HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2023

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

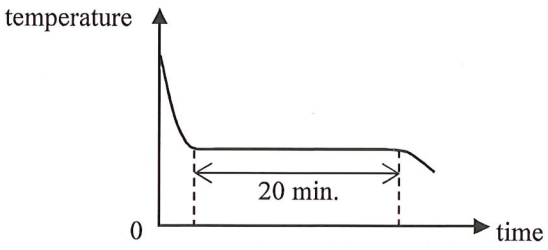
There are 33 questions. Questions marked with * involve knowledge of the extension component.

1. Which of the following statements involving heat transfer via radiation is/are correct ?

(1) Objects hotter than the surroundings do not absorb heat by radiation.
(2) The silvery surfaces of survival blankets help the body absorb heat from the surroundings by radiation.
(3) The cooling fins of a car engine should preferably be black in colour.

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

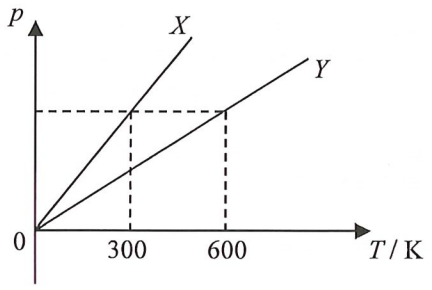
2.



A hot liquid substance of mass 0.3 kg and with heat capacity 600 J $°C^{-1}$ is left to cool in air. Its temperature falls at a rate of 2 °C per minute just before it begins to solidify. Then its temperature remains steady for 20 minutes until all the liquid just solidifies. Estimate the specific latent heat of fusion of the substance.

A. 20000 J kg^{-1}
B. 24000 J kg^{-1}
C. 48000 J kg^{-1}
D. 80000 J kg^{-1}

*3. A fixed mass of an ideal gas contained in a closed vessel X of volume V is heated. Line X in the figure shows the variation of pressure p with temperature T of the gas. The experiment is repeated with another closed vessel Y containing the same amount of this ideal gas and line Y represents the result.



Find the volume of vessel Y.

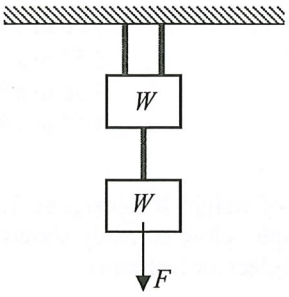
A. 0.25 V
B. 0.5 V
C. 2V
D. 4V

4. Which of the following are vector quantities ?

(1) acceleration
(2) momentum
(3) work done

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

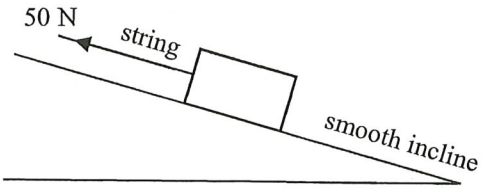
5. Two blocks, each of weight W, are hung by three identical light strings as shown. Each string has a limiting tension of $2W$, i.e. it will break for a tension larger than this value.



Force F acts vertically on the lower block. What is the largest value of F without breaking any of the strings ?

A. $0.5W$
B. W
C. $1.5W$
D. $3W$

6. On a smooth incline, a block of weight 120 N is kept stationary by a string with tension 50 N parallel to the incline.



The string is then cut and the block accelerates down the incline. What is the **net force acting on the block** before and after the string is cut ?

	before the string is cut	**after the string is cut**
A.	50 N	70 N
B.	50 N	50 N
C.	0 N	70 N
D.	0 N	50 N

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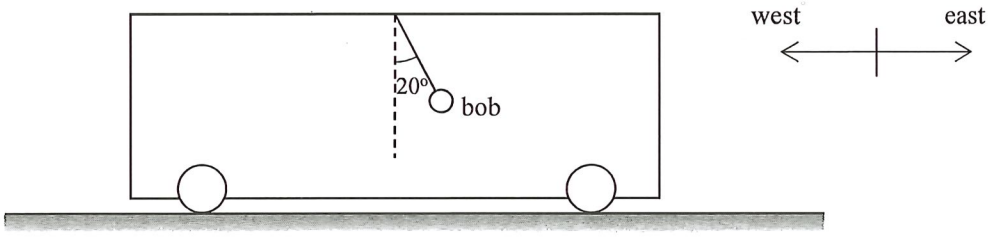
7. A bob is suspended from the ceiling of a train moving along a horizontal east-west rail.

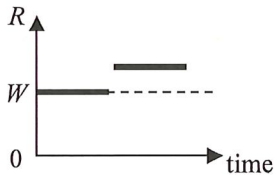


The bob slants towards east and makes an angle of 20° with the vertical as shown. What is the direction and magnitude of the acceleration of the train ? ($g = 9.81$ m s^{-2})

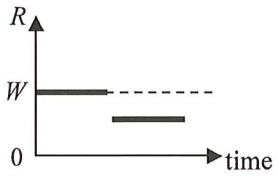
	direction	**magnitude**
A.	due west	3.36 m s^{-2}
B.	due west	3.57 m s^{-2}
C.	due east	3.36 m s^{-2}
D.	due east	3.57 m s^{-2}

8. In an amusement park ride, a boy of weight W undergoes free fall vertically in a chair at first and then decelerates uniformly. Which graph below correctly shows the time variation of the reaction force R acting on the boy by the chair ? Neglect air resistance.

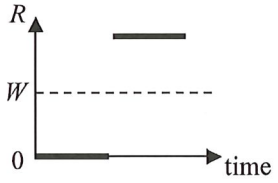
A.



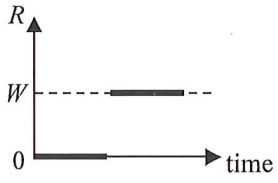
B.



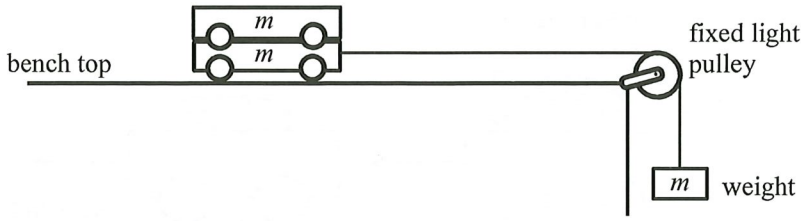
C.



D.



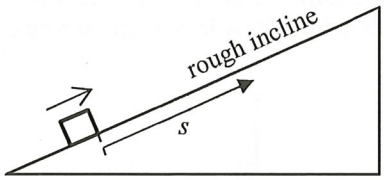
9. The figure shows a set-up in which a weight of mass m is attached to two trolleys stacked together, each trolley of mass m, via a light inextensible string.



After the weight is released from rest, which of the following is correct ? Assume that all contact surfaces are smooth and neglect air resistance. g is the acceleration due to gravity.

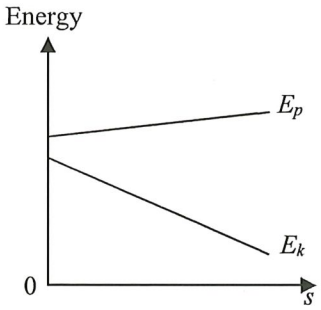
	magnitude of the acceleration	**tension in the string**
A.	$g/2$	smaller than mg
B.	$g/2$	equal to mg
C.	$g/3$	smaller than mg
D.	$g/3$	equal to mg

10. A block is projected upwards along a **rough** incline which has a constant frictional force acting on the block.

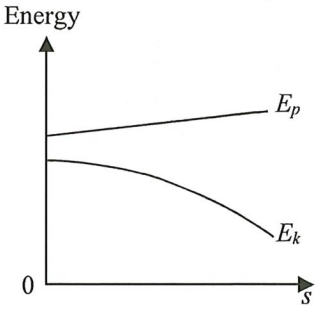


Which of the following correctly shows the variation of potential energy E_p and kinetic energy E_k with distance s that the block travelled up the incline ? Neglect air resistance.

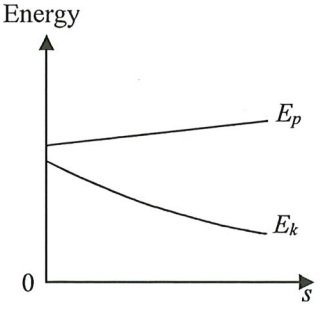
A.



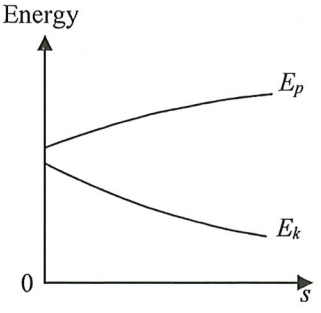
B.



C.



D.



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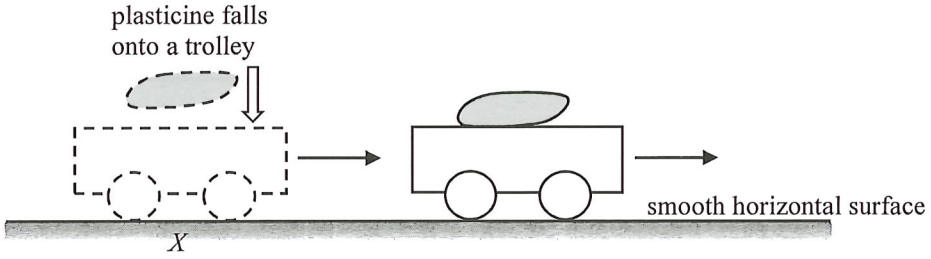
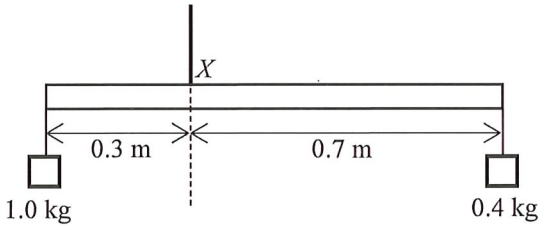
11. A trolley moves with a constant velocity along a smooth horizontal surface. When the trolley reaches point *X*, a plasticine falls vertically onto it. After the collision, they stick together and continue to move forward.



Which description about the **total linear momentum of the trolley and the plasticine** just before and just after collision is correct ?

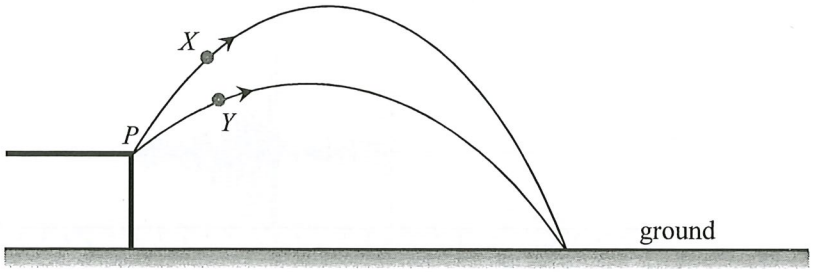
	along the horizontal direction	**along the vertical direction**
A.	conserved	conserved
B.	conserved	not conserved
C.	not conserved	conserved
D.	not conserved	not conserved

12. A uniform metre rule of a certain weight is hung by a string at *X* such that it is kept in equilibrium with weights hanging at both ends as shown. If the 1.0-kg weight is shifted 0.1 m towards *X*, what distance should the 0.4-kg weight be shifted towards *X* in order to restore equilibrium ?



A. 0.1 m
B. 0.2 m
C. 0.25 m
D. 0.45 m

*13. Two identical particles X and Y are projected from point P **simultaneously with the same initial speed** but with different angles as shown. They finally hit the ground at the same point via different paths.

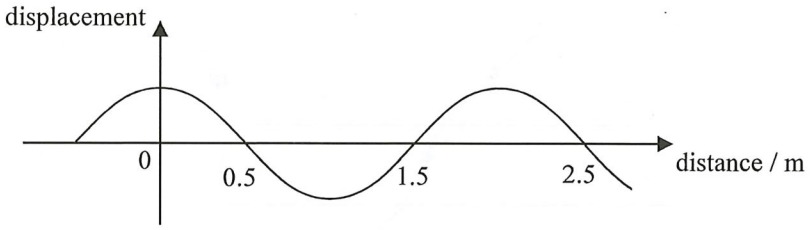


Which of the following statements is/are correct ? Neglect air resistance.

(1) They hit the ground at the same time.
(2) They hit the ground with the same speed.
(3) The kinetic energy of Y is greater than that of X at their respective maximum heights.

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

14.



The above figure shows the displacement-distance graph of a wave travelling at a speed of 10 m s^{-1}. What is the period of this wave ?

A. 0.10 s
B. 0.15 s
C. 0.20 s
D. 0.25 s

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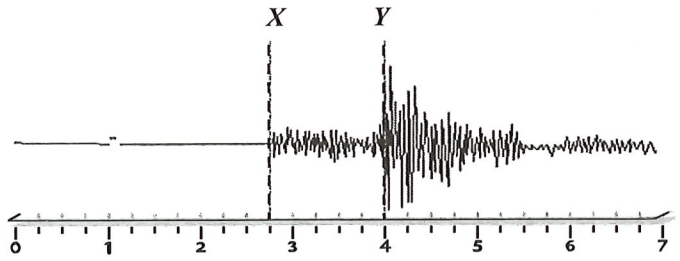
15. Earthquakes produce P-waves (longitudinal) and S-waves (transverse) which travel at 7.0 km s^{-1} and 4.0 km s^{-1} respectively. On a given day, a seismometer detected the P- and S- waves from a shallow earthquake (see the figure below) with its quake centre located at a distance D from the seismometer.

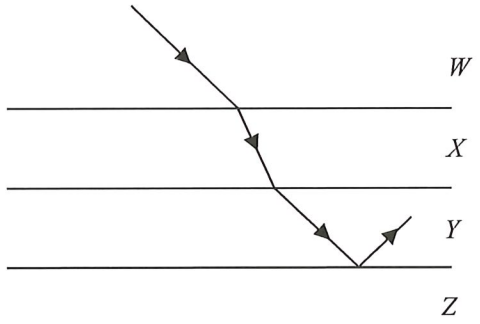


time / minutes

Which deduction below is correct ?

	Y in the figure denotes the arrival of	D / km
A.	P-waves	225
B.	P-waves	700
C.	S-waves	225
D.	S-waves	700

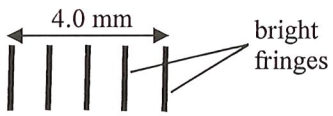
16. The figure shows a light ray passing through the horizontal boundaries between media W, X, Y and Z. The light ray in W is parallel to that entered into Y from X. Total internal reflection occurs at the boundary between Y and Z.



Which medium has the highest refractive index ?

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

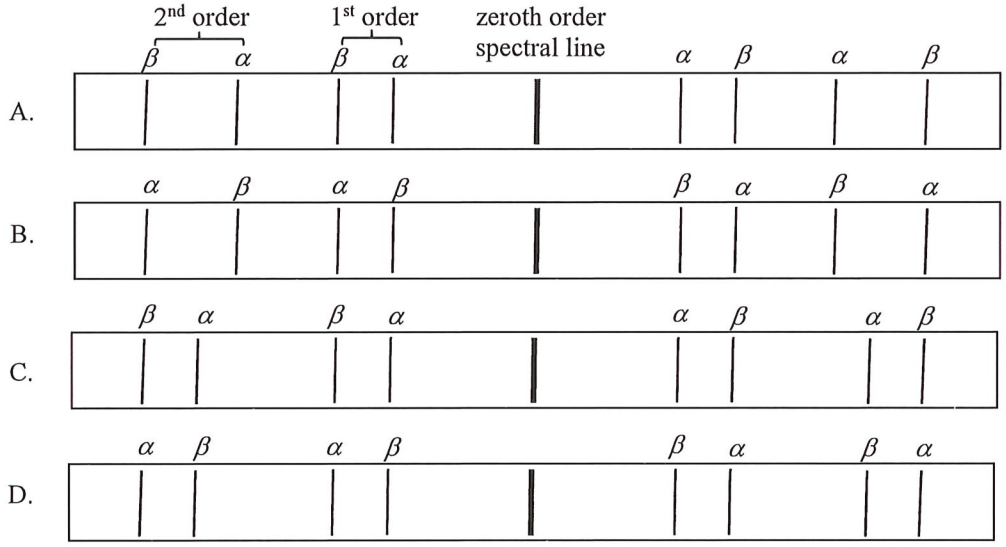
*17.



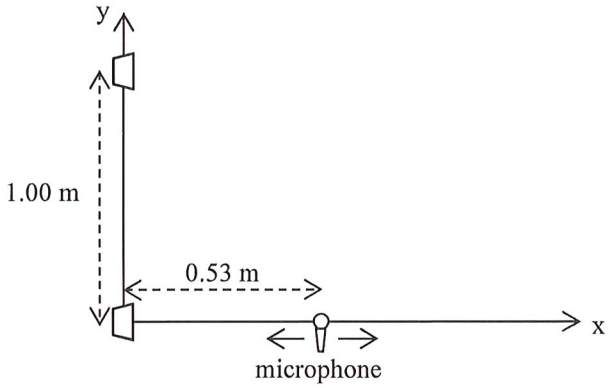
In Young's double-slit experiment, monochromatic light of wavelength λ is used and the slit separation is a. On a screen placed at a distance of 1.8 m from the double slits, the separation between five consecutive bright fringes is 4.0 mm. Which relationship below is correct ?

A. $a = 1800\ \lambda$
B. $a = 2250\ \lambda$
C. $a = 7200\ \lambda$
D. $a = 11250\ \lambda$

18. A diffraction grating is used to observe the α (656 nm) and β (486 nm) lines emitted from a gas discharge tube. Which of the following best represents the pattern observed ?



19. Two loudspeakers separated by 1.00 m along the y-axis emit coherent sound waves which are in phase. When a microphone is moved along the x-axis, only one maximum is detected at a distance of 0.53 m as shown. Find the wavelength of the sound waves.



A. 0.60 m
B. 0.75 m
C. 1.00 m
D. 1.20 m

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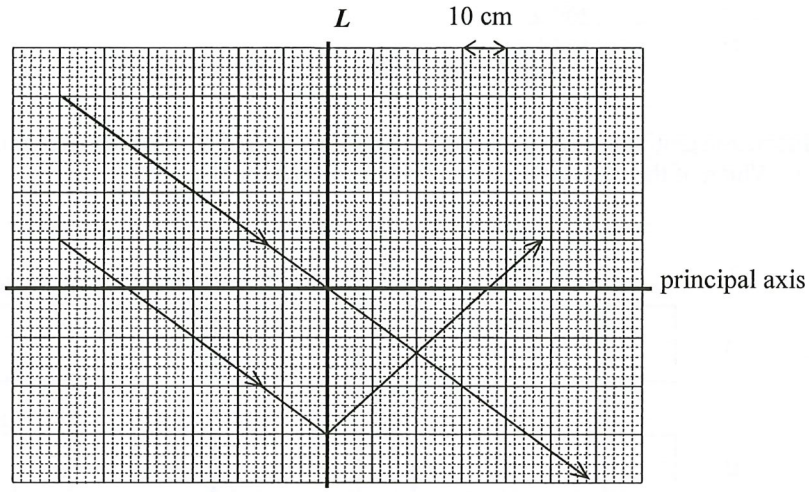
20. Virtual images of an object formed by a single lens are always

(1) erect.
(2) on the opposite side of the lens to the object.
(3) smaller than the object.

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

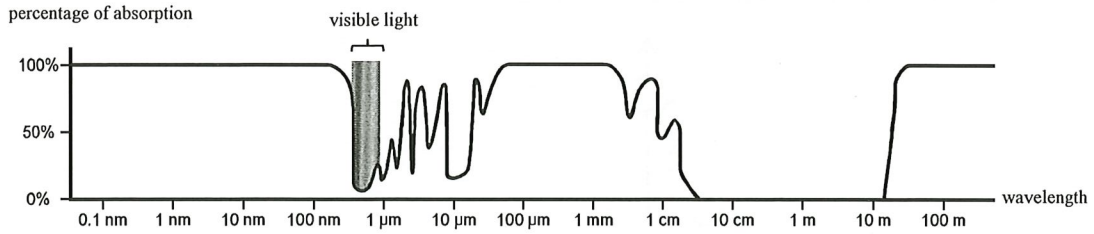
21.



The ray diagram shows the refraction of two parallel light rays through a lens L. What is the type and the focal length of L ?

	type	focal length
A.	convex lens	20 cm
B.	convex lens	36 cm
C.	concave lens	20 cm
D.	concave lens	36 cm

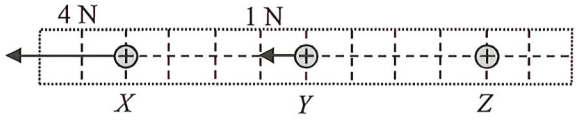
22. When measuring electromagnetic waves from outer space on the Earth's surface, the percentage of absorption by the atmosphere for various wavelengths of electromagnetic waves is shown below.



Referring to this absorption graph, determine which statement below is correct.

A. Gamma rays from galaxies can be observed on Earth's surface.
B. Nearly all ultra-violet radiation can reach Earth's surface.
C. Infra-red radiation from stars can reach Earth's surface without absorption.
D. GHz radio waves (wavelength about 0.5 m) are the best for communications between ground station and space station in the upper atmosphere.

23. Positive point charges X, Y and Z are placed along a straight line with Y at the mid-point between X and Z. Assume that the only interaction among them is the electrostatic force.

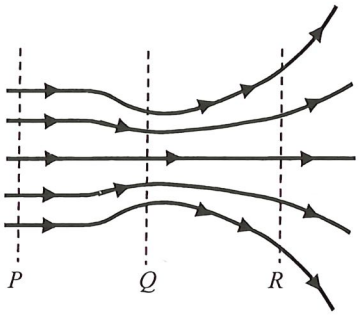


At the instant shown, the net forces acting on X and Y respectively are 4 N and 1 N both towards the left. At that instant, which statements about Z are correct ?

(1) The net force acting on Z is towards the right.
(2) The net force acting on Z is 5 N in magnitude.
(3) The charge of Z must be larger than that of X.

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

24. The figure shows the field lines of an electric field. Arrange the respective electric field strength E_P, E_Q and E_R of regions P, Q and R in ascending order.



A. $E_P < E_Q < E_R$
B. $E_Q < E_R < E_P$
C. $E_R < E_P < E_Q$
D. $E_Q < E_P < E_R$

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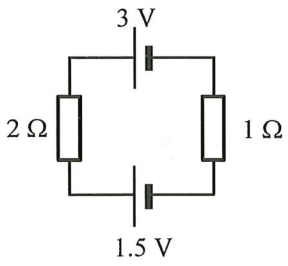
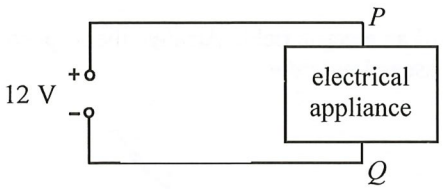
25. Two cells of negligible internal resistance are connected to two resistors as shown.



Which of the following is correct ?

	direction of current	current in the circuit
A.	anticlockwise	0.5 A
B.	clockwise	0.5 A
C.	anticlockwise	1.5 A
D.	clockwise	1.5 A

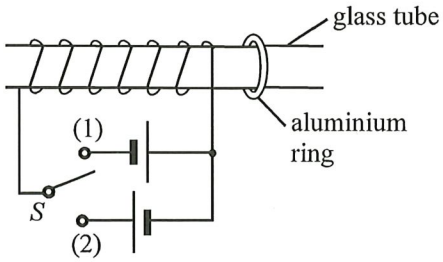
26. The figure shows an electrical appliance connected to a potential difference of 12 V.



When a charge of +2 C passes from P to Q in the circuit, how much electrical energy is supplied to the appliance ?

A. 2 J
B. 6 J
C. 12 J
D. 24 J

27. A solenoid is tightly wound around a smooth horizontal glass tube as shown. A movable aluminium ring is threaded on the right side of the tube.



Initially the ring is at rest and the 2-way switch S is in open circuit. In what direction would the ring move at the moment when S is connected in turns to (1) and (2) ?

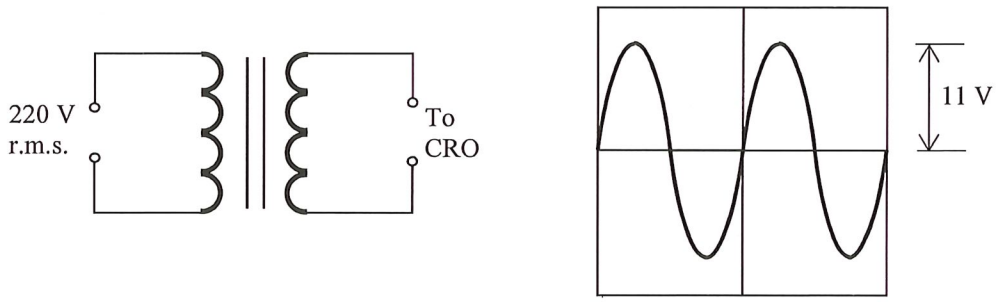
	when S is connected to (1)	when S is connected to (2)
A.	to the left	to the left
B.	to the right	to the right
C.	to the right	to the left
D.	to the left	to the right

28. Which of the following statements about domestic circuits is/are correct ?

(1) The live (L) wire is sometimes positive and sometimes negative with respect to the neutral (N) wire.
(2) The kilowatt-hour meter measures the total power consumed by the domestic electrical appliances.
(3) With more electrical appliances connected, the total resistance of the domestic circuit becomes smaller.

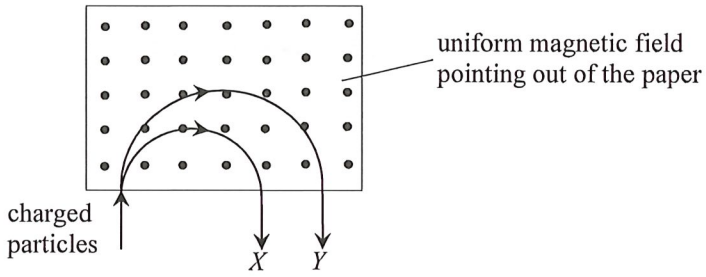
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

*29. A transformer is connected to a.c. mains of 220 V r.m.s. value. The peak value of the output voltage displayed on a CRO is found to be 11 V. If the transformer has 2000 turns in its primary coil, find the number of turns in the secondary coil.



A. 71
B. 100
C. 141
D. 200

*30. The figure shows two charged particles X (mass m_X) and Y (mass m_Y) which enter a region of uniform magnetic field pointing out of the paper. X and Y, having the **same speed and charge**, move along the paths in the plane of the paper as shown below.



X and Y are

A. positively charged and $m_X > m_Y$.
B. positively charged and $m_X < m_Y$.
C. negatively charged and $m_X > m_Y$.
D. negatively charged and $m_X < m_Y$.

Go on to the next page

31. A radioactive source contains a radioactive nuclide X which decays to become a stable nuclide Y. Besides X there is no other radioactive nuclides in this source. Which of the following statements **must be correct** after a time of one half-life of X has elapsed ?

(1) The number of nuclides of X decreases to about half of its initial value.
(2) The number of nuclides of Y increases to about twice of its initial value.
(3) The activity of the radioactive source falls to about half of its initial value.

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

*32. When a proton ($^{1}_{1}\mathrm{H}$) bombards a lithium nucleus ($^{7}_{3}\mathrm{Li}$), two α particles ($^{4}_{2}\mathrm{He}$) are produced.

$$^{1}_{1}\mathrm{H} + {}^{7}_{3}\mathrm{Li} \rightarrow 2\ {}^{4}_{2}\mathrm{He}$$

The energy released in this nuclear reaction is 17.32 MeV. Find the mass of a lithium nucleus.

Given: mass of $^{1}_{1}\mathrm{H} = 1.0078$ u
mass of $^{4}_{2}\mathrm{He} = 4.0026$ u

A. 6.9788 u
B. 6.9974 u
C. 7.0017 u
D. 7.0160 u

33. Which statement about nuclear fission is correct ?

A. It involves two nuclei combined together.
B. All nuclear fission reactions are spontaneous.
C. Rate of fission reaction is temperature dependent.
D. Fission of heavy nuclei yields products that are more stable in terms of energy.

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	$q_e = 1.60 \times 10^{-19}$ C
electron rest mass	$m_e = 9.11 \times 10^{-31}$ kg
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
atomic mass unit	u = 1.661×10^{-27} kg (1 u is equivalent to 931 MeV)
astronomical unit	AU = 1.50×10^{11} m
light year	ly = 9.46×10^{15} m
parsec	pc = 3.09×10^{16} m = 3.26 ly = 206265 AU
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Planck constant	$h = 6.63 \times 10^{-34}$ J s

Rectilinear motion

For uniformly accelerated motion :

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

Mathematics

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

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

Astronomy and Space Science

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

Energy and Use of Energy

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

Atomic World

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

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

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