2023-DSE
PHY
PAPER 1A

DIOCESAN BOYS' SCHOOL
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2023

G 12 FINAL EXAMINATION

PHYSICS PAPER 1

Time allowed: 2 ½ hours

This paper must be answered in English

Name: _____ Class: _____ ( )

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.

(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.

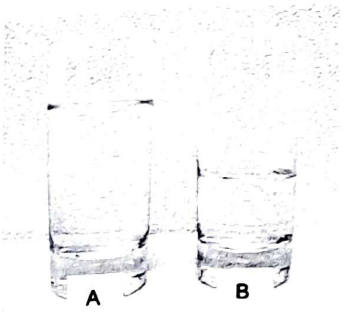
(5) You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

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

Section A

There are 33 questions.

1. Two glasses of water, A and B, are shown in the figure. There is more water in glass A than in glass B. Both glasses of water have the same total kinetic energy. Which of the following statements is / are correct?



(1) Water in glass A is colder than that in glass B.
(2) Water in glass A has the same internal energy as that in glass B.
(3) Water in glass A has the same average kinetic energy as that in glass B.

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

(For Questions 2 and 3) As shown in Figure (a), some liquid in a cup is heated by an immersion heater which is fully immersed into the liquid. Figure (b) shows the variation of the reading on the electronic balance with time *t*.

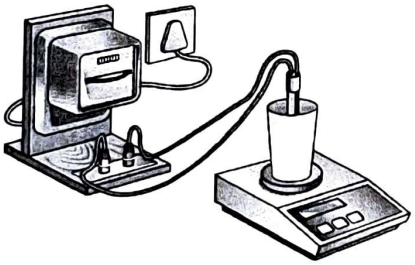


Figure (a)

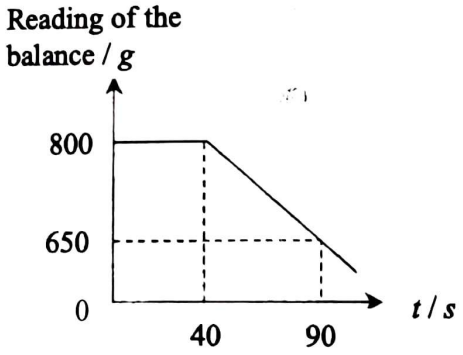


Figure (b)

2. The power of the heater is 1000 W. What is the specific latent heat of vaporization of the liquid?

A. 2.67×10^2 J kg $^{-1}$
B. 3.33×10^2 J kg $^{-1}$
C. 2.67×10^5 J kg $^{-1}$
D. 3.33×10^5 J kg $^{-1}$

3. How will the specific latent of vaporization obtained be affected respectively if the experiment is repeated with the following changes?

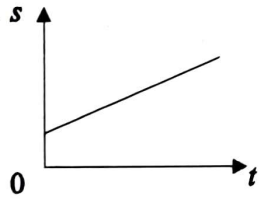
I. Some steam condenses on the top part of the container.
II. Some water splashes out of the cup as it boils.

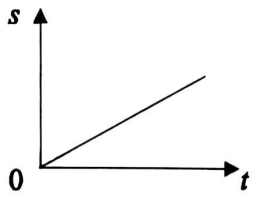
	I	II
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

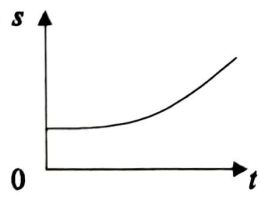
4. A container of fixed volume $5\times10^{-3}\text{m}^3$ contains 0.25 mole of an ideal gas. The mass of each molecule is 8×10^{-26} kg and the root-mean-square speed of the gas is 500 ms^{-1}. What is the pressure of the gas inside the container?

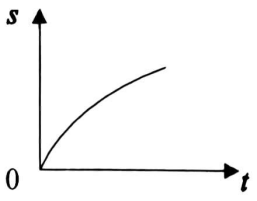
A. 8×10^5 Pa
B. 4×10^5 Pa
C. 2×10^5 Pa
D. 1×10^5 Pa

5. An object moves along a straight line with non-zero acceleration and non-zero initial velocity. Which of the following graphs best shows the variation of its displacement s with time t?

A. 

B. 

C. 

D. 

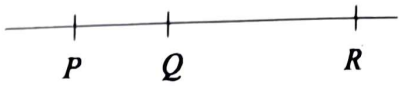
6. A particle accelerates uniformly along a straight line from P to R through Q. The ratio of the length of PQ to that of QR is $1 : 2$. It has speeds u and v at P and R respectively. What is the speed of the particle at Q in terms of u and v?

A. $\sqrt{\frac{3u^2+v^2}{3}}$

B. $\sqrt{\frac{2u^2+v^2}{2}}$

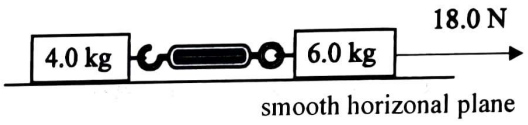
C. $\sqrt{\frac{3u^2+v^2}{2}}$

D. $\sqrt{\frac{2u^2+v^2}{3}}$

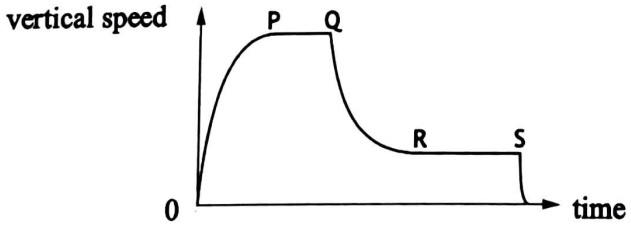


7. Two blocks of masses 4.0 kg and 6.0 kg are placed on a smooth horizontal plane. They are connected by a light spring balance. A force of 18.0 N acts on the 6.0-kg block to the right as shown. The reading on the spring balance is

A. 7.2 N.
B. 9.0 N.
C. 14.4 N.
D. 18.0 N.



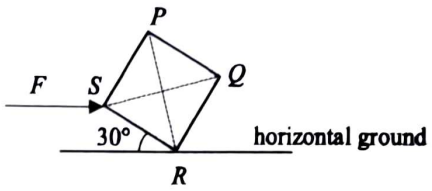
8. A skydiver jumps out of a plane with zero initial vertical speed and falls vertically. After a while, the skydiver opens a parachute. The variation of the vertical speed of the skydiver with time is shown in the following graph. Which of the following statements about the skydiver is/are **incorrect**?



(1) The skydiver decelerates between $t = 0$ and P.
(2) The air resistance acting on the skydiver between Q and R is less than the weight of the skydiver.
(3) The net force acting on the skydiver is zero between R and S.

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

9. A uniform cube $PQRS$ of weight W is placed on a horizontal ground. It is pushed by a horizontal force F at S such that it remains at rest, touches the ground at R and the angle between SR and the ground is $30°$. Which of the following gives the correct expression of F?



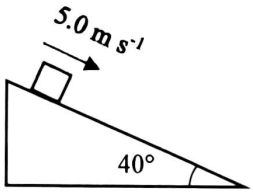
A. $\frac{(\sqrt{2}\sin 15°)W}{2\sin 30°}$

B. $\frac{(\sqrt{2}\sin 15°)W}{2\cos 30°}$

C. $\frac{(\sqrt{2}\cos 15°)W}{2\sin 30°}$

D. $\frac{(\sqrt{2}\cos 15°)W}{2\cos 30°}$

10. A block of mass 2.0 kg slides down a plane inclined at an angle of $40°$ with the horizontal. The block has a constant speed of 5.0 m s^{-1}. At what rate does the gravitational force do work on the block?



A. 0 W
B. 63 W
C. 75 W
D. 98 W

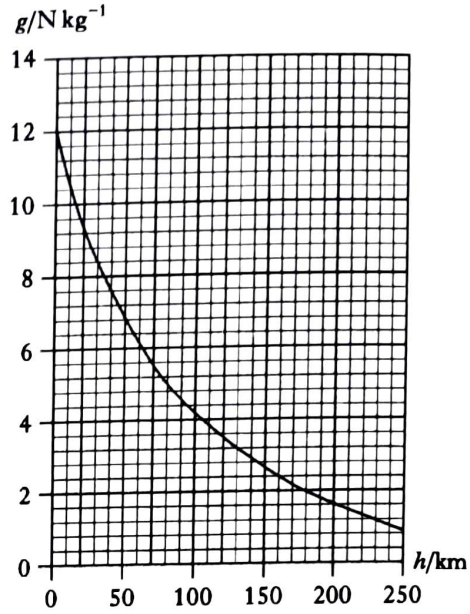
11. The maximum speed at which a car can take a circular turn without skidding on a level road of radius R is v. The maximum speed at which the same car, under the same conditions, can take a circular turn of radius $2R$ is

A. $\sqrt{2}v$.
B. $2v$.
C. $2\sqrt{2}v$.
D. $4v$.

12. Two identical satellites P and Q revolve around the Earth in 2 stable circular orbits respectively. The orbital radius of Q is longer than that of P. When compared with satellite P, satellite Q has a greater

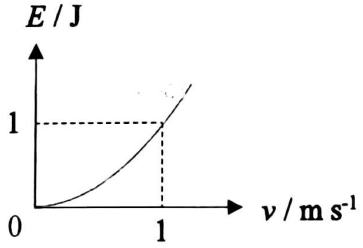
A. centripetal acceleration.
B. gravitational force.
C. linear orbital speed.
D. orbital period.

13. The variation of the gravitational field strength g of a planet with the height h above the surface of the planet is shown in the graph. A stone of mass 0.80 kg falls towards the surface of the planet. At one moment during the fall, the weight of the stone is 1.6 N. What is the height of the stone from the surface of the planet at this moment?



A. 180 km
B. 200 km
C. 230 km
D. It cannot be determined as the mass of the planet is not given.

14. The graph below shows the variation of kinetic energy E of an object with its speed v. What is the magnitude of momentum of the object when it moves at a speed of 4 m s^{-1}?



A. 2 N s
B. 4 N s
C. 8 N s
D. 16 N s

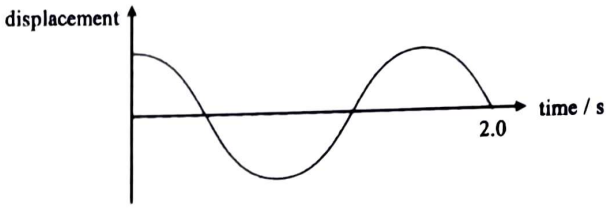
15. A sphere X initially moving at a certain velocity makes a head-on collision with another identical sphere Y initially at rest. If the collision is perfectly inelastic, which of the following statements is/are correct?

(1) Linear momentum of sphere X is conserved in this collision.
(2) X and Y stick together and move at the same speed after the collision.
(3) Total kinetic energy is conserved in this collision.

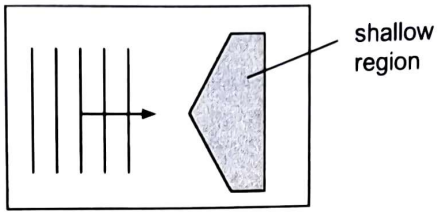
A. (2) only
B. (1) and (2) only
C. (1) and (3) only
D. (2) and (3) only

16. The figure below shows the displacement-time graph of a particle in a transverse travelling wave. What is the frequency of this wave?

A. 0.375 Hz
B. 0.625 Hz
C. 0.75 Hz
D. 1.125 Hz

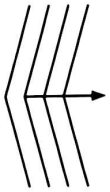


17. In the figure below, a plane wave travels towards a shallow region in a ripple tank.

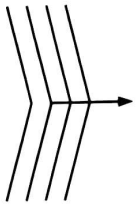


Which of the following figures best shows the wave in the shallow region?

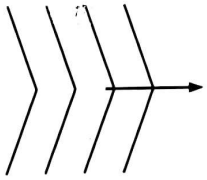
A.



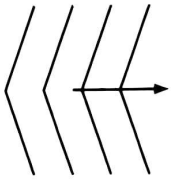
B.



C.



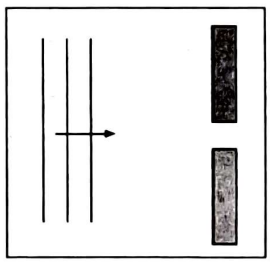
D.



18. In a ripple tank experiment, a water wave is diffracted while passing through a small gap. Which of the following changes would reduce the diffraction effect?

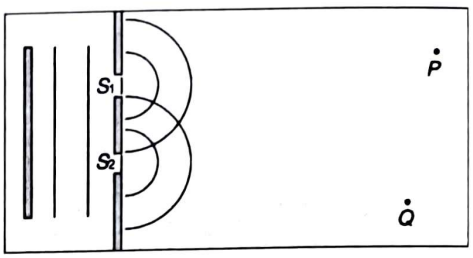
(1) Adding more water into the ripple tank
(2) Increasing the frequency of the vibrator
(3) Doubling the width of the gap

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



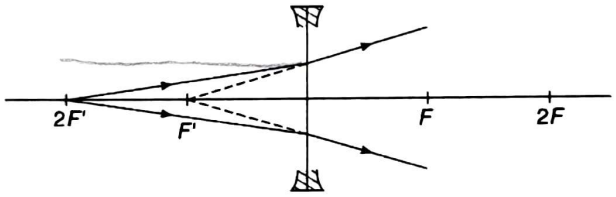
19. In a ripple tank, a plane wave of wavelength 1 cm travels towards a double-slit and circular waves come out from the slits S_1 and S_2 as shown. P is 15 cm away from S_1 and 20 cm away from S_2, while Q is 14 cm away from S_1 and 12 cm away from S_2. What kinds of interference will occur at P and Q if the frequency of the wave is halved?

	P	Q
A.	Destructive	Constructive
B.	Constructive	Destructive
C.	Constructive	Constructive
D.	Destructive	Destructive

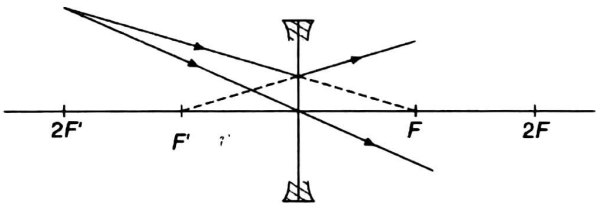


20. If F and F' are the foci of a concave lens, which of the following ray diagrams are **incorrect**?

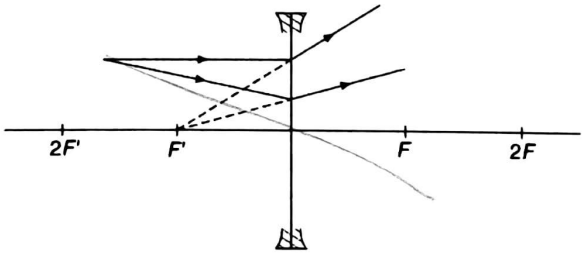
(1)



(2)



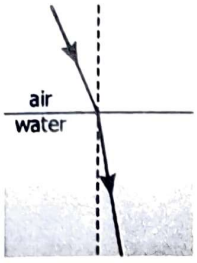
(3)



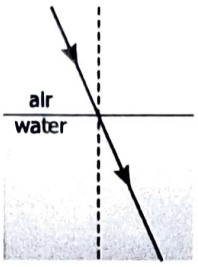
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

21. Which of the following diagrams best represents the refraction of a sound wave travelling from air to water?

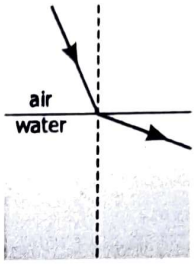
A.



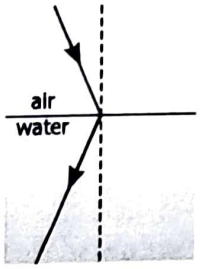
B.



C.



D.



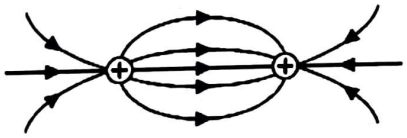
22. Which of the following about ultrasonic wave is / are correct?

(1) It is an electromagnetic wave.
(2) It is a longitudinal wave.
(3) It does not require a medium to travel.

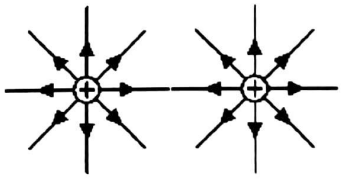
A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

23. Which of the following diagrams best shows the pattern of electric field lines due to two small positive charges held at the positions shown?

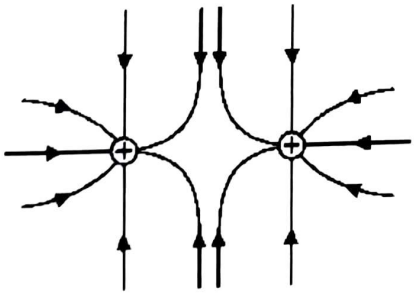
A.



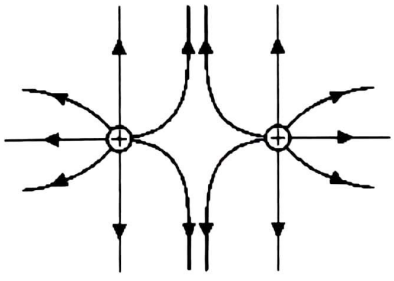
B.



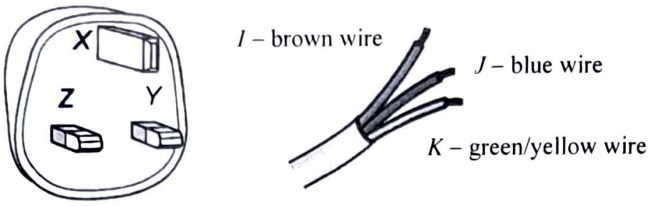
C.



D.



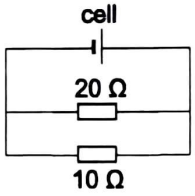
24. The figure shows a 3-pin plug and three wires *I*, *J* and *K* inside a cable.



Which of the following is the correct way to connect the wires?

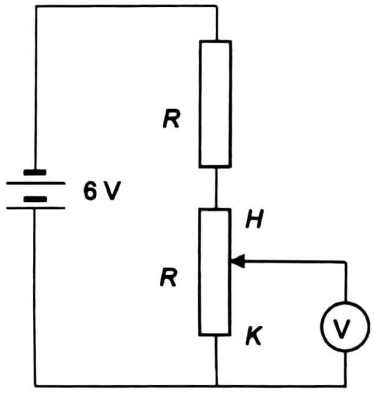
	Pin *X*	**Pin *Y***	**Pin *Z***
A.	*K*	*J*	*I*
B.	*K*	*I*	*J*
C.	*J*	*K*	*I*
D.	*J*	*I*	*K*

25. Two resistors of resistance 10 Ω and 20 Ω are connected in parallel to a cell of negligible internal resistance. The energy dissipated by the 10-Ω resistor in one second is *E* . What is the energy dissipated in **two** seconds by the 20-Ω resistor?

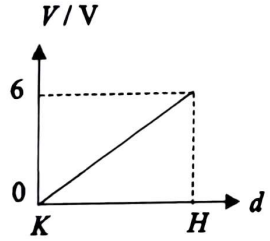


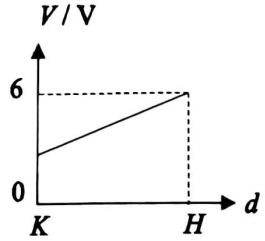
A. $\frac{E}{2}$
B. E
C. $2E$
D. It cannot be determined as the e.m.f. of the cell is not given.

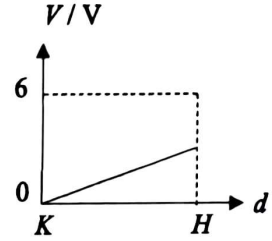
26. A rheostat of maximum resistance *R* is connected in series with a resistor of resistance *R* and a battery of e.m.f. 6 V. The battery has negligible internal resistance. The slider on the rheostat is moved from *K* to *H* .

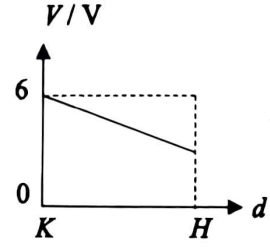


Which graph best shows the variation of the voltmeter reading *V* with the slider distance *d* ?

A.


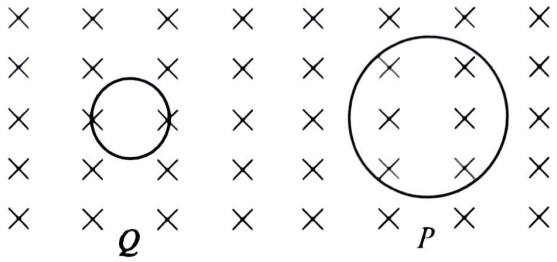
B.


C.


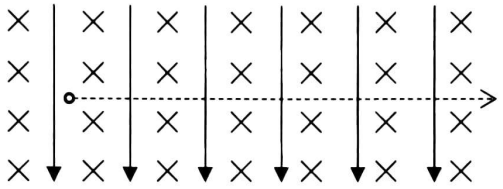
D.


27. Two circular wire frames, P and Q, are placed separately in a large uniform magnetic field as shown. They are made of the same material and have the same cross-sectional area. The radius of the larger frame P is double that of the smaller one Q. When the flux density of the field is increased at a steady rate, the ratio of the induced current in P to that in Q is

A. 8 : 1 .
B. 4 : 1 .
C. 2 : 1 .
D. 1 : 1 .



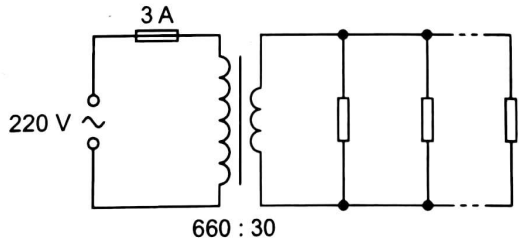
28. A light charged particle enters a region in which both a uniform electric field E and a uniform magnetic field B exist. The electric field E points downward while the magnetic field B points into paper as shown.



The charged particle travels through this region in a horizontal straight line (the dotted path). Which of the following statements must be true?

A. The particle must be positively charged.
B. If the magnitude of the electric field is decreased, the particle will deflect upward.
C. If the electric field is absent, the particle will move in a parabolic path.
D. If the speed of the particle is increased, the particle will not move in a straight line.

29. The primary coil of a transformer is connected to a 220-V a.c. supply via a 3-A fuse. A number of identical resistors are connected in parallel to the secondary coil of the transformer. The resistance of each resistor is 3 Ω.



If the efficiency of the transformer is 70% and the fuse does not melt, what is the maximum number of resistors connected to the secondary coil?

A. 12
B. 13
C. 14
D. 15

30. Two identical resistors R are connected in series with an a.c. power supply. The r.m.s. values of the voltage and the current of the power supply are denoted by V and I respectively. What is the maximum power developed in **one** of the resistors in the circuit?

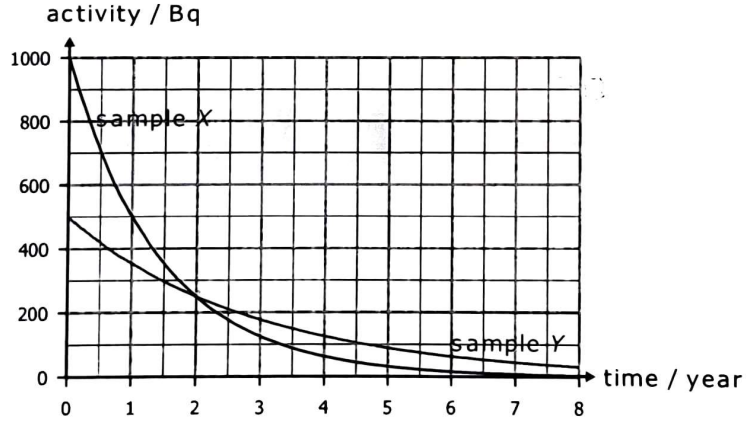
A. $\frac{VI}{\sqrt{2}}$
B. $2VI$
C. VI
D. $\sqrt{2}VI$

31. Which of the following statements about X-rays and γ-rays is / are correct?

(1) Both X-rays and γ-rays can exhibit interference.
(2) Both X-rays and γ-rays are ionizing radiations.
(3) Both X-rays and γ-rays are nuclear radiations.

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

32. The graph below shows the activities of two radioactive samples X and Y in 8 years.



Which of the following statements is/are correct?

(1) The half-life of X is two times that of Y.
(2) X has a larger probability of decay than Y.
(3) The rate of radioactive decay in X is always higher than that in Y.

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

33. Which of the following nuclear reactions is / are energy-releasing?

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

(2) ${}_{92}^{235}\mathrm{U}+{}_{0}^{1}\mathrm{n}\rightarrow{}_{37}^{90}\mathrm{Rb}+{}_{55}^{143}\mathrm{Cs}+3{}_{0}^{1}\mathrm{n}$

(3) ${}_{21}^{47}\mathrm{Sc}^{*}\rightarrow{}_{21}^{47}\mathrm{Sc}+\gamma$

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

END OF SECTION A

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
acceleration due to gravity	$g = 9.81\ \text{m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8\ \text{m s}^{-1}$
charge of electron	$e = 1.60 \times 10^{-19}\ \text{C}$
electron rest mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}\ \text{m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \text{H m}^{-1}$
atomic mass unit	$\text{u} = 1.661 \times 10^{-27}\ \text{kg}$ (1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11}\ \text{m}$
light year	$\text{ly} = 9.46 \times 10^{15}\ \text{m}$
parsec	$\text{pc} = 3.09 \times 10^{16}\ \text{m} = 3.26\ \text{ly} = 206\ 265\ \text{AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$

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
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}\ \text{eV}$	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Energy and Use of Energy

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

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
$\text{power} = \frac{1}{f}$	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	D1.	$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
A2.	$E = l\Delta m$	energy transfer during change of state	D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
A3.	$pV = nRT$	equation of state for an ideal gas	D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
A4.	$pV = \frac{1}{3} Nm\overline{c^2}$	kinetic theory equation	D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy	D5.	$R = R_1 + R_2$	resistors in series
			D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force	D7.	$P = IV = I^2R$	power in a circuit
B2.	moment = $F \times d$	moment of a force	D8.	$F = BQv \sin\theta$	force on a moving charge in a magnetic field
B3.	$E_P = mgh$	gravitational potential energy	D9.	$F = BIl \sin\theta$	force on a current-carrying conductor in a magnetic field
B4.	$E_K = \frac{1}{2} mv^2$	kinetic energy	D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
B5.	$P = Fv$	mechanical power	D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration	D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
B7.	$F = \frac{Gm_1 m_2}{r^2}$	Newton's law of gravitation	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	E1.	$N = N_0 e^{-kt}$	law of radioactive decay
C2.	$d \sin\theta = n\lambda$	diffraction grating equation	E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens	E3.	$A = kN$	activity and the number of undecayed nuclei
			E4.	$\Delta E = \Delta mc^2$	mass-energy relationship