2022-DSE
PHY

PAPER 1A

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2022

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 well-insulated vessel with negligible heat capacity contains warm water at 45 °C. The temperature of warm water drops by 5 °C after mixing with 50 g water at temperature 0 °C added to the vessel. Find the original mass of warm water in the vessel.

A. 400 g
B. 450 g
C. 500 g
D. 550 g

2. When ice melts into water at 0 °C, what happens to the molecules during the melting process ?

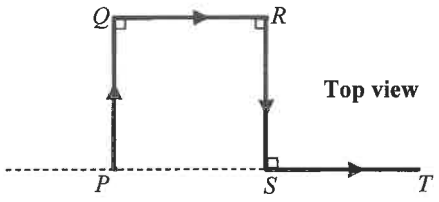
(1) their average separation increases
(2) their average kinetic energy increases
(3) their average potential energy increases

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

*3. A weather balloon filled with 21 kg of helium gas has a volume of 120 m^3 at 27 °C. Find the gas pressure in the balloon. Given: mass of one mole of helium gas = 4×10^{-3} kg

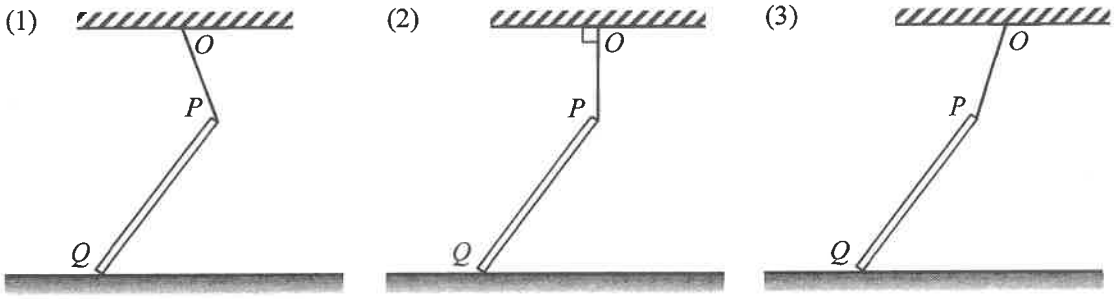
A. 9.93×10^4 Pa
B. 1.00×10^5 Pa
C. 1.05×10^5 Pa
D. 1.09×10^5 Pa

4. A car travels with constant speed v along a horizontal road $PQRST$ with four sections of equal length as shown. Determine v if the car's average velocity for the journey $PQRST$ is 20 km h^{-1} in magnitude.



A. 10 km h^{-1}
B. 20 km h^{-1}
C. 40 km h^{-1}
D. It cannot be found as the length of each section is unknown.

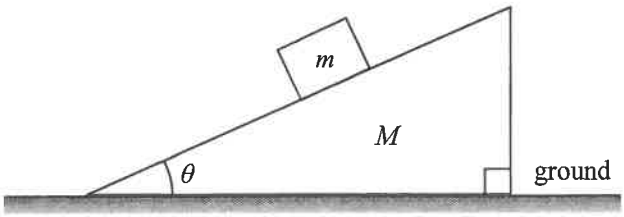
5. In each figure below, a uniform rod PQ has its upper end P attached to point O on the ceiling by a light inextensible string. The rod's lower end Q rests on a rough horizontal ground as shown.



In which figure is the frictional force acting on the rod due to the ground towards the right ?

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

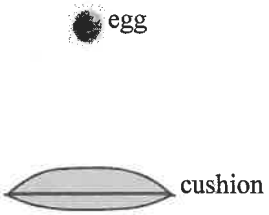
6.



A block of mass m is placed on a wedge of mass M as shown. The system remains at rest. What is the normal force exerted on the wedge by the ground ?

A. Mg
B. $(M+m)g$
C. $Mg + mg\cos\theta$
D. $Mg + mg\tan\theta$

7. An egg is released from a height and falls towards a cushion without breaking.



Which of the following is the most probable explanation ?

A. The cushion makes the egg stop at a shorter distance.
B. The cushion helps lengthen the time of impact.
C. The cushion helps reduce part of the gravitational force acting on the egg.
D. The cushion increases the reaction force acting on the egg during impact.

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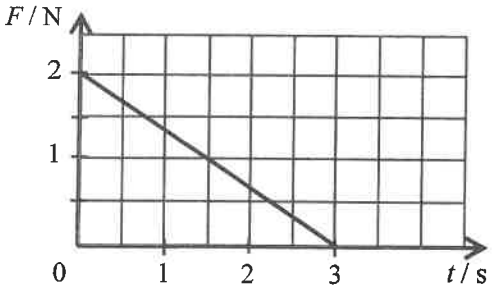
8. An object of mass 2 kg moves with velocity 1 m s^{-1} initially. It is acted upon by a force F which varies with time t as shown in the graph. The force and the object's velocity are in the same direction. Find the speed of the object at $t = 3$ s.



A. 1.5 m s^{-1}
B. 2.5 m s^{-1}
C. 3.5 m s^{-1}
D. 4.5 m s^{-1}

*9. A trolley with a spring-loaded launcher in Figure (1) can project a ball vertically upward. The trolley travels on the ground at a constant speed in a horizontal circle (with centre O) as shown in Figure (2).

Figure (1)

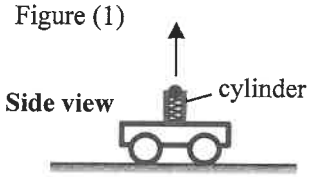
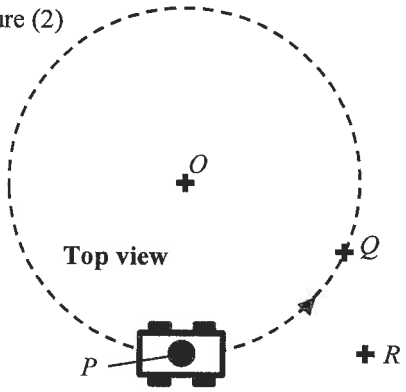


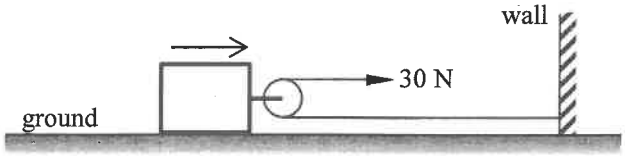
Figure (2)



The ball is projected when the trolley is at point P. After some time, the ball falls back to the ground as the trolley just reaches point Q. Neglecting air resistance, where would the ball land ?

A. O
B. P
C. Q
D. R

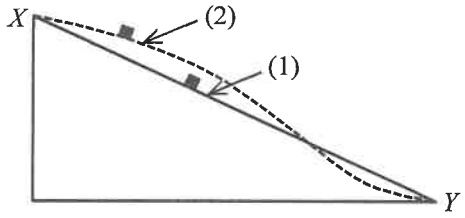
10.



On a horizontal ground there is a block attached with a smooth light pulley as shown. A light and inextensible horizontal string, with one end fixed to a wall, passes the pulley. A man exerts a horizontal force of 30 N at the other end of the string and pulls a distance of 4 m. Find the work done by the man if the ground exerts a frictional force of 10 N on the block.

A. 20 J
B. 80 J
C. 100 J
D. 120 J

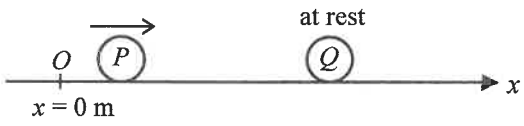
11. In the figure below, the straight path (1) and the curved path (2) in a vertical plane are smooth. A small block slides from rest at X along the respective paths to Y.

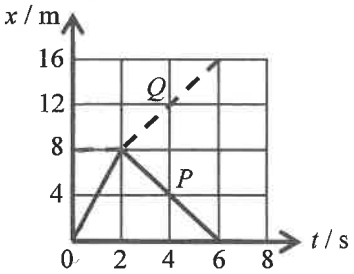


Which of the following about the speed of the block at Y and the time taken to reach Y is correct ? Neglect air resistance.

	speed at *Y*	**time taken to reach *Y***
A.	the same	different
B.	the same	the same
C.	different	the same
D.	different	different

12.





On a smooth horizontal surface, sphere P travelling along the x-axis collides head-on with another sphere Q, which is initially at rest at $x = 8$ m. The graph shows the displacement-time (x-t) relationship of P (solid line) and Q (dotted line). The collision takes place at $t = 2$ s and the collision time is negligible. Which statement is correct ?

A. The collision is perfectly inelastic.
B. The mass of P is larger than that of Q.
C. P still moves along $+x$ direction after collision.
D. P and Q move with the same speed after collision.

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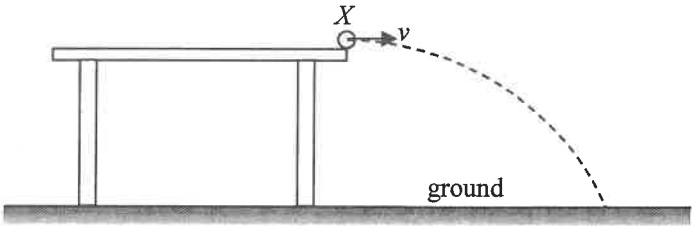
*13. A marble leaves the edge of a table at point X with a horizontal speed v and hits the ground at a certain point as shown.

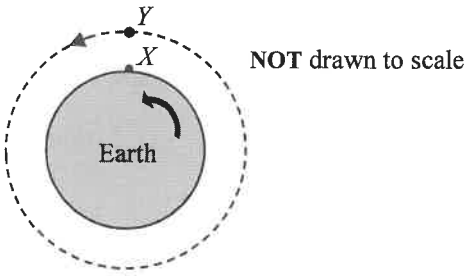


If the marble leaves the table at a higher speed, which of the following would remain unchanged ? Neglect air resistance.

(1) the time of flight of the marble in the air
(2) the acceleration of the marble during its flight in air
(3) the horizontal distance between X and the landing point

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

*14. In the figure, X is an object resting on the Earth's equator. Y is a geostationary satellite moving in a circular orbit above the equator such that it always appears stationary to an observer on Earth.

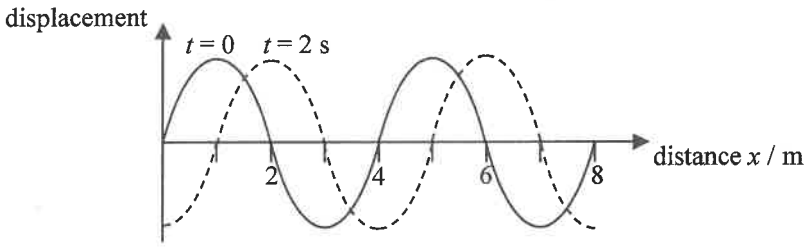


Which descriptions about the motion of X and Y are correct ?

(1) The motion of X and Y takes the same period.
(2) X is moving with a slower speed.
(3) X has a greater acceleration.

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

15. The figure shows the displacement-distance graph at time $t = 0$ and $t = 2$ s respectively of a wave travelling to the right.

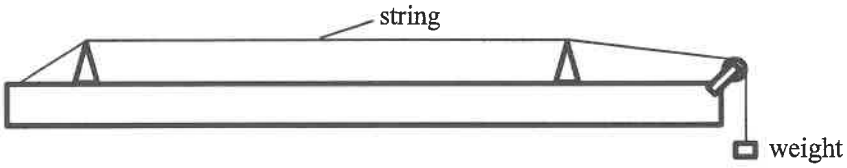


Which statements about the wave are correct ?

(1) The wavelength is 4 m.
(2) The period is 4 s.
(3) The speed of the wave can be 2.5 m s^{-1}.

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

16. Referring to the set-up below, which of the following combinations would give the highest speed of wave propagation along the string when the string is plucked ?



	tension of the string	**radius of the cross-section of the string**
A.	T	r
B.	T	$2r$
C.	$2T$	r
D.	$2T$	$2r$

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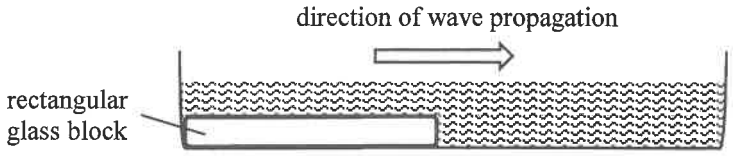
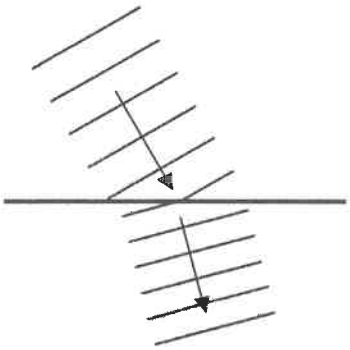
17. Plane water waves travel from shallow water to deep water in a ripple tank as shown below.

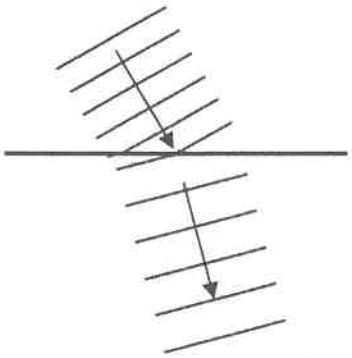


Which diagram correctly shows the top view of the wavefronts in the ripple tank ?

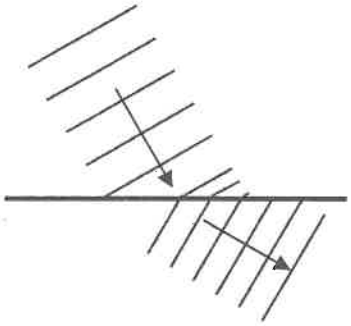
A.



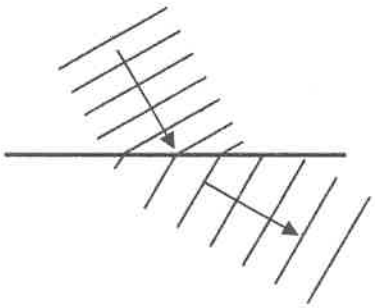
B.



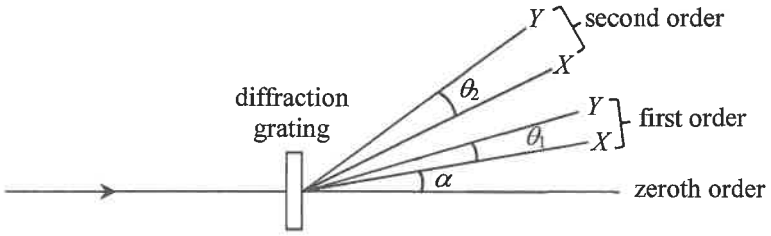
C.



D.



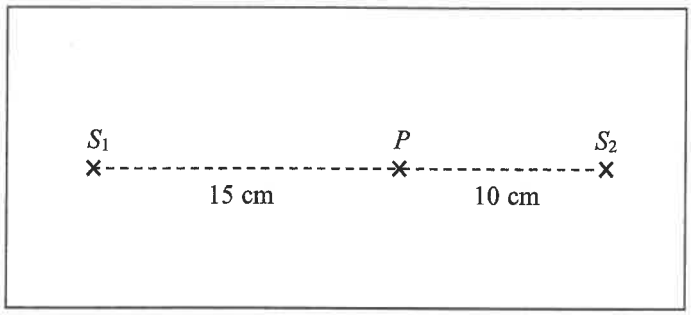
*18.



A light beam which consists of monochromatic lights X and Y is incident normally on a diffraction grating. The figure shows the spectra of the first two orders. The diffraction angle of X in the first order is α. The angular separation between X and Y in the first order is θ_1 and that in the second order is θ_2. Which statement **must be** correct ?

A. The wavelength of Y is shorter than that of X.
B. α would be larger if the grating spacing is smaller.
C. θ_1 is independent of the grating spacing.
D. $\theta_2 = 2\theta_1$

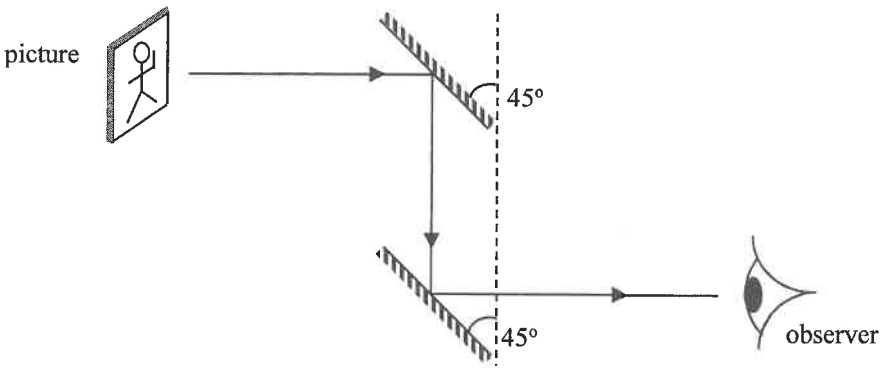
19. In the ripple tank shown below, dippers S_1 and S_2 are vibrating in phase with frequency f and generate two sets of waves towards each other at a speed of 20 cm s^{-1}. Destructive interference occurs at point P on the straight line S_1S_2.



Which of the following is a possible value of f ?

A. 24 Hz
B. 20 Hz
C. 18 Hz
D. 16 Hz

20. A periscope is formed by two plane mirrors as shown.

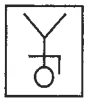


Which image will the observer see ?

A. 

B. 

C. 

D. 

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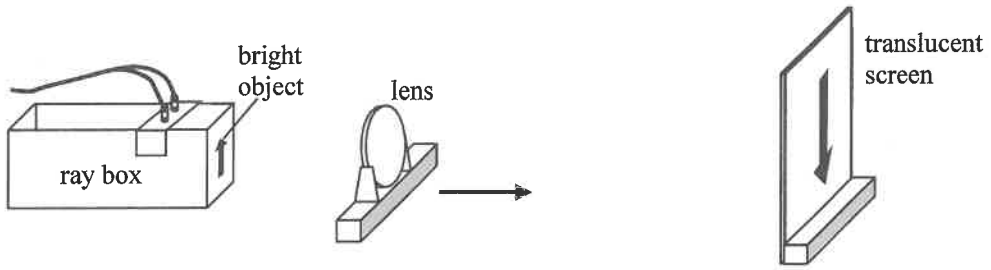
21. In the set-up below, the separation between the bright object and the translucent screen is fixed. A lens is moved from the object towards the screen as shown.



The first sharp image formed is inverted as shown and its length is 9 cm. When the lens is moved further towards the screen, a second sharp image of length 1 cm is observed. Which of the following statements is/are correct ?

(1) The second image is erect.
(2) The length of the object is 3 cm.
(3) There are at most two positions of the lens that can give a sharp image on the screen when the lens is moved.

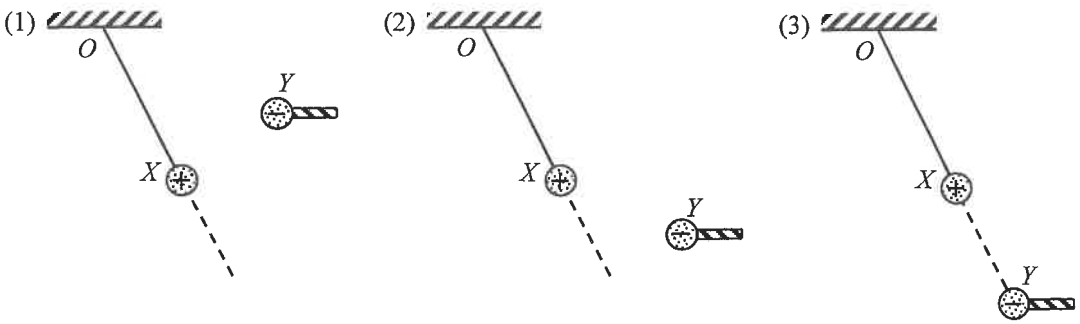
A. (1) only
B. (2) only
C. (2) and (3) only
D. (1), (2) and (3)

22. Which statements about ultrasound are correct ?

(1) Ultrasound is longitudinal waves.
(2) Ultrasound needs media to propagate.
(3) The speed of ultrasound in glass is higher than that in air.

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

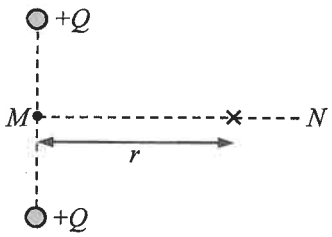
23. A positively charged sphere X of mass m is suspended from a fixed point O by a nylon thread. Another negatively charged sphere Y at the end of an insulating rod is held in various positions as shown. O, X and Y are in the same vertical plane.



In which situation(s) could X be kept at rest as shown ?

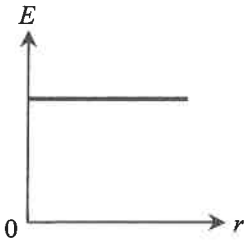
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

*24.

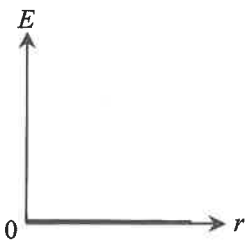


Two positive point charges $+Q$ are fixed as shown above. MN is the perpendicular bisector of the line joining the charges. Which graph correctly shows the variation of the electric field strength E on line MN with distance r from M?

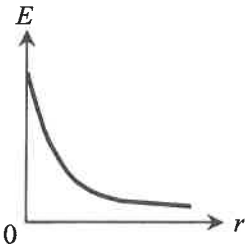
A.



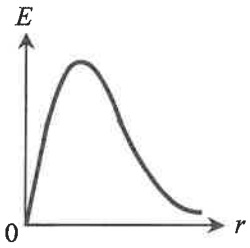
B.



C.



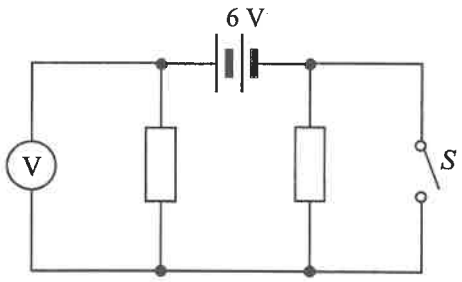
D.



25. An electrical device is charged with a steady d.c. of 60 mA for 30 minutes. Find the **number of electrons** that pass through the device during charging.

A. 108
B. 1800
C. 3.75×10^{17}
D. 6.75×10^{20}

26.



In the above circuit, the resistors are identical and the 6 V battery has negligible internal resistance. Which of the following is the set of readings on the voltmeter when (1) S is open; (2) S is closed ?

	***S* open**	***S* closed**
A.	0 V	6 V
B.	3 V	6 V
C.	6 V	0 V
D.	6 V	3 V

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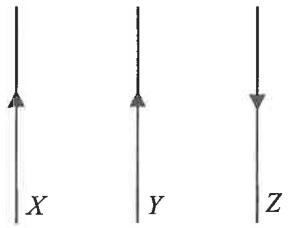
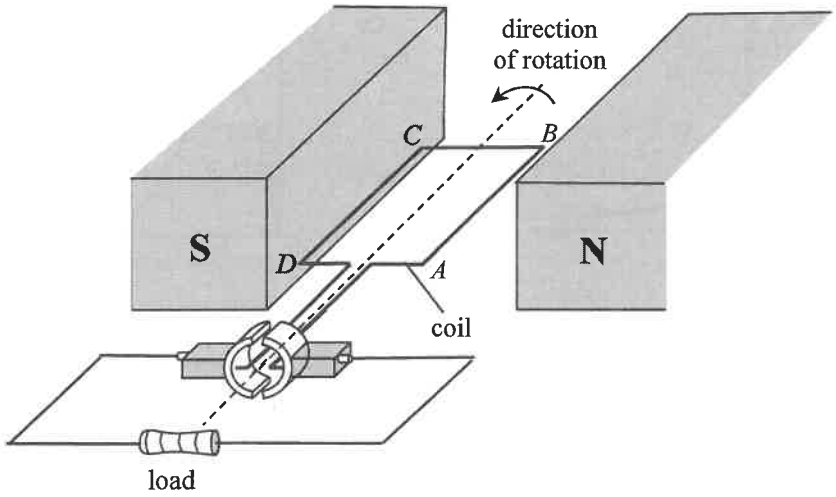
27. The figure below shows three parallel wires carrying currents in the directions shown.



If one of the wires experiences zero resultant magnetic force, that wire

A. must be *X*.
B. must be *Y*.
C. must be *Z*.
D. may be *Y* or *Z*.

28.

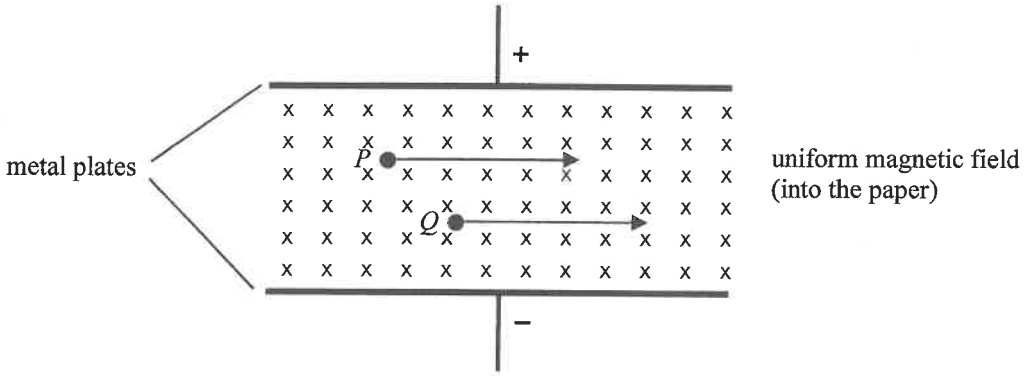


The figure shows the structure of a simple generator. Which of the following statements is/are correct ?

(1) The magnetic force acting on side *AB* of the coil is upward at the instant shown.
(2) The commutator would reverse the direction of current in the coil whenever the coil passes its vertical position.
(3) The current flowing through the load is an unsteady d.c.

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

*29. Charged particles P and Q are moving in a region with mutually perpendicular uniform electric and magnetic fields as shown.



If both particles are not deflected by the fields, which of the following statements **must be** correct ? Neglect the effects of gravity.

(1) They are positively charged.
(2) They are moving with the same velocity.
(3) They have the same charge to mass ratio.

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

*30. Arrange the following in ascending order of power delivered when each of them is connected to the same resistor.

(1) a 100 Hz sinusoidal a.c. of peak voltage 2 V
(2) a 50 Hz sinusoidal a.c. of r.m.s. voltage 2 V
(3) a steady d.c. of voltage 1.5 V

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

Go on to the next page

31. Which of the following statements about X-rays is **INCORRECT** ?

A. X-rays can be produced by high-speed electrons hitting a metal target.
B. X-rays are a kind of electromagnetic waves.
C. X-rays can be deflected by an electric field.
D. Although X-rays do not carry charges, they can cause ionization.

*32. Radioactive sources *X* and *Y* have initial activities 100 kBq and 200 kBq respectively. One day later, their activities are found to be equal. After another day, the activity of *X* becomes 80 kBq. Deduce the corresponding activity of *Y*.

A. 40 kBq
B. 50 kBq
C. 89 kBq
D. 160 kBq

33. What is the value of x for the fission reaction below ?

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{92}_{36}\mathrm{Kr} + {}^{141}_{56}\mathrm{Ba} + x\,{}^{1}_{0}\mathrm{n}$$

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

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 $= 1.661 \times 10^{-27}$ 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
$E_n = -\frac{1}{n^2}\left\{\frac{m_e q_e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ 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