HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2015

PHYSICS PAPER 1

8.30 am – 11.00 am (2½ hours)

This paper must be answered in English

GENERAL INSTRUCTIONS

(1) There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.

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

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

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

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

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

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

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

(3) All questions carry equal marks.

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

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

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

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

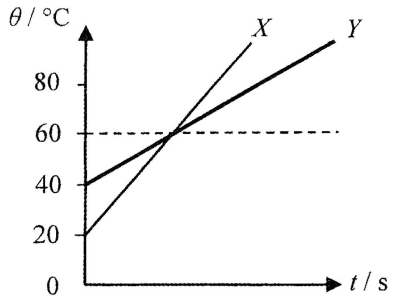
Section A

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

1. A driver turns off the engine after parking his car outdoors under the sun. Two hours later when getting into the car, he feels that the inside of the car is far hotter than outside. The best explanation is

   A. the car's engine is still generating heat after the engine has been switched off.
   B. the car's metal parts absorb infra-red radiation at a faster rate than the surroundings.
   C. the glass windows of the car trap infra-red radiation and a greenhouse effect results.
   D. the surrounding air is a good insulator of heat which reduces heat loss by conduction.

2.



Two objects X and Y are made of the same material. They are heated separately by heaters of the same power. The graph shows the variation of temperature θ of X and Y with time t. What is the ratio of mass of X to that of Y ?

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

3. When an object P is in contact with another object Q, heat flows from P to Q. P must have a higher

   (1) temperature.
   (2) internal energy.
   (3) specific heat capacity.

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

4. A particle travels at 2.0 m s^{-1} due east for 1.5 s and then travels at 4.0 m s^{-1} due north for 1.0 s. What is the magnitude of its average velocity for the whole journey ?

   A. 2.0 m s^{-1}
   B. 2.8 m s^{-1}
   C. 3.0 m s^{-1}
   D. 5.0 m s^{-1}

5. A constant net force acting on an object of mass m_1 produces an acceleration a_1 while the same force acting on another object of mass m_2 produces an acceleration a_2. If this net force acts on an object of mass (m_1+m_2), what would be the acceleration produced ?

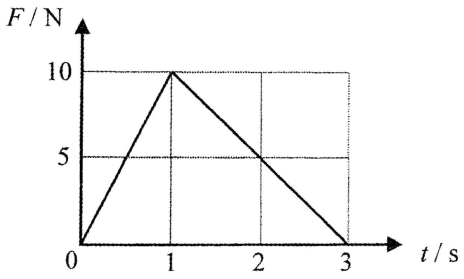
A. $a_1 + a_2$

B. $\dfrac{a_1 + a_2}{2}$

C. $\dfrac{a_1 a_2}{a_1 + a_2}$

D. $\dfrac{2a_1 a_2}{a_1 + a_2}$

6.

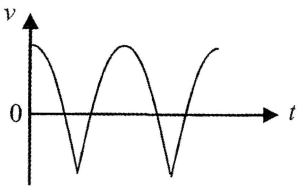


An object of mass 3 kg is initially at rest on a smooth horizontal ground. A force F is applied horizontally to the object such that the magnitude of F varies with time t as shown. What is the speed of the object at $t = 3$ s ? Neglect air resistance.

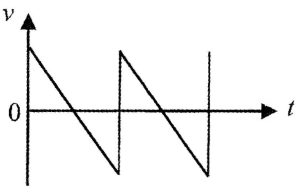
A. 2.5 m s^{-1}
B. 5 m s^{-1}
C. 10 m s^{-1}
D. 15 m s^{-1}

7. A rubber ball bounces vertically up and down from the ground. Which graph best shows the variation of its velocity v with time t if the collisions are elastic ? Neglect air resistance.

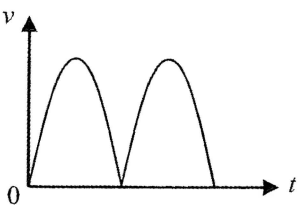
A.



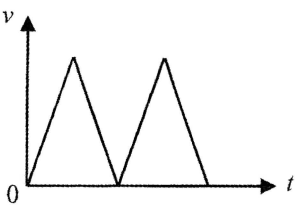
B.



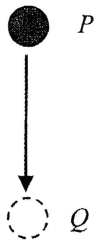
C.



D.



8. An object falls from P to Q as shown below. Throughout the motion, air resistance increases with the speed of the object.

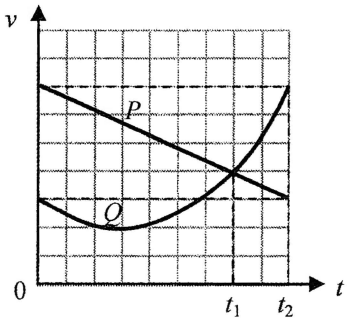


Which of the following descriptions is/are correct ?

(1) The net force acting on the object is constant throughout the motion.
(2) The magnitude of the object's acceleration decreases from P to Q.
(3) The kinetic energy gained by the object from P to Q is equal to its loss in gravitational potential energy.

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

9.

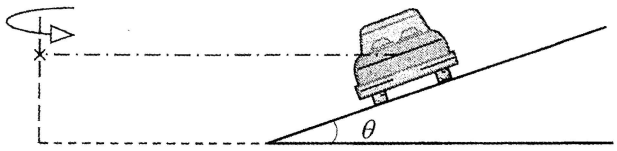


The figure shows the velocity-time (v-t) graph of two cars P and Q travelling along the same straight road. At $t = 0$, the cars are at the same position. Which deductions about the cars between $t = 0$ and $t = t_2$ are correct ?

(1) P and Q are always travelling in the same direction.
(2) At $t = t_1$, the separation between P and Q is at a maximum.
(3) At $t = t_2$, Q lags behind P.

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

*10.



The figure shows the rear view of a car of mass m which travels along a circular road banked with an angle θ to the horizontal. The car moves at a certain speed such that it experiences **no frictional force along the inclined surface**. Which of the following represents the centripetal force on the car ?

A. $mg\sin\theta$

B. $mg\sin\theta\cos\theta$

C. $\dfrac{mg\cos\theta}{\sin\theta}$

D. $\dfrac{mg\sin\theta}{\cos\theta}$

11. The gravitational force exerted on the Earth by the Sun is F_0. The gravitational force exerted on the Sun by the Earth is

A. equal to F_0 and in the same direction.
B. equal to F_0 and in the opposite direction.
C. much smaller than F_0 and in the same direction.
D. much smaller than F_0 and in the opposite direction.

12.

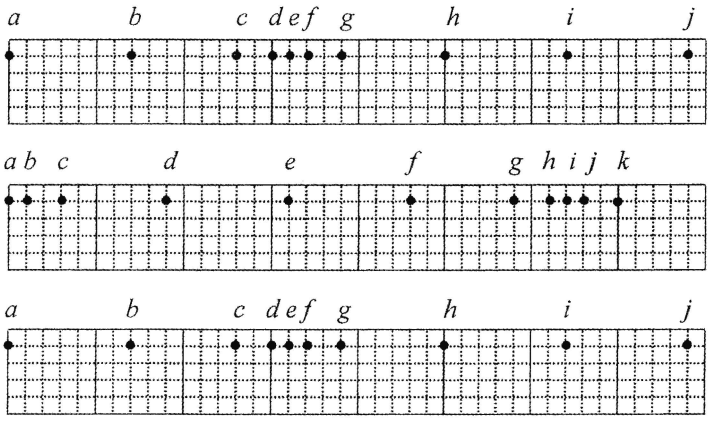


Figure (a)

Figure (b)

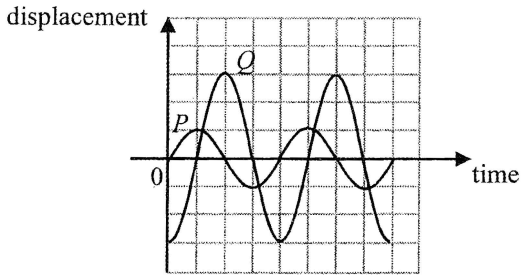
Figure (c)

A series of particles is uniformly distributed along a slinky spring initially. When a travelling wave propagates along the slinky spring from left to right, Figure (a) shows the positions of the particles at a certain instant. Figures (b) and (c) respectively show their positions 0.05 s and 0.1 s later. Which of the following is/are a possible frequency of the wave ?

(1) 10 Hz
(2) 20 Hz
(3) 40 Hz

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

13.

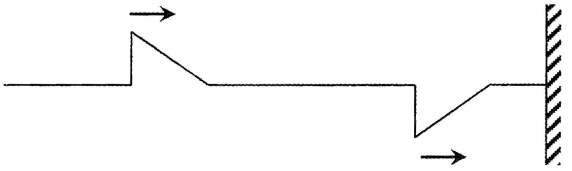


Two waves P and Q travel in the same direction and meet at a point. The above graph shows the variation of the displacement of each wave with time at that point. Which of the following statements is/are correct ?

(1) P and Q have the same frequency.
(2) The oscillation due to P is in anti-phase with that due to Q.
(3) The amplitude of the resultant wave at that point is four times the amplitude of P.

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

14.

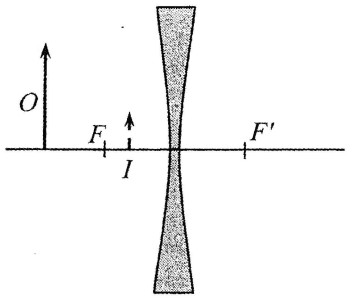


Two pulses of the same shape travel along a stretched string with one end fixed to the wall as shown above. Which of the following can be the resultant waveform at different instants later ?

(1) (2) (3)

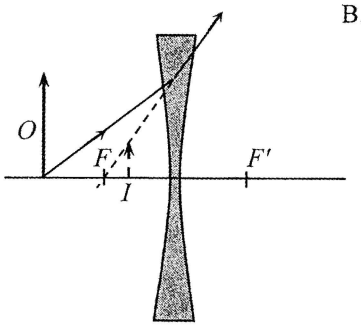
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

15.

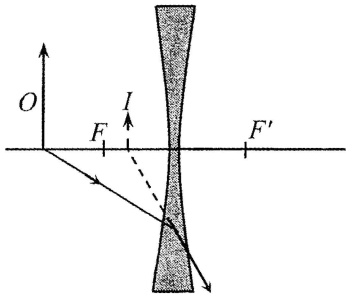


An object O placed in front of a concave lens forms an image I as shown. F and F' are the foci of the lens. Which ray diagram is correct ?

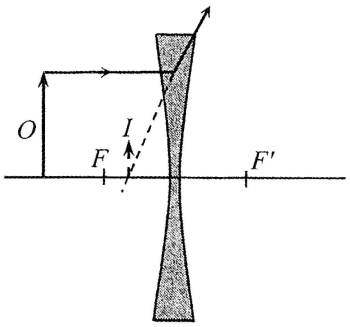
A.



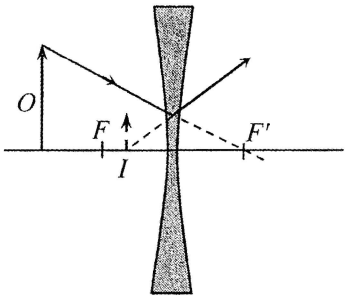
B.



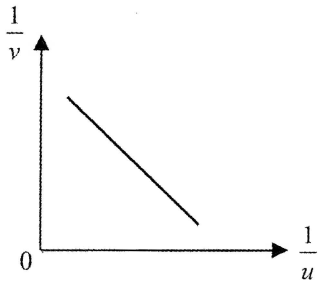
C.



D.

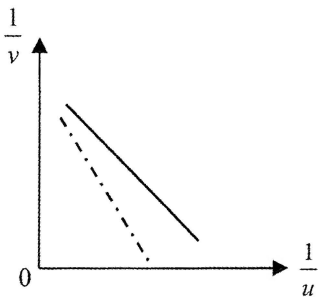


*16.

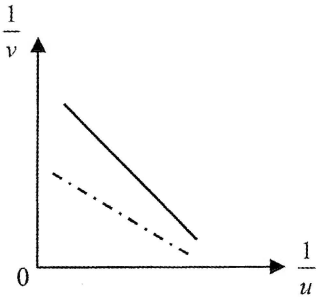


A student uses a convex lens to investigate the variation of image distance v with object distance u for real images. The graph of $\frac{1}{v}$ plotted against $\frac{1}{u}$ is shown above. If a convex lens of longer focal length is used, what would be the expected result (in dotted lines) ?

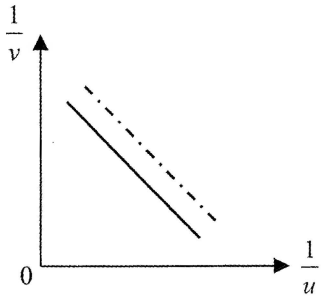
A.



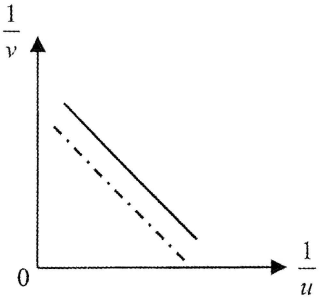
B.



C.

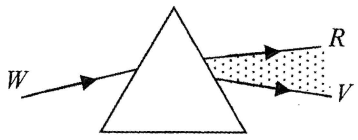


D.

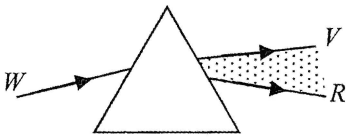


17. Which diagrams below correctly show the spectra formed from white light by a glass prism and a diffraction grating respectively ? It is known that red light travels faster than violet light in glass. (R = red, V = violet, W = white)

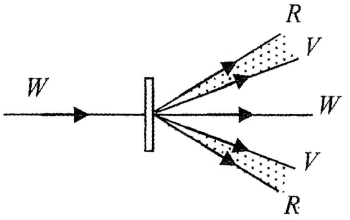
(1)



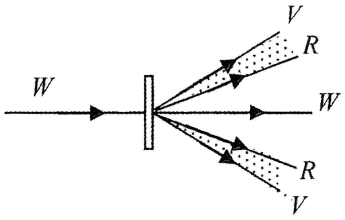
(2)



(3)

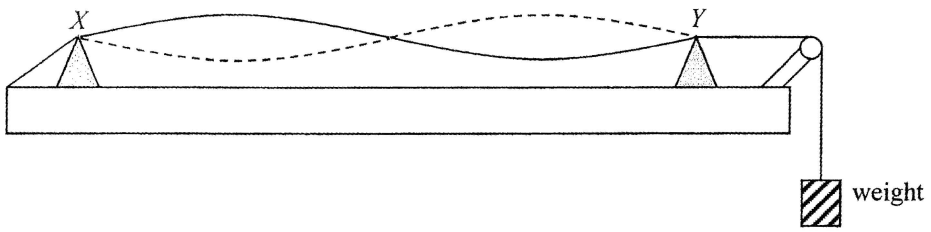


(4)

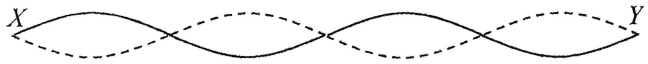


A. (1) and (3) only
B. (1) and (4) only
C. (2) and (3) only
D. (2) and (4) only

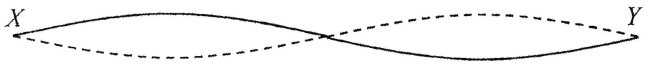
18.



A string is set to vibrate at frequency f such that a standing wave is formed between two fixed supports X and Y as shown. If the tension in the string is increased by adding weight gradually while the frequency is kept at f, which of the following is a possible mode of vibration at a steady state ?

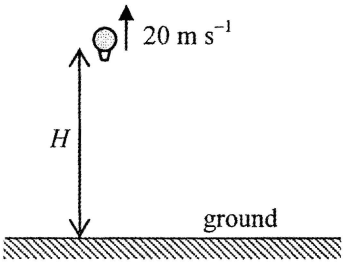
A. 

B. 

C. 

D. 

19. A balloon is rising at a uniform speed of 20 m s^{-1}. When the balloon is at an altitude H as shown, it sends a sound signal towards the ground. After 5 s, the balloon receives the echo of the signal. Estimate H. Given: speed of sound in air = 340 m s^{-1}



A. 1600 m
B. 850 m
C. 800 m
D. 750 m

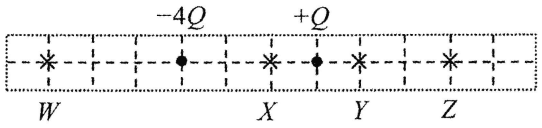
20. Which of the following gives the order of magnitude of the wavelengths of ultra-violet radiation and microwave in a vacuum ?

	ultra-violet radiation	**microwave**
A.	10^{-8} m	10^{-2} m
B.	10^{-8} m	10^{-5} m
C.	10^{-10} m	10^{-2} m
D.	10^{-10} m	10^{-5} m

21. Three conducting balls are suspended by insulating threads. **Any two of them** are found to attract each other if brought close to each other. Which conclusion below is correct ?

A. Only one ball is uncharged while the other two carry like charges.
B. Only one ball is uncharged while the other two carry unlike charges.
C. Only one ball is charged.
D. All three balls are charged.

22.



Two point charges $-4Q$ and $+Q$ are fixed as shown. At which point indicated in the figure is the resultant electric field due to these two charges zero ?

A. W
B. X
C. Y
D. Z

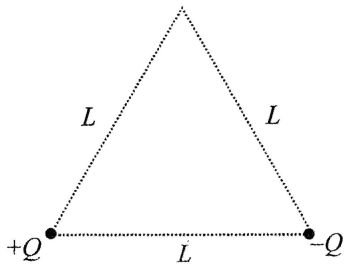
*23. Point charges $+Q$ and $-Q$ are fixed respectively at two vertices of an equilateral triangle with sides of length L as shown. What is the minimum energy required for bringing another point charge $+Q$ from infinity to the third vertex ?

A. 0

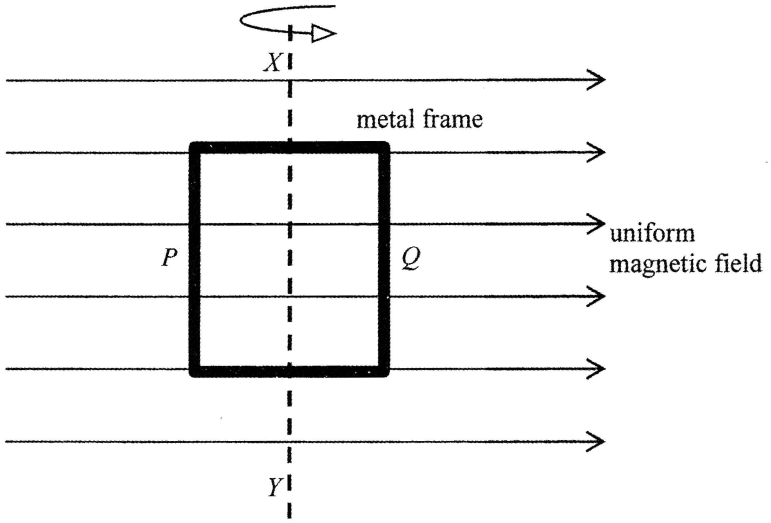
B. $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q^2}{L}\right)$

C. $\frac{1}{4\pi\varepsilon_0}\left(\frac{2Q^2}{L}\right)$

D. $\frac{1}{4\pi\varepsilon_0}\left(\frac{3Q^2}{L}\right)$



24.

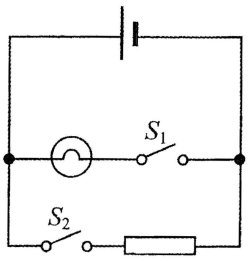


A rectangular metal frame is made to rotate steadily about its axis XY in a uniform magnetic field. At the instant shown, the frame is in the plane of the paper and side P is moving out of the paper while side Q is moving into the paper. Which statement is **INCORRECT at this instant** ?

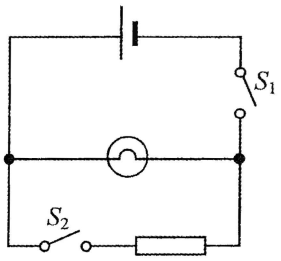
A. The induced e.m.f. in the frame is at a maximum.
B. The induced current produced in the frame is flowing in anti-clockwise direction.
C. The magnetic force acting on side P is in a direction pointing into the paper.
D. The magnetic forces acting on the frame produce a moment opposing the frame's rotation.

25. For safety purposes, the driver seat of a car is equipped with a seat belt warning light. When the driver seat is occupied, the switch S_1 under his seat will close. If the seat belt is not yet fastened, switch S_2 will remain open and the warning light will light up. If the seat belt is fastened, the switch S_2 will close and the warning light will shut off. Which circuit design below is the best design ?

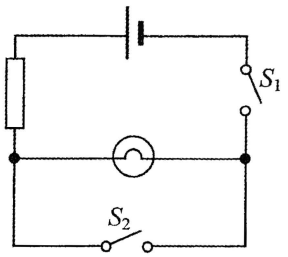
A.



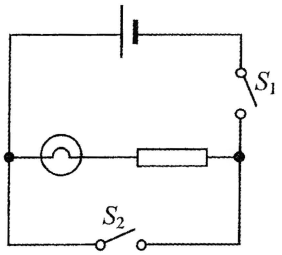
B.



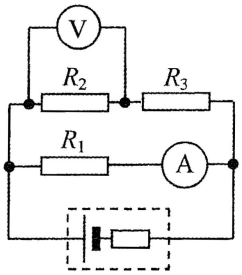
C.



D.



26. In the following circuit, the cell has a finite internal resistance and both meters are ideal.



In which situation below will the readings of the ammeter and the voltmeter suddenly increase ?

A. R_1 is faulty and becomes a short circuit.
B. R_2 is faulty and becomes a short circuit.
C. R_3 is faulty and becomes a short circuit.
D. R_2 is faulty and becomes an open circuit.

*27. A copper wire of uniform cross-section carries a current of 0.5 A. Each metre of the wire contains 10^{22} free electrons. Find the magnitude of the drift velocity of the electrons in the wire.

A. 2.5×10^{-3} m s^{-1}
B. 7.8×10^{-3} m s^{-1}
C. 3.1×10^{-4} m s^{-1}
D. 9.7×10^{-4} m s^{-1}

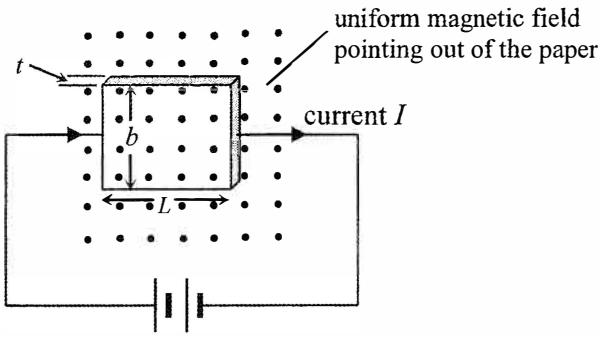
28. Which statement is **NOT** a reason why mains sockets at home are connected in parallel instead of a series circuit ?

A. Electrical appliances connected to different sockets can be switched on or off independently.
B. Voltage supplied to each socket is fixed and all electrical appliances can operate at their rated voltages.
C. The current supplied can be reduced and thinner cables can then be used.
D. When an electrical appliance breaks down and becomes an open circuit, other appliances can still work normally.

29. An electric iron of 1800 W sold in Hong Kong (220 V 50 Hz) is connected to a 110 V 60 Hz mains socket in another country. How does its performance compare on the same ironing setting ?

A. The electric iron does not work because the a.c. supply is 60 Hz instead of 50 Hz.
B. The electric iron is as hot as when it is used in Hong Kong.
C. The electric iron is hotter than when it is used in Hong Kong.
D. The electric iron is colder than when it is used in Hong Kong.

*30.



A slice of conductor (with a certain resistivity) of thickness t, breadth b and length L is connected to a battery of constant e.m.f. and negligible internal resistance. A steady current I passes through it as shown. When a uniform magnetic field is applied normally to the slice, a Hall voltage V is set up between two of its opposite faces. If the thickness and the breadth of the slice are reduced to ½ t and ½ b respectively, what would the following quantities be ?

	current passing through the slice	**Hall voltage developed**
A.	$\frac{I}{4}$	$\frac{V}{4}$
B.	I	$\frac{V}{4}$
C.	$\frac{I}{4}$	$\frac{V}{2}$
D.	I	$\frac{V}{2}$

31. Which of the following nuclear reactions is/are **spontaneous** reaction(s) ?

(1) $^{24}_{11}\mathrm{Na} \rightarrow {}^{24}_{12}\mathrm{Mg} + {}^{0}_{-1}\mathrm{e}$

(2) $^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{7}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$

(3) $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

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

32. Workers in nuclear power plants wear clothes with film badges to measure the dosage of radiation received over a period of time. Which type of radiation below **CANNOT** be monitored by the film badges ?

A. α-radiation
B. β-radiation
C. γ-radiation
D. X-rays

*33. A piece of wood found in an archaeological site is dated using carbon-14 dating method. It registers a corrected count rate of 11.0 counts per minute while a fresh wood sample cut from the same kind of trees gives a corrected count rate of 15.6 counts per minute. What is the approximate age of the wood found in the archaeological site ? Given: half-life of carbon-14 is 5730 years.

A. 890 years
B. 1300 years
C. 2000 years
D. 2900 years

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 $= 1.661 \times 10^{-27}$ kg (1 u is equivalent to 931 MeV)
astronomical unit	AU $= 1.50 \times 10^{11}$ m
light year	ly $= 9.46 \times 10^{15}$ m
parsec	pc $= 3.09 \times 10^{16}$ m $= 3.26$ ly $= 206265$ AU
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Planck constant	$h = 6.63 \times 10^{-34}$ J s

Rectilinear motion

For uniformly accelerated motion :

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

Mathematics

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

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

Astronomy and Space Science

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

Energy and Use of Energy

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

Atomic World

$\frac{1}{2}m_e v_{max}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ 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