HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION

PHYSICS PAPER 1

(Sample Paper)

Time allowed: 2 hours 30 minutes

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. Section A consists of multiple-choice questions in this question book, while Section B contains conventional questions printed separately in Question-Answer Book B. You are advised to finish Section A in about 60 minutes.

2. 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 must be handed in separately at the end of the examination.**

SECTION A (MULTIPLE-CHOICE QUESTIONS)

INSTRUCTIONS FOR SECTION A

1. Read the instructions on the Answer Sheet carefully. Stick a barcode label and insert the information required in the spaces provided.

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 should use an **HB** pencil to mark all your answers on the Answer Sheet. Wrong marks must be completely erased.

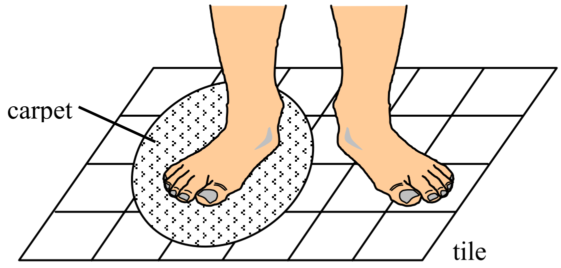
5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

6. No marks will be deducted for wrong answers.

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

There are 36 questions. Questions marked with "*" involve knowledge of the extension component. The back cover of this question paper contains a list of data, formulae and relationships which you may find useful.

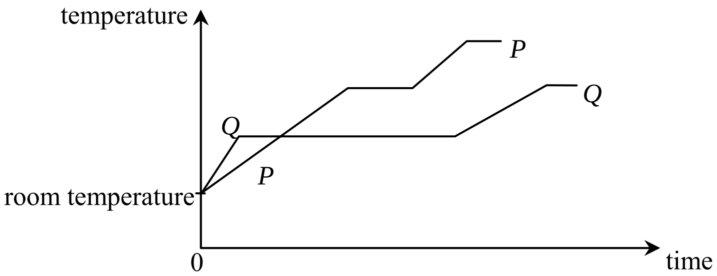
1.



Cynthia places a piece of carpet on a tiled floor. After a while, she stands in bare feet with one foot on the tiled floor and the other on the carpet as shown above. She feels that the tiled floor is colder than the carpet. Which of the following best explains this phenomenon ?

A. The tile is a better insulator of heat than the carpet.
B. The tile is at a lower temperature than the carpet.
C. The specific heat capacity of the tile is smaller than that of the carpet.
D. Energy transfers from Cynthia's foot to the tile at a greater rate than that to the carpet.

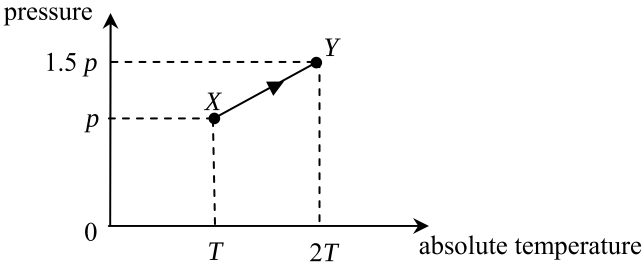
2.



The graph shows the variation in temperature of equal masses of two substances *P* and *Q* when they are separately heated by identical heaters. Which deduction is correct ?

A. The melting point of *P* is lower than that of *Q*.
B. The specific heat capacity of *P* in solid state is larger than that of *Q*.
C. The specific latent heat of fusion of *P* is larger than that of *Q*.
D. The energy required to raise the temperature of *P* from room temperature to boiling point is more than that of *Q*.

*3.



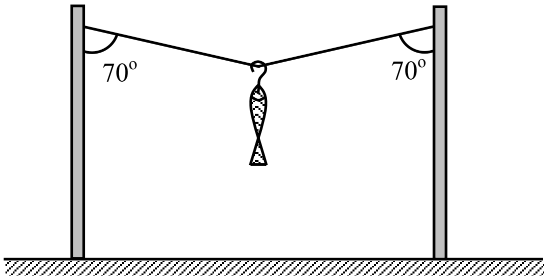
As the gas in a vessel of fixed volume is heated, it gradually leaks out. The gas in the vessel changes from state *X* to state *Y* along the path *XY* shown in the plot of pressure against absolute temperature. What percentage of the original mass of the gas leaks out from the vessel in this process ?

A. 10%
B. 20%
C. 25%
D. 50%

*4. Two vessels contain hydrogen gas and oxygen gas respectively. Both gases have the same pressure and temperature and are assumed to be ideal. Which of the following physical quantities must be the same for the two gases ?

A. The volume of the gas
B. The mass per unit volume of the gas
C. The r.m.s. speed of the gas molecules
D. The number of gas molecules per unit volume

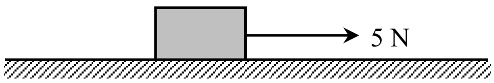
5.



A fish is hung on a light string as shown above. The tension in the string is 10 N. Find the total weight of the fish and the hook.

A. 20 sin 70° N
B. 20 cos 70° N
C. 10 sin 70° N
D. 10 cos 70° N

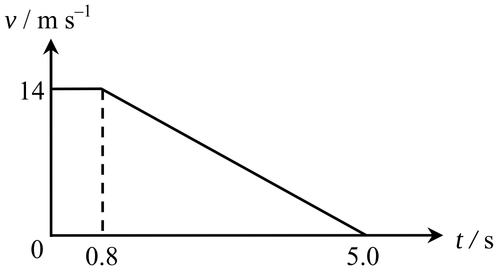
6.



A 1 kg block is pulled by a horizontal force of 5 N and moves with an acceleration of 2 m s^{-2} on a rough horizontal plane. Find the frictional force acting on the block.

A. zero
B. 2 N
C. 3 N
D. 7 N

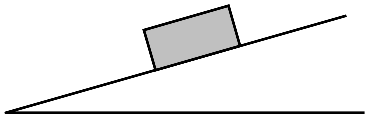
7. Patrick is driving along a straight horizontal road. At time t = 0, he observes that an accident has happened. He then applies the brakes to stop his car with uniform deceleration. The graph shows the variation of the speed of the car with time.



Find the distance travelled by the car from time t = 0 to 5.0 s.

A. 29.4 m
B. 40.6 m
C. 46.2 m
D. 81.2 m

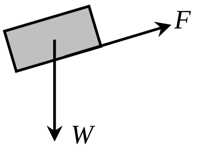
8.



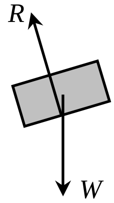
A block remains at rest on a rough inclined plane. Which diagram shows all the forces acting on the block ?

Note : W = gravitational force acting on the block,
R = normal reaction exerted by the inclined plane on the block, and
F = friction acting on the block.

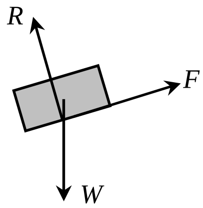
A.



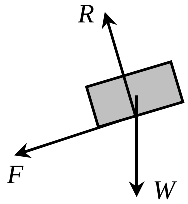
B.



C.



D.



9. Kelvin is standing on a balance inside a lift. The table shows the readings of the balance in three situations.

Motion of the lift	**Reading of the balance**
moving upwards with a uniform speed	R_1
moving downwards with a uniform speed	R_2
moving upwards with an acceleration	R_3

Which relationship is correct ?

A. $R_1 = R_2 > R_3$
B. $R_3 > R_1 = R_2$
C. $R_1 > R_2 > R_3$
D. $R_3 > R_1 > R_2$

10.

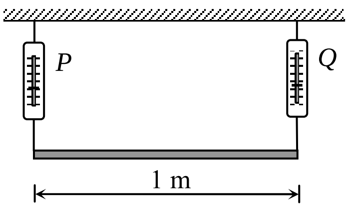


Figure (a)

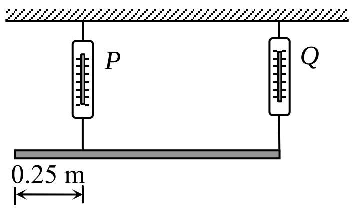


Figure (b)

Figure (a) shows a uniform plank supported by two spring balances P and Q. The readings of the two balances are both 150 N. P is now moved 0.25 m towards Q (see Figure (b)). Find the new readings of P and Q.

	Reading of *P*/N	**Reading of *Q*/N**
A.	100	200
B.	150	150
C.	200	100
D.	200	150

11. Which of the following pairs of forces is/are example(s) of action and reaction ?

(1) The centripetal force keeping a satellite in orbit round the earth and the weight of the satellite.
(2) The air resistance acting on an object falling through the air with terminal velocity and the weight of the object.
(3) The forces of attraction experienced by two parallel wires carrying currents in the same direction.

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

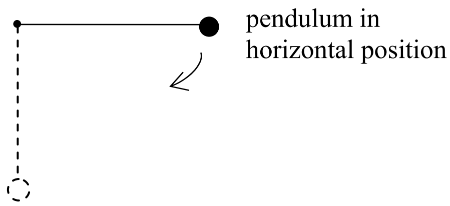
12. Two small identical objects *P* and *Q* are released from rest from the top of a building 80 m above the ground. *Q* is released 1 s after *P*. Neglecting air resistance, what is the maximum vertical separation between *P* and *Q* in the air ?

A. 5 m
B. 10 m
C. 35 m
D. 45 m

13. A car *P* of mass 1000 kg moves with a speed of 20 m s^{-1} and makes a head-on collision with a car *Q* of mass 1500 kg, which was moving with a speed of 10 m s^{-1} in the opposite direction before the collision. The two cars stick together after the collision. Find their common velocity immediately after the collision.

A. 2 m s^{-1} along the original direction of *P*
B. 2 m s^{-1} along the original direction of *Q*
C. 14 m s^{-1} along the original direction of *P*
D. 14 m s^{-1} along the original direction of *Q*

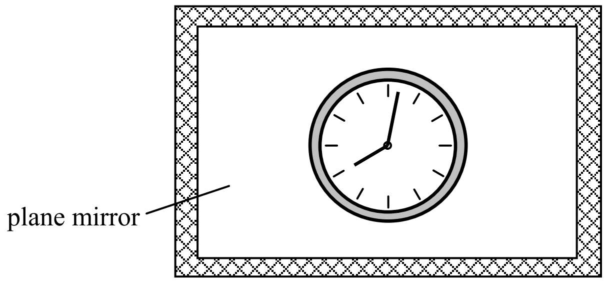
*14.



A simple pendulum is held at rest in a horizontal position. It is then released with the string taut. Which statement about the tension in the string is **not correct** when the pendulum reaches its vertical position ?

A. The tension equals the weight of the pendulum bob in magnitude.
B. The tension attains its greatest value.
C. The tension does not depend on the length of the pendulum.
D. The tension depends on the mass of the pendulum bob.

15.



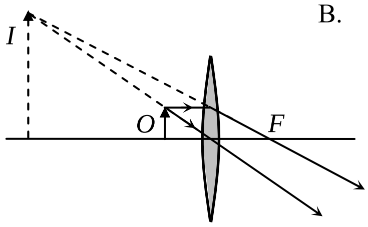
The diagram shows the image of a clock in a plane mirror. What is the time displayed by the clock ?

A. 3:58
B. 4:02
C. 7:58
D. 8:02

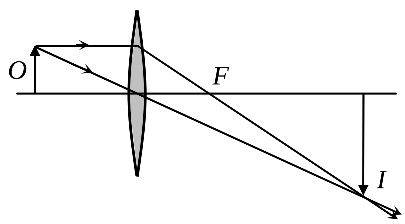
16.

Cecilia uses a magnifying glass to read some small print. Which diagram shows how the image of the print is formed ?

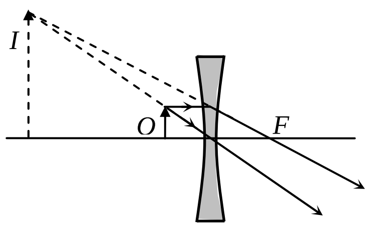
A.



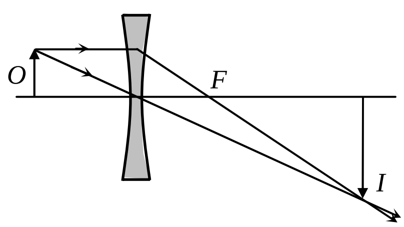
B.



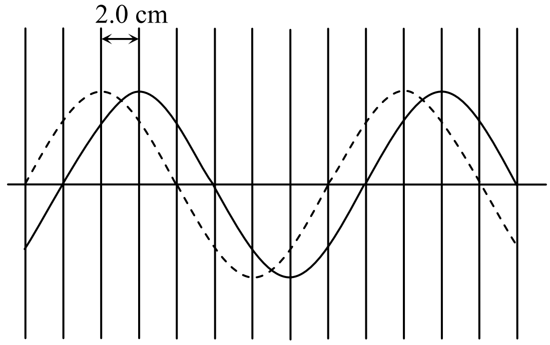
C.



D.



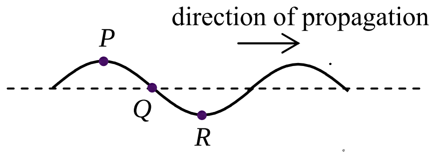
17.



The solid curve in the diagram shows a transverse wave at a certain instant. After 0.05 s, the wave has travelled a distance of 2.0 cm and is indicated by the dashed curve. Find the wavelength and frequency of the wave.

	Wavelength/cm	**Frequency/Hz**
A.	8	2.5
B.	16	2.5
C.	8	5
D.	16	5

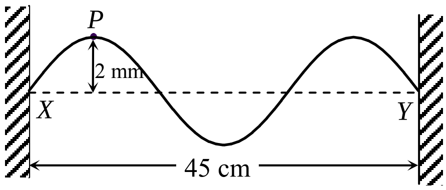
18.



The figure shows the shape of a transverse wave travelling along a string at a certain instant. Which statement about the motion of the particles *P*, *Q* and *R* on the string at this instant is correct ?

A. Particle *P* is moving downwards.
B. Particle *Q* is stationary.
C. Particle *R* attains its maximum acceleration.
D. *P* and *Q* are in phase.

19.



String *XY* is fixed at both ends. The distance between *X* and *Y* is 45 cm. Two identical sinusoidal waves travel along *XY* in opposite directions and form a stationary wave with an antinode at point *P*. The figure shows the string when *P* is 2 mm, its maximum displacement, from the equilibrium position. What is the amplitude and wavelength of each of the **travelling waves** on the string ?

	Amplitude	**Wavelength**
A.	1 mm	30 cm
B.	1 mm	15 cm
C.	2 mm	30 cm
D.	2 mm	15 cm

20. A Young's double-slit experiment was performed using a monochromatic light source. Which change would result in a greater fringe separation on the screen ?

(1) Using monochromatic light source of longer wavelength
(2) Using double slit with greater slit separation
(3) Using double slit with larger slit width

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

21. An object is placed at the focus of a concave lens of focal length 10 cm. What is the magnification of the image formed ?

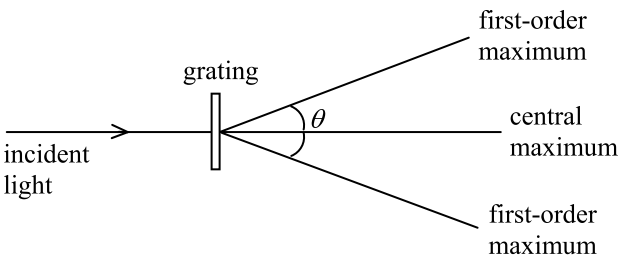
A. 0.5
B. 1.0
C. 2.0
D. infinite

22. Which of the following statements about sound waves is/are correct ?

(1) Sound waves are longitudinal waves.
(2) Sound waves are electromagnetic waves.
(3) Sound waves cannot travel in a vacuum.

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

23.

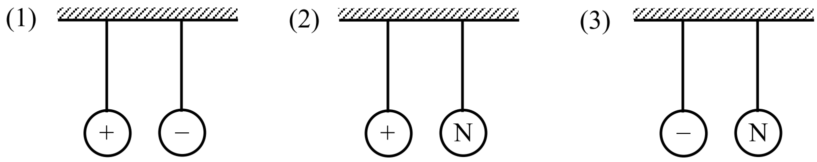


When monochromatic light is passed through a diffraction grating, a pattern of maxima and minima is observed as shown. Which combination would produce the largest angle θ between the first-order maxima ?

	Grating (lines per mm)	**Colour of light used**
A.	200	blue
B.	200	red
C.	400	blue
D.	400	red

24. Two conducting spheres are hanging freely in air by insulating threads. In which of the following will the two spheres attract each other ?

Note : ‘N’ denotes that the sphere is uncharged.



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

25. The table shows three electrical appliances which Clara used in a certain month :

Appliance	Rating	Duration
Air-conditioner	220 V, 1200 W	250 hours
television	220 V, 250 W	80 hours
computer	220 V, 150 W	60 hours

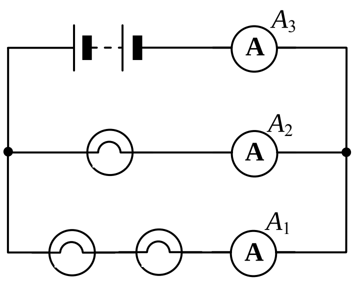
Calculate the cost of electricity used.
Note : 1 kW h of electricity costs $ 0.86.

A. $ 62.25
B. $ 73.79
C. $ 282.94
D. $ 536.64

26. If a 15 A fuse is installed in the plug of an electric kettle of rating ‘220 V, 900 W’, state what happens when the kettle is plugged in and switched on.

A. The kettle will not operate.
B. The kettle will be short-circuited.
C. The output power of the kettle will be increased.
D. The chance of the kettle being damaged by an excessive current will be increase

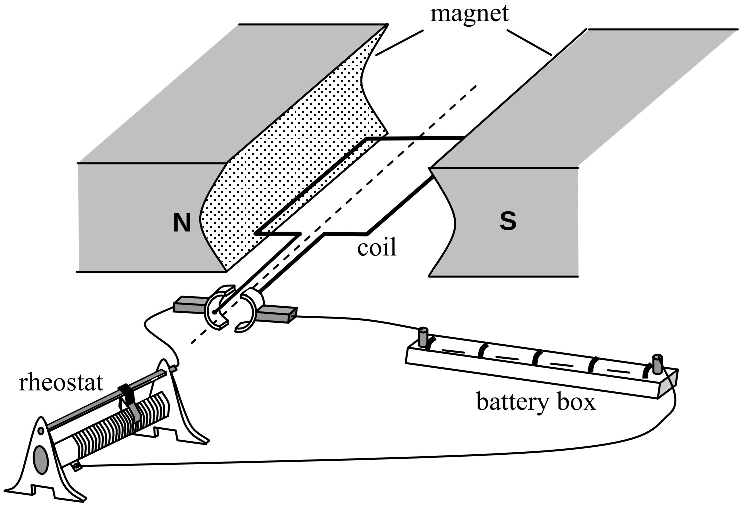
27.



In the above circuit, the bulbs are identical. The reading of ammeter A_1 is 1 A. Find the readings of ammeters A_2 and A_3.

	Reading of A_2	**Reading of A_3**
A.	2 A	2 A
B.	2 A	3 A
C.	0.5 A	1 A
D.	0.5 A	1.5 A

28.

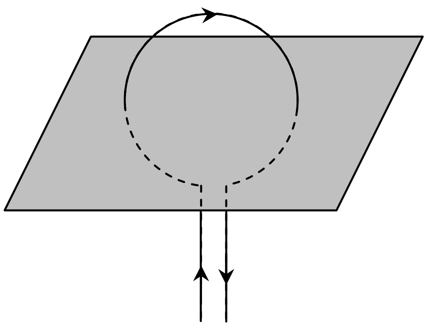


The figure shows a simple motor. Which of these changes would increase the turning effect of the coil ?

(1) using a stronger magnet
(2) reducing the resistance of the rheostat
(3) using a coil with a smaller number of turns

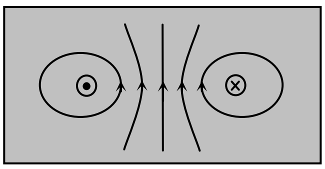
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

29.

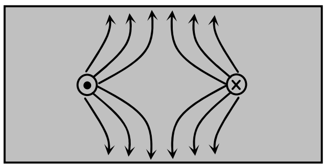


Which diagram shows the magnetic field pattern around a flat circular current-carrying coil, in the plane shown ?

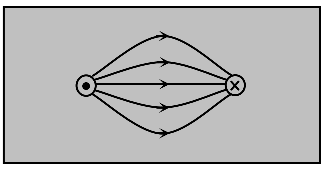
A.



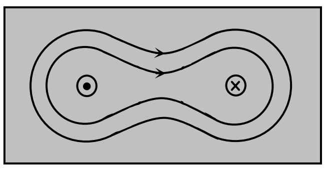
B.



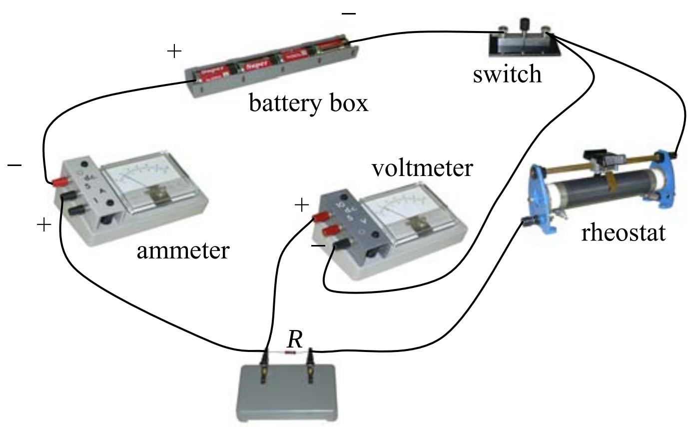
C.



D.



30.

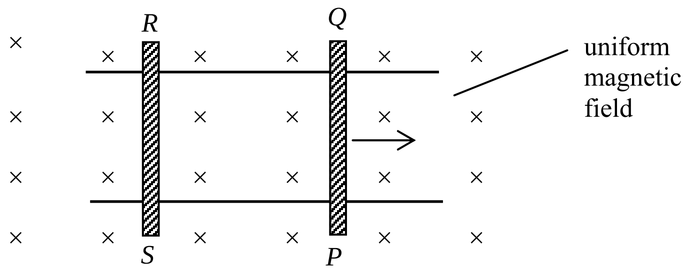


A student wants to measure the resistance of a resistor R and sets up the circuit shown. The student made which of these mistakes setting up the circuit ?

(1) The polarity of the ammeter was reversed.
(2) The polarity of the voltmeter was reversed.
(3) The voltmeter was connected across both R and the rheostat.

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

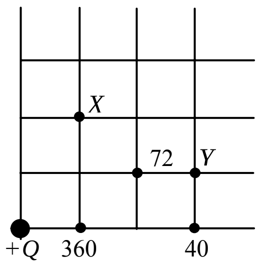
31.



The figure shows conducting rods PQ and RS placed on two smooth, parallel, horizontal conducting rails. A uniform magnetic field is directed into the plane of the paper. PQ is given an initial velocity to the right and left to roll. Which statement is **INCORRECT** ?

A. The induced current is in the direction $PQRS$.
B. The magnetic force acting on rod PQ is towards the left.
C. Rod RS starts moving towards the right.
D. Rod PQ moves with a uniform speed.

32.



The figure shows the location of an isolated charge of size $+Q$. The size (in an arbitrary unit) of the electric field strength is marked at certain points. What is the size (in the same arbitrary unit) of the electric field strength at X and Y ?

	electric field strength at *X*	**electric field strength at *Y***
A.	72	30
B.	72	36
C.	90	30
D.	90	36

*33. Power is transmitted over long distances at high alternating voltages. Which statements are correct ?

(1) Alternating voltages can be stepped up or down efficiently by transformers.
(2) For a given transmitted power, the current will be reduced if a high voltage is adopted.
(3) The power loss in the transmission cables will be reduced if a high voltage is adopted.

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

34. Which of these is a nuclear fusion reaction ?

A. ${}^{235}_{92}\text{U} + \text{n} \rightarrow {}^{144}_{56}\text{Ba} + {}^{90}_{36}\text{Kr} + 2\text{n}$
B. ${}^{2}_{1}\text{H} + {}^{3}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + \text{n}$
C. ${}^{14}_{7}\text{N} + \text{n} \rightarrow {}^{14}_{6}\text{C} + {}^{1}_{1}\text{H}$
D. ${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + \alpha$

*35. On which of the following does the activity of a radioactive source depend ?

(1) the nature of the nuclear radiation emitted by the source
(2) the half-life of the source
(3) the number of active nuclides in the source

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

36. Different absorbers are placed in turn between a radioactive source and a Geiger-Muller tube. Three readings are taken for each absorber. The following data are obtained:

Absorber	**Count rate / s^{-1}**		
–	200	205	198
paper	197	202	206
5 mm aluminium	112	108	111
25 mm lead	60	62	58
50 mm lead	34	36	34

What type(s) of radiation does the source emit ?

A. β only
B. γ only
C. β and γ only
D. α, β and γ

END OF SECTION A

List of data, formulae and relationships

Data

speed of light in vacuum	$c = 3.00 \times 10^{8}$ m s^{-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}
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	$\varepsilon_o = 8.85 \times 10^{-12}$ C^{2} N^{-1} m^{-2}
permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ H m^{-1}
Planck constant	$h = 6.63 \times 10^{-34}$ J s
molar gas constant	$R = 8.31$ J K^{-1} mol^{-1}
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
atomic mass unit (1 u is equivalent to 931 MeV)	u = 1.661×10^{-27} kg

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 $\quad y = mx + c$

Arc length = $r\,\theta$

Surface area of cylinder $\quad = 2\pi rh + 2\pi r^2$

Volume of cylinder $\quad = \pi r^2 h$

Surface area of sphere $\quad = 4\pi r^2$

Volume of sphere $\quad = \frac{4}{3}\pi r^3$

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

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.	$F = kx$	Hooke's law
B6.	$P = Fv = \frac{W}{t}$	mechanical power
B7.	$a = \frac{\upsilon^2}{r} = \omega^2 r$	centripetal acceleration
B8.	$F = \frac{Gm_1m_2}{r^2}$	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.	$E = \frac{V}{d}$	energy field between parallel plates (numerically)
D5.	$I = nA\upsilon Q$	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.	$F = BQ\upsilon\sin\theta$	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.	$E = mc^2$	mass-energy relationship

Astronomy and Space Science

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

Energy and Energy Use

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

Atomic World

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

Medical Physics

$\theta = \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
power $= \frac{1}{f}$	power of a lens
$10\log\frac{I}{I_o}$	intensity level (dB)
$Z = pc$	acoustic impedance
$\alpha = \frac{I_r}{I_o} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_o e^{-\mu x}$	transmitted intensity through a medium

B

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

PHYSICS PAPER 1 (Sample Paper)

Section B : Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS

(1) Write your Candidate Number in the space provided on Page 1.

(2) Stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.

(3) This section carries 84 marks. 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) 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. Tie them loosely but securely with a string INSIDE this Question-Answer Book.

(6) The diagrams in this section are **NOT** necessarily drawn to scale.

Please stick the barcode label here.

Candidate Number							

	Marker's Use Only	**Examiner's Use Only**
	Marker No.	Examiner No.
Question No.	Marks	Marks
1		
2		
3		
4		
5		
6		
7		
8		
9		
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12		
13		
14		
Total		

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

1.

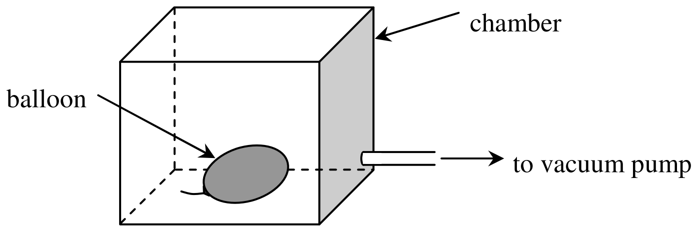


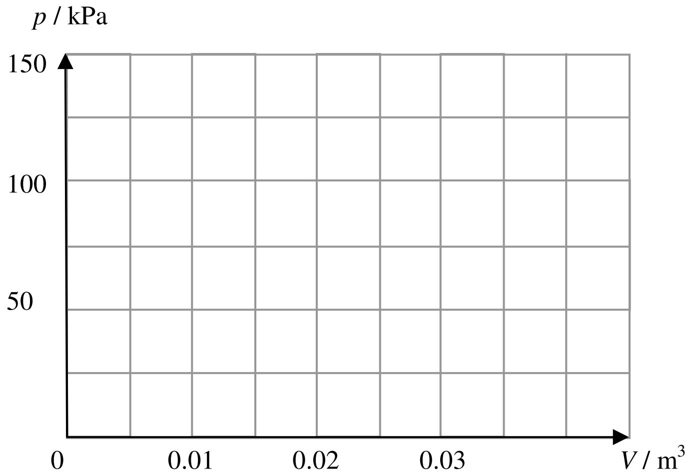
Figure 1.1

A balloon containing 0.01 m^3 of gas at a pressure of 100 kPa is placed inside a chamber. Air is slowly pumped out from the chamber while the temperature remains unchanged.

*(a) Explain, in terms of molecular motion, how the gas inside the balloon exerts a pressure on its inner surface. (2 marks)

*(b) Find the final pressure inside the balloon when its volume is doubled. (2 marks)

*(c) Sketch a graph to show the relationship between the pressure p inside the balloon and the volume V of the balloon. (2 marks)



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2.

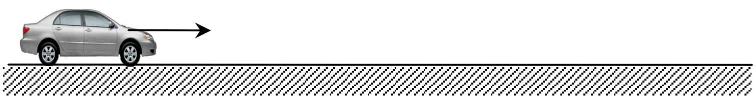

Figure 2.1

In a road test, John drives his car along a straight horizontal road (see Figure 2.1). The car takes 9.3 s to accelerate from rest to 100 km h^{-1}. The total mass of John and his car is 1400 kg.
(Note: 100 km h^{-1} = 27.8 m s^{-1})

(a) Find the total kinetic energy of John and his car when travelling at 100 km h^{-1}. Hence estimate the average output power of the car during this acceleration. (3 marks)

(b) A similar road test is conducted on an inclined road. The car now takes more than 9.3 s to accelerate from rest to 100 km h^{-1} along the road (see Figure 2.2). Assume the output power of the car remains unchanged. Explain why it takes a longer time for the car to accelerate up an inclined road than along a horizontal road. (2 marks)

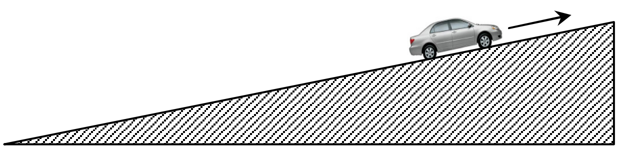

Figure 2.2

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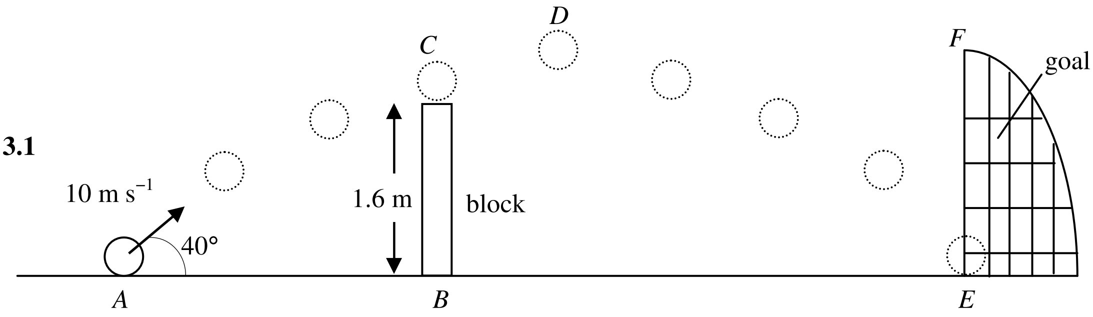
3. A ball is kicked and moves with an initial velocity of 10 m s^{-1} at an angle of 40° to the horizontal. The ball then just passes a block of height 1.6 m, reaching the highest point *D*, and finally hits the ground at *E* as shown in Figure 3.1. (Neglect air resistance and the size of the ball.)

Figure 3.1



(a) Draw an arrow to indicate the direction of acceleration of the ball at *C*. (1 mark)

*(b) For a projectile of initial velocity u that makes an angle θ with the horizontal, show that its horizontal range is given by $\dfrac{u^2 \sin 2\theta}{g}$. Hence, or otherwise, find another angle of projection such that the ball can still reach *E* with the same initial speed of 10 m s^{-1}.
(Given: $2 \sin\theta\cos\theta = \sin2\theta$) (4 marks)

(c) Calculate the speed of the ball at *C*. (2 marks)

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4. One end of a piece of string is fixed to a wall. A wave pulse travels along the string at a speed of $0.5\ \text{m s}^{-1}$ towards the fixed end. Figure 4.1 shows the string at time $t = 0$ s and $t = 2$ s.

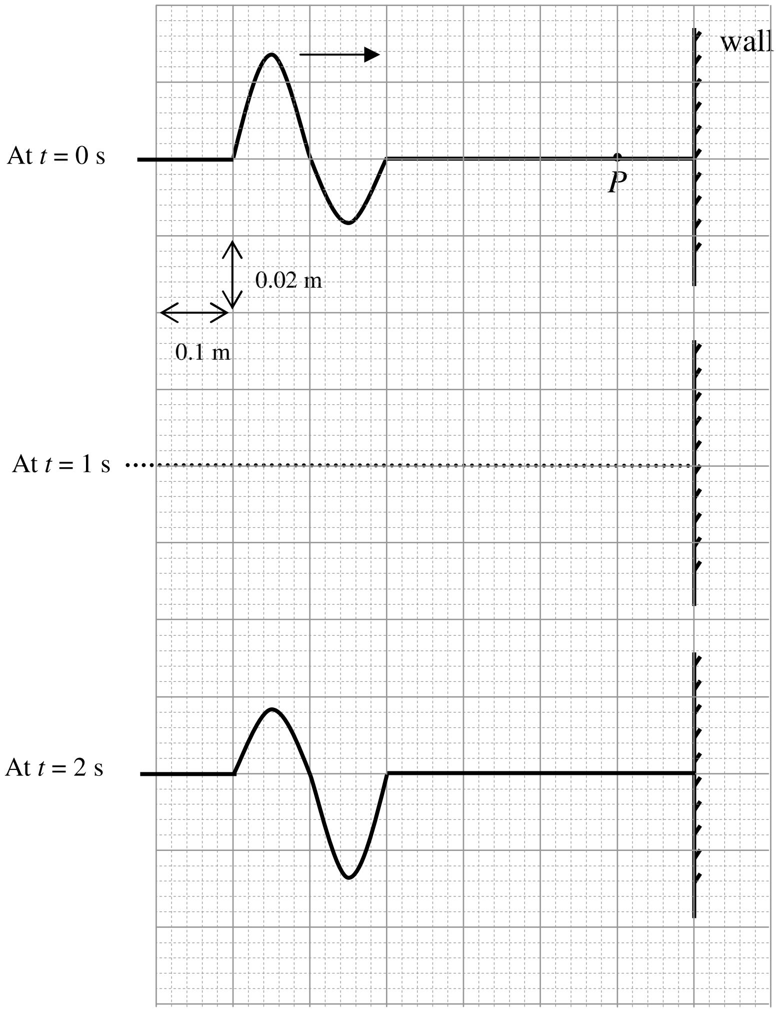
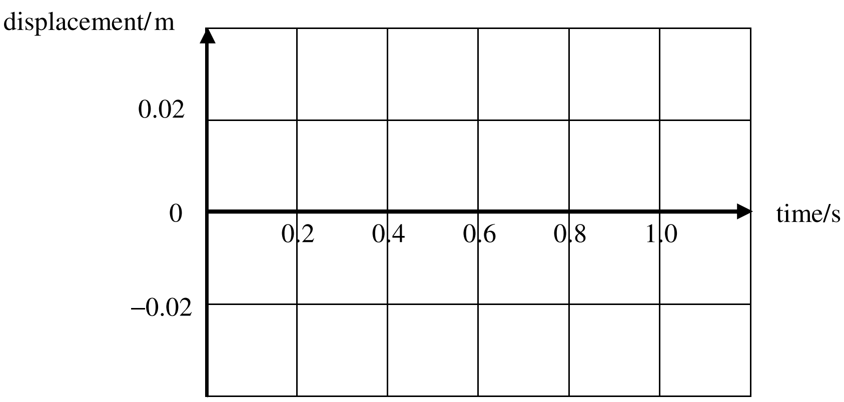


Figure 4.1

(a) On Figure 4.1, draw the shape of the wave pulse at t = 1 s. (1 mark)

(b) Sketch a graph of the displacement of point P on the string at a distance of 0.1 m from the wall during the period $t = 0$ s to $t = 1$ s. (2 marks)



5.

Figure 5.1

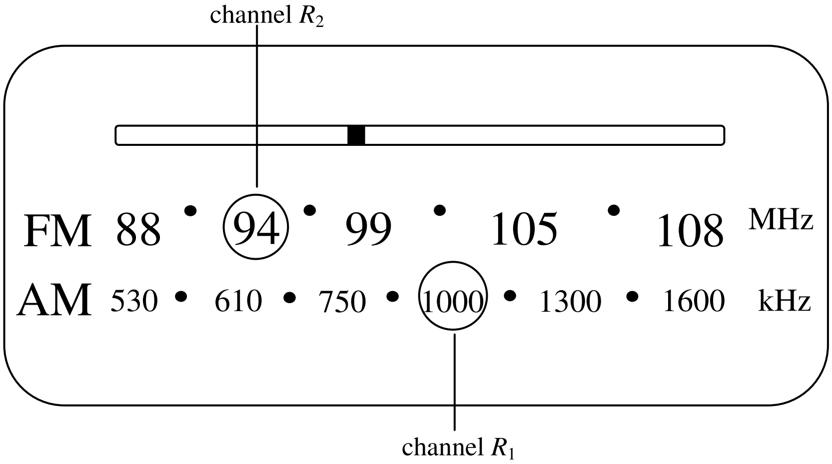


Figure 5.1 shows the display panel of a radio and the broadcasting frequencies of two radio channels R_1 and R_2. Given : speed of electromagnetic waves = 3.00×10^8 m s^{-1}

(a) Find the wavelength of the radio waves used by channel R_1. (1 mark)

(b) Anita's house is surrounded by hills and at her house, the reception of one of the two radio channels is better. For which radio channel is the reception better ? Explain your answer. (2 marks)

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6.

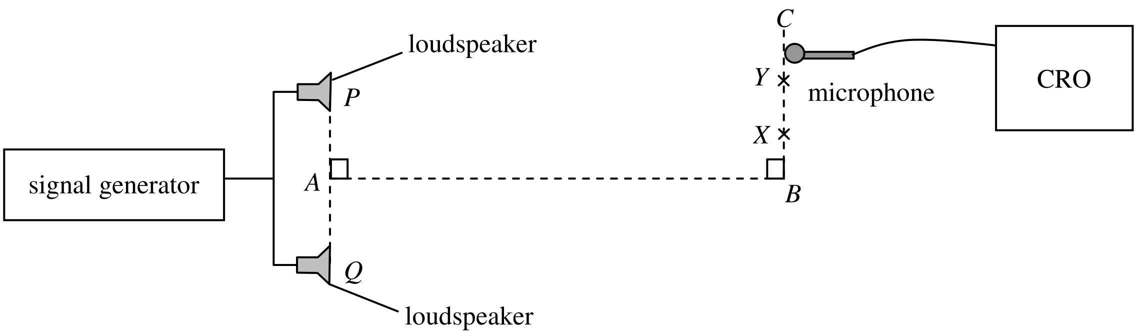

Figure 6.1

Figure 6.1 shows two identical loudspeakers *P* and *Q* are connected to a signal generator. Position *A* is the mid-point of *PQ*. A microphone connected to a CRO is moved along *BC*. The amplitude of the CRO trace increases as the loudness of the sound detected increases. Figure 6.2 shows how the amplitude of the CRO trace varies with the position of the microphone.

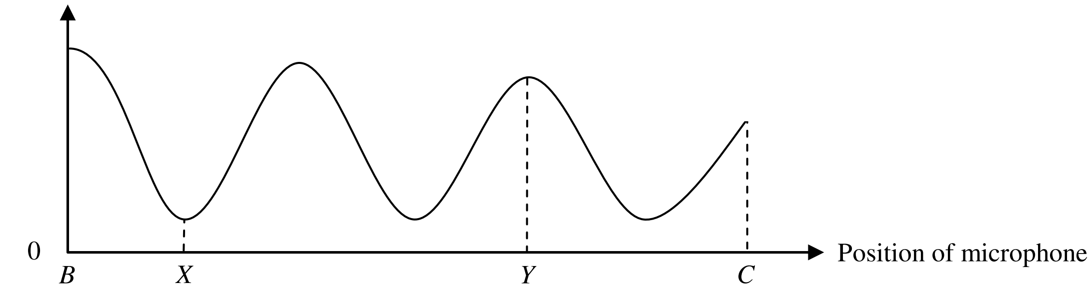

Figure 6.2

(a) (i) Explain why the loudness of the sound varies along *BC*. (2 marks)

(ii) State **ONE** reason why the amplitude of the CRO trace is **NOT** zero at position *X*. (1 mark)

(b) If $PY = 5.10$ m and $QY = 5.78$ m, find the wavelength of the sound. (2 marks)

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7. Amy uses the motor of a toy fan as a simple generator. She connects a bulb to the two terminals of the motor. This is shown in Figure 7.1.

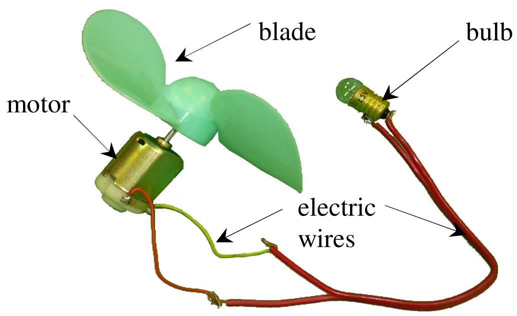

Figure 7.1

The bulb lights up when the blades are turned rapidly. Explain why and state the energy conversion taking place in this process. (4 marks)

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8. Figure 8.1 shows an earth leakage circuit breaker (漏電斷路器) installed in a domestic circuit. The live and the neutral wires pass through the centre of a soft iron ring of mean radius 1 cm. A 100-turn coil C with cross-section area 0.8 cm^2 is wound on the ring.

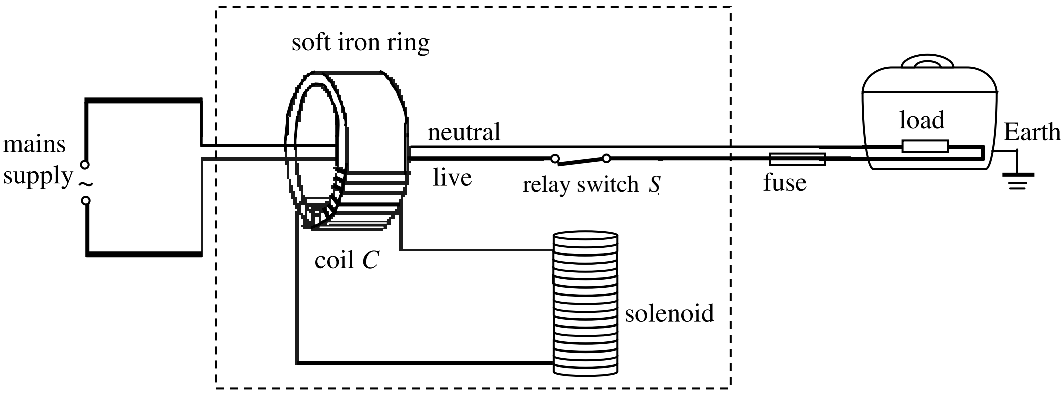

Figure 8.1

In case of an earth leakage in the domestic circuit such that the current in the neutral wire and the live wire differ by 0.5 A or more, the relay switch *S* opens and disconnects the mains supply. To reconnect the supply, *S* has to be reset manually.

(a) Explain why *S* opens when there is a leakage current of 0.5 A from the load to the Earth. (3 marks)

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(b) Calculate the magnetic field B through coil C when there is a leakage current of 0.5 A from the load to the Earth. The magnetic field B due to a current-carrying conductor is 1500 times larger in soft iron. (2 marks)

(c) Electrical appliances are usually equipped with fuses. When a short circuit occurs between the live and neutral wires, the fuse blows but the earth leakage circuit breaker does not operate. Explain these observations. (2 marks)

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9.

Figure 9.1

Figure 9.1 shows a microwave oven. Mary wants to estimate the useful output power of the oven. She is provided with the apparatus and material shown in Figure 9.2.

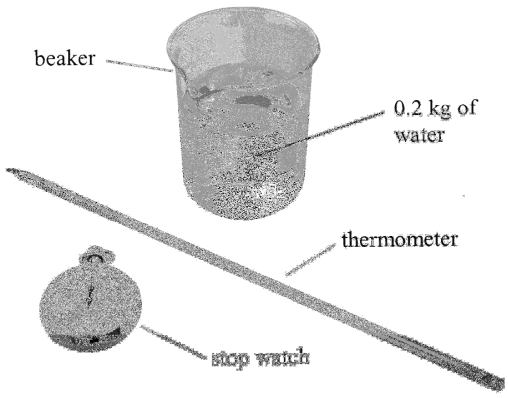

Figure 9.2

(a) Describe how Mary should conduct the experiment. Specify all measurements Mary has to take. State **EITHER** one precaution taken **OR** one assumption made when conducting this experiment. Write down an equation for calculating the useful output power. (5 marks)

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(b) The value obtained by Mary is found to be smaller than the rated power of the oven. Suggest one possible reason to account for this difference. (1 mark)

(c) Explain whether increasing the mass of water used in the experiment would improve the accuracy of the experiment. (1 mark)

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10.

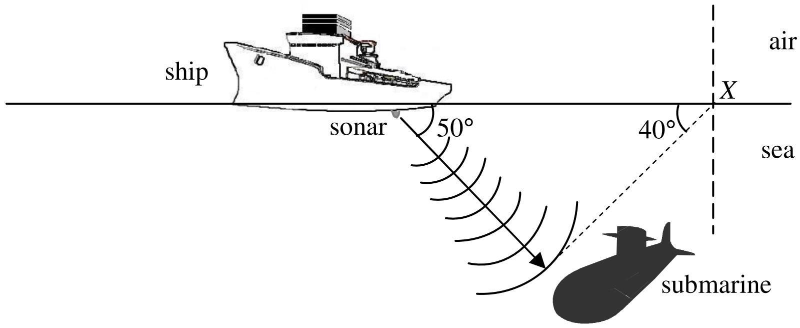

Figure 10.1

Figure 10.1 shows a ship equipped with sonar. The sonar emits ultrasonic waves of frequency 25 kHz into the sea. The waves propagate at an angle of 50° to the surface of the sea and are reflected from a submarine back to the ship after 0.15 s.

Given : speed of sound in air = 340 m s^{-1}
speed of sound in sea water = 1500 m s^{-1}

(a) Calculate the vertical distance of the submarine beneath the sea surface. (2 marks)

(b) Some of the reflected waves propagate along the dotted line and emerge into the air at *X*. Calculate the angle of refraction in air. (2 marks)

(c) Is it possible for ultrasonic waves, at certain angles of incidence, to undergo total internal reflection when they go from sea water to the air ? Explain. (2 marks)

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11. (a) A spacecraft with an astronaut on board is launched on a rocket. The rocket with the spacecraft has an initial mass of 4.80×10^5 kg at take-off. The rocket engine expels hot exhaust gas at a constant speed of 2600 m s^{-1} downwards relative to the rocket. Assume that 1.15×10^3 kg of gas is expelled in the first 0.5 s. (Neglect air resistance.)

(i) Calculate the average thrust (the upward force) acting on the rocket due to the exhaust gas during the first 0.5 s. (2 marks)

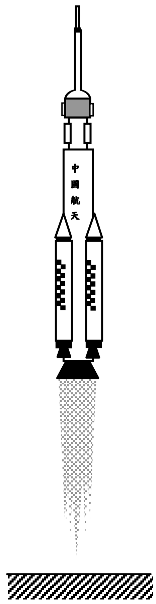

Figure 11.1

(ii) On Figure 11.1, draw and label an arrow for each force acting on the rocket. Assuming that the change in mass of the rocket during the first 0.5 s is negligible, estimate the acceleration of the rocket. (3 marks)

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(b) The spacecraft of mass 7.80×10^{3} kg now enters a circular orbit of radius r around the Earth.

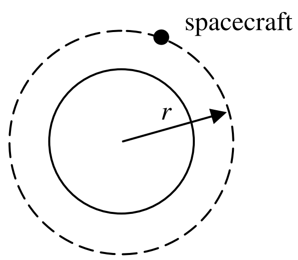

Figure 11.2

*(i) Show that the speed of the spacecraft in the orbit is given by $\sqrt{\frac{g}{r}}R_E$ where R_E is the radius of the Earth. (2 marks)

*(ii) How long does it take for the spacecraft to orbit the Earth 14 times ? (3 marks)
Given : radius of the orbit $r = 6.71\times10^{6}$ m
radius of the Earth $R_E = 6.37\times10^{6}$ m

(c) Give **ONE** reason why an aircraft is unable to fly in space like a rocket. (1 mark)

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12.

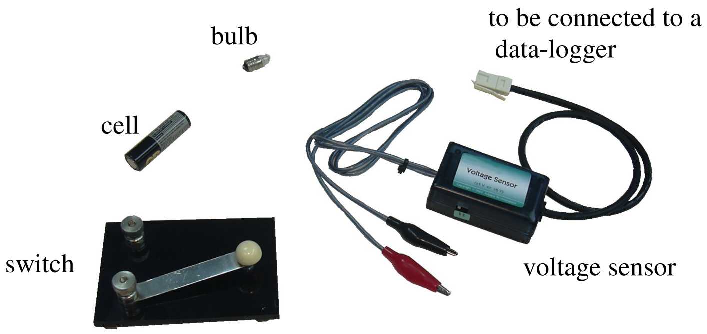


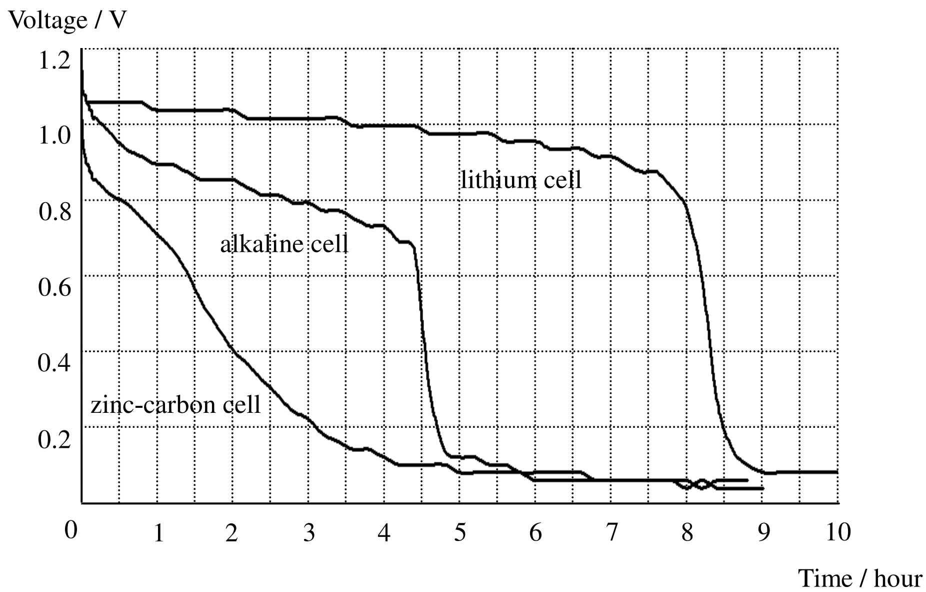
Figure 12.1

Iris uses the apparatus shown in Figure 12.1 to study the lifetime of AA-size cells when used to power a bulb. She connects a cell and a switch to the bulb and uses a voltage sensor to measure the voltage across the bulb.

(a) Draw a circuit diagram to illustrate how the apparatus is connected. Use the symbol (V) to denote the voltage sensor and the data-logger. (2 marks)

(b) Iris conducts the experiment with a zinc-carbon cell, an alkaline cell and a lithium cell separately. Figure 12.2 shows the variation of the voltage across the bulb with time for the cells. The bulb lights up as long as the voltage across it is above 0.6 V.

Figure 12.2



Answers written in the margins will not be marked.

(b) (i) A salesman claims that the lifetime of a lithium cell for lighting up the bulb is five times that of an alkaline cell. Determine whether the claim is correct or not. (2 marks)

(ii) Table 12.3 shows the prices of the three types of cell.

Type of cells	Price per cell
zinc-carbon	\$ 1.5
alkaline	\$ 3.8
lithium	\$25.0

Table 12.3

Which type of cells is the best buy, in terms of the cost per hour for lighting up the bulb ? Show your calculations. (3 marks)

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13. Josephine conducts an investigation on transformers. Primary and secondary coils are wound on two soft-iron C-cores to form a transformer. She sets up a circuit as shown in Figure 13.1.

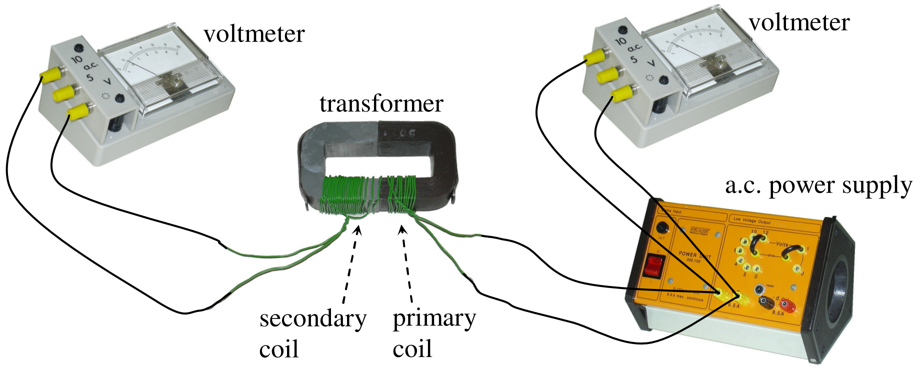

Figure 13.1

*(a) Josephine varies the input voltage V_1 to the transformer and records the corresponding output voltage V_2. The results are shown in Table 13.2. Figure 13.3 shows the graph of V_2 against V_1. Draw a conclusion for this investigation.

V_1 / V	V_2 / V
1.5	2.5
3.0	5.1
4.5	7.6
6.0	10.0

Table 13.2

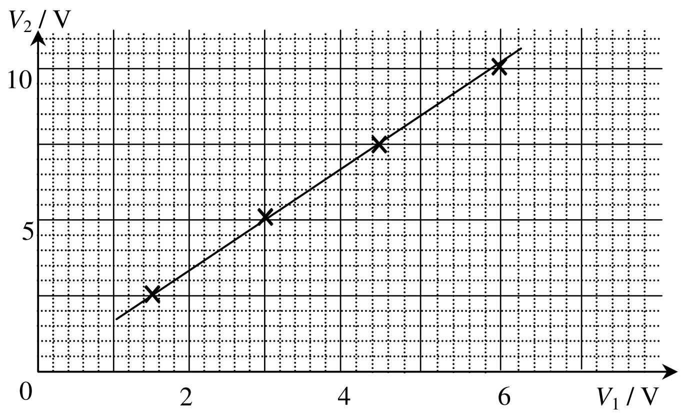

Figure 13.3

(1 mark)

----

*(b) Deduce the value of V_2 that will be produced when V_1 equals 8.0 V. (1 mark)

----

*(c) Josephine wants to study the relationship between the output voltage and the number of turns in the secondary coil of the transformer. Describe how she can conduct the experiment. (2 marks)

*(d) Josephine adds a bulb to the circuit as shown in Figure 13.4. Suggest how Josephine can estimate the efficiency of the transformer. State the measurement(s) she must take. Additional apparatus may be used if necessary. (3 marks)

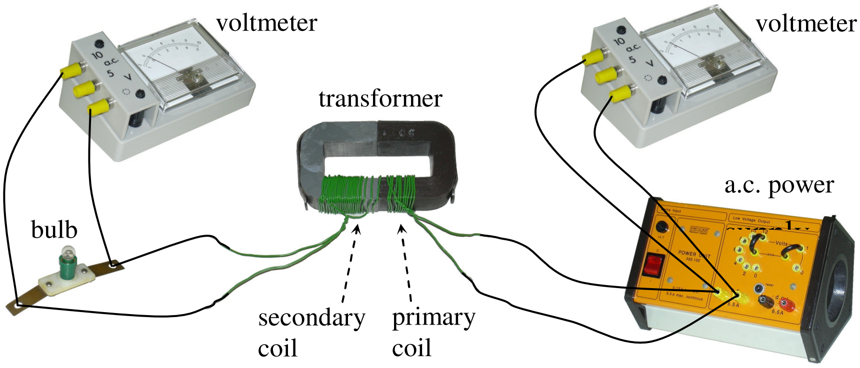

Figure 13.4

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14. In April 1986, a disastrous nuclear accident happened at the Chernobyl Nuclear Power Station. A large quantity of various radioactive substances was released and spread to neighbouring countries. The radiation levels recorded in these countries were much higher than the normal background count rate.

(a) State **ONE** source of background radiation. (1 mark)

(b) One of the radioactive isotopes released in the accident was caesium-137 (Cs-137). The following equation shows how Cs-137 is produced :

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{137}_{55}\mathrm{Cs} + {}^{95}_{37}\mathrm{Rb} + x\,{}^{1}_{0}\mathrm{n}$$

Given : mass of one nuclide of $^{235}_{92}\mathrm{U}$ = 235.0439 u

$^{137}_{55}\mathrm{Cs}$ = 136.9071 u

$^{95}_{37}\mathrm{Rb}$ = 94.9399 u

$^{1}_{0}\mathrm{n}$ = 1.0087 u

1 u is equivalent to 931 MeV

(i) What is the value of x ? (1 mark)

*(ii) Find the energy release in the fission of one U-235 nuclide in MeV. (2 marks)

*(iii) The half-life of Cs-137 is 30 years. A soil sample contaminated by Cs-137 has an activity of 1.2×10^{6} Bq (disintegrations per second). A physicist comments that the contaminated sample will affect the environment for more than 350 years. Justify the physicist's claim with calculations. It is known that the activity of an uncontaminated soil sample is 200 Bq. (2 marks)

END OF PAPER

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PHYSICS PAPER 2 (Sample Paper)

Question-Answer Book

Time allowed : 1 hour
This paper must be answered in English

INSTRUCTIONS

(1) Write your Candidate Number in the space provided on Page 1.

(2) Stick barcode labels in the spaces provided on Pages 1, 3, 5 and 7.

(3) Answer the questions from any **TWO** sections of this paper.

(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) 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. Tie them loosely but securely with a string INSIDE this Question-Answer Book.

(6) The diagrams in this section are **NOT** necessarily drawn to scale.

	Marker's Use Only	**Examiner's Use Only**
	Marker No.	Examiner No.
Question No.	Marks	Marks
Section A 1-8		
Section A 9		
Section B 1-8		
Section B 9		
Section C 1-8		
Section C 9		
Section D 1-8		
Section D 9		

Section A : Astronomy and Space Science

Given : 1 astronomical unit = 1.50×10^{11} m
1 parsec = 3.08×10^{16} m = 3.26 ly
1 light year = 9.46×10^{15} m

A1. Which of the following is **NOT** contained in the astronomical object shown in the figure ?

A. Cluster of galaxies
B. Nebula
C. Star
D. Star cluster

Answer : _______

A2. Hong Kong's longitude and latitude are 114.1°E and 22.3°N respectively. What is the altitude of the north celestial pole when observed in Hong Kong ?

A. 22.3°
B. 65.9°
C. 67.7°
D. 114.1°

Answer : _______

A3. Which of the following statements concerning the celestial sphere model can be used to explain why stars in the east are rising and stars in the west are setting ?

A. The celestial sphere rotates from west to east with a period of a day.
B. The celestial sphere rotates from east to west with a period of a day.
C. Stars move on the celestial sphere from west to east with a period of a year.
D. Stars move on the celestial sphere from east to west with a period of a year.

Answer : _______

A4. According to the Ptolemy's geocentric model,

A. Jupiter moves in a circular orbit around the Earth.
B. The Earth-Venus distance is always smaller than the Earth-Sun distance.
C. The Earth-Mars distance is always smaller than the Earth-Sun distance.
D. It is not possible to observe Jupiter at mid-night.

Answer : _______

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A5. Which statement is **INCORRECT** ?

A. Planets move around stars in elliptical orbits.
B. Comets move around the Sun in elliptical orbits.
C. The cube of the orbital period of a planet is proportional to the square of the length of its semi-major axis around the Sun.
D. For a given planet orbiting around the Sun, the speed of the planet increases as its distance from the Sun decreases.

Answer : _______

A6. The average of the closest and farthest distances of a comet from the Sun is 18 AU. What is its orbital period ?

A. 6.9 yr
B. 18 yr
C. 76 yr
D. 200 yr

Answer : _______

(For Questions 7 and 8) A star has a luminosity 1000 times that of the Sun and its surface temperature is 3900 K.

A7. The star is a

A. supernova.
B. white dwarf.
C. blue giant star.
D. red giant star.

Answer : _______

A8. What is the radius of the star ? (Assume that the surface temperature of the Sun is 5800 K and that all stars are blackbody emitters.)

A. 14 times the radius of the Sun
B. 21 times the radius of the Sun
C. 70 times the radius of the Sun
D. 4900 times the radius of the Sun

Answer : _______

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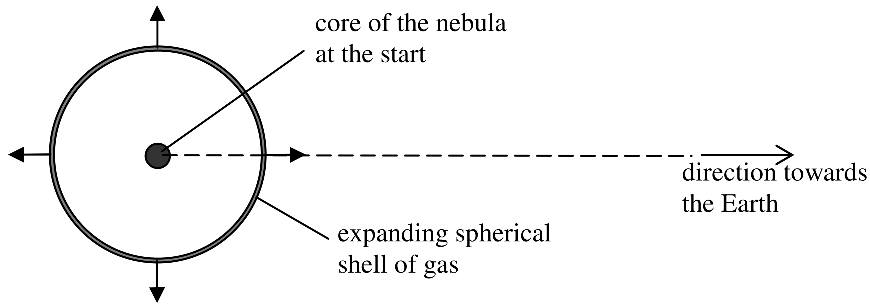
A9. The Crab Nebula is an expanding, roughly spherical shell of gas in the constellation Taurus. According to a recent study, its average apparent angular size is 5.8 arc minute. The whole nebula has negligible velocity relative to the Earth, and the nebula is at a distance of 2000 pc from the Earth. The wavelength of an O III spectral line found in the spectrum of the light emitted by the gas moving towards the Earth from around the middle part of the Crab Nebula is 374.13 nm along the line of sight of an observer on the Earth. The wavelength of the same spectral line observed in the laboratory is 375.99 nm.



(a) What is the radius of the Crab Nebula ? Give your answer to two significant figures in parsecs. (2 marks)

(b) Calculate the speed of that gas which is moving towards the Earth. Give your answer in km s^{-1} to two significant figures. (3 marks)

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A9. (c) (i) The Crab Nebula was formed by the explosion of a star whose size was negligible compared with the present size of the nebula. Estimate the age of the Crab Nebula. Give your answer to two significant figures in years. State the assumption made in your calculation. (3 marks)

(ii) Actually, the Chinese observed the stellar explosion which created the Crab Nebula in 1054 A.D. and so we know that its age is about 950 years. Give a possible reason to explain why the Crab Nebula's age estimated in (c)(i) is longer than 950 years. (2 marks)

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Section B : Atomic World

B1. Which of these conclusions could **NOT** be deduced from Rutherford's scattering experiment ?

(1) Alpha particles are helium nuclei.
(2) There are discrete energy levels in an atom.
(3) The positive charge in an atom is confined to a very small region.

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

Answer : _______

B2. The equivalent wavelength of a photon of energy 10 eV is

A. 213 nm
B. 124 nm
C. 25.6 nm
D. 19.7 nm

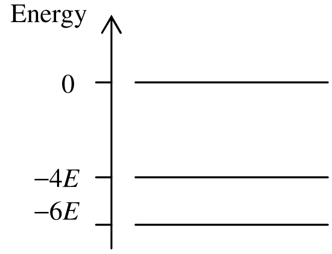
Answer : _______

B3. The ionization potential of a hydrogen atom is 13.6 V. How much energy is required to excite an electron from the ground state to the first excited state in a hydrogen atom ?

A. 10.2 eV
B. 6.8 eV
C. 3.4 eV
D. 1.9 eV

Answer : _______

B4.



The energy levels of a certain atom are as shown. Which of these may undergo an inelastic collision with the atom ?

(1) an electron with kinetic energy $3E$
(2) a photon with energy $2E$
(3) a photon with energy $3E$

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

Answer : _______

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B5. In an experiment on the photoelectric effect, a beam of monochromatic light is directed onto a metal plate to liberate electrons. The velocity of the fastest photoelectrons emitted is

A. directly proportional to the frequency of the incident light.
B. directly proportional to the intensity of the incident light.
C. independent of the nature of metal.
D. independent of the intensity of the incident light.

Answer : _______

B6. The work function W of five metals are tabulated below.

Metal	Caesium	Barium	Calcium	Magnesium	Beryllium
$W/10^{-19}$ J	3.4	4.0	4.6	5.9	8.0

When monochromatic light of wavelength 400 nm is incident on each of the metals, how many of them would exhibit photoelectric emission ?

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

Answer : _______

B7. Which of the following statements is/are correct ?

(1) Photoelectric effect is an evidence that light possesses particle nature.
(2) Electron diffraction suggests that electrons can behave like waves.
(3) The line spectrum of atomic hydrogen suggests that the atom has discrete energy levels.

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

Answer : _______

B8. Graphite is a conductor because of the ‘delocalization’ of electrons. Where are these delocalized electrons ?

A. formed on the surface of graphite.
B. formed within the carbon layers of graphite.
C. formed homogeneously within graphite.
D. formed in a ‘sea’ of positive ions.

Answer : _______

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B9. (a) An electron is accelerated from rest through a potential difference V (in V). Show that its final de Broglie wavelength λ (in nm) is given by $\lambda \approx \dfrac{1.23}{\sqrt{V}}$. (2 marks)

(b) In a transmission electron microscope (TEM), electrons are accelerated by a potential difference of 50 kV.

(i) Estimate the final de Broglie wavelength of the electrons. (1 mark)

(ii) Describe how the electrons are focused in the TEM and explain how the image of the sample is formed. (3 marks)

(iii) Suggest **ONE** method to increase the resolving power of the TEM. Explain. (2 marks)

(c) State **ONE** daily life application of nanotechnology and discuss any potential health risks associated with it. (2 marks)

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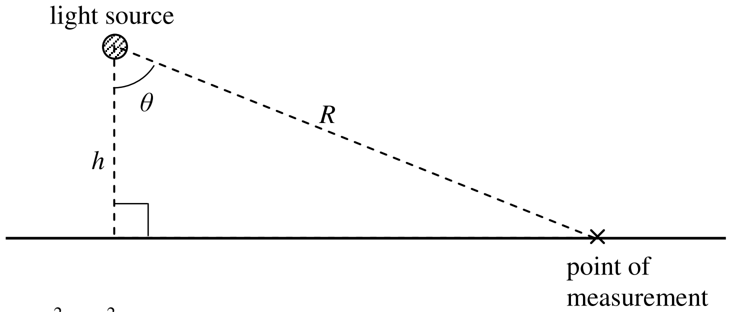
Section C : Energy and Use of Energy

C1. The Coefficient of Performance (COP) of a heat pump is

A. the ratio of energy absorbed from the cold reservoir to the energy rejected to the hot reservoir.
B. the heat energy rejected to the hot reservoir per unit work input.
C. the ratio between the total energy input to the useful work done.
D. the ratio between the extra work input to the total energy input.

Answer : _______

C2. In the figure, a light source is a perpendicular distance h above a horizontal surface. The amount of illuminance (unit: lux) of a point on the surface at a distance R from the source is directly proportional to



A. $\cos^2\theta / R^2$
B. $\cos^2\theta / h^2$
C. $\cos^3\theta / h^2$
D. $\cos^3\theta / R^2$

Answer : _______

C3. If each fission of uranium-235 liberates 200 MeV of energy, how much uranium-235 must undergo fission per second to generate a power of 1000 MW ?

A. 2.0×10^{-24} kg
B. 2.2×10^{-10} kg
C. 5.2×10^{-8} kg
D. 1.2×10^{-5} kg

Answer : _______

C4. Which of these is **NOT** an advantage of Battery Electric Vehicle ?

A. zero emission
B. low energy cost per kilometre covered
C. long mileage range
D. energy security by diversifying energy sources

Answer : _______

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C5. Which of these actions reduces the heat gained in the summer by buildings in Hong Kong ?

A. Increase the OTTV values of the building envelope
B. Apply solar films on windows to reduce solar heat gain
C. Minimise internal heat gain from indoor activities
D. Improve the air-tightness of the building envelope

Answer : _______

C6. The solar constant is 1367 W m^{-2} (power per unit area from the Sun reaching the outer atmosphere) and the Earth-Sun distance is 1.50×10^{11} m (i.e. 1 AU), estimate the total radiation power of the Sun.

A. 3.9×10^{26} W
B. 3.2×10^{25} W
C. 2.3×10^{25} W
D. 7.7×10^{24} W

Answer : _______

C7. In estimating the maximum power available from a wind turbine, what is assumed to true ?

(1) The density of air is constant.
(2) The direction of wind relative to the orientation of the turbine is unchanged.
(3) The area swept by the turbine is constant.

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

Answer : _______

C8. A fuel cell cannot be classified as a Renewable Energy Source because

A. it is a secondary energy source.
B. its supply is limited.
C. it is from fossil sources.
D. the time scale for regeneration is too long.

Answer : _______

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C9. (a) Gas cookers and induction cookers are common domestic cooking devices. Their typical conversion efficiencies and costs are tabulated below:

Cooking device	Conversion efficiency	Cost
Gas cooker	40%	\$0.25 per MJ
Induction cooker	75%	\$0.90 per kW h

(i) Explain how an induction cooker generates heat in a cooking vessel placed on it. (2 marks)

(ii) Give a reason why the conversion efficiency of gas cookers is much lower than that of induction cookers. (1 mark)

(iii) If a gas cooker and an induction cooker are used to heat up 1 kg of water at room temperature of 25°C to boiling. Calculate the cost of doing this for each cooker. (4 marks)
Given : specific heat capacity of water = 4200 J $kg^{-1}°C^{-1}$.

(b) The European Commission is preparing to replace incandescent light bulbs across most of Europe by compact fluorescent light bulbs (CFLs) or light emitting diodes (LEDs). State **TWO** advantages and **TWO** disadvantages of such a move. (3 marks)

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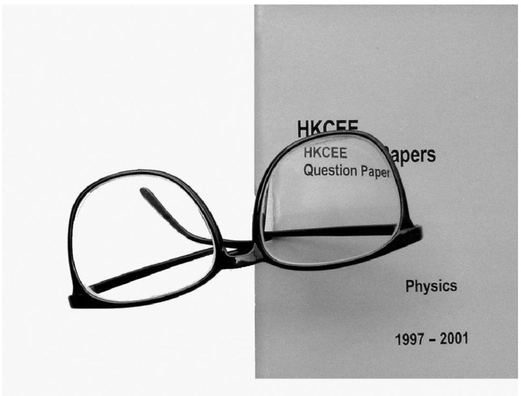
Section D : Medical Physics

The table shows the speed of sound in, and density of, different tissues.

Tissue	Speed of sound in tissue / m s^{-1}	Density / kg m^{-3}
Fat	1450	952
Blood	1570	1025
Muscle	1580	1076
Bone	3050	2560

D1.



A man places his spectacles on a book as shown above. What kind of lenses does he wear and what defect of vision does he have ?

	Lenses	**Defect of vision**
A.	converging lenses	long-sightedness
B.	converging lenses	short-sightedness
C.	diverging lenses	long-sightedness
D.	diverging lenses	short-sightedness

Answer : _______

D2. Which of these contribute to the attenuation of ultrasound when it passes through body tissues ?

(1) interference
(2) scattering
(3) absorption

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

Answer : _______

D3. Which part of the body is most clearly imaged with ultrasound ?

A. lung
B. bone
C. liver
D. intestine

Answer : _______

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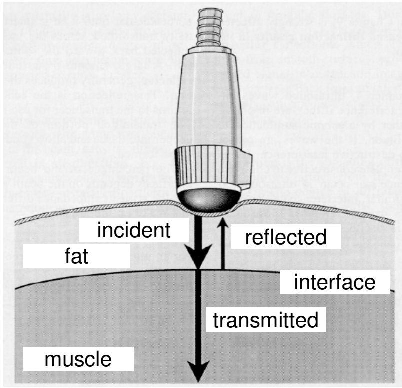
D4. Ultrasound of intensity 10 mW cm^{-2} is incident normally at a fat-muscle interface as shown. What is the intensity of the ultrasound reflected from the interface ?



A. 0.11 mW cm^{-2}
B. 0.33 mW cm^{-2}
C. 0.67 mW cm^{-2}
D. 0.89 mW cm^{-2}

Answer : _______

D5. Which statements about Radionuclide Imaging (RNI) are correct ?

(1) The image resolution of a radionuclide image is far worse than that of an X-ray image.
(2) RNI relies on its ability for the study of function rather than structure.
(3) A bone scan that shows a hot spot (i.e. intense increase uptake of tracer) in the bone reveals the existence of a tumour.

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

Answer : _______

D6. Why is a rotating anode used in an X-ray tube ?

A. To save energy
B. To dissipate heat more efficiently
C. To produce better image resolution
D. To produce a more intense X-ray beam

Answer : _______

D7. Which criteria are essential when choosing radioactive sources as medical tracers in human bodies ?

(1) The sources should have a short half-life.
(2) The radiation emitted should have a weak ionizing power.
(3) The radiation emitted should not be deflected by an electric field.

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

Answer : _______

D8. The half-life of Tc-99m is 6 hours. A patient is given an injection containing 5.7×10^{-18} kg of Tc-99m and the scan is taken 4 hours after the injection. Calculate how much Tc-99m remains undecayed when the scan is taken.

A. 2.9×10^{-18} kg
B. 3.3×10^{-18} kg
C. 3.6×10^{-18} kg
D. 3.8×10^{-18} kg

Answer : _______

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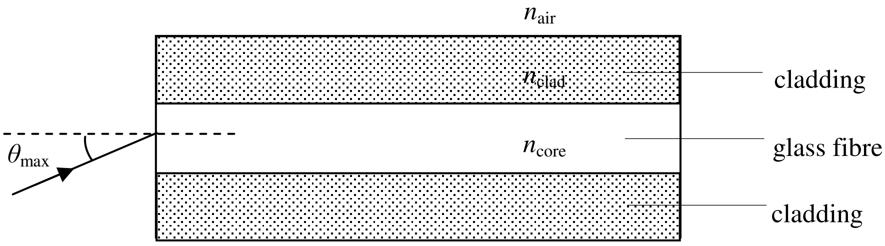
D9. (a)



The figure shows the cross-section of an optical fibre in an endoscope. Rays incident with angle θ smaller than a certain value θ_{max} will fall into the range of guided modes, i.e. they can be transmitted to the far end of the optical fibre.

(i) Complete the light ray in the figure and explain why it will be guided through the optical fibre. (3 marks)

(ii) Show that $\sin\theta_{max} = \dfrac{1}{n_{air}}(n_{core}^2 - n_{clad}^2)^{\frac{1}{2}}$. (3 marks)

(b) Briefly describe how an endoscope could be used to obtain tissue samples from inside the trachea of the lung, and explain why the endoscope is of particular use in this procedure. (4 marks)

END OF PAPER

Answers written in the margins will not be marked.