TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	( )
CIVICS GROUP	

H2 PHYSICS 9749/01

Paper 1 Multiple Choice **22 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

You do not need to submit this Booklet at the end of the examination.

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and index number on the Multiple Choice Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions.
For each question there are four possible answers **A**, **B**, **C**, **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	8.85×10^{-12} F m^{-1}
		=	$\left(1/\left(36\pi\right)\right) \times 10^{-9}$ F m^{-1}
elementary charge	e	=	1.60×10^{-19} C
the Planck constant	h	=	6.63×10^{-34} J s
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
molar gas constant	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant	k	=	1.38×10^{-23}J K^{-1}
gravitational constant	G	=	6.67×10^{-11} N m^2 kg^{-2}
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on / by a gas	W	=	$p\Delta V$
hydrostatic pressure	p	=	ρgh
gravitational potential	ϕ	=	$-\frac{GM}{r}$
temperature	T /K	=	T /°C + 273.15
pressure of an ideal gas	p	=	$\frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	E	=	$\frac{3}{2}kT$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos \omega t$
		=	$\pm \omega\sqrt{x_o^2 - x^2}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential	V	=	$\frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage	X	=	$x_o \sin \omega t$
magnetic flux density due to a long straight wire	B	=	$\frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	B	=	$\frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	B	=	$\mu_0 nI$
radioactive decay	x	=	$x_0 \exp(-\lambda t)$
decay constant	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

Answer **all** questions.

1 Which of the following shows the base units for magnetic flux density B?

A kg s^{-2} A^{-1} **B** kg s^{-1} A^{-1} **C** kg s^{-1} C^{-1} **D** N A^{-1} m^{-1}

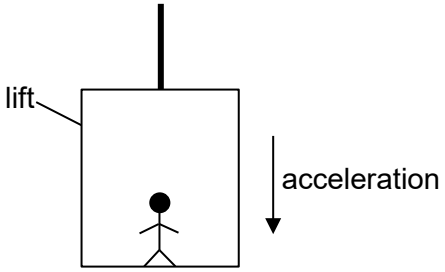
2 The marathon is a long-distance foot race with a distance of 42.195 km.
Which of the following shows the equivalent distance?

A 4.2195×10^{5} cm
B 4.2195×10^{6} mm
C 4.2195×10^{10} μm
D 4.2195×10^{12} nm

3 A body falls in a vacuum from rest a distance x in time t.
How far will the body fall in the next time interval t?

A x **B** $2x$ **C** $3x$ **D** $4x$

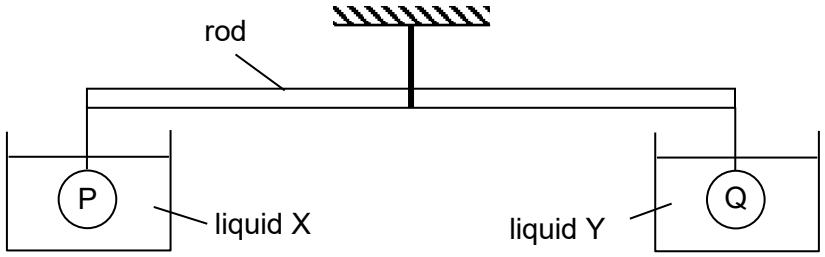
4 A boy stands in a lift that is accelerating downwards as shown.



Which statement describes the magnitude of the force exerted by the boy on the floor?

A It is equal to the weight of the boy.
B It is less than the weight of the boy.
C It is less than the force exerted by the floor on the boy.
D It is greater than the force exerted by the floor on the boy.

5 Two objects P and Q of the same volume are hung at either ends of a light uniform rod. They are fully submerged in liquids X and Y. Liquid X is denser than liquid Y. The rod is held in equilibrium when it is supported at its centre by a string as shown below.



Which of the following statements is correct?

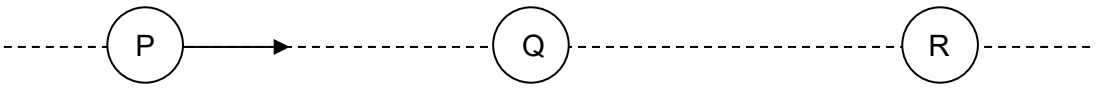
A P and Q has the same mass.

B Mass of P is larger than mass of Q.

C P and Q experience the same magnitudes of upthrust.

D Upthrust acting on P is smaller than the upthrust acting on Q.

6 Three identical stationary discs P, Q and R are placed in a line on a horizontal flat, frictionless surface. Disc P is projected straight towards disc Q.



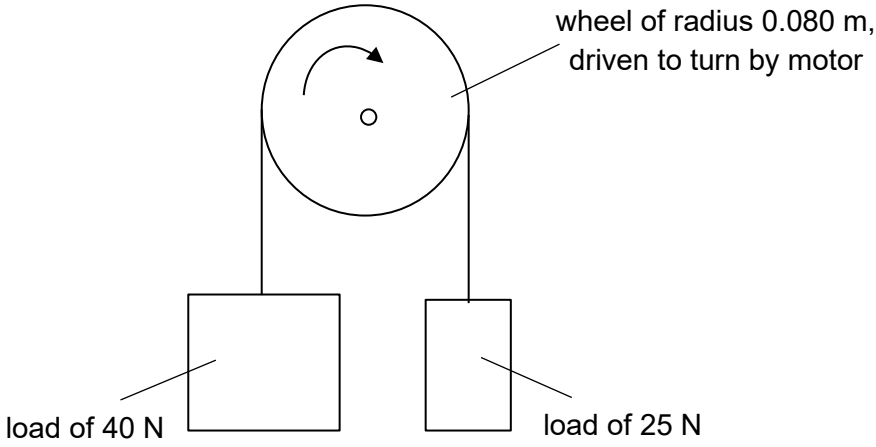
If all collisions are elastic, what will be the final motion of the three discs?

	P	Q	R
A	moving right	moving right	moving right
B	moving left	moving left	moving right
C	moving left	stationary	moving right
D	stationary	stationary	moving right

7 A wheel of radius 0.080 m is driven by a motor, as shown in the diagram below.

A light rope is passed over the circumference of the wheel.

One end of the rope is fastened to a freely hanging load of weight 40 N. The other end of the rope is fastened to a load of weight 25 N.

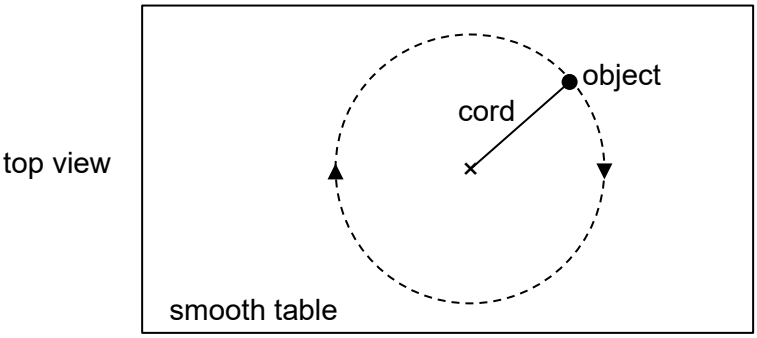


When the wheel turns at a constant rate of 10 revolutions per second, both loads remain stationary.

What is the output power of the motor?

A 12 W **B** 38 W **C** 50 W **D** 75 W

8 An object of mass 0.80 kg is attached to an elastic cord and performs a circular motion on a smooth horizontal table with a constant speed of 3.2 m s^{-1}.

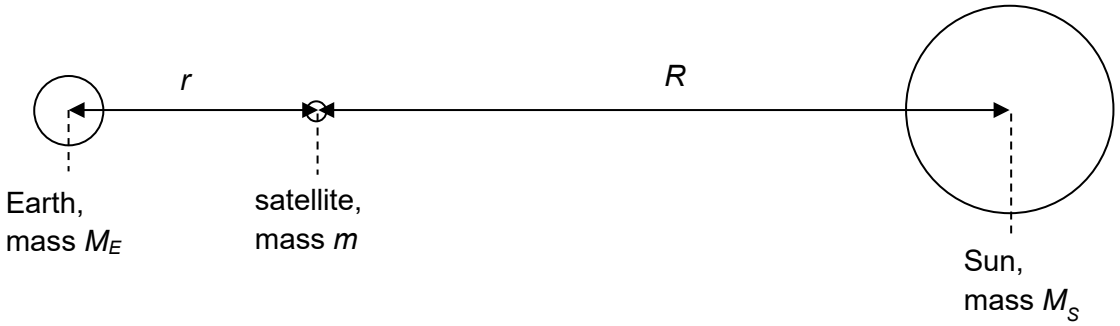


The radius of the circular motion is 0.72 m.
The force constant of the elastic cord is 42 N m^{-1}.

What is the unstretched length of the elastic cord?

A 0.27 m **B** 0.45 m **C** 0.60 m **D** 0.64 m

9 A solar satellite of mass m is positioned between the Earth, mass M_E, and the Sun, mass M_S. The satellite is at a distance r from the Earth and a distance R from the Sun.



The satellite orbits around the Sun with the same orbital period of 1 year as that of the Earth.

Which of the following is the correct expression for the acceleration of the satellite?

A $G\frac{M_S}{R^2}$

B $G\frac{M_E}{R^2}$

C $G\frac{M_E}{r^2} - G\frac{M_S}{R^2}$

D $G\frac{M_S}{R^2} - G\frac{M_E}{r^2}$

10 The escape speed from the surface of the Moon is v_m.

The escape speed from the surface of the Earth is v_E.

The ratios of the masses and the radii of the Moon and the Earth are:

$$\frac{M_m}{M_E} = \frac{1}{81}; \quad \frac{r_m}{r_E} = \frac{1}{4}$$

where M_m is the mass of the Moon, M_E is the mass of the Earth, r_m is the radius of the Moon and r_E is the radius of the Earth.

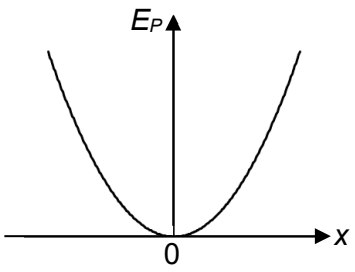
What is the ratio of $\frac{v_m}{v_E}$?

A 0.049 **B** 0.098 **C** 0.22 **D** 0.31

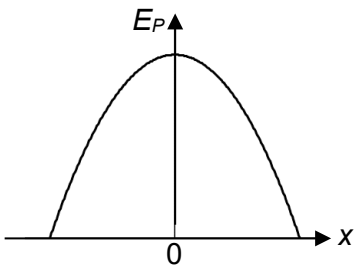
11 A mass attached to a spring is undergoing simple harmonic oscillations vertically.

Which graph shows the variation with displacement x of the potential energy E_P of the oscillation?

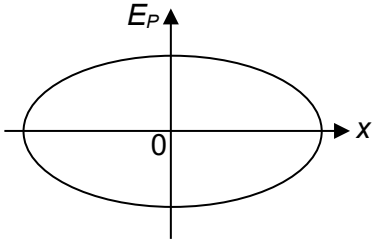
A



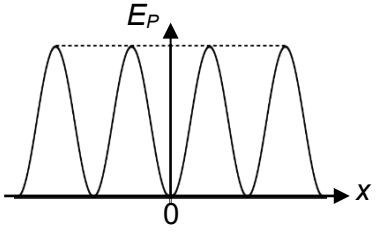
B



C

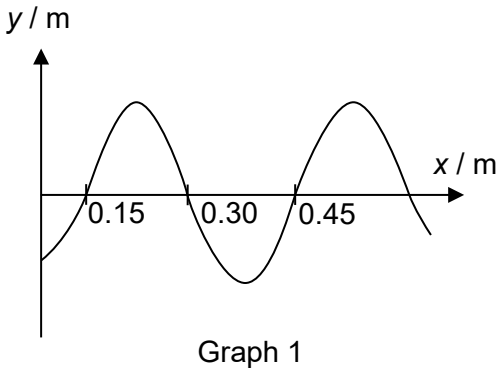


D

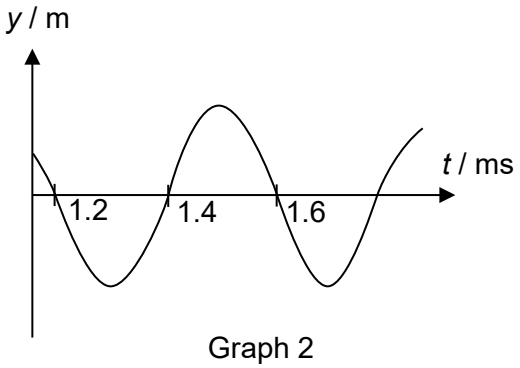


12 Graph 1 shows how the displacement y of a particular wave varies with distance x along the wave.

Graph 2 shows how the displacement y of one particular point of the same wave varies with time, t.



Graph 1



Graph 2

What is the speed of the wave?

A 0.75 m s^{-1} **B** 375 m s^{-1} **C** 750 m s^{-1} **D** 1500 m s^{-1}

13 An image on the television screen is made up of many tiny pixels. The distance between two adjacent pixels is 3.0×10^{-4} m. The human eye has a slit width of about 2.8 mm and the average wavelength of light emitted from the screen is 550 nm.

What is the distance a viewer should be away from the television for the individual pixels to be just resolved?

A 0.60 m **B** 0.90 m **C** 1.5 m **D** 3.0 m

14 A beam of light, comprising red and blue light, is incident normally on a diffraction grating. The wavelength of the red light is 685 nm, while that of the blue light is 411 nm.

Which of the following orders of red and blue maxima will coincide on the screen?

	order of red maximum	order of blue maximum
A	3rd	5th
B	5th	3rd
C	2nd	3rd
D	3rd	2nd

15 In the kinetic model of an ideal gas, it is assumed that

A the momentum of a given molecule of the gas is constant.

B the kinetic energy of a given molecule of the gas is constant.

C the forces between the molecules of the gas and the container are always zero.

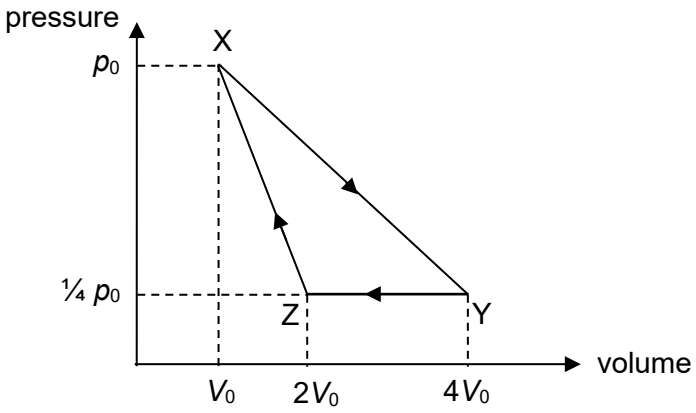
D the potential energy of the molecules of the gas is zero.

16 A mixture of neon and helium gases are in thermal equilibrium. The mass of a single neon atom is 2.5 times that of helium. The mixture of gases behaves ideally.

What is the ratio of $\frac{\text{root-mean-square speed of a helium atom}}{\text{root-mean-square speed of a neon atom}}$?

A 0.80 **B** 1.0 **C** 1.6 **D** 2.5

17 The graph shows the variation of pressure with volume of an ideal gas during a thermodynamic cycle.



Which of the following statements is incorrect?

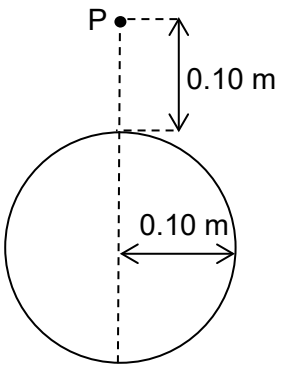
A The internal energy of the gas decreases when it goes from state Z to state X.

B The mean kinetic energy of the gas molecules is the same at state X and state Y.

C Work is done on the gas when it goes from state Y to state Z.

D Net heat is supplied to the gas in one complete cycle.

18 The surface of an isolated conducting sphere is at a potential of −180 kV. The radius of the sphere is 0.10 m. P is a point 0.10 m above the surface as shown below.

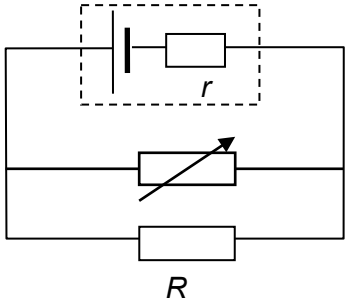


What is the potential at point P?

A −90 kV **B** −45 kV **C** 45 kV **D** 90 kV

19 A battery with an internal resistance *r* is connected to a variable resistor and a resistor *R* as shown.

The resistance of the variable resistor is slowly increased from zero to the same value as resistor *R*.



What happens to the terminal potential difference of the battery?

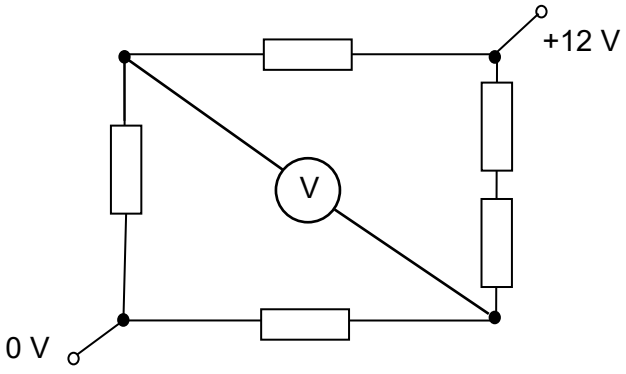
A increases

B decreases

C decreases before increasing

D no change

20 In the circuit shown, all the resistors have the same resistance. The voltmeter can be assumed to be ideal.

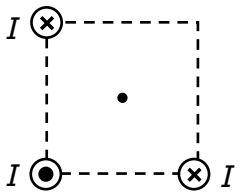


The potential difference between the terminals is 12 V.

What is the reading on the voltmeter?

A 0 V **B** 2 V **C** 4 V **D** 6 V

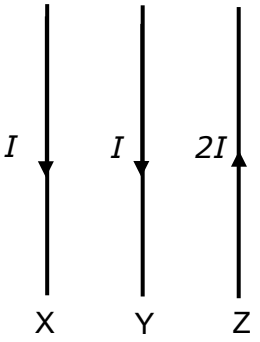
21 The diagram shows three wires carrying equal currents. The wires pass through the three corners of a square as shown.



What is direction of the magnetic field at the centre of the square due to wires?

A ← **B** ↖ **C** ↘ **D** ↑

22 The diagram shows three wires X, Y and Z that are equally spaced from each other. The current running through each wire is as shown.

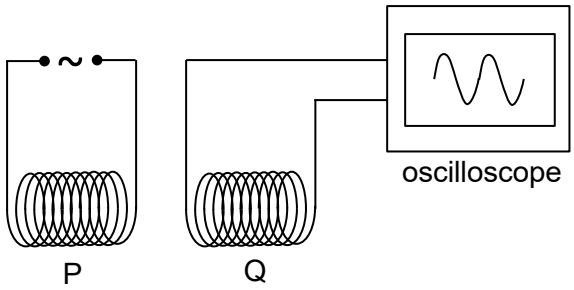


The magnitude of the magnetic force exerted by wire X on Y is *F*.

What is the magnitude and direction of the resultant magnetic force exerted on wire Y?

A *F*, rightwards **B** *F*, leftwards **C** 2*F*, leftwards **D** 3*F*, leftwards

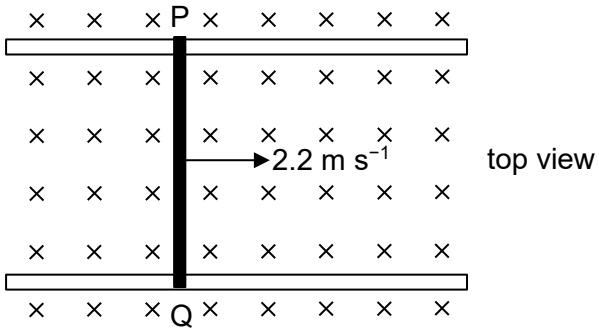
23 A coil P is connected to a 50 Hz alternating voltage supply. Another coil Q is placed close to coil P with both coils lying on the same axis. Coil Q is connected to an oscilloscope, which detects a sinusoidal signal on the screen.



What would be the effect on the oscilloscope signal if both coils are linked by a soft iron core?

	amplitude of signal	number of cycles on screen
A	increases	unchanged
B	increases	increases
C	unchanged	unchanged
D	unchanged	increases

24 A conducting rod PQ of length 10 cm is placed on two horizontal, parallel and smooth metal rails as shown below. A uniform magnetic field of flux density 0.54 T is applied perpendicularly to the plane of the rails into paper.

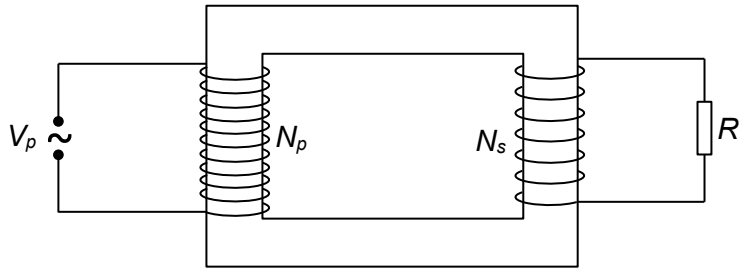


Rod PQ moves at a constant speed of 2.2 m s^{-1}.

Which of the following correctly states the magnitude of the induced e.m.f. and the end of the rod with higher potential?

	magnitude of e.m.f.	end of rod with higher potential
A	0.12 V	P
B	12 V	P
C	0.12 V	Q
D	12 V	Q

25 The figure below shows an ideal transformer with N_p turns in its primary coil and N_s turns in its secondary coil.

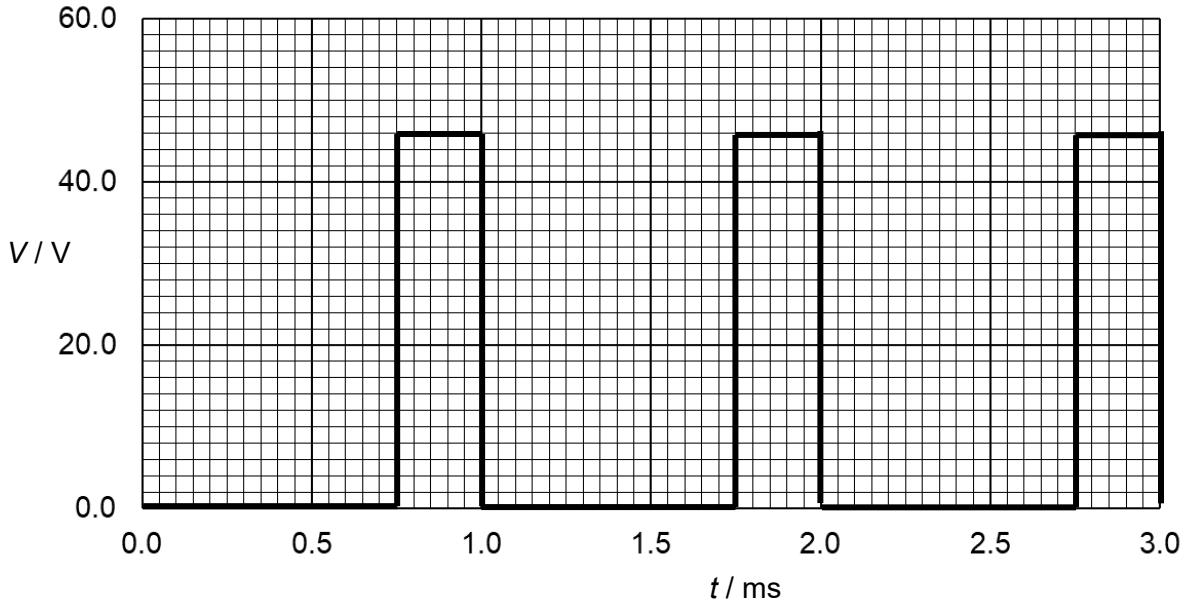


An alternating voltage supply of V_p is connect to the primary coil. A resistor of R ohms is connected to the secondary coil.

Which expression gives the power in the primary coil?

A $\frac{N_p^2 V_p}{N_s^2 R}$ **B** $\frac{N_s V_p^2}{N_P R}$ **C** $\frac{N_s^2 V_p^2}{N_P^2 R}$ **D** $\frac{N_s^2 V_p}{N_P^2 R}$

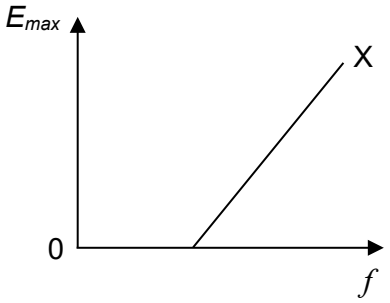
26 The figure below shows the variation with time, t, of a periodic voltage supply, V.



What is the root-mean-square value of the voltage?

A 12 V **B** 23 V **C** 33 V **D** 529 V

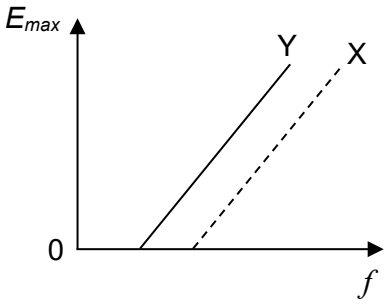
27 Light is incident on the surface of metal X so that it emits electrons. The variation with frequency f of the incident light of the maximum kinetic energy E_{max} of the electrons is given below.



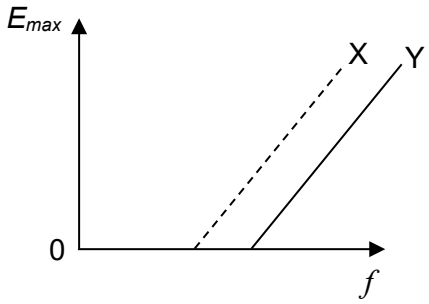
The experiment is repeated with a metal Y of a larger work function.

Which of the following shows the graph for Y?

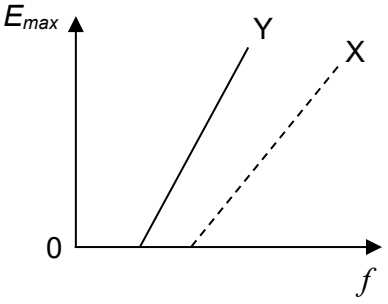
A



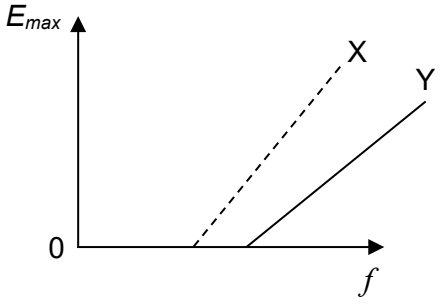
B



C



D



28 The speed of an electron is measured to be 5.8×10^{6} m s^{-1} to an accuracy of 0.2%.

What is the minimum uncertainty in determining the position of the electron?

A 5.7×10^{-38} m **B** 1.1×10^{-26} m **C** 1.3×10^{-10} m **D** 6.3×10^{-8} m

29 Which of the following is a valid observation that leads to the prediction of the existence of the neutrino?

A There is a range of energies for the emitted β-particles during β-decay.

B The total charge of the daughter nuclide and β-particle is not equal to the charge of the parent nuclide that undergoes β-decay.

C There is loss in mass during β-decay.

D The track for a particle, different from that of β-particles, can be observed in a cloud chamber for a radioactive β-emitter.

30 A radioactive source emits radiation of type X.

A counter is placed at a fixed position close to the source.

When a piece of paper is placed between the counter and the source, the average count rate is 24 counts per minute.

When the paper is removed, the average count rate is 532 counts per minute.

What is radiation X and the average count rate immediately after two half-lives?

	radiation X	count rate after two half-lives / min^{-1}
A	α	127
B	β	127
C	α	151
D	β	151

End of Paper