HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013

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 the Question-Answer Book. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**

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

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

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

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

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

(3) All questions carry equal marks.

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

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

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

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

Section A

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

1. Which of the following statements about *boiling* and *evaporation* of a liquid is/are correct ?

(1) A liquid absorbs energy when it boils but does not absorb energy when it evaporates.
(2) Boiling occurs at a definite temperature while evaporation takes place above room temperature.
(3) Boiling occurs throughout the liquid while evaporation only takes place at the liquid's surface.

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

2. In an experiment to measure the specific latent heat of vaporization of water, a beaker of water is boiled off using an electric heater. Which of the following sources of error would lead to an experimental result smaller than the standard value ?

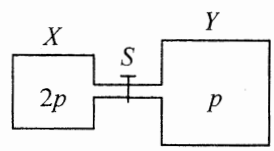
A. Energy is lost to the surroundings.
B. Water splashes out of the beaker.
C. Steam condenses on the cooler part of the heater and drops back to the beaker.
D. The heater is not completely immersed in water.

*3. In which of the following situations would the r.m.s. speed of the molecules of a fixed mass of an ideal gas increase ?

(1) The gas is heated under constant volume.
(2) The gas expands under constant pressure.
(3) The gas is compressed under constant temperature.

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

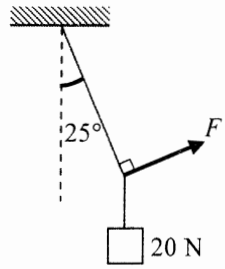
*4.



Vessel X of volume V and vessel Y of volume $2V$ are connected by a short narrow tube as shown. Initially, tap S is closed and the same kind of ideal gas at the same temperature is contained in X and Y at pressure $2p$ and p respectively. The tap S is then opened and equilibrium state is finally reached with the temperature unchanged. Which statement is **INCORRECT** ?

A. Before S is opened, both vessels contain the same number of gas molecules.
B. Before S is opened, the average kinetic energy of the gas molecules in both vessels is the same.
C. When S is opened, a net flow of gas from X to Y occurs.
D. When equilibrium is reached, the gas pressure becomes $\frac{3}{2}p$.

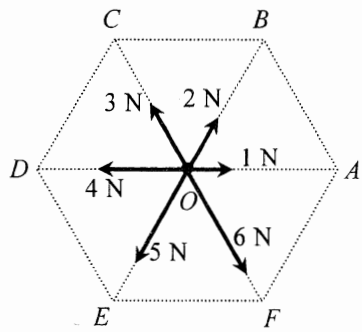
5.



A block of weight 20 N is suspended by a light string from the ceiling. A force F is applied such that the block is displaced to one side with the string making an angle of 25° with the vertical as shown. Find the magnitude of F.

A. 8.5 N
B. 9.3 N
C. 18.1 N
D. 47.3 N

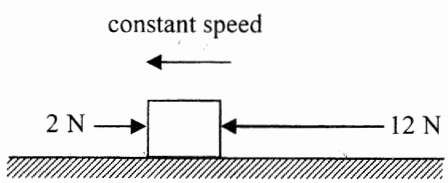
6.



In the figure, O is the centre of a regular hexagon. A particle at O is subject to six forces with magnitudes indicated as shown. The resultant force acting on the particle is

A. 9 N along direction OE.
B. 8 N along direction OE.
C. 8 N along direction OF.
D. 6 N along direction OE.

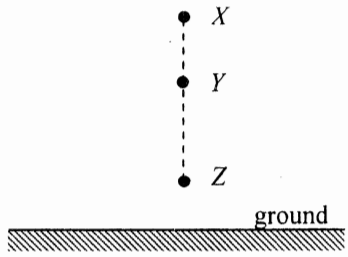
7.



A block on a rough horizontal surface is moving to the left with constant speed under two horizontal forces 2 N and 12 N indicated as shown. If the force of 12 N is suddenly removed, what is the net force acting on the block at that instant ?

A. 12 N
B. 10 N
C. 8 N
D. 2 N

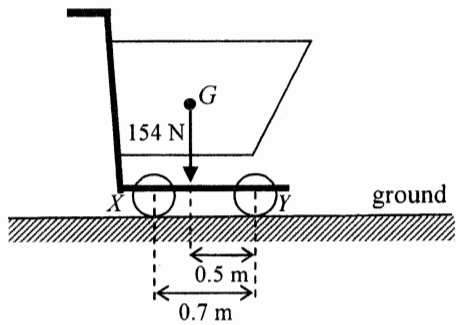
8.



A particle is released from rest at X as shown. It takes time t_1 to fall from X to Y and time t_2 to fall from Y to Z. If $XY : YZ = 9 : 16$, find $t_1 : t_2$. Neglect air resistance.

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

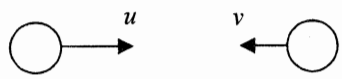
9.



The figure shows a supermarket trolley resting on the ground. The separation between cylindrical wheels X and Y is 0.7 m. When the trolley is loaded to a total weight of 154 N, its centre of gravity G is at a horizontal distance of 0.5 m from the wheel Y. What is the reaction acting on the wheel X from the ground ?

A. 44 N
B. 62 N
C. 92 N
D. 110 N

10.



Two identical spheres are moving in opposite directions with speeds u and v (with $u > v$) respectively as shown. They make a head-on collision. Which of the following diagrams show(s) a *possible* situation of the spheres after collision ?

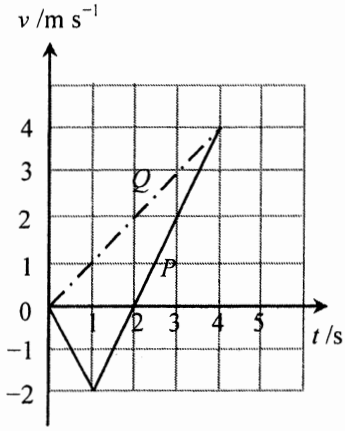
(1) 

(2) 

(3) 

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

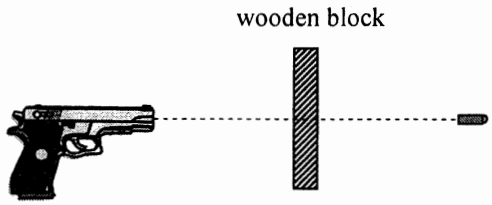
11. Two particles P and Q start from the same position and travel along the same straight line. The figure shows the velocity-time (v-t) graph for P and Q. Which of the following descriptions about their motion is/are correct ?



(1) At t = 1 s, P changes its direction of motion.
(2) At t = 2 s, the separation between P and Q is 4 m.
(3) At t = 4 s, P and Q meet each other.

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

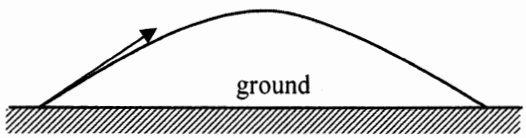
12.



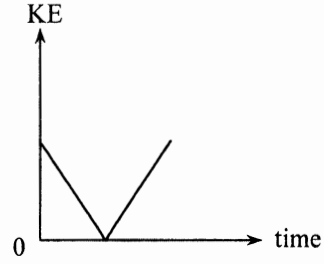
A bullet of mass 50 g is fired from a gun with a speed of 400 m s^{-1} and passes right through a fixed wooden block of 6 cm thickness as shown. Find the average resistive force acting on the bullet due to the block if it emerges with a speed of 250 m s^{-1}. Neglect air resistance and the effects of gravity.

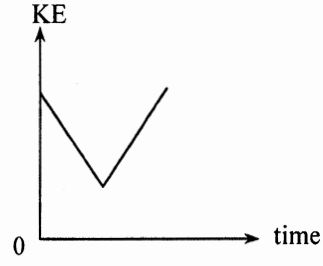
A. 4.06×10^4 N
B. 1.02×10^4 N
C. 125 N
D. Answer cannot be found as the time of travel of the bullet within the block is not known.

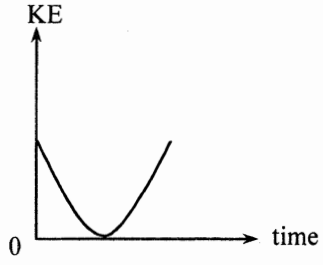
*13.

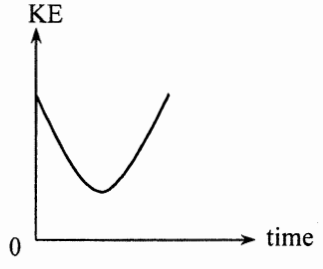


A particle is projected into the air at time t = 0 and it performs a parabolic motion before landing on the ground as shown. Which graph represents the variation of the kinetic energy (KE) of the particle with time before landing ? Neglect air resistance.

A.


B.


C.


D.


14.

A semi-circular cardboard hangs from a spring balance from point O as shown. The reading of the spring balance is 5 N. Which statements are correct ?

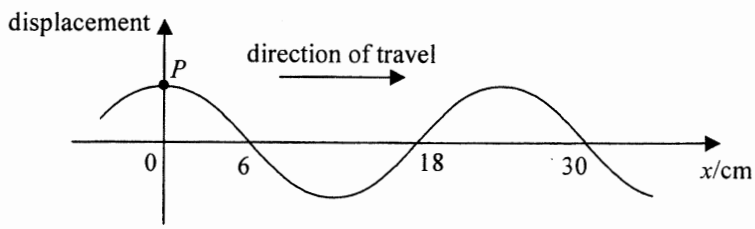
(1) The weight of the cardboard is 5 N.
(2) The centre of gravity of the cardboard is directly under O.
(3) The reading of the balance would become zero if the set-up is brought to the Moon's surface.

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

*15. It is known that the mass of Mars is about $\frac{1}{10}$ of that of the Earth while its radius is about $\frac{1}{2}$ of the Earth's radius. In terms of the gravitational acceleration g on the Earth's surface, the approximate gravitational acceleration on the surface of Mars is

A. $0.2\,g$.
B. $0.4\,g$.
C. $2.5\,g$.
D. $4\,g$.

16.



The figure shows a snapshot of a section of a continuous transverse wave travelling along the x-direction at time $t = 0$. At $t = 1.5$ s, the particle P just passes the equilibrium position for a *second* time at that moment. Find the wave speed.

A. 20 cm s^{-1}
B. 12 cm s^{-1}
C. 6 cm s^{-1}
D. 4 cm s^{-1}

17.

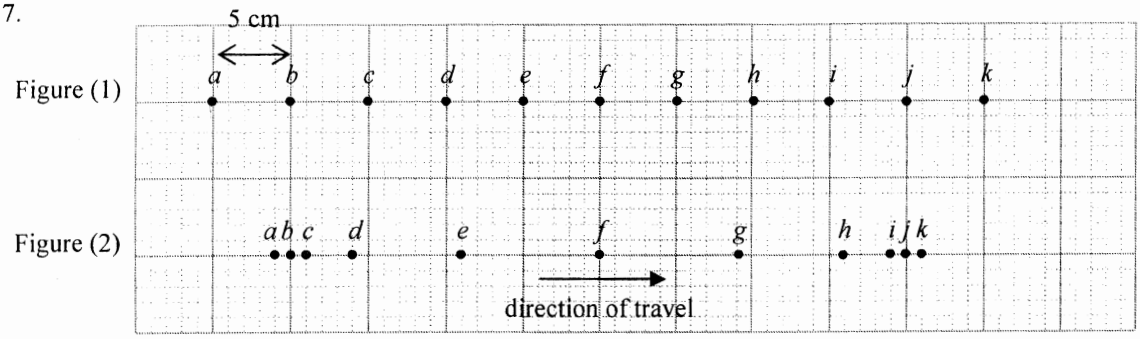
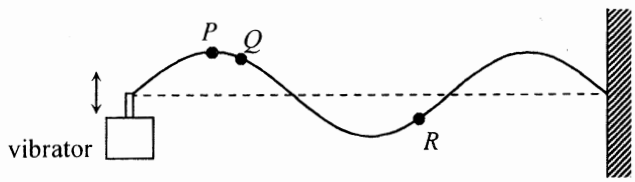


Figure (1) shows the equilibrium positions of particles a to k separated by 5 cm from each other in a medium. A longitudinal wave is travelling from left to right with a speed of 80 cm s^{-1}. At a certain instant, the positions of the particles are shown in Figure (2). Determine the amplitude and frequency of the wave.

	amplitude	**frequency**
A.	6 cm	2 Hz
B.	6 cm	4 Hz
C.	9 cm	2 Hz
D.	9 cm	4 Hz

18.

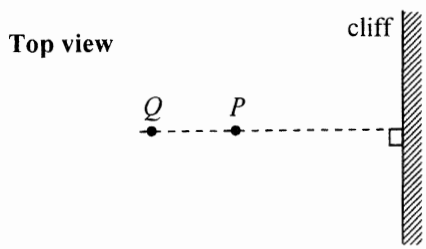


A vibrator generates a stationary wave on a string which is fixed at one end. The figure shows the appearance of the string at a certain instant. Which of the following descriptions about the motion of particles P, Q and R must be correct ?

(1) P and Q are momentarily at rest at this instant.
(2) Q and R take the same time to reach their respective equilibrium positions.
(3) P and R are always in antiphase.

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

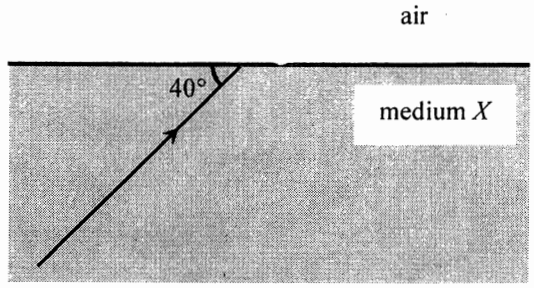
19.



Astronauts P and Q stand at 400 m and 600 m respectively from a vertical cliff on the surface of a planet. The figure shows the top view. P claps his hands once and Q hears two clapping sounds separated by 4 s. What is the speed of sound in the atmosphere of this planet ?

A. 100 m s^{-1}
B. 150 m s^{-1}
C. 200 m s^{-1}
D. 250 m s^{-1}

20.



A ray of light is travelling from a transparent medium X to air making an angle of 40° with the boundary plane as shown. If the angle between the refracted ray in air and the reflected ray in medium X is 70°, find the refractive index of medium X.

A. $\dfrac{\sin 40°}{\sin 30°}$

B. $\dfrac{\sin 30°}{\sin 40°}$

C. $\dfrac{\sin 60°}{\sin 50°}$

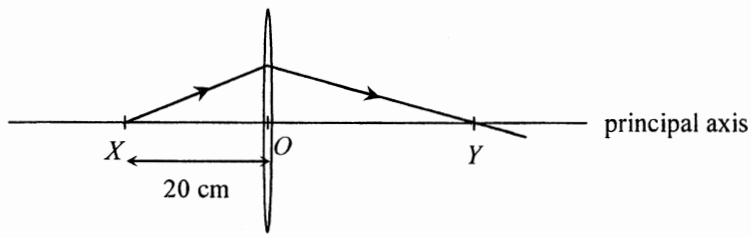
D. $\dfrac{\sin 50°}{\sin 60°}$

21. White light can be resolved into component colours by using a glass prism. Which of the following statements is/are correct ?

(1) The refractive indices of glass for different component colours are not the same.
(2) Red light travels faster than violet light in a vacuum.
(3) The frequencies of all the component colours are reduced when entering the prism.

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

22.

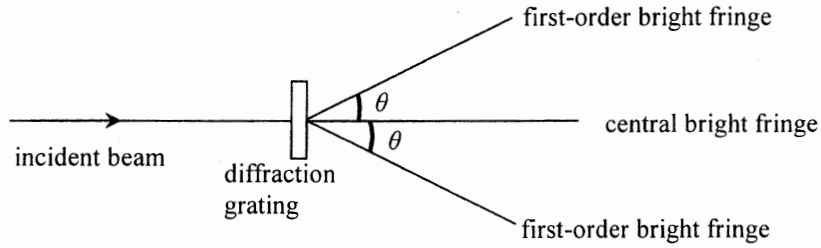


A point light source at X on the principal axis of a thin convex lens emits a ray of light. The ray passes through the lens and reaches the principal axis at point Y as shown. O is the optical centre of the lens such that $OX = 20$ cm and $OY > OX$. Which of the following statements is/are correct ?

(1) The focal length of the lens is shorter than 20 cm.
(2) If the point light source is shifted away from the lens, separation OY would increase.
(3) An object placed at Y would give a diminished image at X.

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

*23.



When monochromatic light passes through a diffraction grating, a pattern of bright fringes is formed. Which arrangement would produce the greatest angle θ between the central and first-order bright fringes ?

	grating (lines per mm)	colour of light
A.	400	green
B.	400	blue
C.	200	green
D.	200	blue

24. X and Y are two small identical metal spheres carrying charges $-2Q$ and $+6Q$ respectively. When X and Y are separated by a certain distance, the magnitude of the electrostatic force between them is F.

The spheres are brought to touch each other and then placed back to their original positions. The electrostatic force between them becomes

A. $\frac{1}{4}F$, attractive.

B. $\frac{1}{4}F$, repulsive.

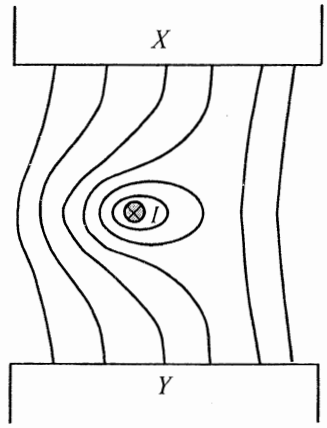
C. $\frac{1}{3}F$, attractive.

D. $\frac{1}{3}F$, repulsive.

*25. Lightning flash may occur when the strength of the electric field (assumed uniform) between a thundercloud and the ground reaches 3×10^6 N C^{-1}. A lightning flash on average discharges about 20 C of charge. If a thundercloud is at a height of 500 m above the ground, estimate the order of magnitude of the energy released in a lightning flash.

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

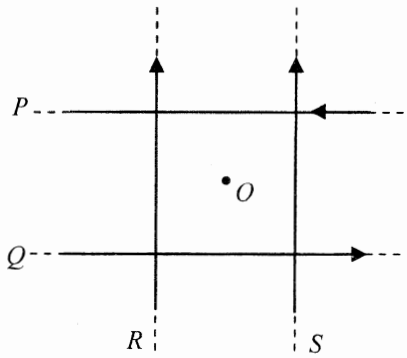
26.



A straight wire carrying current I pointing into the paper is placed in a magnetic field between pole pieces X and Y. The figure shows the resultant field line pattern. What is the polarity of pole piece X and in what direction is the magnetic force acting on the wire ? Ignore the effect of the Earth's magnetic field.

	polarity of X	**direction of magnetic force**
A.	**N**	to right
B.	**N**	to left
C.	**S**	to right
D.	**S**	to left

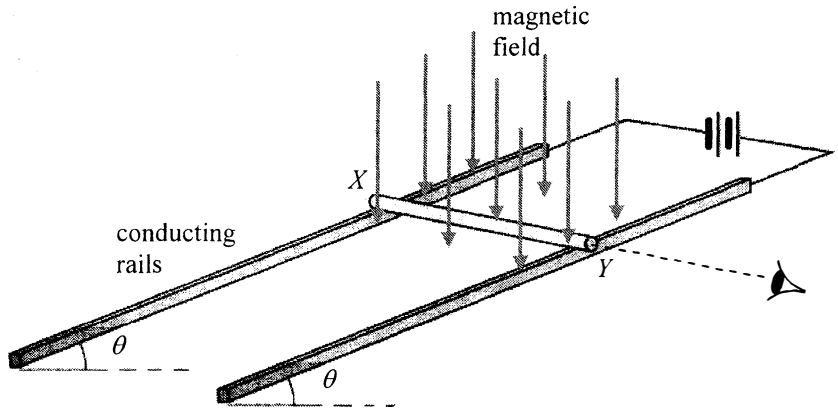
27.



In the figure, four long straight wires P, Q, R and S in the same plane carry equal currents in the directions shown. The wires are insulated from each other. O is a point on the same plane and is equidistant from each wire. Removing which wire would increase the magnetic field strength at O ?

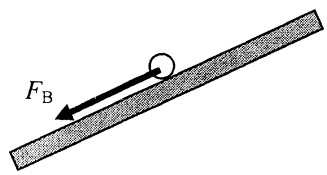
A. wire P
B. wire Q
C. wire R
D. wire S

28.

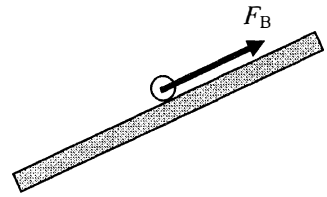


A copper rod XY is placed on a pair of smooth inclined conducting rails which are located in a magnetic field applied vertically downward. The rails make an angle θ to the horizontal and a battery is connected to the rails as shown above. Which diagram shown below represents the magnetic force F_B acting on the rod when viewed from end Y?

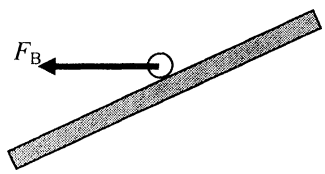
A.



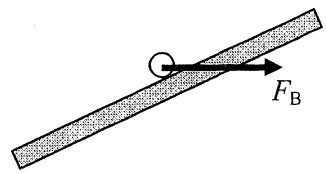
B.



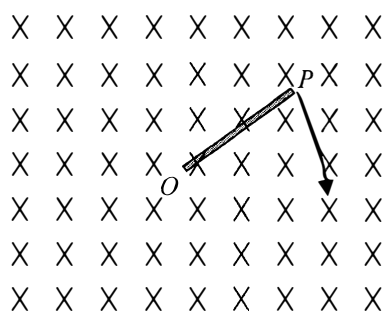
C.



D.



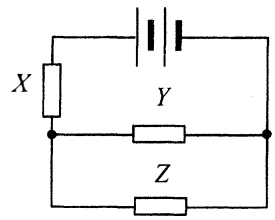
29.



A metal rod OP is rotated about O in a clockwise direction in the plane of the paper with a uniform magnetic field pointing into the paper. Which statement is correct ?

A. An induced current flows in the rod from O to P.
B. An induced current flows in the rod from P to O.
C. E.m.f. is induced in the rod with end O at a higher electric potential.
D. E.m.f. is induced in the rod with end P at a higher electric potential.

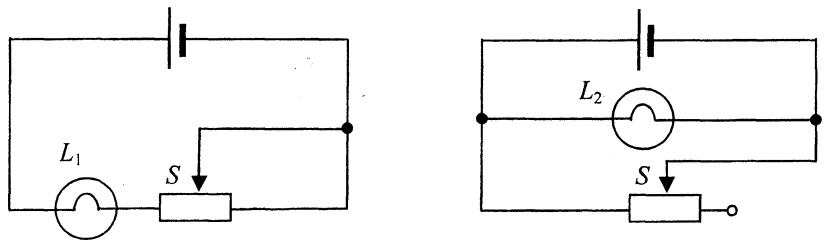
30.



Resistors X, Y and Z in the above circuit are identical while the battery of negligible internal resistance supplies a total power of 24 W. What is the power dissipated in resistor Z ?

A. 3 W
B. 4 W
C. 6 W
D. 8 W

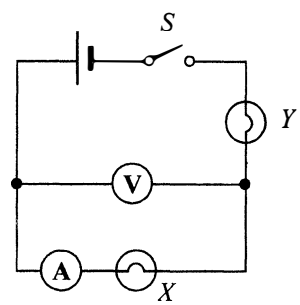
31.



In each of the above circuits, the cell has constant e.m.f. and negligible internal resistance. When the sliding contact S of each rheostat shifts from the mid-position to the right, how would the brightness of each bulb change ?

	bulb L_1	**bulb L_2**
A.	becomes dimmer	remains unchanged
B.	becomes dimmer	becomes brighter
C.	remains unchanged	becomes dimmer
D.	becomes brighter	remains unchanged

32.



In the above circuit, the cell has negligible internal resistance. When switch S is closed, both bulbs are not lit. The voltmeter has a reading but the ammeter reads zero. If only one fault has been developed in the circuit, which of the following is possible ?

A. Bulb X has been shorted accidentally.
B. Bulb Y has been shorted accidentally.
C. Bulb X is burnt out and becomes open circuit.
D. Bulb Y is burnt out and becomes open circuit.

33. Which of the following domestic electrical appliances consumes a power close to 1 kW in normal working conditions ?

A. an electric fan
B. a microwave oven
C. a fluorescent lamp
D. a TV set

34. $^{238}_{92}\mathrm{U}$ undergoes α-β-β-α decay and becomes a nuclide X. What are the atomic number and mass number of X ?

	atomic number	**mass number**
A.	90	230
B.	90	234
C.	88	230
D.	88	234

*35. Polonium-210 is a pure α-emitter with a half-life of 140 days and it will decay into lead, which is stable. Initially there is a sample containing 420 mg of pure polonium-210. Estimate the mass of polonium-210 left after 70 days.

A. 315 mg
B. 297 mg
C. 210 mg
D. 105 mg

*36. The sun releases huge amount of energy through thermonuclear fusion while at the same time its mass decreases. The average power released by the sun is about 3.8×10^{26} W. Estimate the decrease in mass of the sun in one second.

A. 4.2×10^{6} kg
B. 4.2×10^{9} kg
C. 1.3×10^{15} kg
D. 1.3×10^{18} kg

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
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	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.	$V = \frac{Q}{4\pi\varepsilon_0 r}$	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

2013-DSE
PHY
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013

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	**6**
2	**6**
3	**8**
4	**7**
5	**5**
6	**9**
7	**10**
8	**9**
9	**6**
10	**11**
11	**7**

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

1.

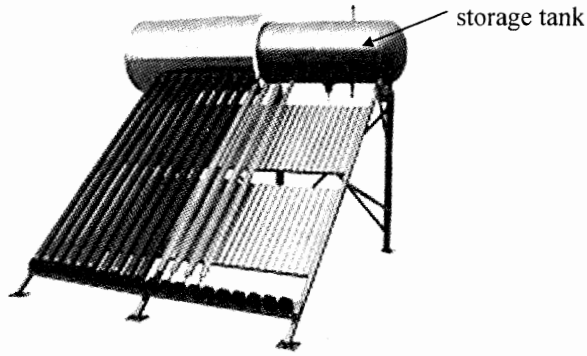

Figure 1.1

A solar water heater shown in Figure 1.1 is installed on the rooftop of a house. During the day, the heater heats up 1.5 m^3 of water to 80 °C. At night, the hot water in the storage tank is circulated to the radiators (see Figure 1.2) in different rooms of the house to keep the rooms warm.

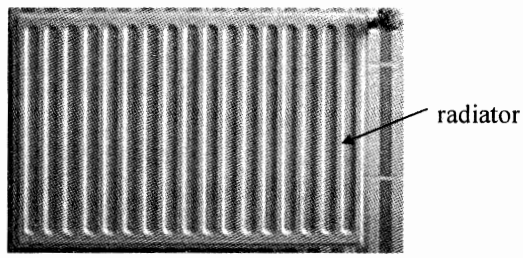

Figure 1.2

Given: density of water = 1000 kg m^{-3}
specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

(a) Given that 15% of the energy is lost during the transfer of water, how much heat can be released from the system to the rooms when the water temperature drops to 60 °C ? (3 marks)

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(b) Given that during night time the radiators maintain an average output power of 4.5 kW, how long can the radiators maintain this average power until the water temperature in the system drops to 60 °C ? Give your answer in hours. (2 marks)

(c) The rate of heat released by the solar water heating system during the time period calculated in (b) is in fact not constant and gradually drops. Explain why this is so. (1 mark)

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*2.

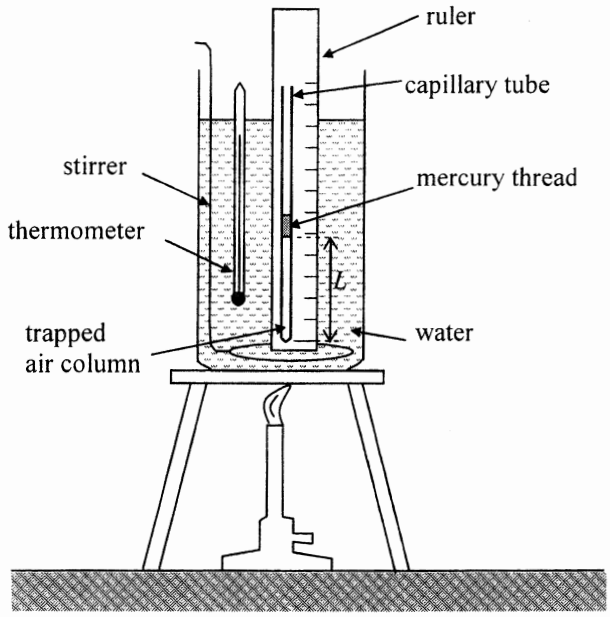

Figure 2.1

Figure 2.1 shows an air column trapped by a small mercury thread inside a uniform capillary tube. The set-up is heated by a water bath. The length of the air column L is measured at various temperature θ. Some of the results are tabulated below:

Temperature θ / °C	20		92
Length of air column L / mm	64		80

(a) Describe the procedure(s) to be done before taking a reading in order to ensure that the trapped air reaches the same temperature as the water. (2 marks)

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(b) Assume that length L increases linearly with temperature θ throughout.

(i) Estimate the length of the air column when the temperature indicated by the thermometer is 65 °C. (2 marks)

(ii) Find the 'absolute zero' as obtained from this experiment. (2 marks)

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3. A lift car of weight 8000 N is going up with constant speed 2 m s^{-1} as shown in Figure 3.1. The upward force raising the lift car is provided by the cable wound on a drum which is driven by a motor. The other end of the cable is firmly attached to the drum at *P*. Neglect air resistance and the mass of the cable.

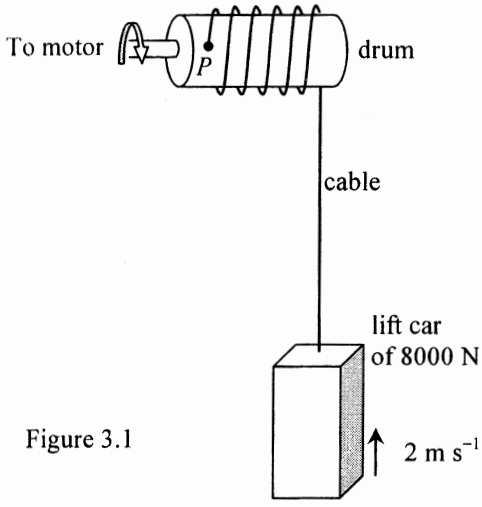

Figure 3.1

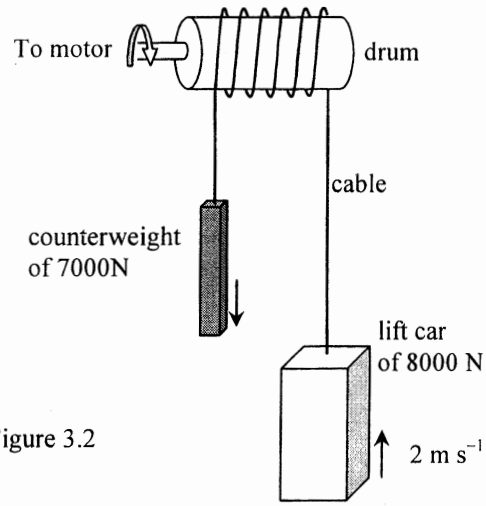

Figure 3.2

(a) (i) Calculate the mechanical power delivered to the rising lift car by the motor. (2 marks)

(ii) The total mechanical power output of the motor is 20 kW. How much power is lost due to overcoming friction between the movable parts ? (1 mark)

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(b) Now a 7000 N counterweight is installed at the other end of the cable as shown in Figure 3.2. The counterweight always moves in the opposite direction to the lift car which again moves up at 2 m s^{-1}. Assume that there is no slipping between the cable and the drum.

(i) Calculate the total mechanical power output of the motor required in this case, assuming the same power loss in overcoming friction between movable parts as found in (a). (2 marks)

(ii) State the advantage of having the counterweight installed. (1 mark)

(iii) A claim is made that as power is lost due to friction, a drum with frictionless surface can further reduce the power required from the motor. Comment on this claim. (2 marks)

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*4. An electron moving with speed 1.2×10^7 m s^{-1} enters a square region $ABCD$ with a uniform magnetic field of 0.01 T pointing into the paper as shown in Figure 4.1. The electron describes a quarter circle from A to C and it emerges from C with the same speed. Neglect the effects of gravity.

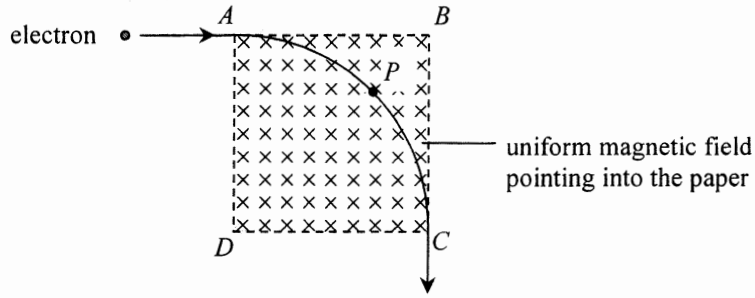

Figure 4.1

(a) (i) Find the magnitude of the magnetic force acting on the electron at point P on its path. (2 marks)

(ii) Indicate in Figure 4.1 the direction of the electron's acceleration at the point P. (1 mark)

(b) Although the electron accelerates due to the magnetic force, explain why it emerges from the magnetic field with the same speed. (2 marks)

(c) Deduce the speed of the electron when entering the magnetic field such that it would describe a semi-circle from A to D instead. (2 marks)

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5. Figure 5.1 shows a smooth sloping track *ABC* firmly fixed in a vertical plane with its horizontal part *BC* resting on a bench surface. You are given a toy skier, a metre rule and a long rough paper strip with adhesive tape on the bottom surface.

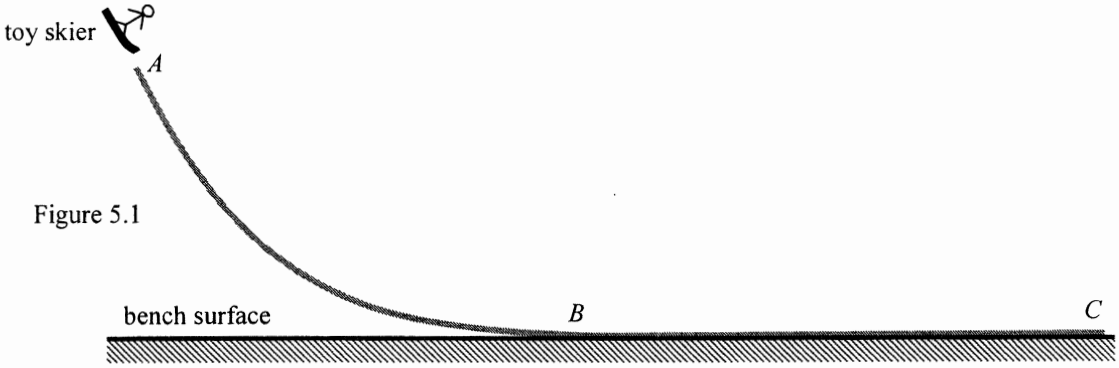

Figure 5.1

Using the apparatus provided, describe an experiment to study how the stopping distance of the toy skier depends on its height of release. Your description should include the physical quantities to be measured and the result expected. (5 marks)

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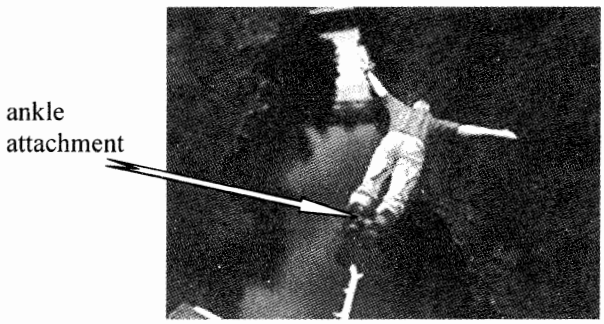
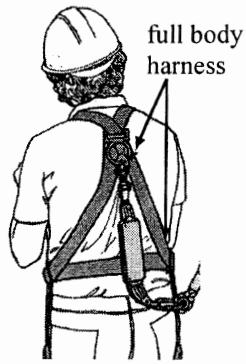
6. Read the following description about '**Bungee jumping**' and answer the questions that follow.

Bungee jumping is an activity that involves jumping from a tall structure while the person is connected to it via a thick elastic cord. When the bungee jumper jumps, the cord stretches after falling a certain distance. The bungee jumper is momentarily at rest at the lowest point but then bounces back up into the air. The bungee jumper continues to oscillate up and down a few times before he comes to a complete stop.



A simple 'ankle attachment' (as shown in the above photo) can be used to secure the player to the cord. However, due to accidents where the ankle attachment became detached from the bungee jumper, many operators now use a 'full body harness'.



When answering the following questions, neglect the effects of air resistance.

(a) (i) Describe the acceleration of the bungee jumper during the first downward fall to the lowest point. (3 marks)

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(a) (ii) State the energy change during the period from the beginning of the jump to the moment when the bungee jumper is at the lowest point of his first downward fall. (2 marks)

(b) In terms of the net force acting on the bungee jumper, explain why the cord has to be elastic. (2 marks)

(c) In terms of contact area, explain why a 'full body harness' is less likely to cause injuries to or detach from the bungee jumper than a simple 'ankle attachment' during a fall. (2 marks)

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7.

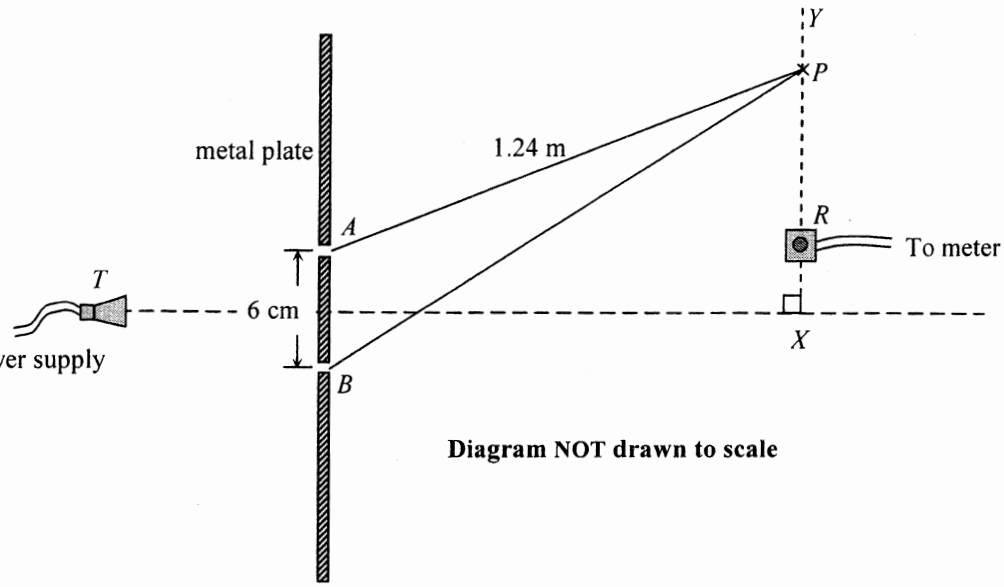

Figure 7.1

Diagram NOT drawn to scale

Figure 7.1 shows a set-up for the study of interference of microwaves. Microwaves of wavelength 2 cm emitted from a transmitter T pass through two slits A and B formed by metal plates. The slits are separated by 6 cm as shown. A probe R connecting to a meter is moved from X to Y to detect the intensity of microwaves received. Transmitter T and point X are equidistant from A and B.

(a) Calculate the frequency of the microwaves. (2 marks)

(b) (i) The meter shows alternate maxima and minima when R moves along XY. Explain. (2 marks)

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Answers written in the margins will not be marked.

(b) (ii) The second minimum is found at position P where $AP = 1.24$ m. Find BP. (2 marks)

(iii) When R is moved along XY from X towards Y and beyond, explain whether or not it is possible to detect more than three maxima. (2 marks)

(c) Microwaves can be used in radar. Why are radio waves of lower frequencies not suitable for use in radar ? (2 marks)

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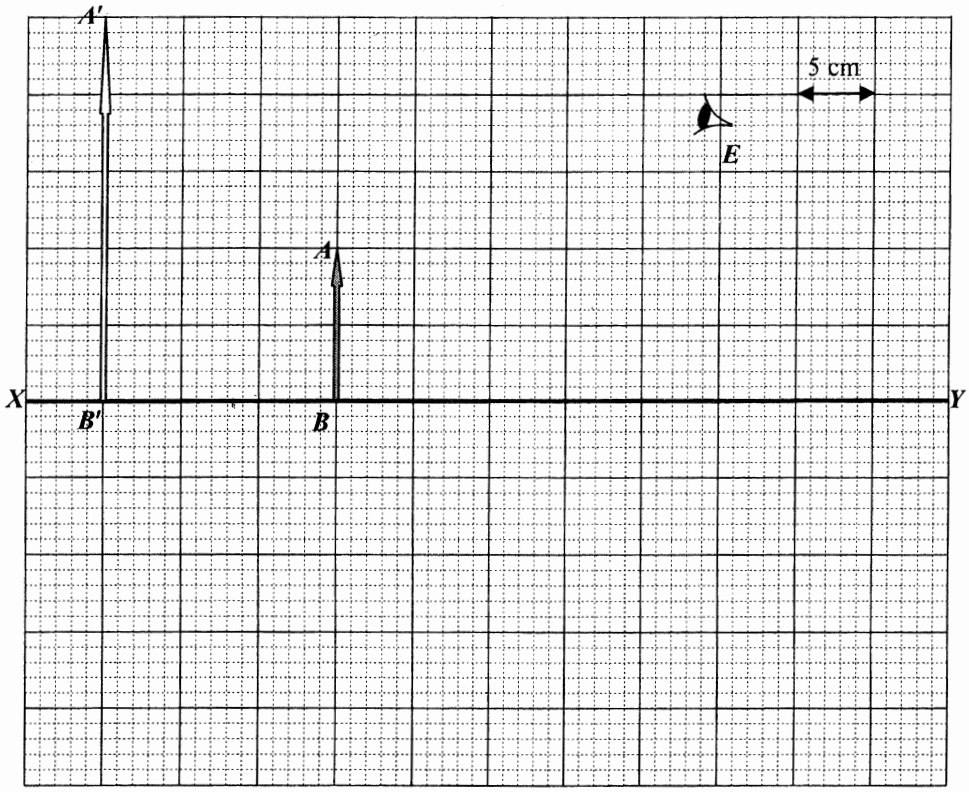
8. In Figure 8.1, $A'B'$ represents the image of an object AB formed by a lens L (not shown) where XY is the principal axis of the lens.

Figure 8.1



(a) (i) Is the image real or virtual ? (1 mark)

.....

(ii) What kind of lens is used ? Explain your answer. (2 marks)

.....

.....

.....

.....

.....

(b) (i) Locate the optical centre O of lens L and draw on Figure 8.1 the position of lens L. (1 mark)

(ii) By drawing an additional light ray, mark the principal focus F of the lens and find its focal length. The horizontal scale is 1 cm to 5 cm. (2 marks)

Focal length = ...

(c) Draw a light ray to show how the eye E shown can see the image of head A through lens L. (2 marks)

(d) State an application of lens L in the situation as shown above. (1 mark)

.....

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9. Carbon-14 dating can be used to identify the age of some objects which have the ^{14}C isotope, as it is radioactive and decays by emitting a β-particle. A piece of wood sample is examined using carbon-14 dating and its activity is 0.2 Bq. The half-life of ^{14}C is 5730 years. Given: 1 year $= 3.16 \times 10^7$ s

*(a) Calculate the decay constant of ^{14}C in s^{-1}. Hence find the number of ^{14}C nuclei in this wood sample. (3 marks)

Assume that living organisms contain a constant proportion of carbon-14 in the ratio of $^{14}C / ^{12}C = 1.3 \times 10^{-12}$ during its life time via intake of carbon dioxide (CO_2) from the atmosphere.

(b) The carbon content of this wood sample is found to contain a total of 1×10^{23} carbon nuclei. Estimate the number of ^{14}C nuclei in the sample originally when it died. (1 mark)

*(c) Estimate the age of this wood sample in years using the results found in (a) and (b). (2 marks)

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10. (a) In the circuit shown in Figure 10.1, a 12 V battery of negligible internal resistance is connected with a thermistor R and a resistor of resistance 120 Ω. The graph shows the variation of the thermistor's resistance with temperature.

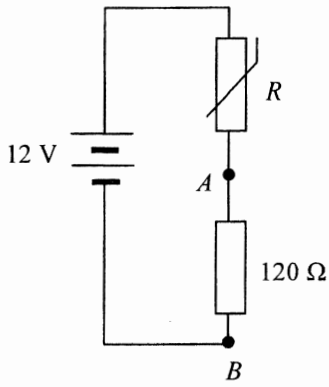
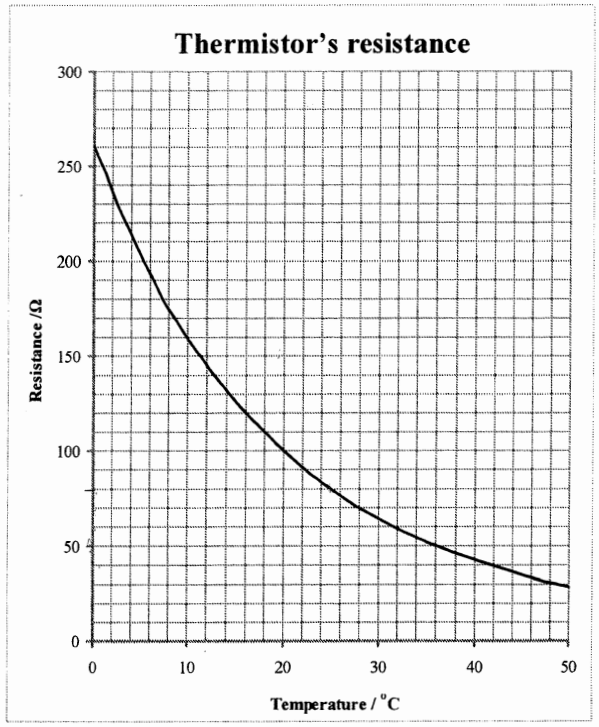


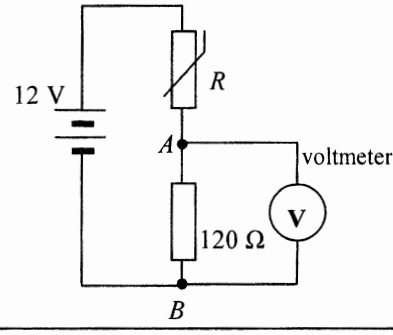
Figure 10.1



(i) Find the resistance of the thermistor R at 25 °C. (1 mark)

(ii) What is the potential difference V_{AB} across A and B at 25 °C ? (2 marks)

(b) Kelly wants to confirm the above calculation by measuring V_{AB} using a voltmeter of about 1 kΩ resistance. She finds that the reading registered is slightly different from the value found in (a) despite making careful measurements. Explain why this is so. Suggest how the accuracy of the measurement could be improved. (3 marks)



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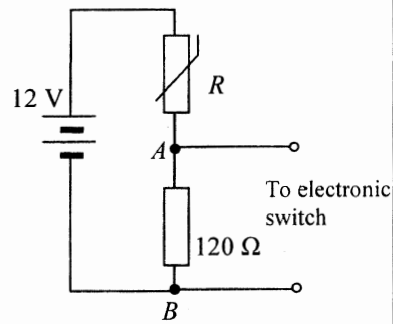
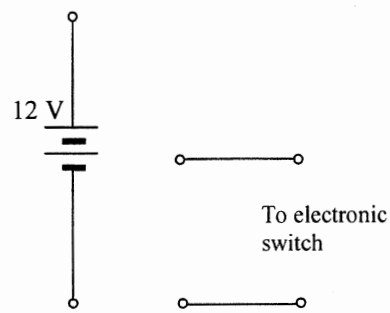
(c) (i) The potential difference V_{AB} is used to drive an electronic switch connected across AB to turn on a fan if temperature rises above a certain value such that V_{AB} is 6.0 V or above. Using the information provided in the graph, find the minimum temperature needed to keep the fan on. Show your working. (2 marks)



(ii) Without using additional components, complete the new circuit diagram below to illustrate how the circuit can be modified to turn on a heating device when temperature falls below a certain value. Explain the action of the circuit. No calculation is required. (3 marks)



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11. Figure 11.1 shows two identical small metal spheres X and Y suspended by insulating threads of the same length. Each sphere has a mass of 1.0×10^{-5} kg and each carries a positive charge of 3.1 nC (1 nC = 10^{-9} C). The separation d of the spheres is 10 cm. The size of the spheres is negligible compared with their separation, therefore they can be treated as point charges.

Take $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$ N m^2 C^{-2}. (g = 9.81 m s^{-2})

Figure 11.1

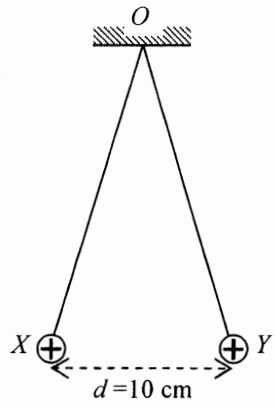

Diagram NOT drawn to scale

(a) Find the angle between the threads. (3 marks)

Answers written in the margins will not be marked.

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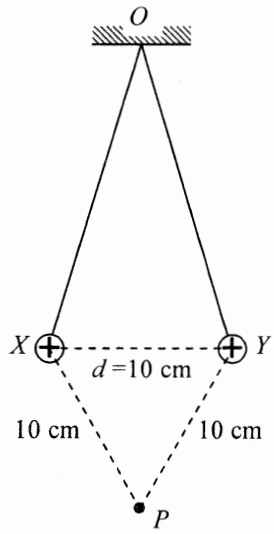
(b) Point P is vertically below the fixed point O and it is 10 cm from each sphere.

(i) Indicate the direction of the resultant electric field at P due to these two charged spheres. (1 mark)

Figure 11.2



*(ii) Calculate the electric potential at point P. The electric potential at infinity is taken to be zero. (2 marks)

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(iii) A neutral metal sphere of finite size is now placed at P. State whether the separation d would increase, decrease or remain unchanged due to the presence of this sphere. (1 mark)

Separation d .....

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.

Answers written in the margins will not be marked.