2012-DSE
PHY

PAPER 1A

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2012

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 60 minutes.

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

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

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

(5) The last 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.

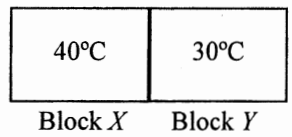
(6) No marks will be deducted for wrong answers.

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

Section A

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

1. Two metal blocks X and Y of the same mass and of initial temperatures 40°C and 30°C respectively are in good thermal contact as shown. The specific heat capacity of X is greater than that of Y. Which statement is correct when a steady state is reached ? Assume no heat loss to the surroundings.

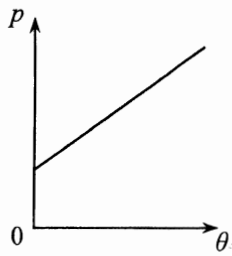


A. The temperature of block X is higher than that of block Y.
B. Their temperature becomes the same and is lower than 35°C.
C. Their temperature becomes the same and is higher than 35°C.
D. Their temperature becomes the same and is equal to 35°C.

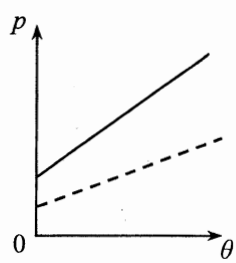
2. When a patient's arm is wiped by a piece of cotton soaked with alcohol, the wiped area will feel cool as that patch of alcohol on the skin evaporates. Which statement explains this phenomenon ?

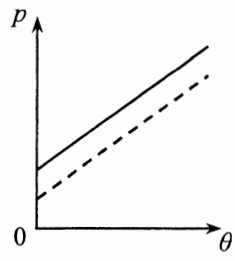
A. The evaporation of alcohol absorbs heat from the patient's arm.
B. The alcohol on the skin releases latent heat to the surrounding air.
C. The motion of all the molecules in the patch of alcohol slows down.
D. Air molecules remove heat from the patch of alcohol by conduction.

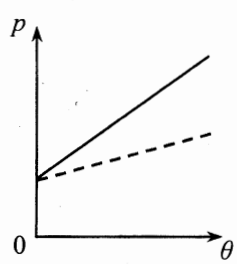
*3. An ideal gas is contained in a closed vessel of fixed volume. The graph below shows the variation of pressure p of the gas against its Celsius temperature θ.

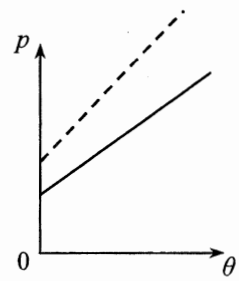


If the number of gas molecules in the vessel is halved, which graph of the dotted line best shows the relationship between p and θ ?

A.


B.


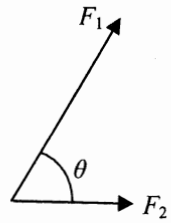
C.


D.


4. Which of the following descriptions is correct ?

A. When water at 25°C is heated to 50°C, both the kinetic energy and potential energy of the water molecules increase.
B. When water at 25°C is heated to 50°C, only the potential energy of the water molecules increases.
C. When water boils at 100°C and turns into steam, the kinetic energy of the water molecules increases.
D. When water boils at 100°C and turns into steam, the potential energy of the water molecules increases.

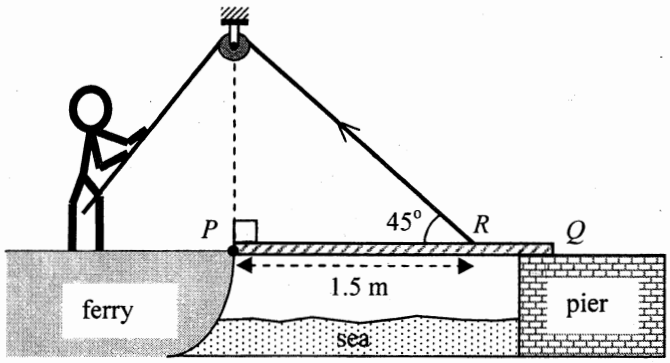
5.



Two forces F_1 and F_2 of constant magnitudes act at the same point as shown. When the angle θ between F_1 and F_2 increases from 0° to 180°, the magnitude of the resultant force

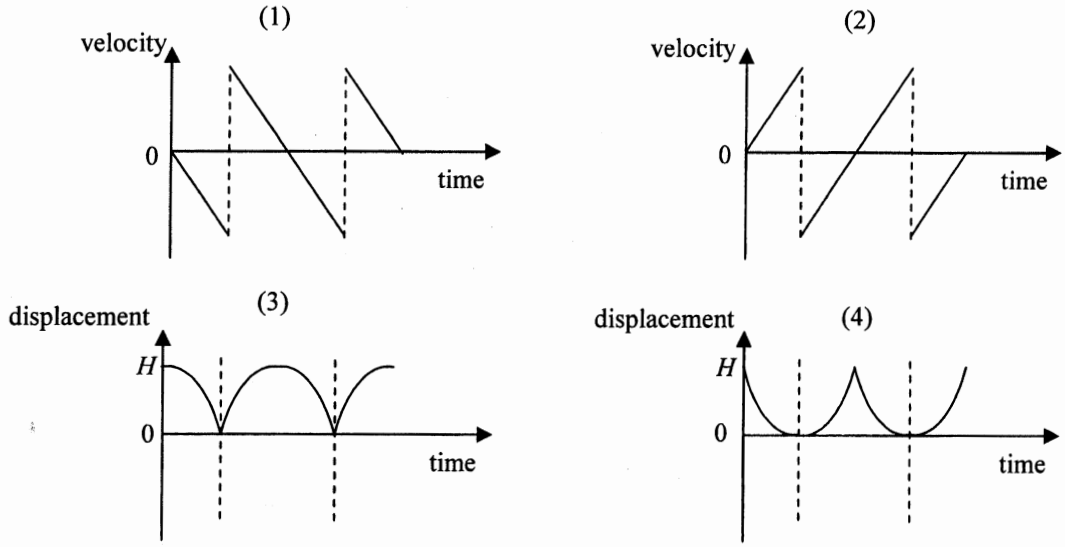
A. decreases throughout.
B. increases throughout.
C. decreases and then increases.
D. increases and then decreases.

6. A uniform gangplank PQ of a ferry smoothly hinged at end P initially rests horizontally on the pier. The gangplank has mass M and length 2 m. It is raised by a man on the ferry using a light rope passing a smooth fixed light pulley and connecting to R on the gangplank as shown. R is 1.5 m from end P. Which of the following correctly describes the force required to raise the gangplank steadily ?



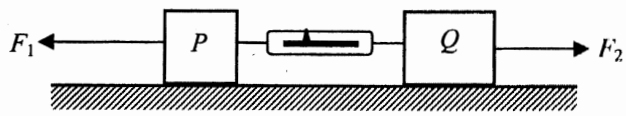
	initial force required to raise the gangplank when it is horizontal	*subsequent* force required to raise the gangplank
A.	0.67 *Mg*	greater than 0.67 *Mg*
B.	0.67 *Mg*	smaller than 0.67 *Mg*
C.	0.94 *Mg*	greater than 0.94 *Mg*
D.	0.94 *Mg*	smaller than 0.94 *Mg*

7. Which of the following graphs (velocity-time and displacement-time) best represent the motion of a ball falling from rest under gravity at a height H and bouncing back from the ground two times ? Assume that the collision with the ground is perfectly elastic and neglect air resistance. (Downward measurement is taken to be negative.)



A. (1) and (3) only
B. (1) and (4) only
C. (2) and (3) only
D. (2) and (4) only

8.



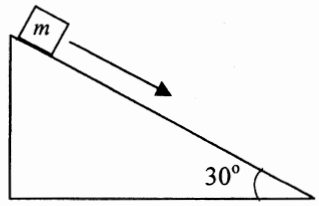
Blocks P and Q of mass m and $2m$ respectively are connected by a light spring balance and placed on a smooth horizontal surface as shown. If horizontal forces F_1 and F_2 (with $F_1 > F_2$) act on P and Q respectively and the whole system moves to the left with constant acceleration, what is the reading of the spring balance ?

A. $\frac{2F_1 - F_2}{3}$
B. $\frac{2(F_1 - F_2)}{3}$
C. $\frac{2F_1 + F_2}{3}$
D. $\frac{F_1 + 2F_2}{3}$

9. An object of mass 0.5 kg is raised vertically from the ground by a motor. The object is raised 2.5 m in 1.5 s with uniform speed. Estimate the output power of the motor. Neglect air resistance. ($g = 9.81$ m s^{-2})

A. 5.5 W
B. 8.2 W
C. 11.0 W
D. 16.4 W

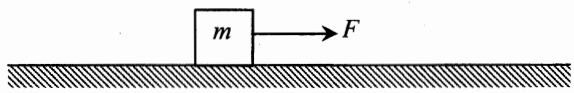
10. A block of mass m resting on a 30° incline is given a slight push and slides down the incline with a uniform speed. Which of the following statements about the block's motion on the incline is/are correct ?



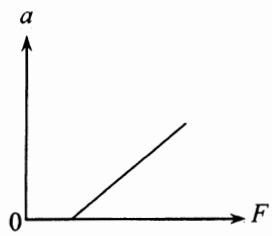
(1) There is no net force acting on the block.
(2) The frictional force acting on the block is 0.5 mg.
(3) If the block is given a greater initial speed, it will slide down the incline with acceleration.

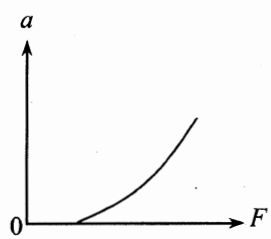
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

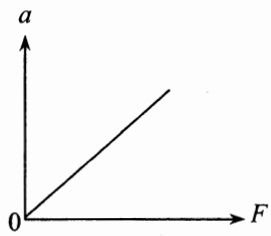
11.

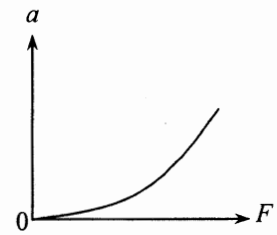


A block of mass m initially resting on a rough horizontal surface is pulled along the surface by a horizontal force F increasing from zero. If the frictional force is constant, which graph shows the relation between the acceleration of the block a and force F ?

A.


B.


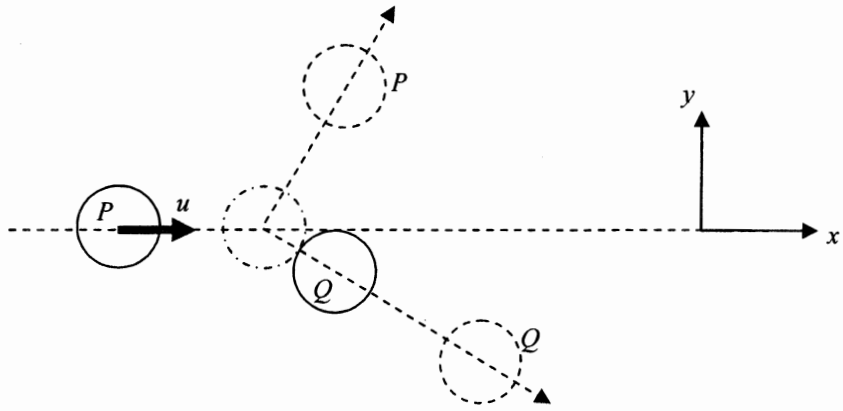
C.


D.


*12. A bomber aircraft is 1 km above the ground and is flying horizontally at a speed of 200 m s^{-1}. The aircraft is going to release a bomb to destroy a target on the ground. How long before flying over the target should the bomb be released ? Assume that the bomber aircraft and the target are in the same vertical plane and neglect air resistance. (g = 9.81 m s^{-2})

A. 5.6 s
B. 10.1 s
C. 14.3 s
D. It cannot be calculated as the horizontal distance between the aircraft and the target is not known.

13. On a smooth horizontal surface, a circular disk P moving at velocity u along the x direction collides obliquely with an identical disk Q initially at rest as shown below. The mass of each disk is m. Which statements about the collision is/are correct ?



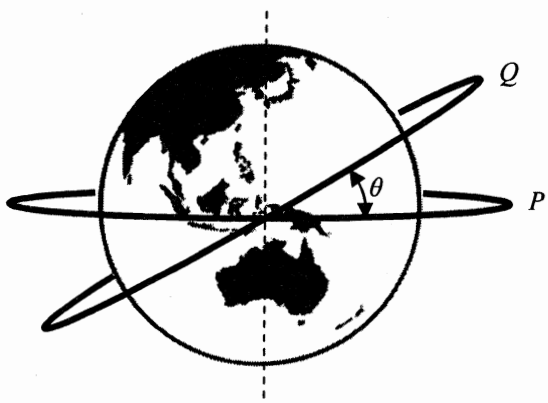
(1) Momentum of the system in the y direction is not conserved.

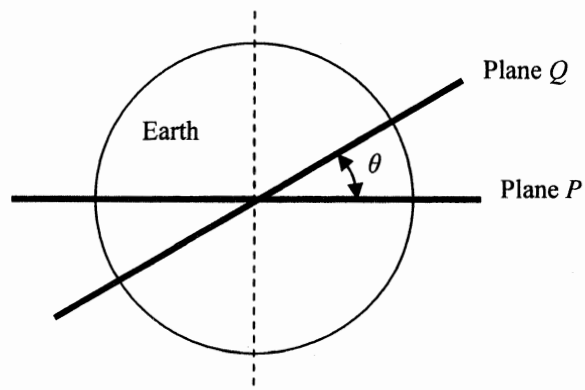
(2) The total kinetic energy of P and Q after collision is $\frac{1}{2}mu^2$ if the collision is perfectly elastic.

(3) Speed of Q after collision is less than u.

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

*14. Two satellites move in circular orbits of the same radius R around the Earth (mass M). The orbits are in two different planes P and Q as shown. Plane P coincides with the Earth's equator while plane Q is inclined to the equator at θ. Which statement is **INCORRECT** ?





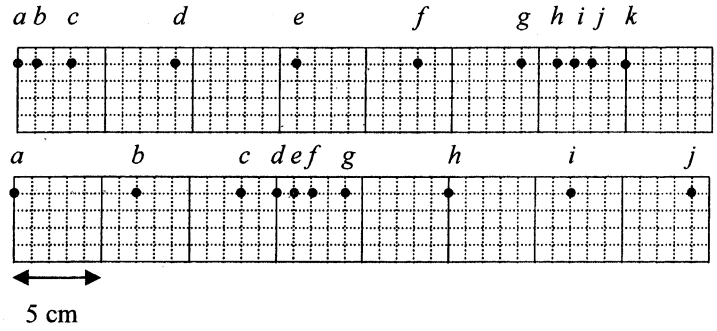
A. The speed of satellite P is $\sqrt{\frac{GM}{R}}$.

B. The centripetal force acting on satellite Q is pointing along the plane Q.

C. The acceleration of both satellites is the same in magnitude.

D. The period of satellite Q is longer than that of satellite P.

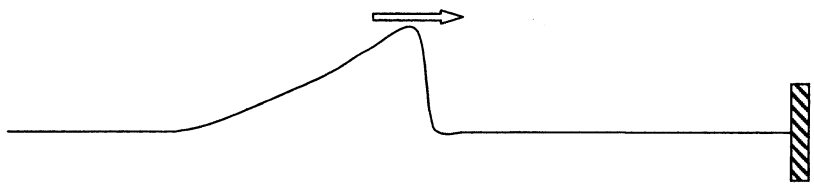
15.



A series of particles is uniformly distributed along a slinky spring initially. Figure (a) shows their positions at a certain instant when a travelling wave propagates along the slinky spring from left to right. Figure (b) shows their positions 0.1 s later. Which statement is correct ?

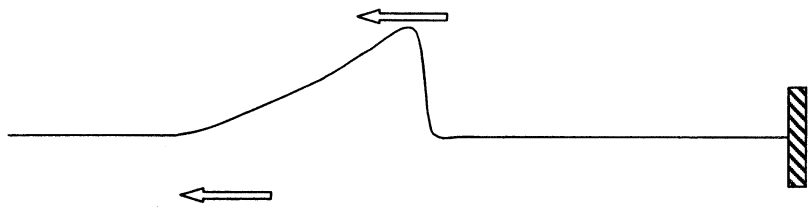
A. Particle *e* is always stationary.
B. Particles *a* and *i* are in phase.
C. The wavelength of the wave is 16 cm.
D. The frequency of the wave is 10 Hz.

16. A pulse on a string propagates towards the right end which is fixed.

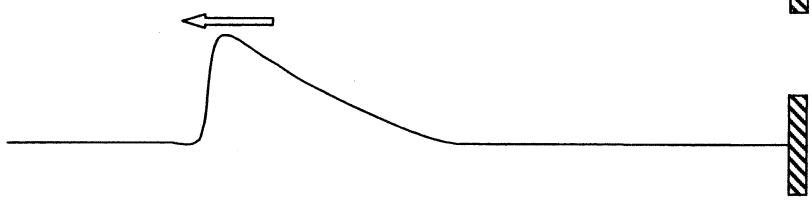


Which of the following represents the reflected pulse ?

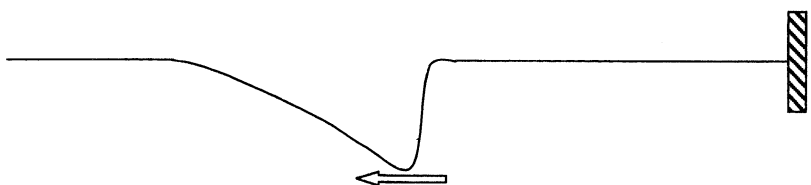
A.



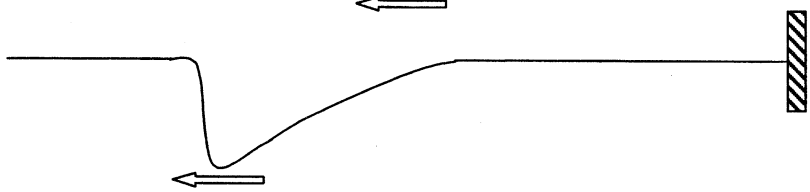
B.



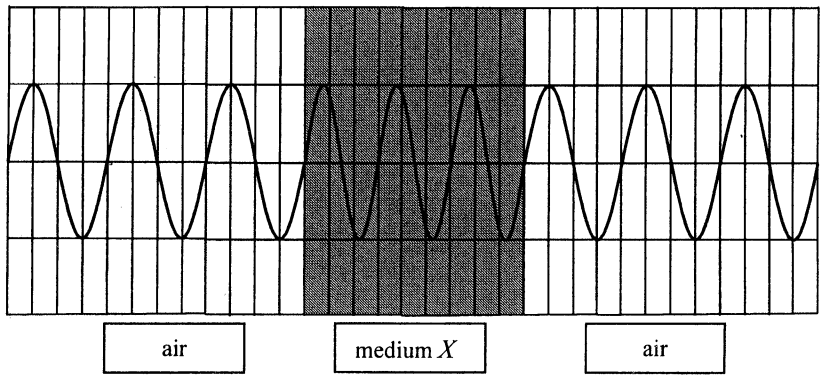
C.



D.

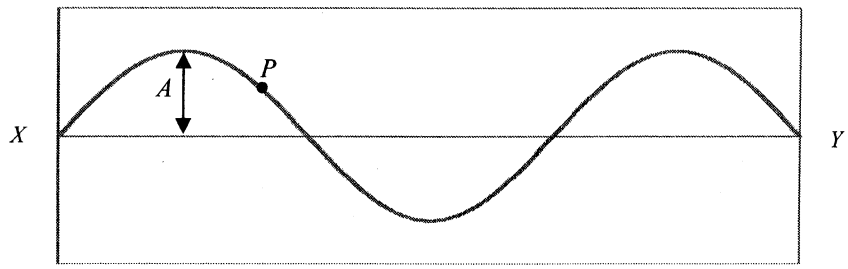


17. A certain monochromatic light passes through medium X as shown below. What is the refractive index of medium X ?

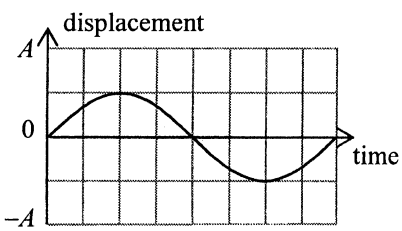


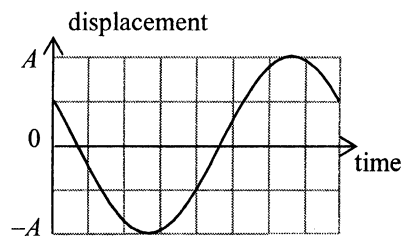
A. 1.25
B. 1.33
C. 1.50
D. 1.65

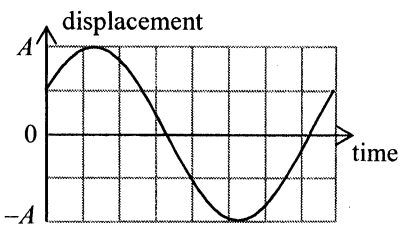
18. A stationary wave is formed on a string fixed at both ends X and Y. The following is a snapshot of the string at time $t = 0$. The amplitude of vibration at an antinode is A.

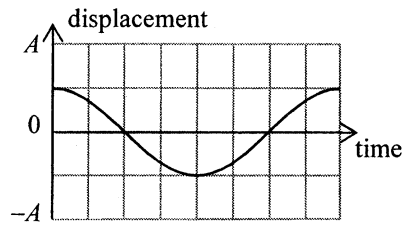


Which of the following shows the displacement-time graph of point P on the string for one period ? (Upward displacement is taken as positive.)

A.


B.


C.


D.


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

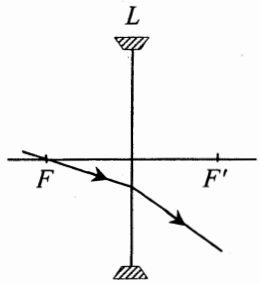
A. In air, the wavelength of infra-red radiation is shorter than that of ultra-violet radiation.
B. Visible light travels faster in air than in glass.
C. Microwaves travel at the speed of light in a vacuum.
D. Both light and sound exhibit diffraction.

*20. For a diffraction grating of 600 lines per mm, the diffracted red light (657 nm) coincides with the diffracted violet light (438 nm) at angle of diffraction 52°. What are the respective orders of the diffracted red light and violet light ?

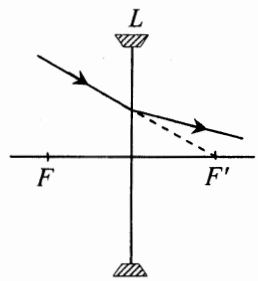
	red	**violet**
A.	2	3
B.	3	4
C.	3	2
D.	4	3

21. In each of the following diagrams, L is a concave lens and its two principal foci are denoted by F and F'. Which of the ray diagrams is/are possible ?

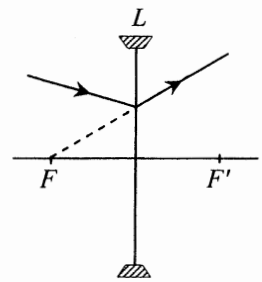
(1)



(2)



(3)



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

22. The figure shows the waveforms of sound notes generated by a violin, a piano and a tuning fork. The scale is the same in time and intensity axes for all three waveforms.

(I)

(II)

(III)

Which of the following about the sound notes are correct ?

(1) They all have the same pitch.
(2) The qualities of sound of (II) and (III) are different.
(3) (I) is generated by the tuning fork.

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

23. Which of the following about ultrasound is **INCORRECT** ?

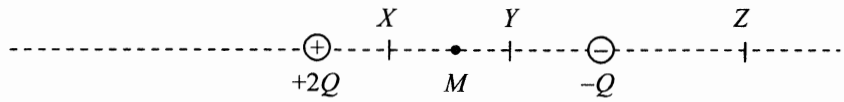
A. Ultrasound is a longitudinal wave.
B. The frequency of ultrasound is greater than 20000 Hz.
C. In air, the speed of ultrasound is faster than the speed of audible sound.
D. In air, the diffraction effect of ultrasound is less prominent than that of audible sound.

24. *P*, *Q*, *R*, *S* are charged objects. When two of them are brought close to each other, *P* and *Q* repel, *R* and *S* also repel while *Q* and *R* attract each other. Which of the following descriptions about their charges is/are possible ?

(1) *P* and *R* are negatively charged.
(2) *Q* and *S* are positively charged.
(3) *P* is positively charged and *S* is negatively charged.

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

*25.

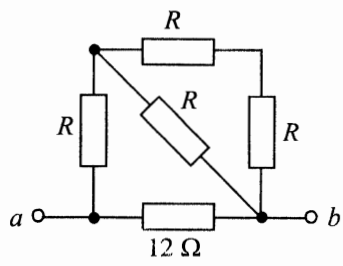


Two point charges $+2Q$ and $-Q$ are situated at fixed positions as shown. *M* is the mid-point between the charges. *X*, *Y* and *Z* are points marked on the line joining these two charges. At which point could

(1) the resultant electric field due to the two charges be zero ?
(2) the total electric potential due to the two charges be zero ?

	(1)	(2)
A.	*Z*	*X*
B.	*Z*	*Y*
C.	*X*	*Z*
D.	*Y*	*Z*

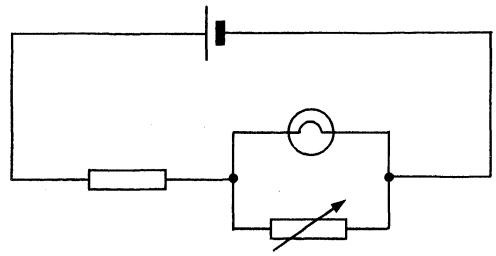
26.



In the above network, the resistance across terminals *a* and *b* is 6 Ω. If the 12 Ω resistor is replaced by a 6 Ω resistor, the resistance across terminals *a* and *b*

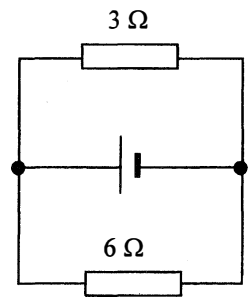
A. becomes 2 Ω.
B. becomes 4 Ω.
C. becomes 6 Ω.
D. cannot be found as the value of *R* is unknown.

27. What will happen if the variable resistor is set to zero in the circuit below ?



A. The light bulb will burn out.
B. The light bulb will not light up.
C. The brightness of the light bulb will increase.
D. The brightness of the light bulb will remain unchanged.

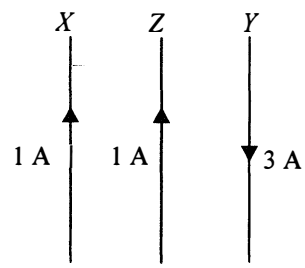
28.



In the above circuit, the cell has e.m.f. 12 V and internal resistance 2 Ω. What is the current in the 6 Ω resistor ?

A. 0.5 A
B. 1.0 A
C. 1.5 A
D. 2.0 A

29. In the figure below, *X*, *Y* and *Z* are three long straight parallel wires with *Z* placed midway between *X* and *Y*. *X* and *Z* carry currents of 1 A in the same direction while *Y* carries a current of 3 A in the opposite direction. The magnetic force per unit length experienced by wire *X* due to wire *Z* is of magnitude *F*.

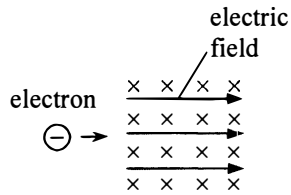


The magnetic force per unit length acting on wire *Z* due to both *X* and *Y* is

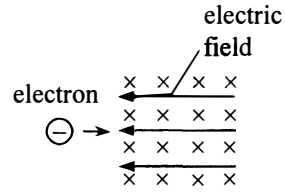
A. 2*F* to the right.
B. 2*F* to the left.
C. 4*F* to the right.
D. 4*F* to the left.

30. An electron enters a region in which both a uniform electric field E and a uniform magnetic field B exist. The magnetic field B is pointing into the paper. In which direction should the electric field be applied so that the electron could be undeflected ?

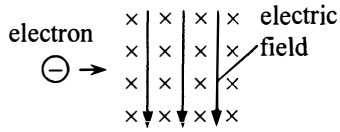
A.



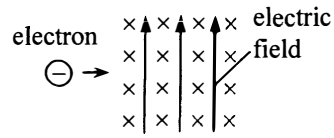
B.



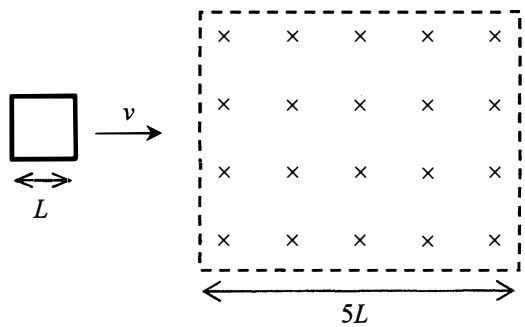
C.



D.



31.



A square metal frame of length of side L moving with constant velocity v passes through a region of uniform magnetic field of width $5L$ as shown. What is the total time period during which a current is induced in the frame ?

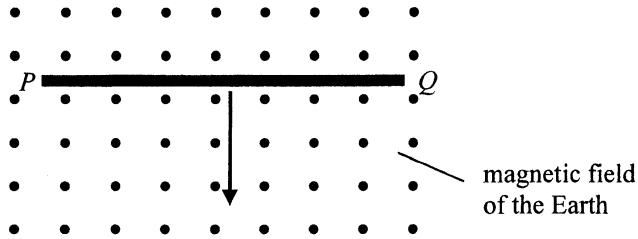
A. $\frac{L}{v}$

B. $\frac{2L}{v}$

C. $\frac{3L}{v}$

D. $\frac{4L}{v}$

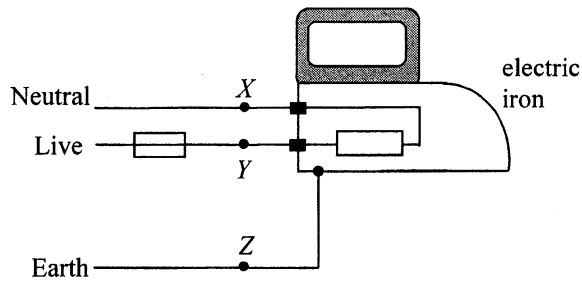
32. A copper rod PQ is placed horizontally as shown below. It is released and then falls vertically, cutting across the magnetic field of the Earth pointing out of the paper. Neglect air resistance. Which of the following statements is/are correct ?



(1) A voltage is induced across PQ.
(2) A steady induced current is generated in the rod.
(3) Due to the effect of the Earth's magnetic field, the copper rod falls with an acceleration less than the acceleration due to gravity.

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

33.

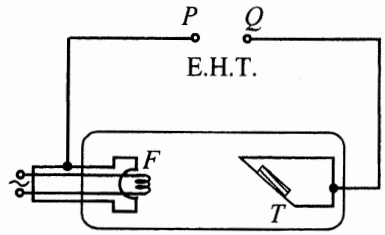


The figure shows a simple domestic circuit for an electric iron. The fuse will blow when which of the following points are short-circuited ?

(1) X and Y
(2) Y and Z
(3) X and Z

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

34.



The figure shows a schematic diagram of an X-ray tube in which the filament F and the metal target T are connected to terminals P and Q of an E.H.T. Which statement is correct ?

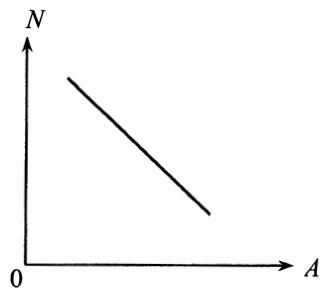
A. P is the positive terminal and X-rays are emitted from T.
B. P is the positive terminal and X-rays are emitted from F.
C. Q is the positive terminal and X-rays are emitted from T.
D. Q is the positive terminal and X-rays are emitted from F.

35. A certain radioactive isotope X has a half-life of 20 hours. After a time interval of 10 hours, what is the approximate fraction (f) of a sample of the radioactive isotope X remaining ?

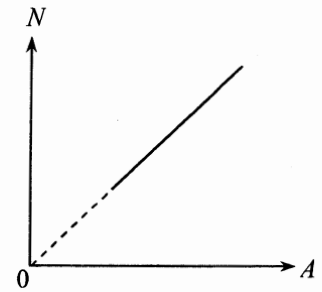
A. $\frac{1}{4} \leq f \leq \frac{1}{2}$
B. $f = \frac{1}{2}$
C. $\frac{3}{4} > f > \frac{1}{2}$
D. $f > \frac{3}{4}$

36. Isotopes of an element have different mass number A and neutron number N. Which of the following N - A plots correctly shows the relationship of N and A for any given element ?

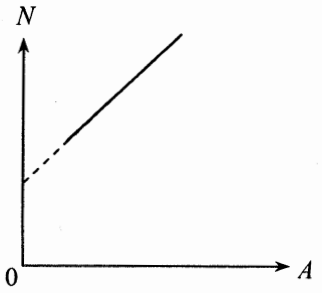
A.



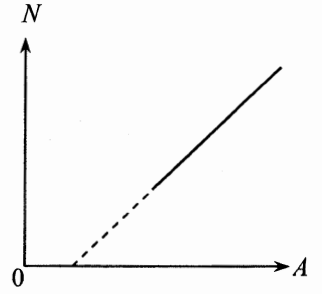
B.



C.



D.



END OF SECTION A

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 = 1.661×10^{-27} kg (1 u is equivalent to 931 MeV)
astronomical unit	AU = 1.50×10^{11} m
light year	ly = 9.46×10^{15} m
parsec	pc = 3.09×10^{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
$\frac{Q}{t} = k\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{k}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

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

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
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.	$V = \frac{Q}{4\pi\varepsilon_0 r}$	electric potential due to a point charge
D4.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D5.	$I = nAvQ$	general current flow equation
D6.	$R = \frac{\rho l}{A}$	resistance and resistivity
D7.	$R = R_1 + R_2$	resistors in series
D8.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D9.	$P = IV = I^2R$	power in a circuit
D10.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D11.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D12.	$V = \frac{BI}{nQt}$	Hall voltage
D13.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D14.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D15.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D16.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0e^{-kt}$	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

2012-DSE
PHY
PAPER 1B

B

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Candidate Number

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2012

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	4
3	7
4	11
5	8
6	8
7	10
8	8
9	7
10	7
11	7

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

1. Cappuccino is an Italian style coffee topped with a layer of frothy milk (Figure 1.1).

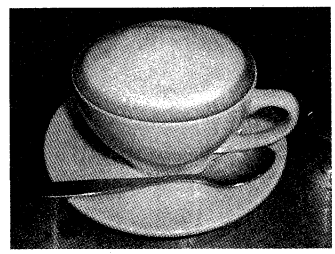

Figure 1.1

Frothy milk is made by bubbling steam through milk, which is held in a metallic jug (Figure 1.2). Steam is ejected from the steam wand of a cappuccino machine (Figure 1.3).

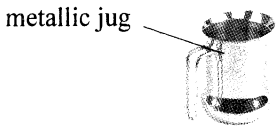

Figure 1.2

Figure 1.3

Given: specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}
specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
specific heat capacity of steam = 2000 J kg^{-1} °C^{-1}
specific heat capacity of milk = 3900 J kg^{-1} °C^{-1}

(a) Calculate the total amount of heat released when 20 g of steam at 110°C cools to 100°C and condenses to water at 100°C. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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(b) 20 g of steam at 110°C is bubbled through 200 g of milk at 15°C to make frothy milk. Using the result in (a), estimate the temperature of the frothy milk. (2 marks)

(c) Would the actual temperature of frothy milk be higher than, equal to or lower than the value found in (b) ? Explain. (2 marks)

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Answers written in the margins will not be marked.

*2. A gas bubble rises from the bottom of a lake to the water surface. Its radius increases from 0.8 cm to 1.0 cm.

(a) If the gas pressure in the bubble at the water surface is 1.01×10^5 Pa, find the gas pressure in the bubble when it is at the bottom of the lake. Assume that the temperature of the gas in the bubble remains constant. (2 marks)

(b) Use kinetic theory to explain the change in gas pressure in the bubble as its volume increases. (2 marks)

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*3.

Figure 3.1

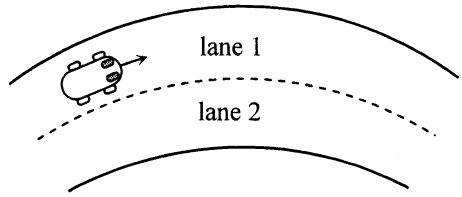

Figure 3.1 shows the top view of a horizontal road with two circular lanes. A car of mass 1200 kg moves with constant speed in lane 1 of radius 45 m.

(a) (i) Name the force that provides the centripetal force for the car. If the maximum value of this force is 8000 N, calculate the highest speed of the car such that it can keep in lane 1. (3 marks)

(ii) Suppose the car takes lane 2 instead of lane 1 and the maximum value of the force providing the centripetal force is still 8000 N. Would the car's highest speed in lane 2 be smaller than, larger than or the same as that found in (a)(i) ? Explain. (2 marks)

(b) Explain why the chance of skidding would increase if there are oil patches on the road surface in Figure 3.1. (2 marks)

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Answers written in the margins will not be marked.

4. Train A initially travels at a speed of 60 m s^{-1} along a straight horizontal railway. Another identical train B travels ahead of A in the same direction on the same railway. Due to mechanical failure, B is only travelling at 20 m s^{-1} (Figure 4.1).

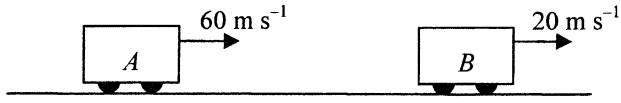
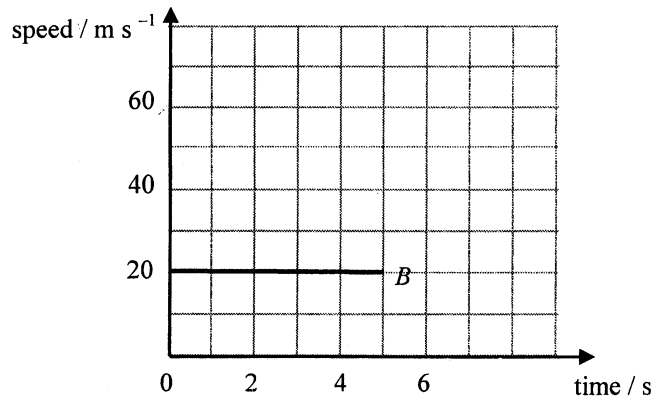


Figure 4.1

At time t = 0, A and B are x m apart, the captain of A receives a stopping signal and immediately A decelerates at 4 m s^{-2} while B continues to travel at 20 m s^{-1}. A eventually collides with B after 5 s. Neglect air resistance.

(a) (i) Find the speed of A just before collision. (2 marks)

(ii) The graph below shows how the speed of B varies with time within this 5 s. Sketch on the same graph the variation of the speed of A within the same period. (1 mark)



(iii) Based on the above information, determine the separation x of the two trains at t = 0. (3 marks)

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(b) A and B locked together after collision.

(i) Find the speed of them just after collision. (2 marks)

(ii) If the collision time between the trains is 0.2 s and the mass of each train is 5000 kg, find the magnitude and direction of the average impact force acted on A during collision. (3 marks)

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Answers written in the margins will not be marked.

5. (a) A bow and arrow is a kind of projectile weapon. The string of a bow is drawn taut by a hunter with a force of 60 N and an arrow of mass 0.2 kg is held stationary as shown in Figure 5.1.

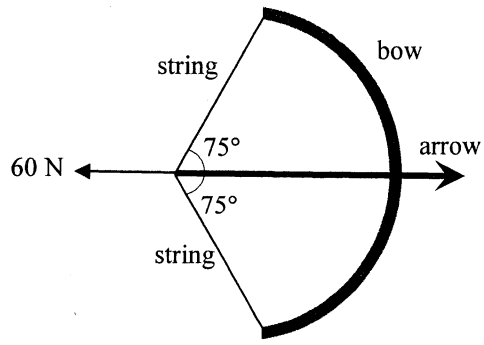

Figure 5.1

(i) Find the tension of the string. Neglect the weight of the arrow. (2 marks)

(ii) Estimate the energy stored in the taut string if the initial speed of the arrow is 45 m s^{-1} when released. Assume that the bow is rigid and neglect the mass of the string. (2 marks)

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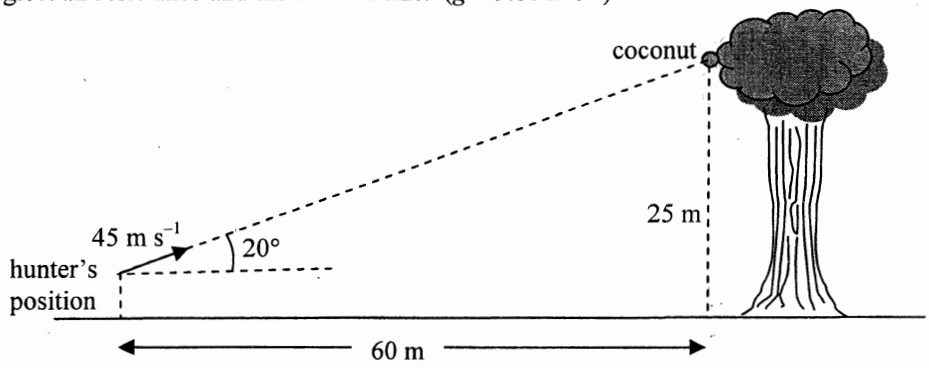
Answers written in the margins will not be marked.

*(b) The hunter stands at about 60 m away from a tree as shown in Figure 5.2. He uses the bow to release the arrow in order to shoot a coconut held by a monkey (not shown in the figure) in the tree. The coconut is at a height of 25 m from the ground. The hunter aims directly at the coconut and the arrow leaves the bow at a speed of 45 m s^{-1} making an angle of 20° to the horizontal. At the moment the hunter releases the arrow, the monkey drops the coconut such that it falls vertically from rest. Neglect air resistance and the arrow's size. (g = 9.81 m s^{-2})

Figure 5.2



(i) Find the time taken for the arrow to hit the coconut. (2 marks)

(ii) Find the height of the coconut from the ground at the moment the arrow hits it. (2 marks)

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Answers written in the margins will not be marked.

6. In a ripple tank, circular water waves are produced by two vibrators S_1 and S_2 of the same frequency vibrating in phase. Their separation is 3.5λ, where λ is the wavelength of the waves. Figure 6.1 shows the two circular waves propagating on the water surface at a certain moment. Line L is a line connecting all points P which have path difference $S_1P - S_2P = 0$.

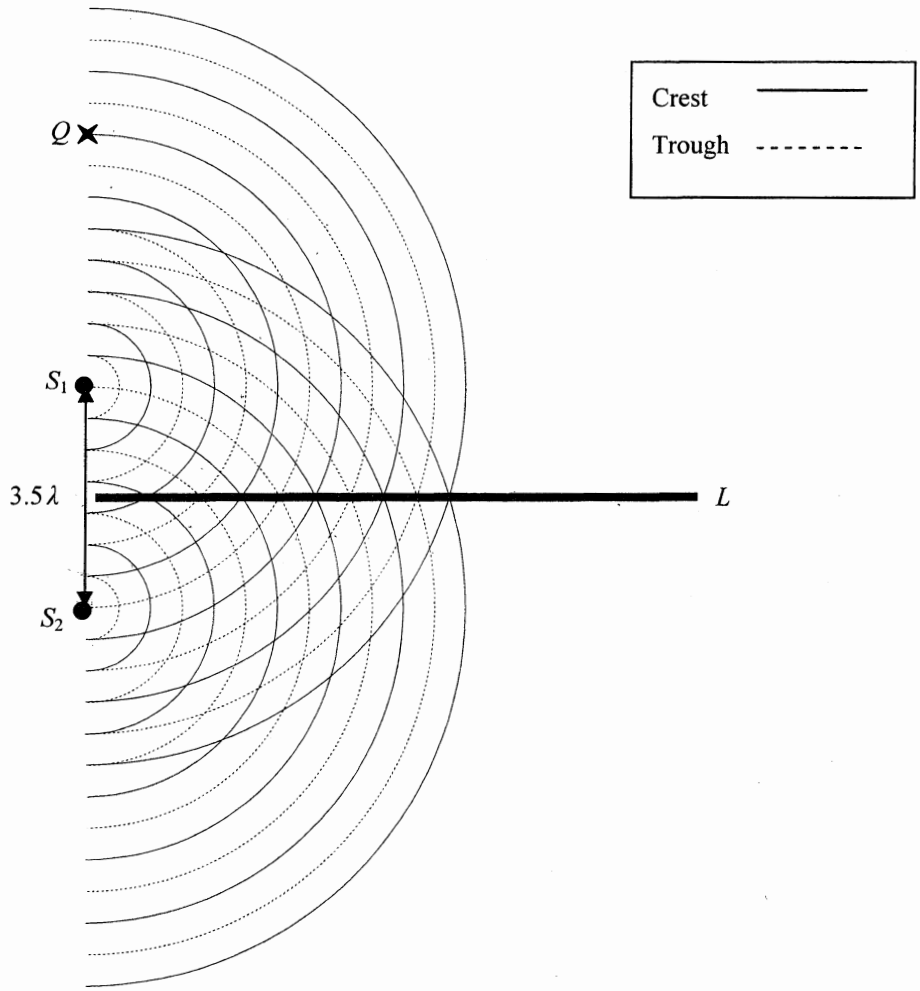


Figure 6.1

(a) Draw and label a line in Figure 6.1 connecting all points P which have path difference

(i) $S_1P - S_2P = \lambda$ (label it as L_1)

(ii) $S_1P - S_2P = -\frac{3}{2}\lambda$ (label it as L_2)

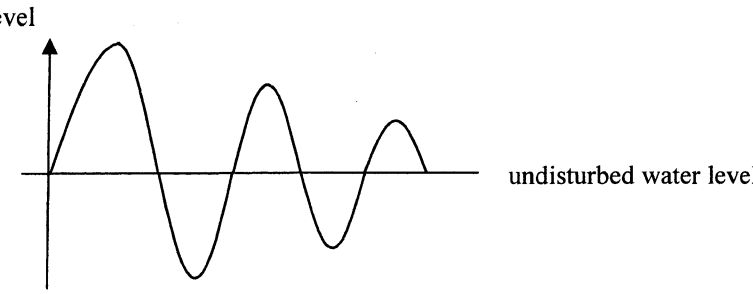
What would happen to L_1 and L_2 if the separation between S_1 and S_2 is reduced slightly ? (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) Figure 6.2 shows the profile of the water level along line L at a certain instant. Sketch on the same figure the profile at a time $\frac{T}{2}$ later, where T is the period of the water waves. (1 mark)

Figure 6.2



(c) Q is a point on the line joining S_1 and S_2 as shown in Figure 6.1. State the kind of interference that occurs at Q and give a reason for this occurrence. (2 marks)

*(d) A similar double-slit set-up is used for the demonstration of the interference of light in which the separation between slits S_1 and S_2 is 0.5 mm and the screen is at 2.5 m from the slits. Calculate the average separation between adjacent bright fringes on the screen for a monochromatic light of wavelength 550 nm. (2 marks)

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7. A luminous object PQ is placed 15 cm in front of a convex lens AB as shown in Figure 7.1.

(a) The focal length of the lens is 5 cm.

(i) Use a graphical method to find the location of the image of the object. Clearly draw all the construction lines on Figure 7.1 and state the nature of the image. (4 marks)

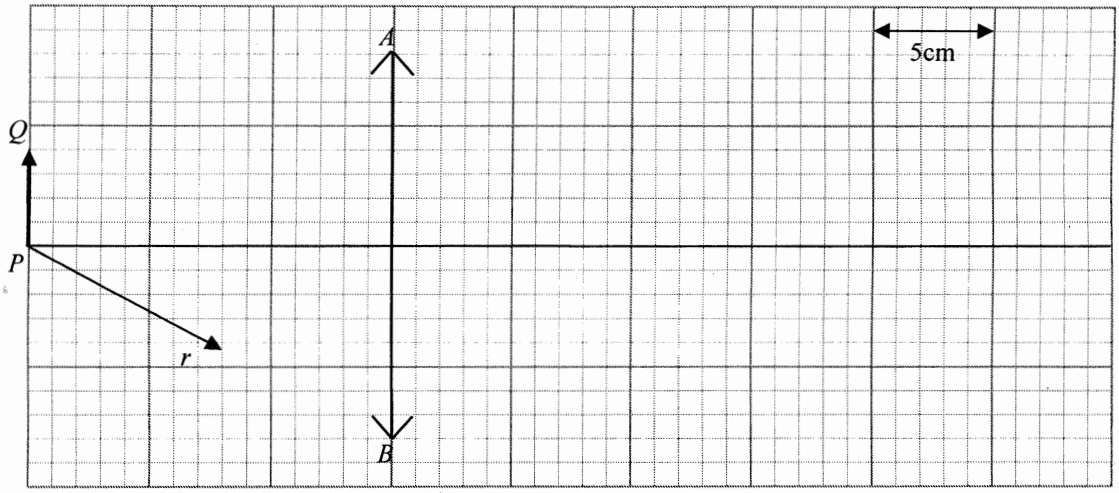

Figure 7.1

(ii) Complete the path of ray r on Figure 7.1 to show how it travels after passing through the convex lens. (1 mark)

(b) Suppose that a convex lens of focal length 10 cm is used instead while the size of the lens and the object distance of PQ from the lens remain unchanged.

*(i) Use the lens formula to find the image distance. Find also the linear magnification of the image. (3 marks)

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(ii) Compare the brightness of this image with that in (a). Explain. (2 marks)

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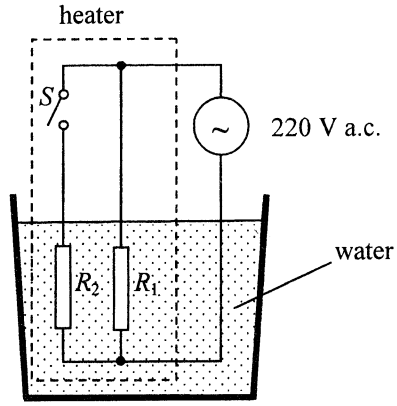
8. In the circuit shown in Figure 8.1, resistors R_1 and R_2 represent the heating elements in a heater using mains supply. Both resistors are immersed in water.

Figure 8.1



The heater can be operated in two modes, namely, heating and keeping warm, and it is controlled by the switch S. The power consumed by the heater in the heating mode is 550 W and in the mode of keeping warm is 88 W. The mains voltage is 220 V a.c.

(a) In which mode is the heater operating when switch S is open ? (1 mark)

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(b) Find the resistance of R_1. (2 marks)

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(c) When switch S is closed, calculate the current passing through resistor R_2. (3 marks)

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*(d) What is the *peak value* of the sinusoidal current flowing through the heater when switch *S* is closed ? (2 marks)

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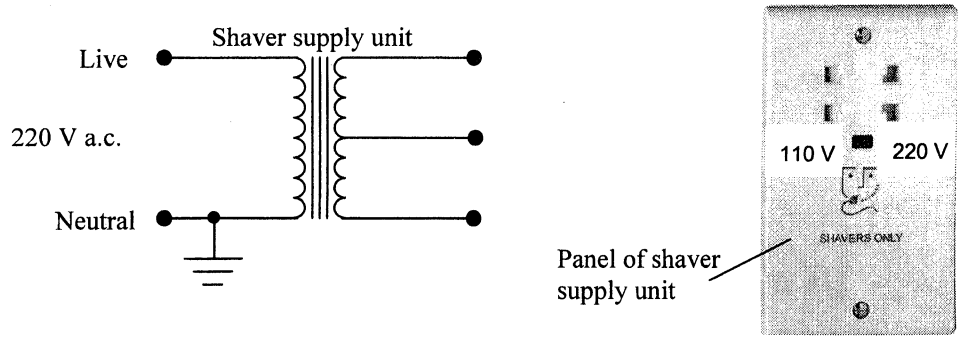
9. Read the following description about the 'shaver supply unit' in bathrooms and answer the questions that follow.

> The danger of electric shock is particularly high in bathrooms. Normal electric socket outlets should not be installed in bathrooms. As electric shavers and toothbrushes are becoming popular these days, a special unit, called 'shaver supply unit' is now common in bathrooms to provide electricity just for these low power consumption electric appliances (Figure 9.1).
>
> The shaver supply unit consists of a transformer in which the secondary is not earthed and is completely isolated from the 220 V a.c. mains supply connecting to the primary. It can be used with 220 V or 110 V shavers.

Figure 9.1



(a) Explain why the chance of electric shock is high in bathrooms. (2 marks)

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(b) Explain what would happen if the human body touches

(i) the live wire of the mains supply in the primary circuit; (2 marks)

(ii) one of the conducting wires in the shaver circuit outlet. (2 marks)

*(c) What is the turns ratio of the primary coil to the secondary coil of the transformer so as to provide 110 V ? (1 mark)

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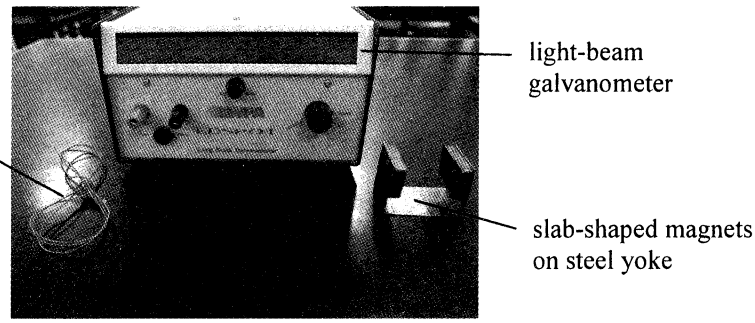
10. You are given a long conducting wire, a pair of slab-shaped magnets on steel yoke and a light-beam galvanometer for detecting small currents. With the aid of a diagram, describe an experiment to investigate **TWO** factors affecting the e.m.f. induced in a conductor when it moves in a magnetic field. (7 marks)



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11. Radium−226 ($^{226}_{88}Ra$) undergoes α-decay into radon (Rn).

(a) Write a nuclear equation for the decay. (2 marks)

*(b) Given : mass of a radium nucleus = 226.0254 u
mass of a radon nucleus = 222.0176 u
mass of an α-particle = 4.0026 u
Calculate the energy released in the decay in MeV. (2 marks)

(c) 1 curie (Ci) is defined as the activity of 1 g of radium. The activity of a radium source used in laboratories is about 5 μCi. Estimate the number of radium atoms in this source and hence find its activity expressed in disintegrations per second. The half-life of radium−226 is 1600 years and take the mass of one mole of radium as 226 g. (1 μCi = 1×10^{-6} Ci) (3 marks)

END OF PAPER

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

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