HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2019

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

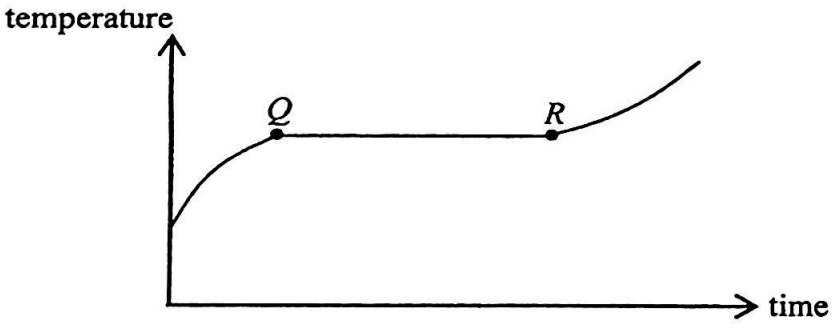
Section A

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

1. A block measuring 80 °C is put into water at a temperature of 40 °C. The final temperature of the mixture is 70 °C. Which of the following deductions must be correct ? Assume that there is no heat loss to the surroundings.

A. The energy gained by the water is greater than the energy lost by the block.
B. The mass of the water is greater than the mass of the block.
C. The specific heat capacity of water is smaller than that of the block's material.
D. The heat capacity of the water is smaller than that of the block.

2.

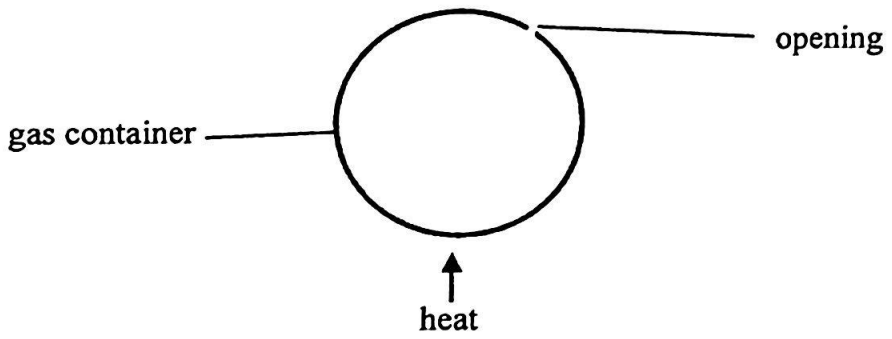


A substance undergoes the fusion process. The figure shows how the substance's temperature varies with time. Its temperature remains constant during the period from Q to R. Which of the following deductions **within this period** is/are correct ?

(1) The substance does not absorb heat.
(2) The mass ratio of the substance in solid and liquid states remains constant throughout.
(3) The average potential energy of the molecules of the substance increases with time.

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

*3. The figure shows an inexpansible container with an opening.

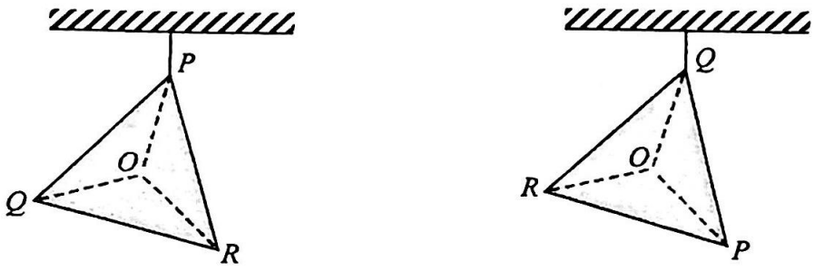


When the gas inside the container is being heated slowly by a heater, which statements about the gas molecules in the container are correct ?

(1) The number of molecules decreases.
(2) The average kinetic energy of molecules increases.
(3) The average separation between molecules remains unchanged.

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

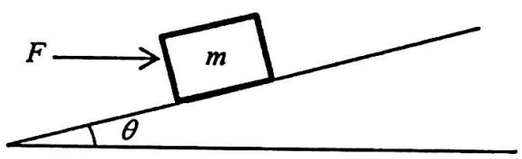
4.



O is the centre of a metal plate PQR in the form of an equilateral triangle with **non-uniform** mass distribution. The plate is suspended from the ceiling at P and then at Q as shown. The centre of gravity of the metal plate is

A. at O.
B. within the region POQ.
C. within the region ROQ.
D. within the region POR.

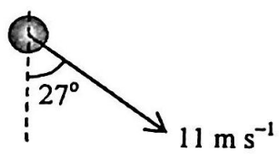
5.



In the above figure, a horizontal force F is applied to a block of mass m so as to keep it at rest on a smooth incline making an angle θ with the horizontal. Find the magnitude of F.

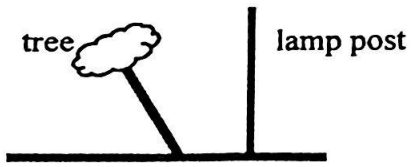
A. $\dfrac{mg\sin\theta}{\cos\theta}$
B. $mg\sin\theta\cos\theta$
C. $\dfrac{mg\cos\theta}{\sin\theta}$
D. $mg\sin\theta$

*6. A small ball after projection moves under the effect of gravity only. Its velocity at a certain instant is shown below. What is the speed of the ball **1 s before** ? Neglect air resistance. ($g = 9.81\ \text{m s}^{-2}$)



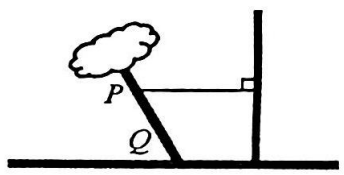
A. $19.1\ \text{m s}^{-1}$
B. $9.8\ \text{m s}^{-1}$
C. $5.0\ \text{m s}^{-1}$
D. $0.2\ \text{m s}^{-1}$

7.

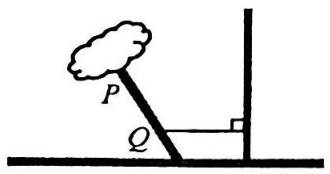


A tree blown by strong wind is found leaning to one side. In order to give the tree some support, a rope is wrapped around its trunk and tied to a fixed lamp post nearby. In which of the following arrangements would the rope have the highest chance of breaking ?

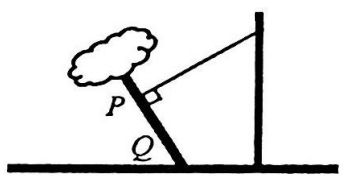
A.



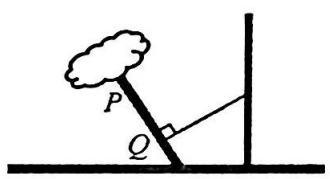
B.



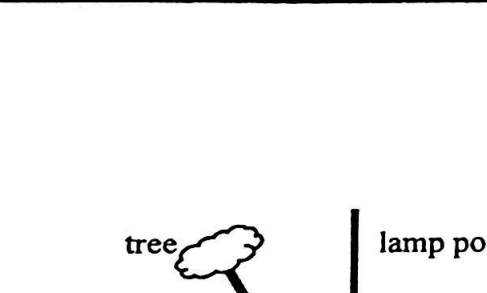
C.



D.

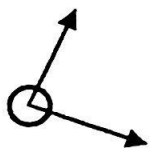


8.

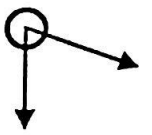


A small sphere suspended by a light inextensible string is released from point H as shown. The string remains taut when the sphere swings downward. Which free-body diagram below best shows all the forces acting on the sphere at K ? Neglect air resistance.

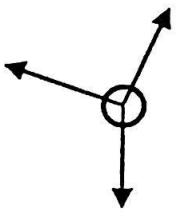
A.



B.

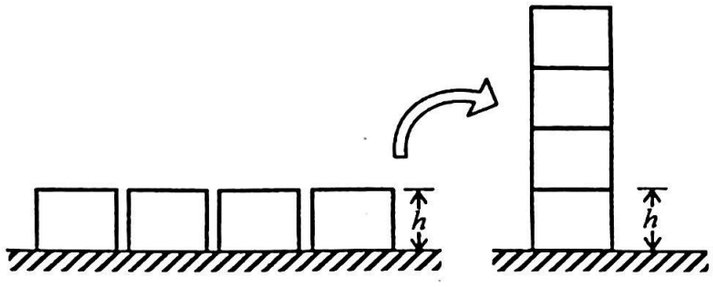


C.



D.

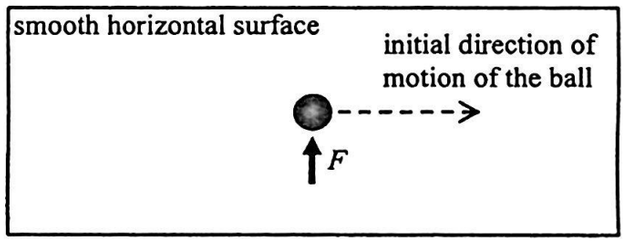
9.



Four identical uniform blocks, each of mass m and height h, are first placed on a horizontal table. If the blocks are stacked on top of one another as shown, what is the minimum work done ?

A. $8\,mgh$
B. $6\,mgh$
C. $4\,mgh$
D. $3\,mgh$

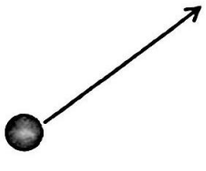
10.



Top view

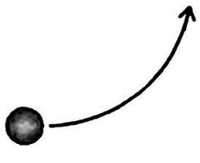
The above figure shows a ball moving with a constant speed along a straight line on a smooth horizontal surface. At a certain instant, the ball is acted on by a force F for a very short time as shown above. Which **subsequent** path below would the ball most closely follow ?

A.

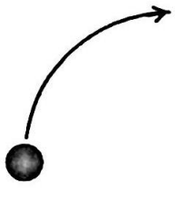


B.

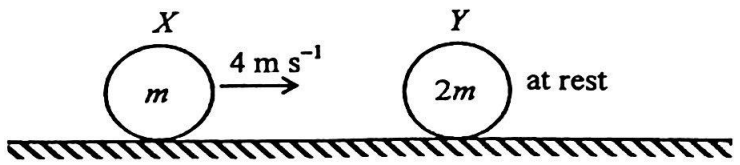
C.



D.



11.

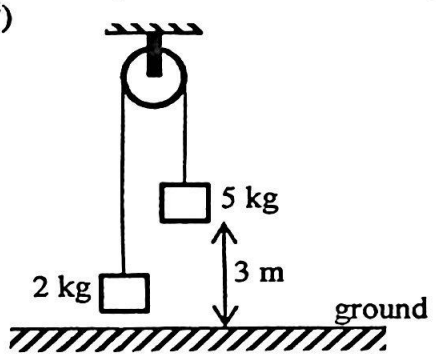


On a smooth horizontal surface, sphere X of mass m travels with speed 4 m s^{-1}. It collides head-on with another sphere Y of mass $2m$, which is at rest initially. Which of the following can be the speed of Y just after collision ?

(1) 1 m s^{-1} (2) 2 m s^{-1} (3) 3 m s^{-1}

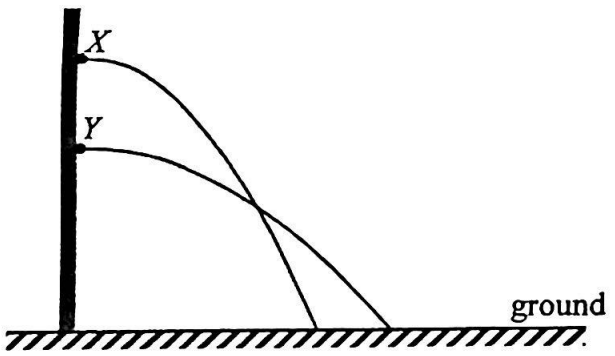
A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

12. Two blocks of respective masses 2 kg and 5 kg are connected by a light inextensible string which passes over a smooth fixed light pulley as shown. The system is released from rest when the 5-kg block is 3 m above the ground. What is the speed of the 5-kg block just when reaching the ground ? Neglect air resistance. (g = 9.81 m s^{-2})



A. 5.0 m s^{-1}
B. 6.0 m s^{-1}
C. 6.5 m s^{-1}
D. 7.7 m s^{-1}

*13.

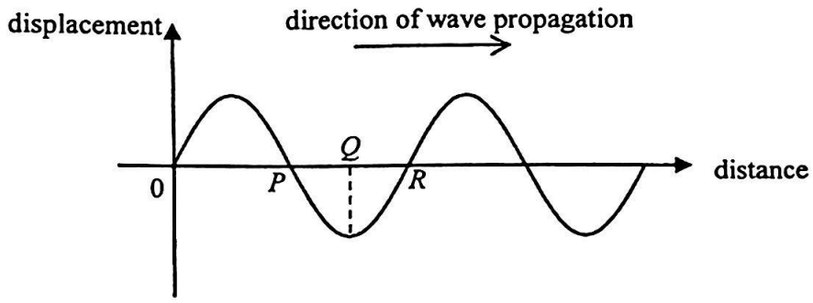


Particles X and Y are projected horizontally from a vertical wall and the figure shows their paths in air before reaching the ground. Which statements below are correct ? Neglect air resistance.

(1) The time of flight of Y is longer.
(2) The projection speed of Y is greater.
(3) X and Y can have the same landing speed.

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

14. The figure shows the displacement-distance graph at a certain instant of a longitudinal wave which travels to the right. Displacement to the right is taken to be positive.

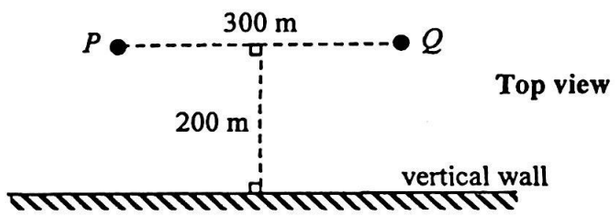


At the instant shown, which of the following statements is/are correct ?

(1) P is a centre of compression.
(2) A particle with its equilibrium position at Q is at rest.
(3) A particle with its equilibrium position at R is moving downwards.

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

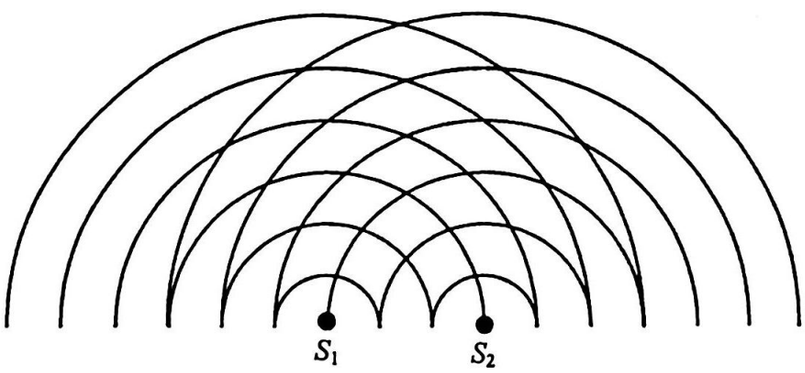
15.



Boys P and Q are 300 m apart and are both at a distance of 200 m from a vertical wall as shown. When P shouts once, two sounds are heard by Q. Which description below is correct ?
Given : speed of sound in air = 340 m s^{-1}

A. The first sound is louder and 0.59 s later the second sound is heard.
B. The first sound is louder and 0.29 s later the second sound is heard.
C. The second sound is louder and 0.59 s earlier the first sound is heard.
D. The second sound is louder and 0.29 s earlier the first sound is heard.

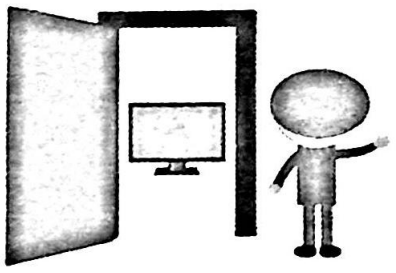
16.



The figure shows the circular water waves generated by two dippers S_1 and S_2 vibrating in phase. The lines represent wave crests. What is the number of nodal lines (i.e. minimum amplitude) formed ?

A. 3
B. 4
C. 6
D. 7

17. Peter is standing next to the door of a room. He can hear the sound emitted by the television inside the room but cannot see the television pictures. Which of the following is/are the possible reason(s) ?



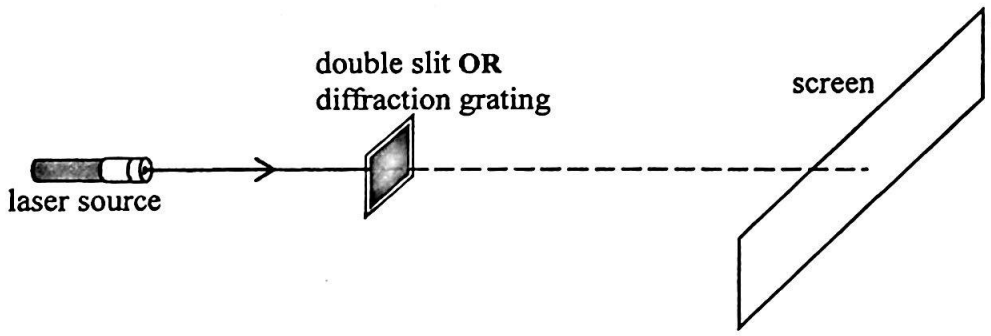
(1) Sound wave diffracts while light wave does not.
(2) Sound wave is mechanical in nature while light wave is electromagnetic.
(3) Sound wave has a much longer wavelength than visible light.

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

18. How does the speed of propagation of waves along a stretched string change if the tension in the string is increased or the string is replaced by a more massive one of the same length and tension ?

	tension increased	**using a more massive string of the same length and tension**
A.	speed increases	speed decreases
B.	speed increases	speed increases
C.	speed decreases	speed decreases
D.	speed decreases	speed increases

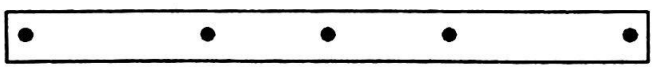
19.



A double slit and a diffraction grating are used in turns in the above set-up such that red and green laser lights are directed one after the other on each of them. The four resulting patterns of bright spots obtained on the screen are shown below. Which one belongs to the pattern formed by **green light** incident on the **diffraction grating** ?

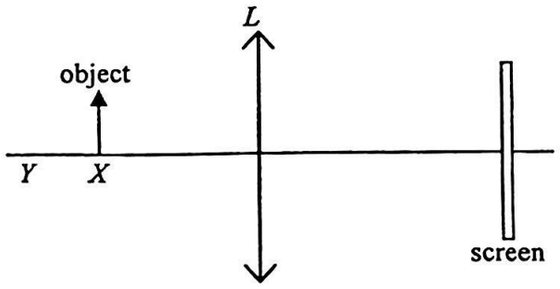
A.


B.


C.


D.

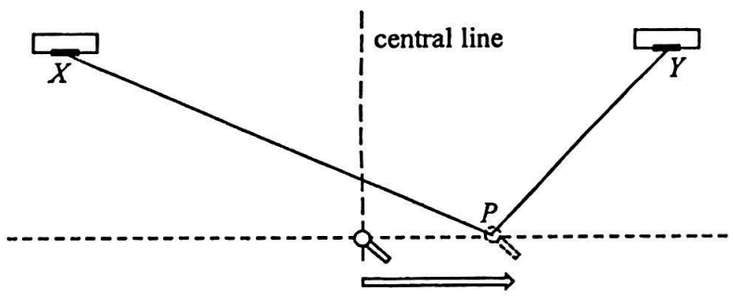

20.



An object is placed at point X in front of a convex lens L as shown. A sharp image is captured by the screen. The object is then shifted to point Y. Which adjustment below may give a sharp image on the screen again ?

A. replacing L with another convex lens of longer focal length
B. replacing L with another convex lens of the same shape but made from material of a larger refractive index
C. replacing L with a concave lens
D. moving the screen to the right

21.



Two loudspeakers X and Y emit sound waves of frequency 500 Hz. A microphone is moved steadily along a line perpendicular to the central line as shown. It detects sound waves of maximum amplitude at the central line and the next maximum amplitude is detected at point P. Find $PX - PY$.
Given: speed of sound in air = 340 m s^{-1}

A. 0.17 m
B. 0.34 m
C. 0.51 m
D. 0.68 m

22. Which of the following statements about infra-red radiation is/are correct ?

(1) It bends towards the normal when it travels from air to water.
(2) It travels faster in water than in air.
(3) It is used for satellite communication.

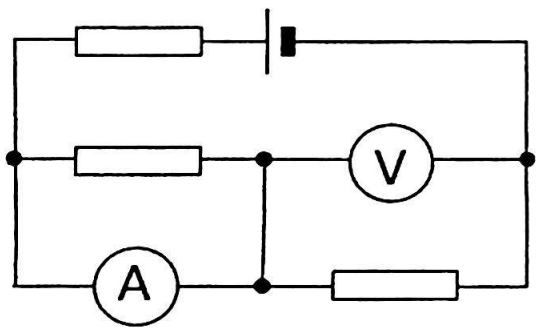
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

23.

In the above figure, point charge Y is placed in the middle of two identical positive point charges X and Z, with Z being fixed. Both X and Y are in equilibrium and at rest initially. What would happen to X if Y is slightly pushed towards Z ?

A. It moves towards the left.
B. It moves towards the right.
C. It remains at rest.
D. It cannot be determined as the sign of Y is not known.

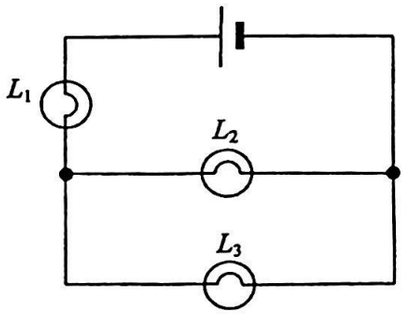
24.



The figure shows a 6 V cell of negligible internal resistance connected to three identical resistors. Both ammeter and voltmeter are ideal. Find the voltmeter reading.

A. 6 V
B. 4 V
C. 3 V
D. 2 V

25.

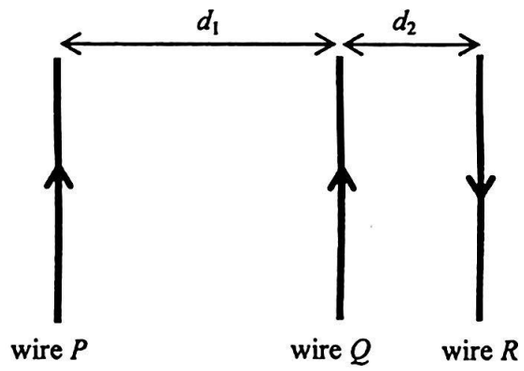


In the above circuit, L_1, L_2 and L_3 are three light bulbs and the cell has negligible internal resistance. Which of the following changes will make L_3 brighter ?

(1) L_1 is faulty and becomes a short circuit.
(2) L_2 is faulty and becomes a short circuit.
(3) L_2 is faulty and becomes an open circuit.

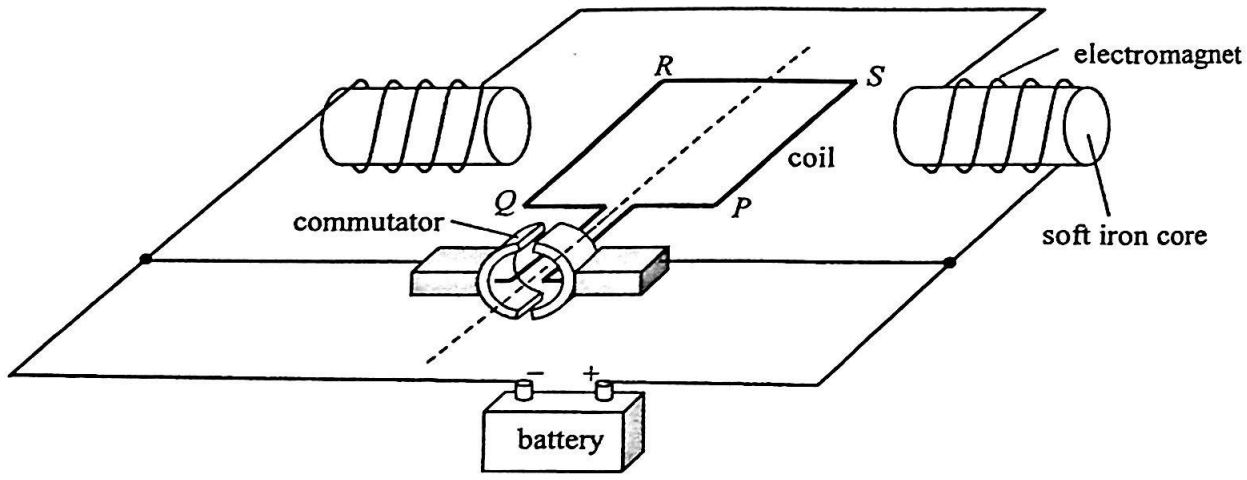
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

26. Three parallel wires P, Q and R are arranged with separations d_1 and d_2 (with $d_1 > d_2$) as shown. Each wire carries the same magnitude of current flowing in the directions indicated. If the magnitude of the magnetic force per unit length exerted on Q by P is F, what are the direction and magnitude of the **resultant magnetic force** per unit length exerted on Q ?



	direction of resultant magnetic force exerted on Q	**magnitude of resultant magnetic force per unit length exerted on Q**
A.	to the right	greater than $2F$
B.	to the right	smaller than F
C.	to the left	greater than $2F$
D.	to the left	smaller than F

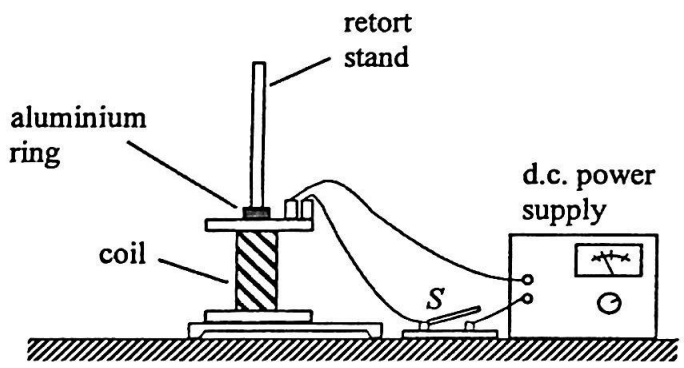
27.



The figure shows the structure of a motor. The coil *PQRS* and the two electromagnets are connected to a battery so that the coil rotates continuously. If a sinusoidal a.c. source of frequency 50 Hz is used instead of a battery, the coil will

A. remain at rest.
B. oscillate at a frequency 50 Hz.
C. rotate to a vertical position and then stop.
D. rotate continuously.

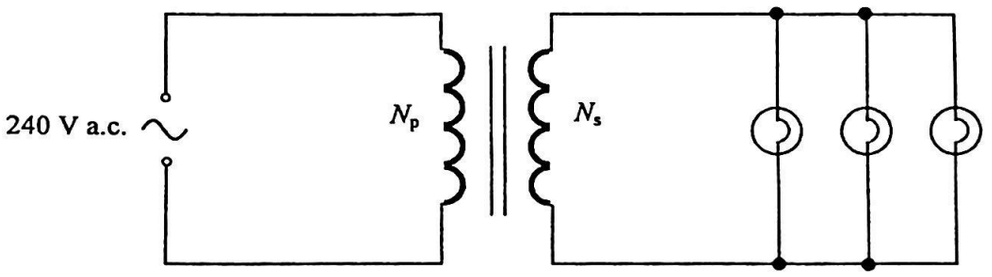
28.



A retort stand and a coil connecting to a d.c. power supply are arranged as shown. An aluminium ring threaded through the stand is placed on top of the coil. When the switch *S* is closed, the aluminium ring jumps up momentarily and then falls back down. Which of the following modifications would enable the ring to rise up and float in the air ?

A. using a ring made from a lighter material
B. using a ring made from a metal of smaller resistivity
C. using a coil with the number of turns doubled
D. using an a.c. power supply instead of a d.c. power supply

*29. In the circuit below, each light bulb works at rated power '12 V 24 W'. What should be the turns ratio (N_p:N_s) of the transformer ?



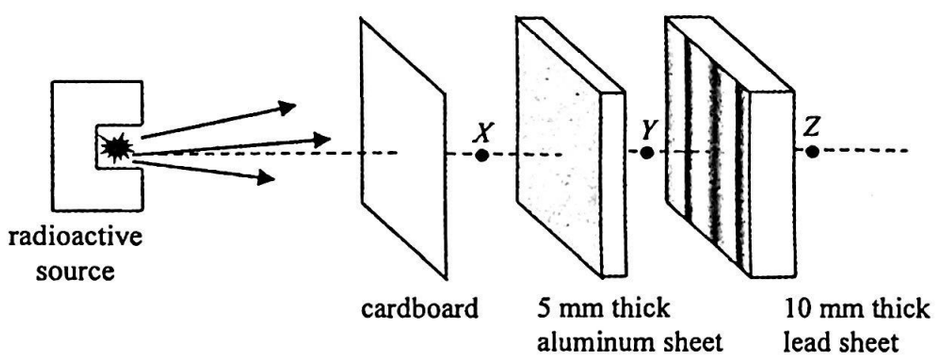
A. 40 : 1
B. 30 : 1
C. 20 : 1
D. 10 : 1

*30. The power consumption of the heating element of an electric heater connected to an a.c. mains can be increased by

(1) increasing the electrical resistance of the heating element.
(2) increasing the frequency of the a.c. voltage.
(3) increasing the r.m.s. value of the a.c. voltage.

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

31. A radioactive source emits α, β and γ radiations.



Which statement about the radiation(s) detected at positions *X*, *Y*, *Z* indicated in the figure is correct ?

A. No radiation from the radioactive source is detected at *Z*.
B. Both β and γ radiations can be detected at *Y*.
C. α radiation can only be detected at *X* but not at *Y* and *Z*.
D. β radiation can only be detected at *X* but not at *Y* and *Z*.

*32. The half-lives of some radioisotopes are tabulated below.

radioisotope	half-life
carbon-11	20.3 minutes
phosphorus-32	14.3 days
sodium-22	2.60 years

Which of the following statements is/are correct ?

(1) The activity of carbon-11 must be the highest.
(2) The decay constant of phosphorus-32 is larger than that of carbon-11.
(3) If the initial activity of sodium-22 is 1520 Bq, its activity would be lower than 380 Bq after 6 years.

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

*33. Given: mass of a neutron = 16749×10^{-31} kg
mass of a proton = 16726×10^{-31} kg
mass of an electron = 9×10^{-31} kg

In a nuclear reaction, a neutron becomes a proton and a β particle. Estimate the energy released in this process.

A. 1.8 MeV
B. 1.3 MeV
C. 0.79 MeV
D. 0.51 MeV

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

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)

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

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.	$pV = \frac{1}{3}Nmc^{\overline{2}}$	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

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

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe separation 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

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