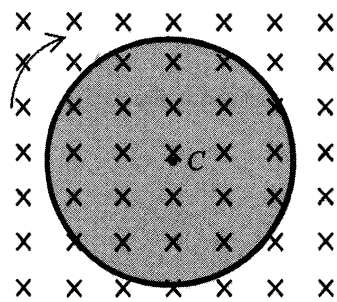
A. Reverse the direction of the magnetic field



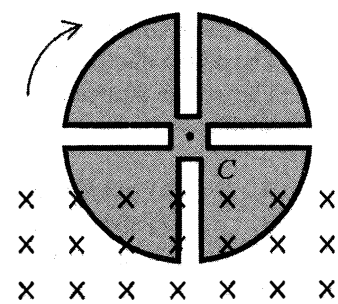
B. Increase the strength of the magnetic field



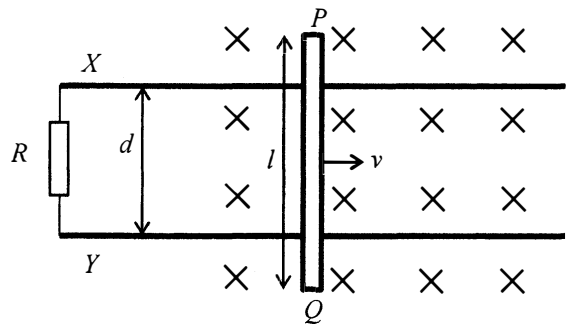
C. Apply the magnetic field over the whole metal disc



D. Cut several slits from the metal disc



*28. A metal rod PQ of length l is moving along smooth horizontal metal rails X and Y with constant speed v in a uniform magnetic field of magnetic field strength B pointing into the paper. The metal rails X and Y are separated by a distance of d and are connected to a resistor of resistance R as shown.



Which of the following descriptions about the induced current is correct ?

	magnitude	**direction**
A.	$\frac{Blv}{R}$	from X to Y through R
B.	$\frac{Blv}{R}$	from Y to X through R
C.	$\frac{Bdv}{R}$	from X to Y through R
D.	$\frac{Bdv}{R}$	from Y to X through R

*29. A heater of resistance 100 Ω is connected to the mains supply. The r.m.s. voltage of the mains supply is 110 V. Which of the following statements are correct ?

(1) The peak voltage across the heater is 156 V.
(2) The power dissipated by the heater is 121 W.
(3) The power dissipated by the heater will be doubled if the r.m.s. voltage of the mains supply doubles.

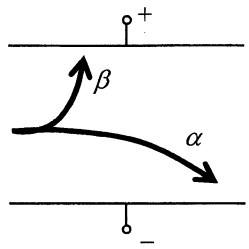
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

*30. The input terminal of a transformer is connected to the 220 V mains supply. Ten identical light bulbs are connected in parallel to the output terminal of the transformer. All the light bulbs are working at their rated values of '3 V, 1.5 W'. If the efficiency of the transformer is 70%, what is the current drawn from the mains supply ?

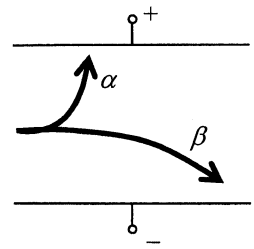
A. 0.007 A
B. 0.048 A
C. 0.068 A
D. 0.097 A

31. Which of the following diagrams best shows the deflection of α and β particles in a uniform electric field in vacuum ?

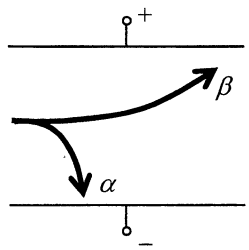
A.



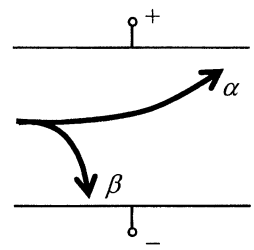
B.



C.



D.



32. Which of the following statements about β particles and γ rays is correct ?

A. Only β particles can ionize air particles.
B. Only γ rays can travel through vacuum.
C. Both of them can be detected by a photographic film.
D. Both of them carry charge.

*33. The following shows the decay of uranium-238 ($^{238}_{92}U$).

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

Given that : mass of $^{238}_{92}U = 238.05079$ u
mass of $^{234}_{90}Th = 234.04363$ u
mass of $^{4}_{2}He = 4.00260$ u

Which of the following statements is/are correct ?

(1) The temperature required to start the decay is about 10^7 K.
(2) The energy released in the decay of one uranium-238 nucleus is 4.25 MeV.
(3) All the energy released in the decay becomes the kinetic energy of $^{4}_{2}He$.

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

END OF SECTION A

2017-DSE
PHY
PAPER 1B

B

Please stick the barcode label here.

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2017

Candidate Number									

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.

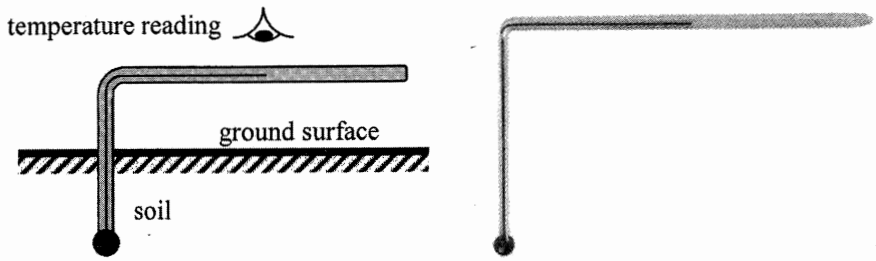
Question No.	Marks
1	**7**
2	**5**
3	**4**
4	**10**
5	**8**
6	**10**
7	**11**
8	**12**
9	**10**
10	**7**

Section B: Answer **ALL** questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

1. Read the following passage about **soil thermometer** and answer the questions that follow.

The temperature of soil changes with depth, and this information is important to farmers and scientists. To measure soil temperatures at depths close to the ground surface, the bulb of a thermometer is buried in the soil. The stem of the thermometer is bent 90° for easy reading. Figure 1.1a is a schematic diagram and Figure 1.1b shows a photo of a soil thermometer.

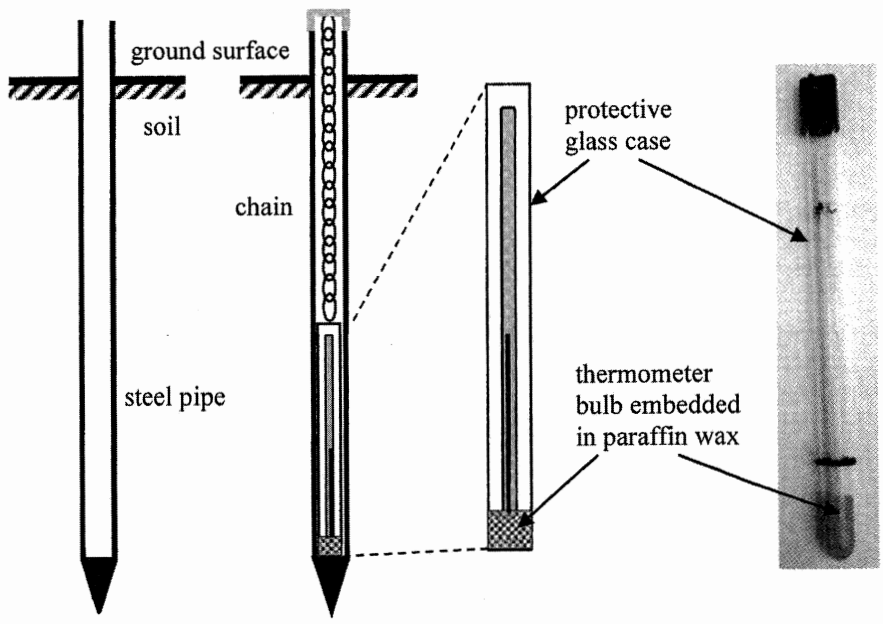
Figure 1.1



(a) (b)

For depths greater than 30 cm, a steel pipe is driven into the soil (Figure 1.2a); and a liquid-in-glass thermometer with a protective glass case is lowered into the steel pipe (Figure 1.2b). The bulb of the thermometer is embedded in paraffin wax (Figure 1.2c). To read the temperature, the thermometer is lifted out of the steel pipe by pulling the chain.

Figure 1.2



(a) (b) (c)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

(a) As shown in Figure 1.1b, the bulb of the soil thermometer is very large compared to those of common thermometers. Suggest a reason for this design. (1 mark)

.....

.....

(b) On a certain morning, the air temperature is 15°C. An observer takes a measurement of the soil temperature at 1 m deep. The thermometer reading is 20°C. It is given that the mass of the paraffin wax enclosing the thermometer bulb is 0.015 kg, and the specific heat capacity of paraffin wax is 2.9×10^3 J kg^{-1} °C^{-1}.

(i) Calculate the energy loss of the paraffin wax as it cools down to the air temperature. (2 marks)

.....

.....

.....

.....

.....

.....

(ii) It is known that the paraffin wax enclosing the bulb of the thermometer gains or loses energy at a constant rate of 0.5 J s^{-1}, estimate the time taken for the paraffin wax to reach the air temperature after the thermometer is lifted out of the soil. (2 marks)

.....

.....

.....

.....

.....

.....

(iii) If there is no paraffin wax enclosing the bulb of the thermometer, explain how the thermometer reading as recorded by the observer is affected. (2 marks)

.....

.....

.....

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

2. The following experimental items are provided to set up an experiment to estimate the speed of a bullet fired from an air gun.

a smooth track
a trolley
a motion sensor used to measure the speed of the trolley
some plasticine
an air gun and bullets
an electronic balance

The set-up is shown in Figure 2.1.

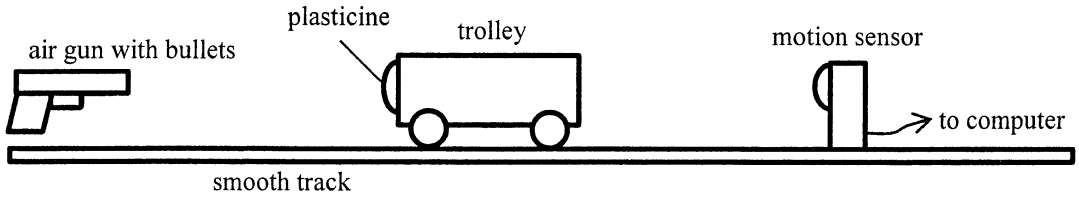


Figure 2.1

Describe the procedures of the experiment. State the physical quantities to be measured and an equation for finding the speed of the bullet. Write down **ONE** precaution for getting a more accurate result. (5 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.

*3. The average kinetic energy of one monatomic gas molecule at temperature T is given by

$$E_K = \frac{3}{2}\left(\frac{R}{N_A}\right)T,$$

where R is the universal gas constant and N_A is the Avogadro constant. A monatomic gas is heated from 300 K to 350 K under fixed volume.

(a) Estimate the ratio of the root-mean-square speed ($c_{r.m.s.}$) of the gas molecules at the two temperatures ($\frac{c_{r.m.s.}\text{ at }350\,K}{c_{r.m.s.}\text{ at }300\,K}$). (2 marks)

(b) Thus, using kinetic theory, explain why the gas pressure would increase. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

4. (a) A steel ball bearing is released from rest at time $t = 0$. A stroboscopic photo is taken at 0.05 s time intervals. The results are shown in Figure 4.1. Neglect air resistance.

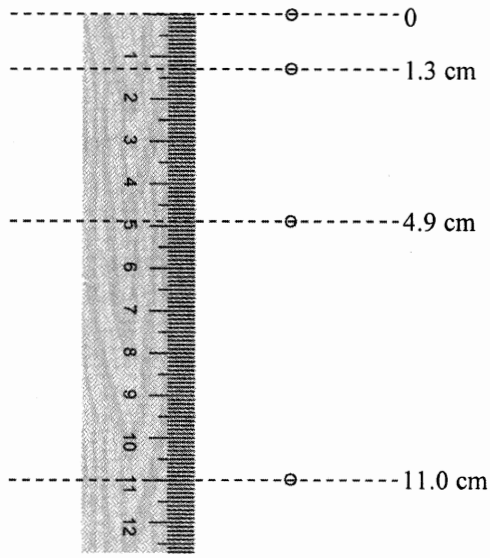


Figure 4.1

(i) Estimate the acceleration due to gravity using the data in Figure 4.1. (2 marks)

*(ii) The bearing is now projected horizontally instead of released from rest. The bearing is projected at time $t = 0$, and a stroboscopic photo is taken at 0.05 s time intervals. The first and the last image of the stroboscopic photo are shown using circles (O) in Figure 4.2. For reference, the stroboscopic photo of the bearing released from rest is also shown in the figure using crosses (×).

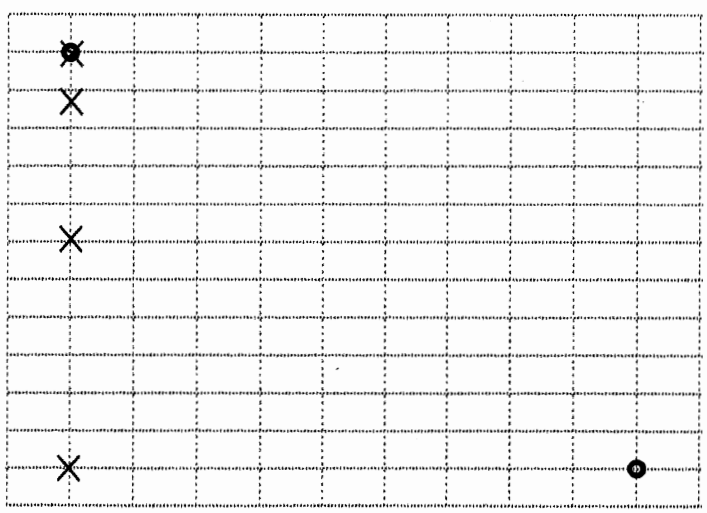


Figure 4.2

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

(1) In Figure 4.2, mark the positions of the projected bearing in the stroboscopic photo using circles (⊙). (2 marks)

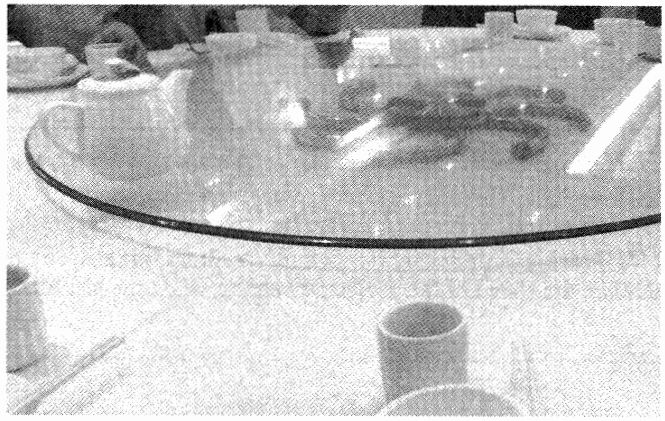
(2) Given that the bearing is projected horizontally with an initial speed of 1 m s^{-1}, use the results of (a)(i) to calculate the speed of the projected bearing when the last image was taken. (3 marks)

(b) If a small ball is released from rest from the top of a cliff, the speed of the ball becomes constant after a period of time. By considering the forces acting on the ball and using Newton's laws of motion, explain why the speed of the ball becomes constant. (3 marks)

Answers written in the margins will not be marked.

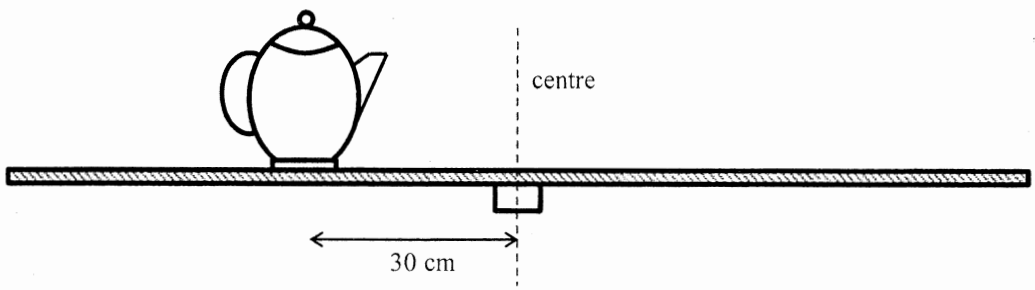
Answers written in the margins will not be marked.

*5. The photo shows a turntable commonly used in restaurants.



A teapot of mass 1 kg is put 30 cm from the centre of a horizontal turntable, Figure 5.1 shows the side view. When the turntable is rotating, the teapot remains at the same position on the turntable.

Figure 5.1



(a) On Figure 5.1, draw and label all the forces acting on the teapot when the turntable is rotating. (2 marks)

(b) Taking the teapot as a point mass, estimate the net force acting on the teapot when the turntable is rotating at a rate of 0.5 revolutions per second. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

(c) The turntable is suddenly stopped and the teapot slips. The turntable is rotating at a rate of 0.5 revolutions per second just before it stops, and the frictional force acting on the teapot is 10 N when it is slipping. Determine the distance travelled by the teapot after the turntable stops. (3 marks)

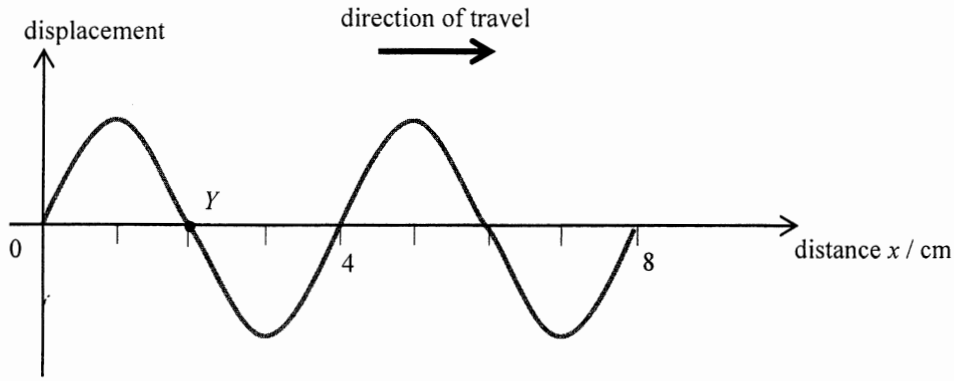
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

6. (a) A dipper vibrating with a frequency of 5 Hz is put in a water tank. Figure 6.1 shows the displacement-distance graph of the water wave at time $t = 0$. Y is a particle in the water tank.

Figure 6.1

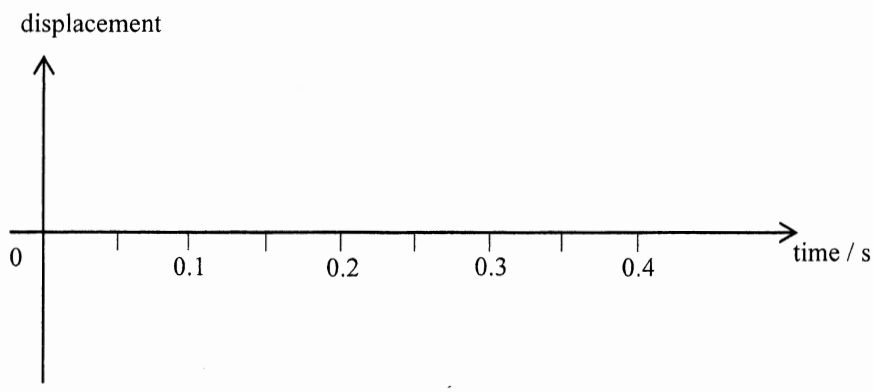


(i) Determine the wave speed of the water wave. (2 marks)

(ii) State the direction of motion of particle Y at $t = 0$. (1 mark)

(iii) Sketch the displacement-time graph of particle Y between $t = 0$ and $t = 0.4$ s in Figure 6.2. (2 marks)

Figure 6.2

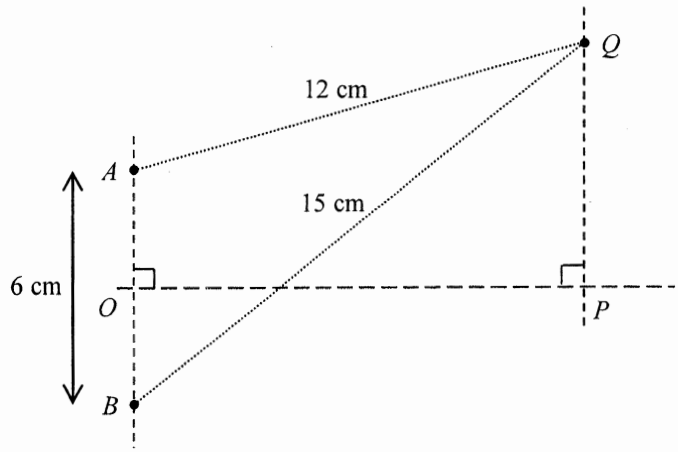


Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) In Figure 6.3, A and B are two dippers vibrating in phase in a water tank. The distance between A and B is 6 cm. OP is the perpendicular bisector of AB. Q is a second minimum from P, where AQ = 12 cm and BQ = 15 cm.

Figure 6.3

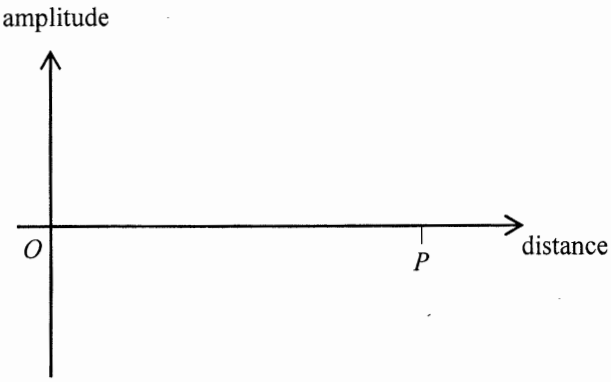


(i) Explain why a minimum occurs at Q. (2 marks)

(ii) Determine the wavelength of the water wave. (2 marks)

(iii) Sketch in Figure 6.4 how the **AMPLITUDE** of the water wave varies along the line OP. (1 mark)

Figure 6.4

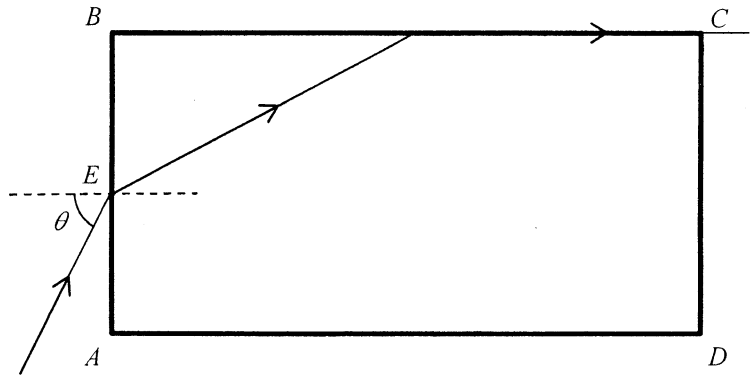


Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

7. (a) A light ray enters a rectangular plastic block $ABCD$ from air at point E, and the angle of incidence is θ. The light ray emerges along face BC as shown in Figure 7.1. The refractive index of the plastic is 1.36.

Figure 7.1



(i) Find the critical angle of the plastic. (2 marks)

(ii) Find the value of θ. (3 marks)

(iii) If the light ray enters the plastic block at point E with an angle of incidence larger than θ, sketch the path of the light ray in Figure 7.1. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) A student designs a periscope using two plastic prisms, the refractive index of the plastic is 1.36. As shown in Figure 7.2, an object is placed in front of the periscope.

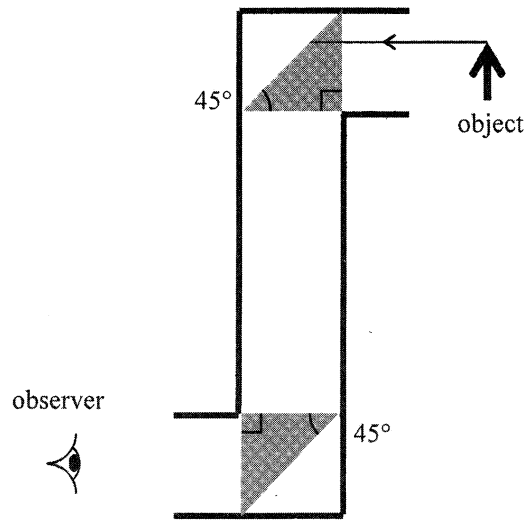


Figure 7.2

(i) Complete the path of the light ray from the object in Figure 7.2, and explain why the periscope fails to work. (3 marks)

.....

.....

.....

.....

.....

.....

(ii) What can be used to replace the two plastic prisms so that the periscope can work properly ? (1 mark)

.....

.....

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

8. A student uses the following apparatus to measure the resistance of a tungsten filament light bulb.

a battery, a switch, a variable resistor, an ammeter, a voltmeter, a light bulb

(a) Figure 8.1 shows an incomplete circuit for the experiment. The '+' symbol represents the positive terminal of the ammeter.
Use suitable circuit symbols to complete the circuit, and mark the positive terminal of the voltmeter with '+'. (3 marks)

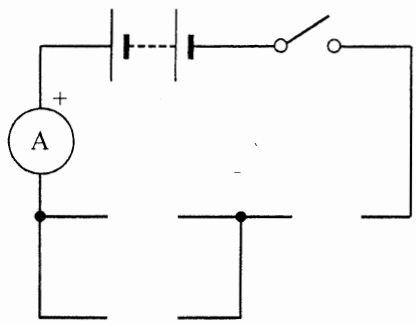


Figure 8.1

The table below and Figure 8.2 show the results obtained.

Voltage across the light bulb V / V	0	0.1	0.2	0.3	0.4	0.5	1.0	2.0	3.0
Current I / mA	0	76	112	126	133	139	170	226	273

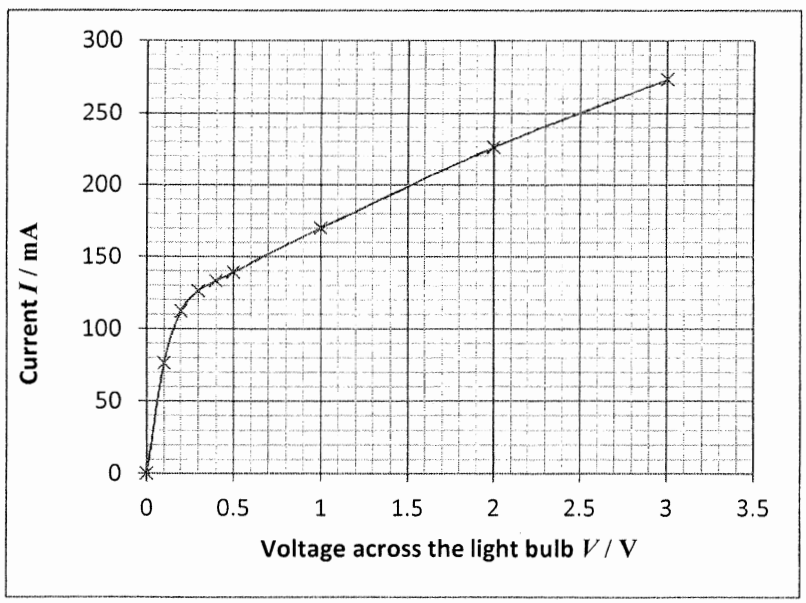


Figure 8.2

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) Briefly explain the variation of the resistance of the light bulb with the voltage across the light bulb. (2 marks)

(c) The student claims that since the resistance of the light bulb is not a constant, the equation $R = V/I$ cannot be used to calculate the resistance of the light bulb. Briefly explain why his claim is wrong. (1 mark)

(d) Determine the resistance of the light bulb at $V = 0.1$ V and 2.5 V. (3 marks)

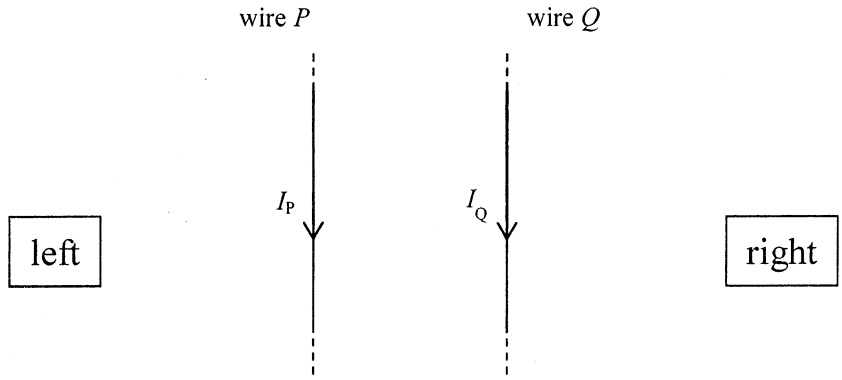
(e) It is given that the cross-sectional area of the tungsten filament in the light bulb is 1.66×10^{-9} m^2, and the resistivity of tungsten at room temperature is about 5.6×10^{-8} Ω m. Estimate the length of the tungsten filament in the light bulb using the appropriate resistance found in (d). (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

9. (a) Two long straight current carrying wires, P and Q, are parallel to each other and lie on the plane of the paper as shown in Figure 9.1. The currents in the wires, I_P and I_Q, flow in the same direction.

Figure 9.1



(i) State the direction (to the left / to the right / into the paper / out of the paper) of the magnetic field at Q due to P. (1 mark)

.....

.....

(ii) In Figure 9.1, draw the direction of the magnetic force acting on Q due to P. (1 mark)

(iii) Show that the magnitude of the magnetic force per unit length F_l acting on Q due to P is

$$F_l = \frac{\mu_o I_P I_Q}{2\pi r},$$

where μ_o is the permeability of free space and r is the separation between the two wires. (3 marks)

.....

.....

.....

.....

.....

.....

.....

.....

(iv) For the magnetic force acting on Q due to P and the magnetic force acting on P due to Q, if $I_P \neq I_Q$, briefly explain whether the two forces are equal in magnitude. (2 marks)

.....

.....

.....

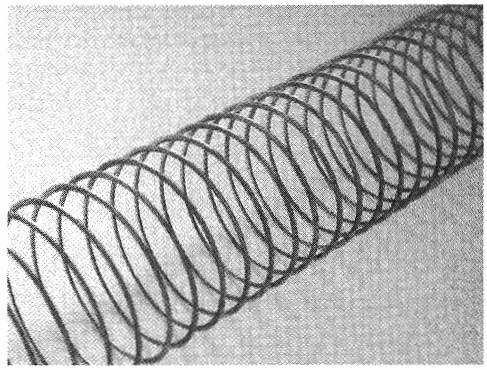
.....

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) Figure 9.2 shows a metal slinky spring.

Figure 9.2



(i) If a direct current passes through the spring, briefly explain whether the spring will be compressed or stretched due to magnetic force. (2 marks)

.....

.....

.....

.....

.....

.....

(ii) A student suggests that the spring will be compressed and stretched alternately due to magnetic force when an alternating current passes through. Briefly explain why he is wrong. (1 mark)

.....

.....

.....

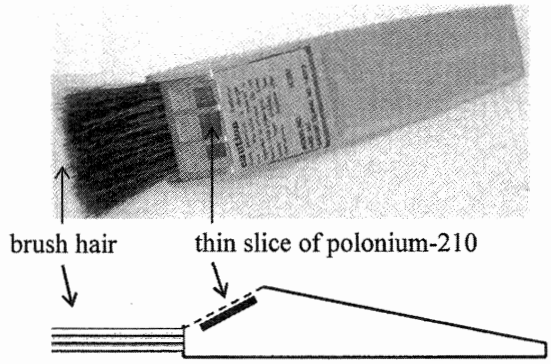
.....

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

10. Dust may adhere to the surfaces of photos and films due to electrostatic attraction. To remove the dust effectively, a special brush with a thin slice of polonium-210 ($^{210}_{84}Po$) fixed near the brush hair as shown in Figure 10.1 may be used. Polonium-210 undergoes α decay and the daughter nucleus lead (Pb) is stable.

Figure 10.1



(a) Write a nuclear equation for the decay of polonium-210. (2 marks)

(b) Briefly explain how the α particles help clean the charged dust. (2 marks)

(c) Briefly explain why the polonium-210 slice must be fixed near to the brush hair. (1 mark)

*(d) The manufacturer recommends that the brush should be returned to the factory for replacement of the polonium-210 slice every year. Taking the activity of a newly replaced polonium-210 slice as 1 unit, find its activity after one year (365 days). Given: half-life of polonium-210 is 138 days. (2 marks)

END OF PAPER

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

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

List of data, formulae and relationships

Data

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

Rectilinear motion

For uniformly accelerated motion :

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

Mathematics

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

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

Astronomy and Space Science

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

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{\kappa}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho A v^3$	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)
power $= \frac{1}{f}$	power of a lens
$L = 10\log\frac{I}{I_0}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_0 e^{-\mu x}$	transmitted intensity through a medium

A1.	$E = mc\,\Delta T$	energy transfer during heating and cooling
A2.	$E = l\,\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy

B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment $= F \times d$	moment of a force
B3.	$E_P = mgh$	gravitational potential energy
B4.	$E_K = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d\sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer

E1.	$N = N_0e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$\Delta E = \Delta mc^2$	mass-energy relationship