Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1A

29 April 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.

1. Instantaneous velocity is defined as...

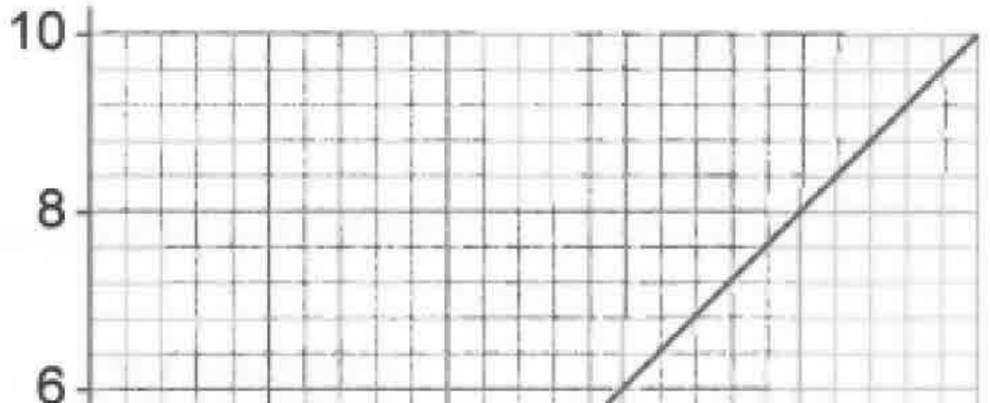
A. $\frac{\text{displacement}}{\text{time taken}}$.

B. rate of change of position.

C. $\frac{\text{distance moved}}{\text{time taken}}$.

D. rate of change of distance.

2. The variation with time t of the acceleration a of an object is shown. At $t = 0$ the object is at rest.



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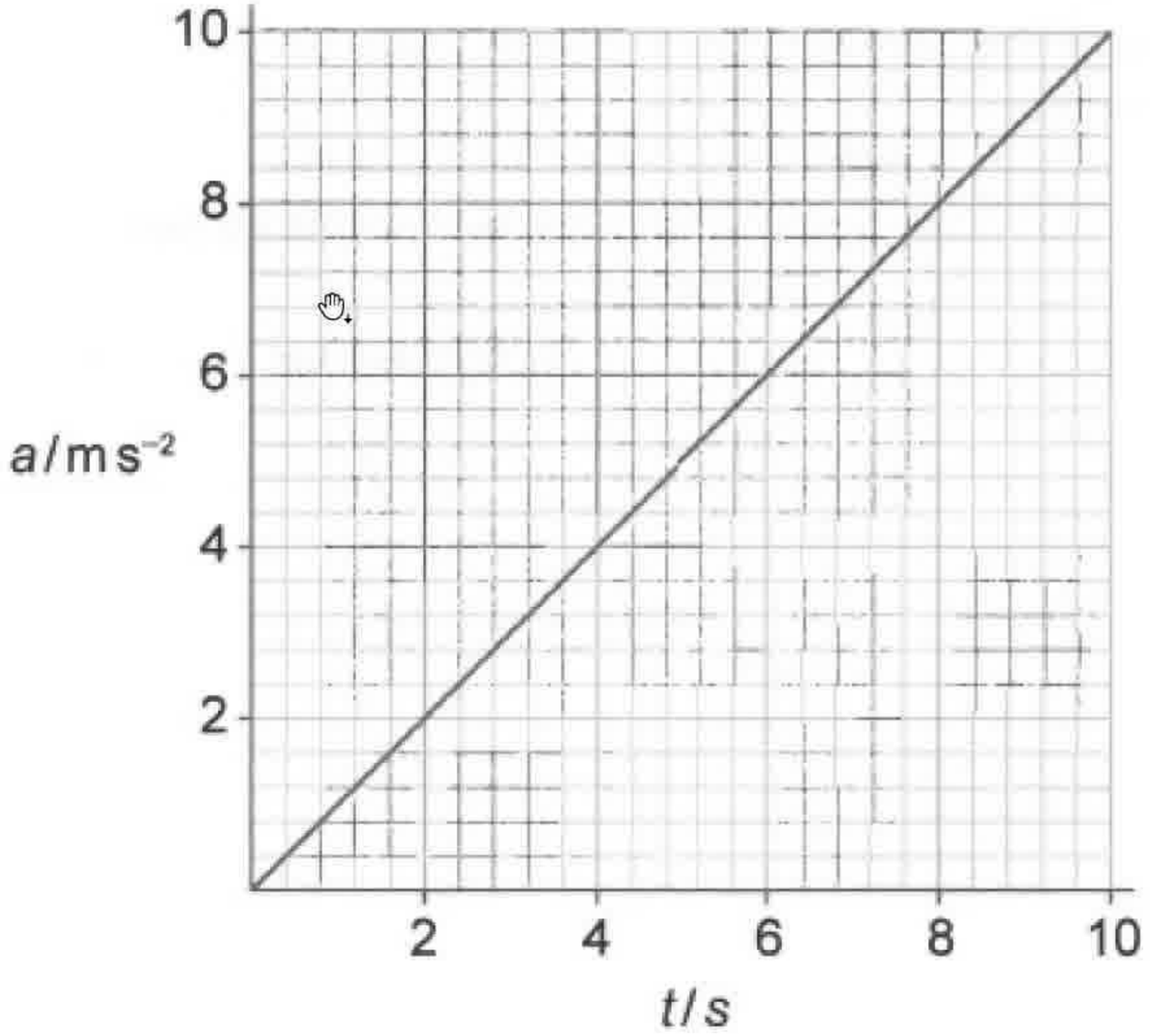
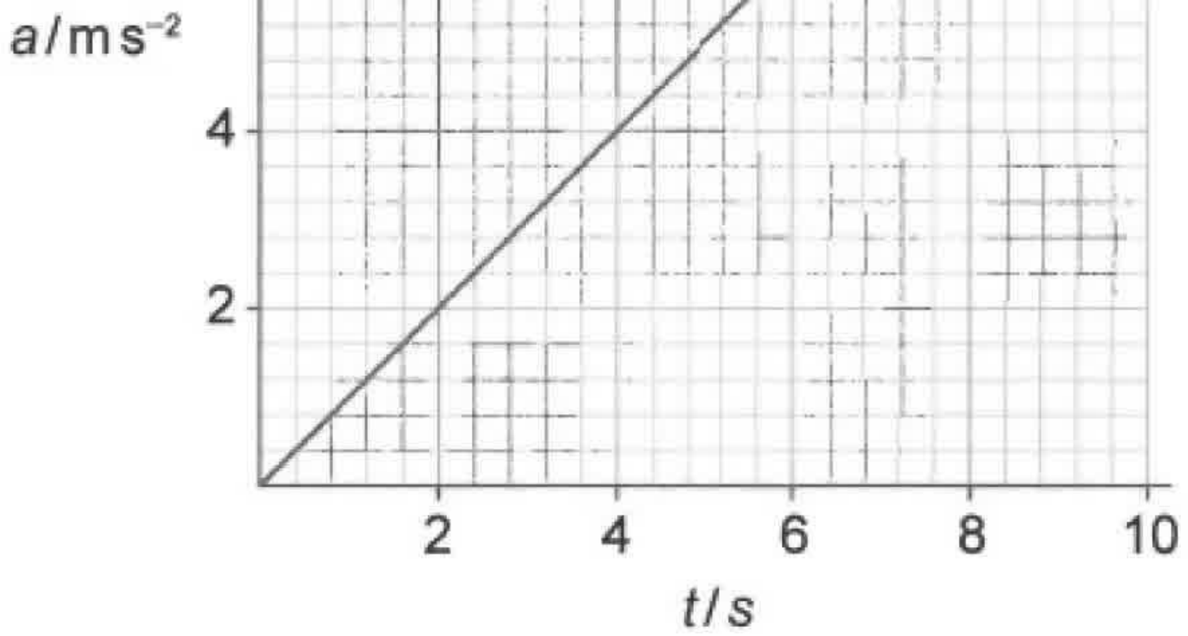


What is the speed of the object when $t = 8.0\,\text{s}$?



What is the speed of the object when $t = 8.0\,s$?

A. $1.0\,m\,s^{-1}$

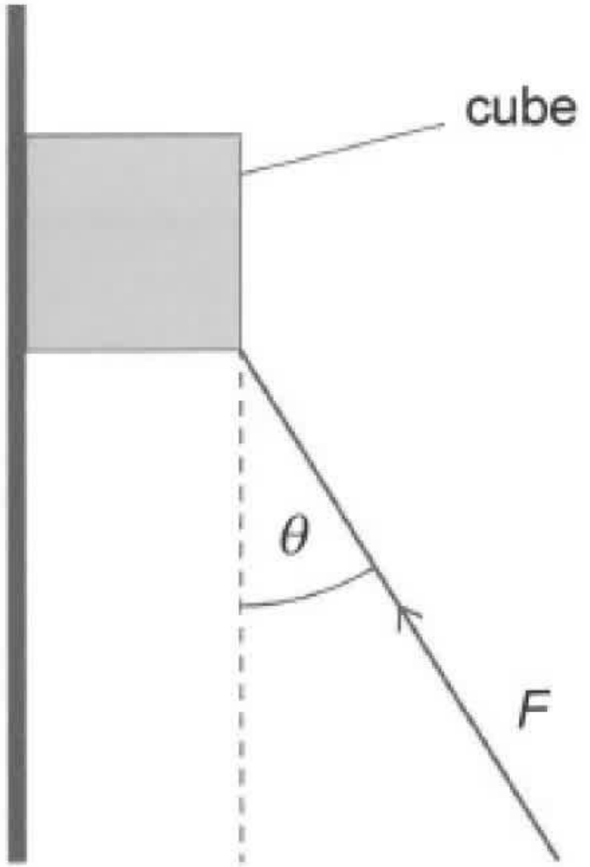
B. $32\,m\,s^{-1}$

C. $50\,m\,s^{-1}$

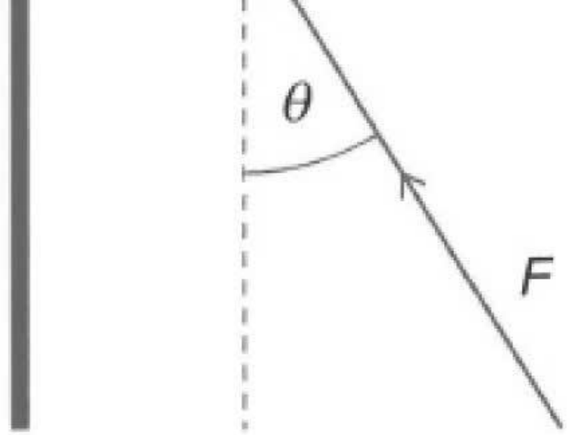
D. $64\,m\,s^{-1}$

3. A force acts on a cube of mass m that accelerates upwards along a vertical frictionless surface.

The magnitude of the force is F and it acts at θ to the vertical.



What is the magnitude of the acceleration of the cube?



What is the magnitude of the acceleration of the cube?

A. $\frac{(F\cos\theta - mg)}{m}$

B. $\frac{(F\sin\theta - mg)}{m}$

C. $\frac{(F\cos\theta - g)}{m}$

D. $\frac{(F\sin\theta - g)}{m}$

D. $\dfrac{(F\sin\theta - g)}{m}$

4. A sphere of density ρ and radius R rests on the bottom of a tank of water. The buoyancy force on the sphere is F_1.

A sphere of density 2ρ and radius $\dfrac{R}{2}$ is at the bottom of the same tank. The buoyancy force on the second sphere is F_2.

What is $\dfrac{F_1}{F_2}$?

A. 2

B. 4

C. 8

D. 16

5. A satellite undergoes one circular orbit of the Earth every 24 hours.

What is the angular velocity of the satellite?

A. $4.4 \times 10^{-3}\,\text{rad s}^{-1}$

B. $1.7 \times 10^{-3}\,\text{rad s}^{-1}$

C. $7.3 \times 10^{-5}\,\text{rad s}^{-1}$

D. $1.2 \times 10^{-5}\,\text{rad s}^{-1}$

6. An object of mass 5.0 kg is initially at rest. An impulse of 2.0 N s acts on the object.

What is the final kinetic energy of the object?

A. 0.40 J

B. 10 J

C. 20 J

D. $1.2 \times 10^{-5}\,\text{rad s}^{-1}$

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What is the final kinetic energy of the object?

A. 0.40 J

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C. 20 J

D. 40 J

7. A system of moment of inertia I rotates from rest about a given axis. The angular acceleration α of the system is constant.

What is the change in angular momentum when the system has made four complete rotations about the given axis?

A. $2I\sqrt{2\pi\alpha}$

B. 10 J

C. 20 J

D. 40 J

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What is the change in angular momentum when the system has made four complete rotations about the given axis?

A. $2I\sqrt{2\pi\alpha}$

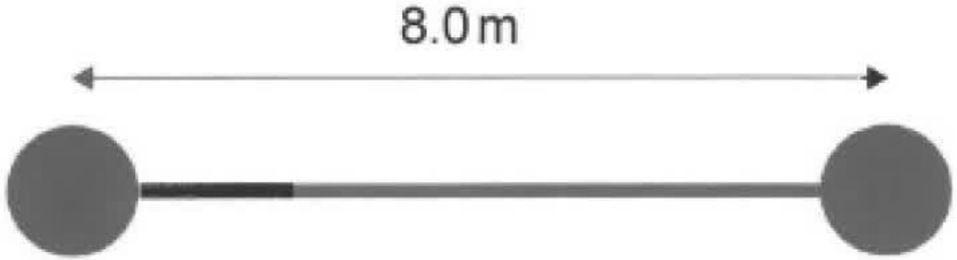
B. $4I\sqrt{\pi\alpha}$

C. $2I\sqrt{2\alpha}$

D. $4I\sqrt{\alpha}$

8. Two small spheres each of mass 10 kg are 8.0 m apart and connected by a rod of negligible mass.

This system rotates about an axis halfway along the rod and at right angles to it.



What is the moment of inertia of the system?

A. $160\,\text{kg}\,\text{m}^2$

B. $320\,\text{kg}\,\text{m}^2$

C. $640\,\text{kg}\,\text{m}^2$

D. $1280\,\text{kg}\,\text{m}^2$

9. Observer X sees a spacecraft moving in the positive x-direction at a speed of $0.50c$.

Observer Y sees the same spacecraft moving in the negative x-direction at a speed of $0.50c$.

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9. Observer X sees a spacecraft moving in the positive x-direction at a speed of $0.50c$.

Observer Y sees the same spacecraft moving in the negative x-direction at a speed of $0.50c$.

What is the speed of Y in the frame of reference of X?

A. 0

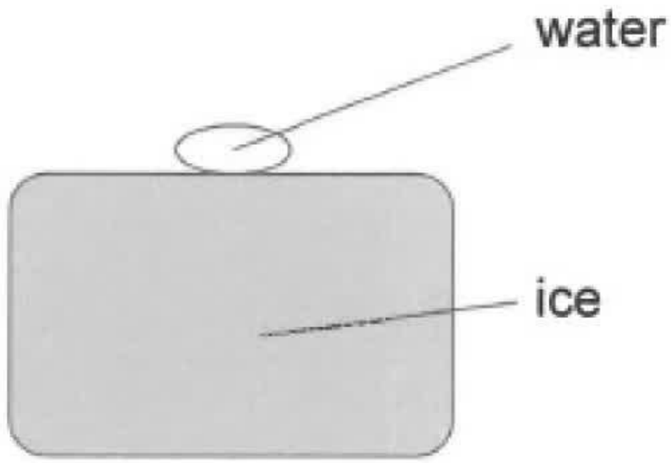
B. $0.80c$

C. c

D. $1.3c$

10. A block of ice of mass M is at its melting point.

A smaller mass m of water at a temperature of T°C is placed on the top surface of the ice and remains there.

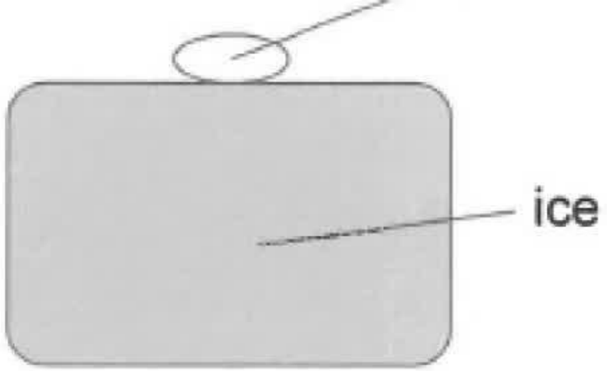


The specific latent heat of fusion of ice is L and the specific heat capacity of water is c.

What mass of ice melts?

A. $\frac{mcT}{L}$

B. $\frac{mLT}{c}$



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B. $\frac{mLT}{c}$

C. $\frac{McT}{L}$

D. $\frac{MLT}{c}$

A. $\frac{}{L}$

B. $\frac{mLT}{c}$

C. $\frac{McT}{L}$

D. $\frac{MLT}{c}$

11. What is a primary cause of the enhanced greenhouse effect?

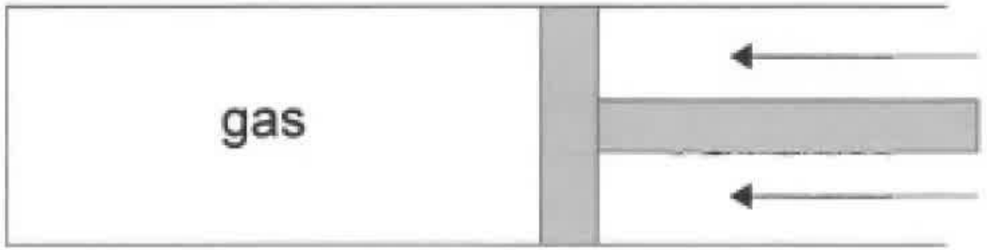
A. Melting of ice at Earth's poles

B. Increases in volcanic activity

C. Deforestation of rainforests

D. Burning of fossil fuels

12. An ideal gas is held in a cylinder by a piston. The piston compresses the gas rapidly.



The average speed of the gas molecules increases because the gas molecules...

A. have a smaller volume available in which they can move.

B. receive thermal energy transferred from outside the cylinder.

C. receive energy from the piston as they collide with it.

D. make more collisions every second with each other.

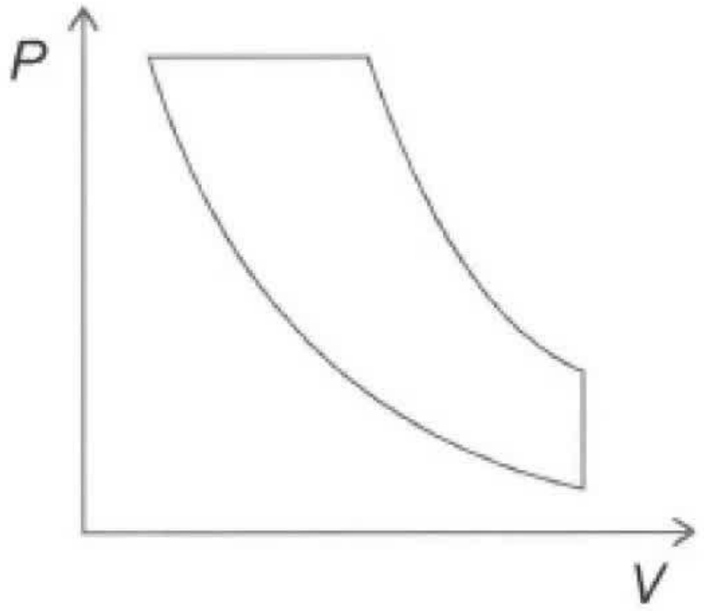
13. Which pressure–volume (P–V) diagram represents a Carnot cycle?

A.

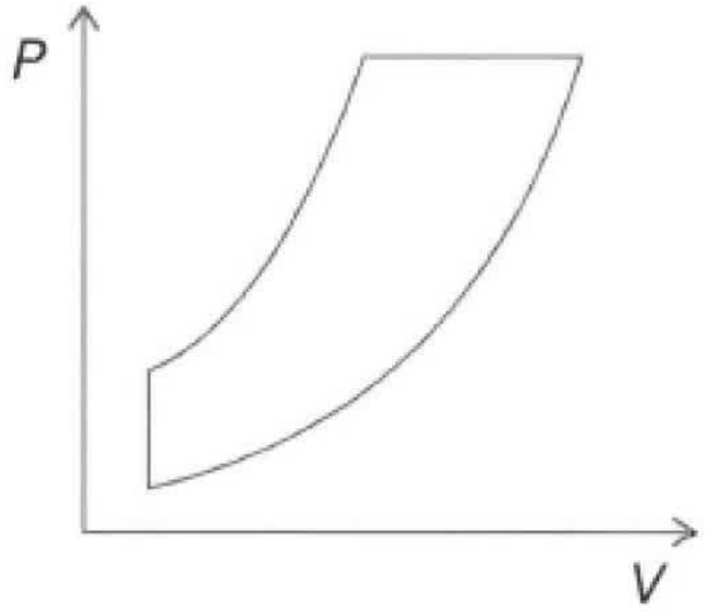
B.

13. Which pressure–volume (P–V) diagram represents a Carnot cycle?

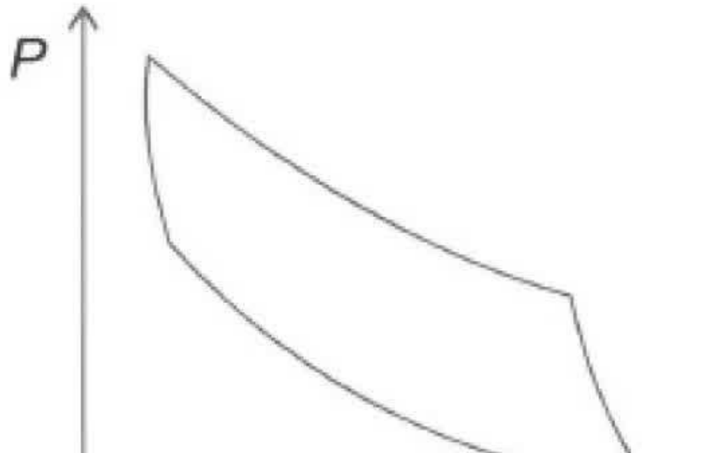
A.



B.

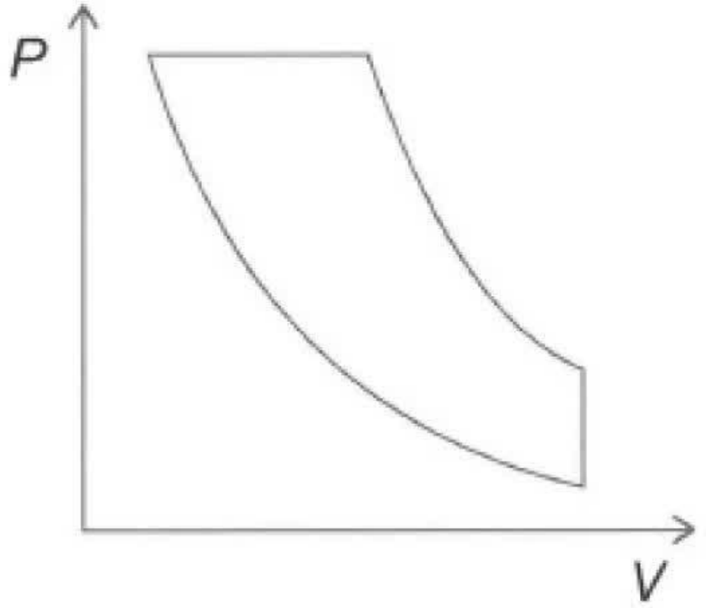


C.



D.

A.



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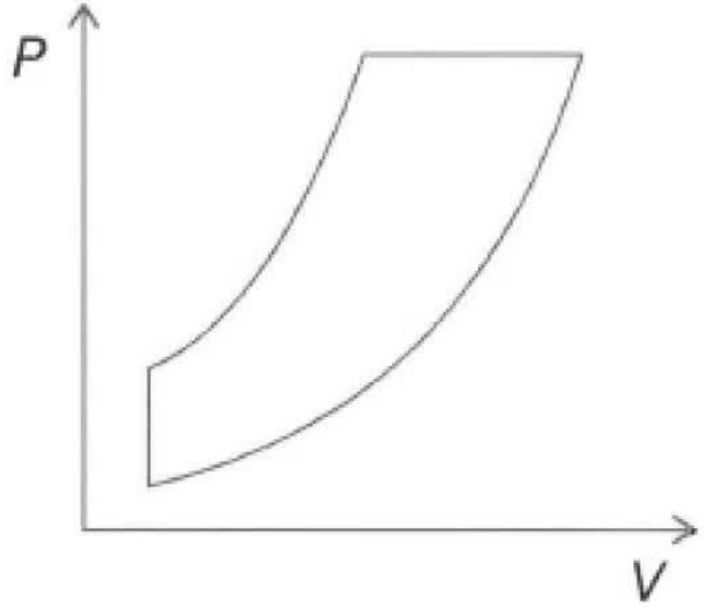
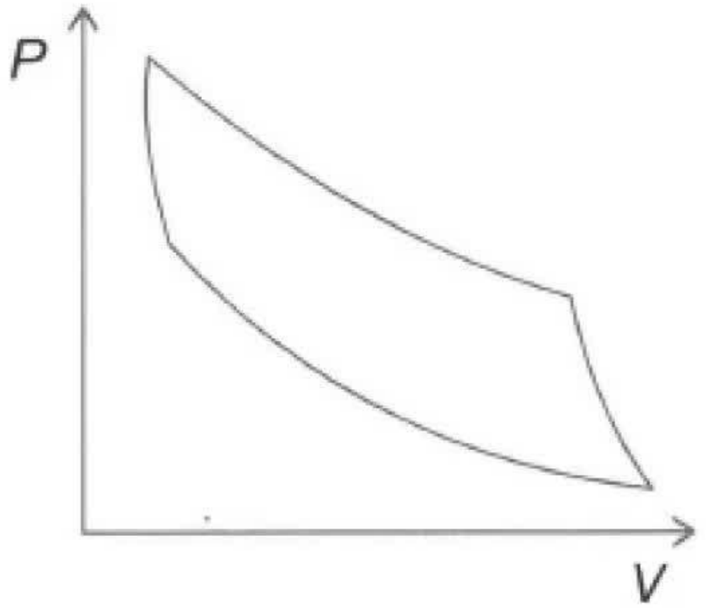
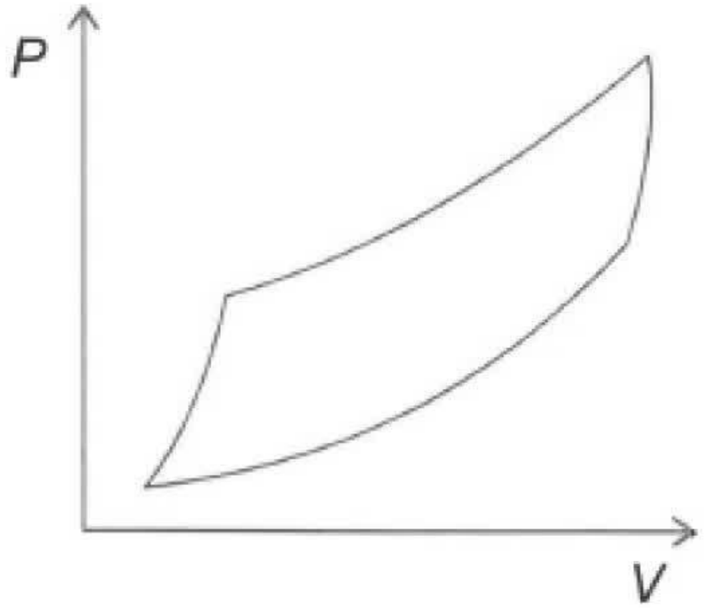


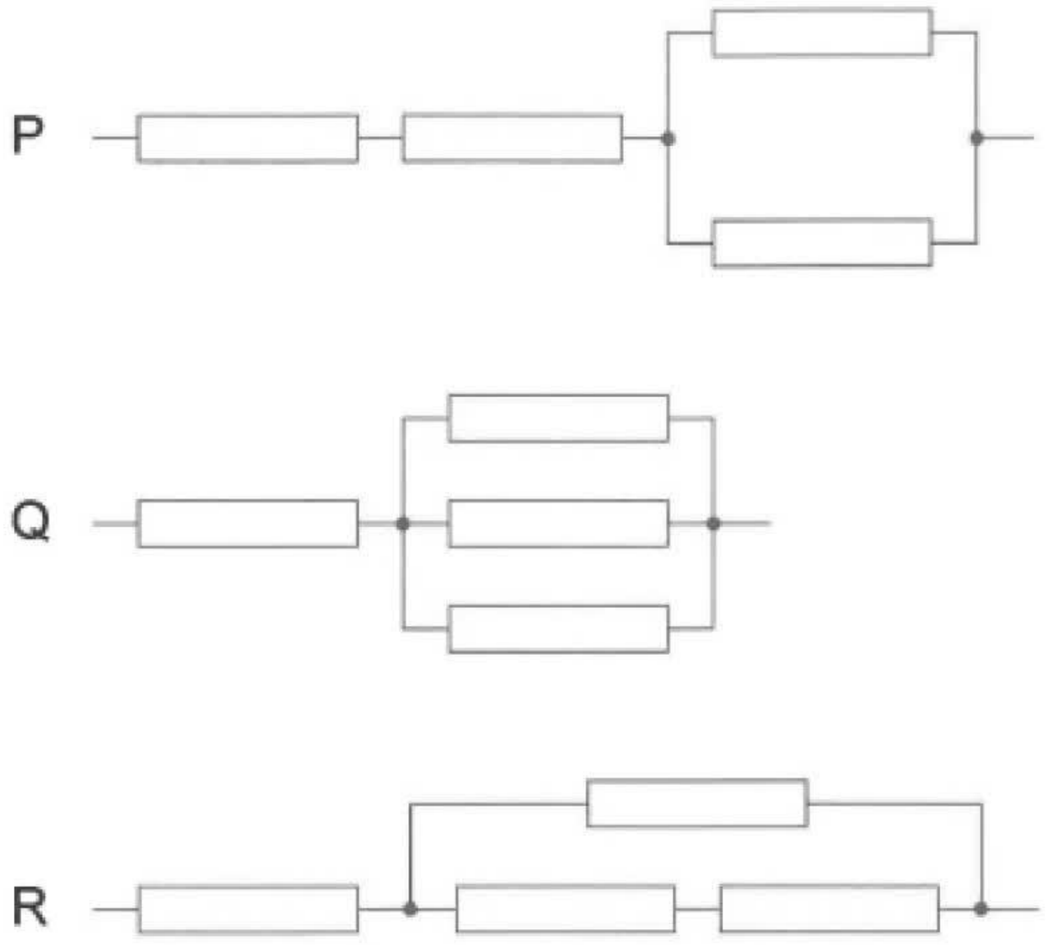
C.



D.

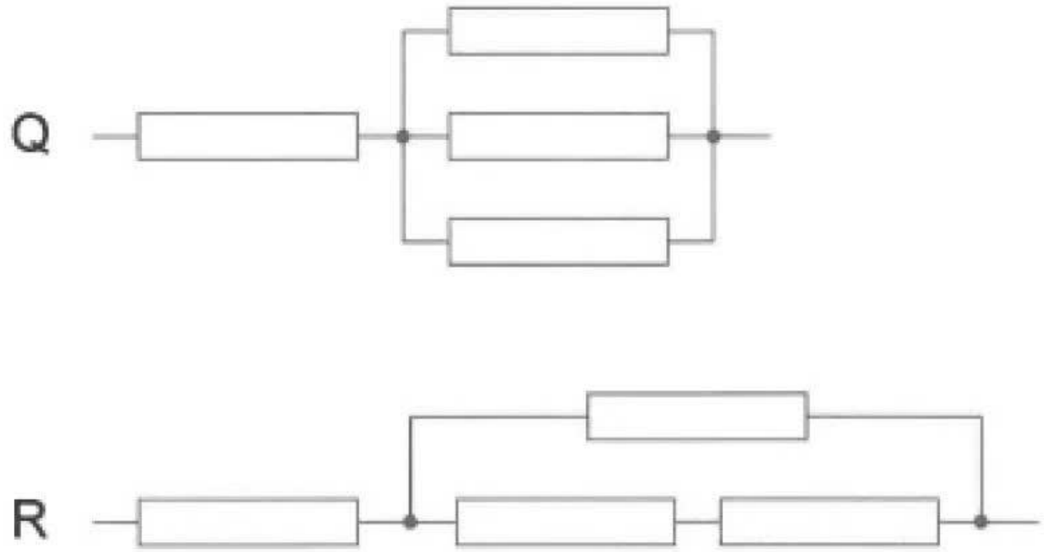


14. Three combinations of resistors are shown. The resistors are identical.



What is the total resistance of each combination of resistors in order of **increasing** resistance?

A. P Q R



What is the total resistance of each combination of resistors in order of **increasing** resistance?

A. P Q R

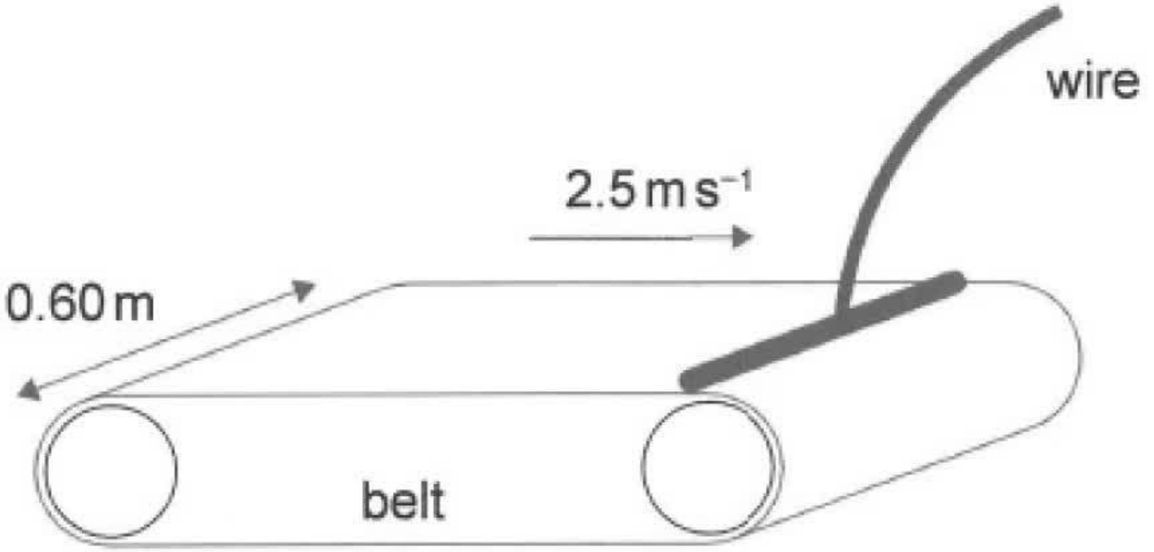
B. Q P R

C. P R Q

D. Q R P

15. A continuous belt of width 0.60 m travels at a constant speed of 2.5 m s^{-1}. The belt has a uniform distribution of charge of 5.0 mC m^{-2} on its surface.

As the belt passes a point all the charge is removed and is carried as a current in a wire.



What is the current in the wire?

A. 1.2 mA

B. 7.5 mA

C. 19 mA

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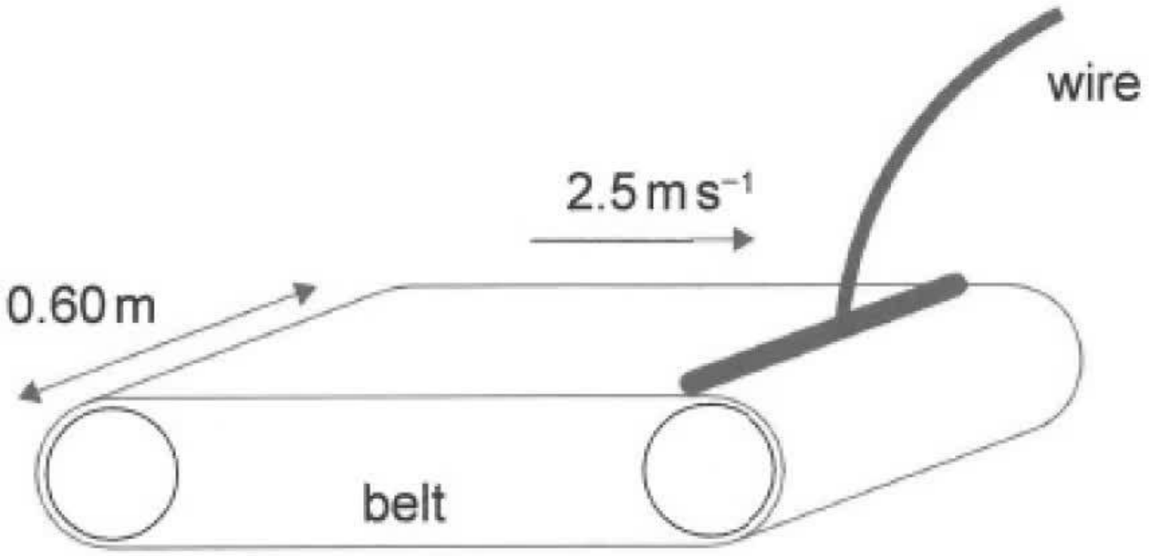


What is the current in the wire?

A. 1.2 mA

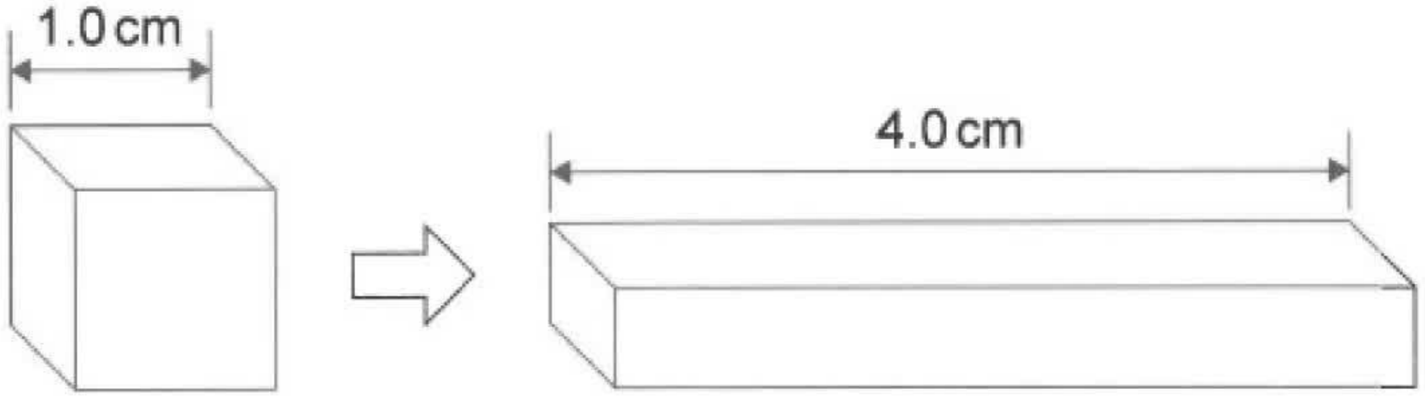
B. 7.5 mA

C. 19 mA

D. 21 mA

16. A cube of side 1.0 cm has a resistance between opposite sides of 50 Ω.

The material is reshaped into a block of length 4.0 cm and constant square cross-section.



What is the resistance of the block between its square ends?

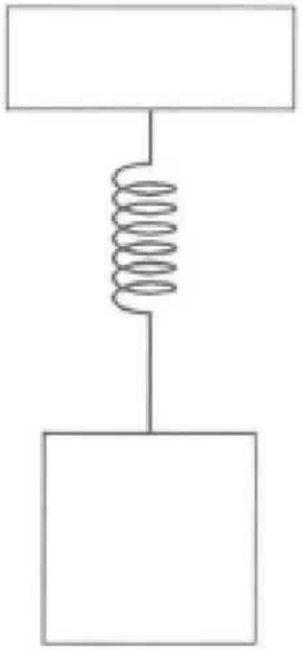
A. 3.1 Ω

B. 50 Ω

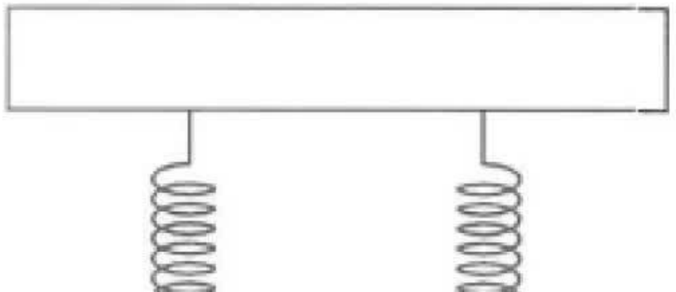
C. 800 Ω

D. 3200 Ω

17. A mass–spring system oscillates with time period T_1.



Another identical spring is connected in parallel with the first spring as shown. The mass is unchanged.



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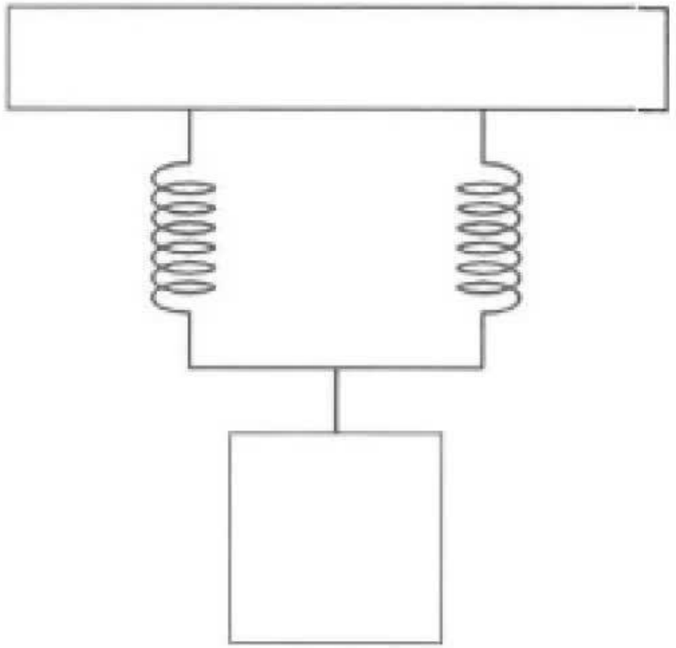
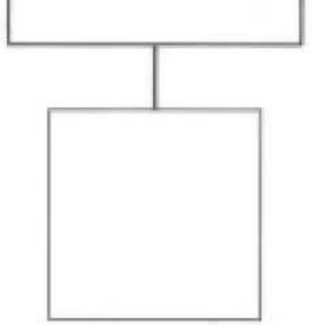


The time period of the oscillation for the two-spring system is T_2.

What is $\frac{T_2}{T_1}$?



The time period of the oscillation for the two-spring system is T_2.

What is $\frac{T_2}{T_1}$?

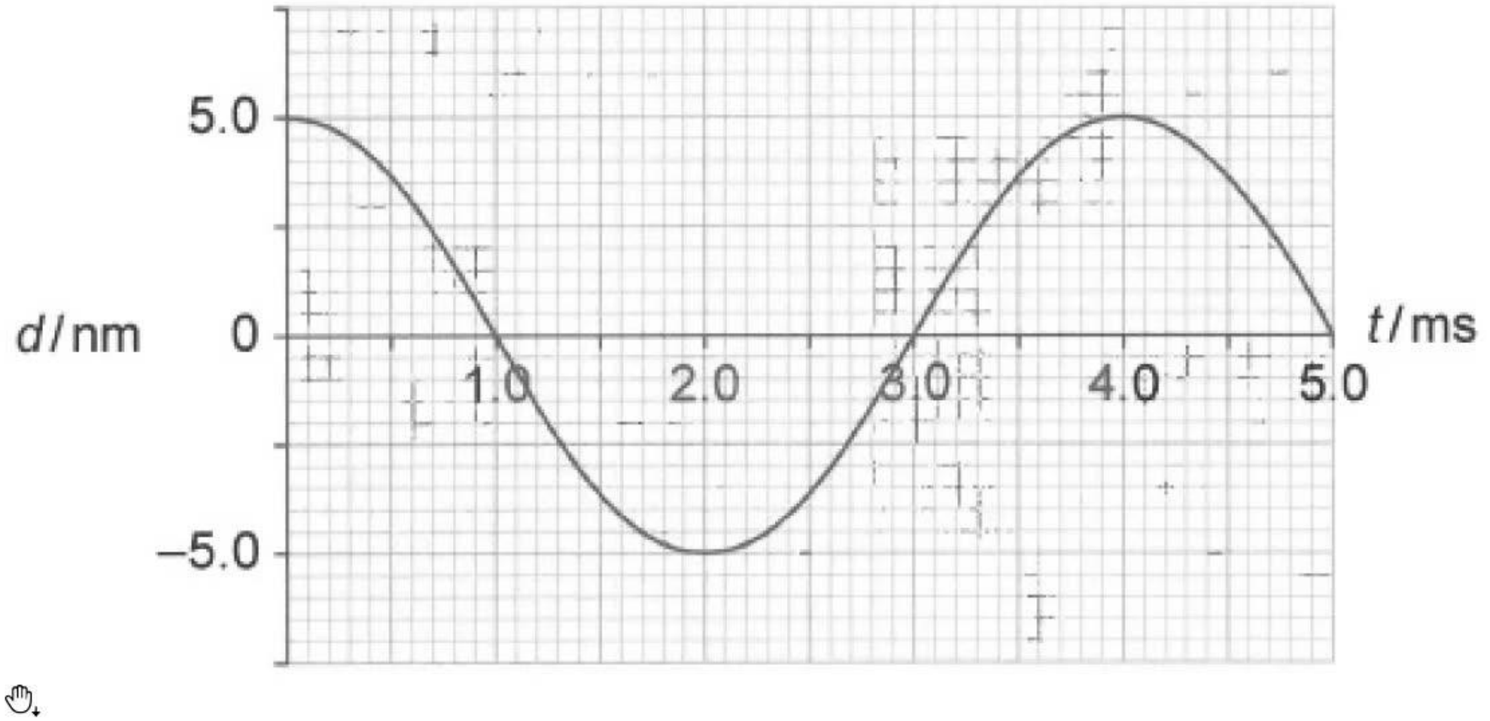
A. $\frac{1}{2}$

B. $\frac{1}{\sqrt{2}}$

C. $\sqrt{2}$

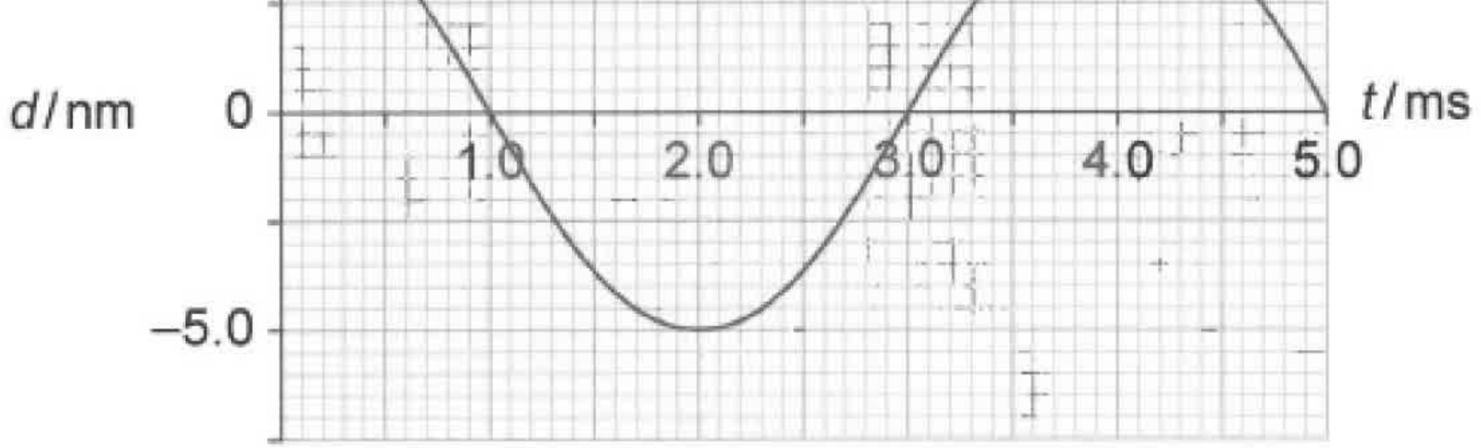
D. 2

18. A wave is travelling through a medium. The variation with time t of the displacement d of a particle in the medium is shown.



What is the frequency and the amplitude of the wave?

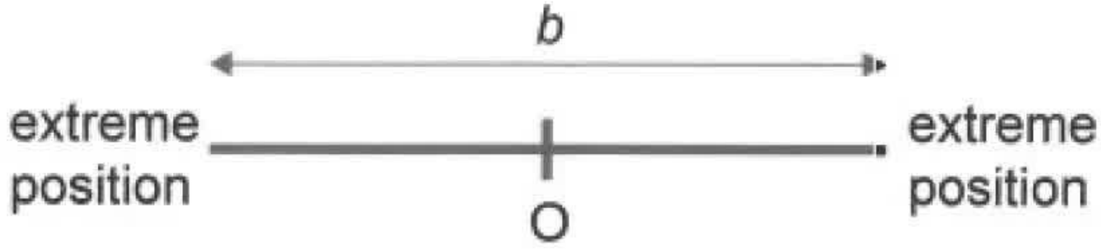
	Frequency / Hz	Amplitude / nm
A.	4.0×10^{-3}	5.0



What is the frequency and the amplitude of the wave?

	Frequency / Hz	Amplitude / nm
A.	4.0×10^{-3}	5.0
B.	250	5.0
C.	4.0×10^{-3}	10.0
D.	250	10.0

19. An object performs simple harmonic motion with frequency f. The distance between the extreme positions at which the object is at rest is b.



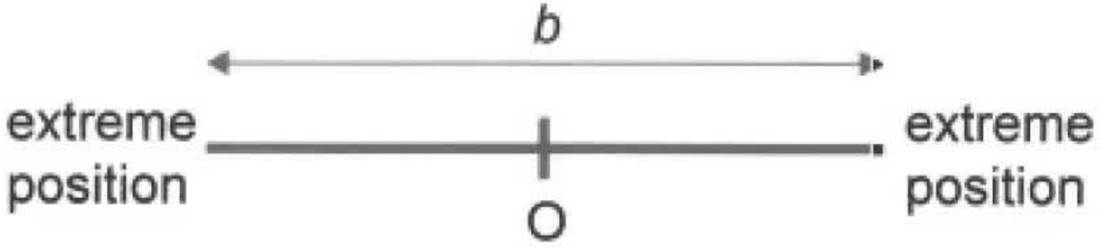
What is the speed of the object when it is halfway between its equilibrium position O and its extreme position?

A. $\frac{1}{4}\pi f b$

B. $\frac{1}{2}\pi f b$

C. $\frac{\sqrt{3}}{4}\pi f b$

19. An object performs simple harmonic motion with frequency f. The distance between the extreme positions at which the object is at rest is b.



What is the speed of the object when it is halfway between its equilibrium position O and its extreme position?

A. $\frac{1}{4}\pi f b$

B. $\frac{1}{2}\pi f b$

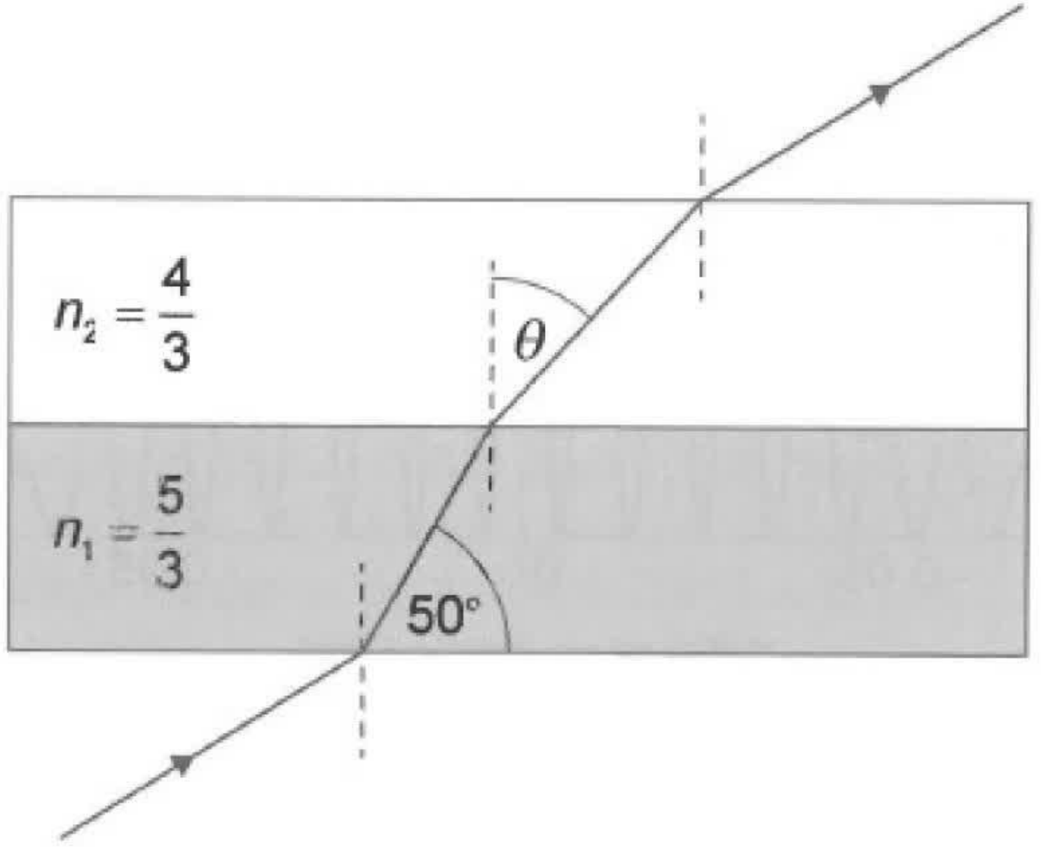
C. $\frac{\sqrt{3}}{4}\pi f b$

D. $\frac{\sqrt{3}}{2}\pi f b$

20. Light passes through two parallel layers as shown.

The refractive indices for light travelling between air and the media are shown in the diagram as n_1 and n_2.

diagram not to scale



What is θ?

What is θ?

A. 31°

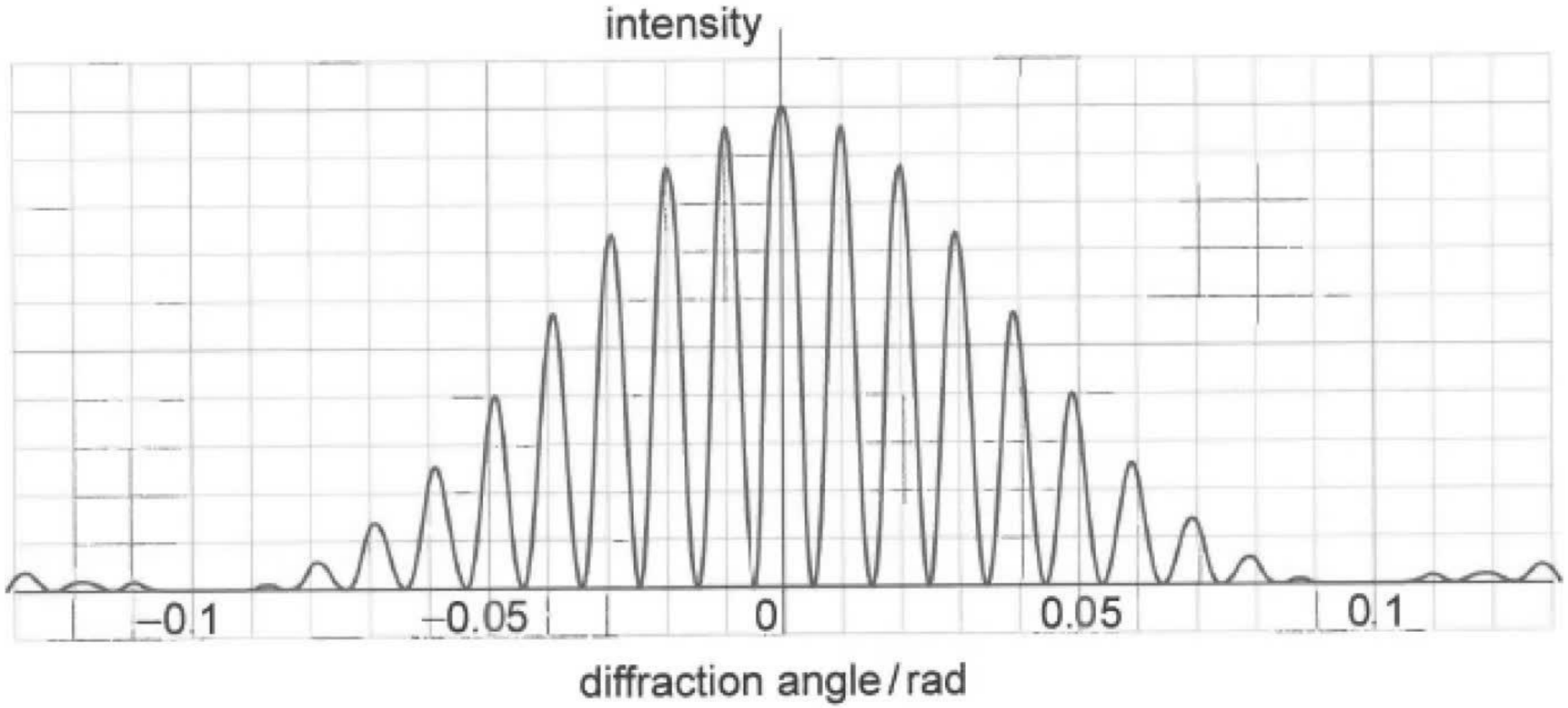
B. 38°

C. 53°

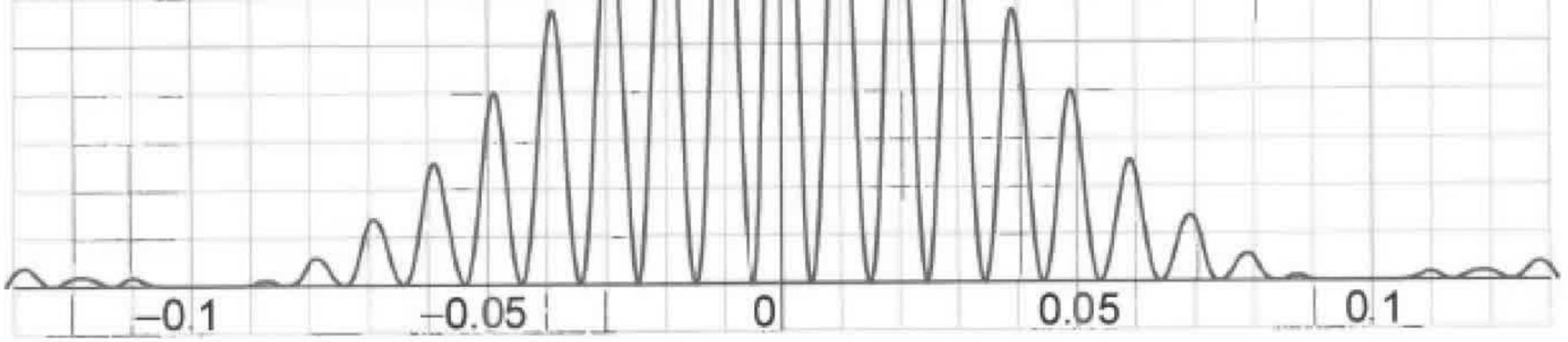
D. 73°

21. Light of wavelength λ is incident on two parallel slits of width b that are separated by distance d.

The graph of intensity against diffraction angle is shown.



What are $\frac{\lambda}{d}$ and $\frac{\lambda}{b}$?



What are $\frac{\lambda}{d}$ and $\frac{\lambda}{b}$?

	$\frac{\lambda}{d}$	$\frac{\lambda}{b}$
A.	0.1	0.1
B.	0.1	0.01
C.	0.01	0.1
D.	0.01	0.01

A.	0.1	0.1
B.	0.1	0.01
C.	0.01	0.1
D.	0.01	0.01

22. A pipe of length L is closed at one end.

What is the wavelength of the fifth-harmonic standing wave in this pipe?

A. $\frac{8L}{5}$

B. $\frac{5L}{4}$

C. $\frac{4L}{5}$

D. $\frac{4L}{9}$

23. Light of wavelength 5.8×10^{-7} m is normally incident on a diffraction grating that has 400 000 lines m^{-1}.

How many maxima can be observed with this diffraction grating?

A. 4

B. 5

C. 8

D. 9

24. A planet P has a diameter one-third that of the Earth. The mass of Earth is 18 times that of P.

The gravitational field strength at the surface of the Earth is g.

What is the gravitational field strength at the surface of P?

A. $\frac{g}{6}$

C. 8

D. 9

24. A planet P has a diameter one-third that of the Earth. The mass of Earth is 18 times that of P.

The gravitational field strength at the surface of the Earth is g.

What is the gravitational field strength at the surface of P?

A. $\frac{g}{6}$

B. $\frac{g}{2}$

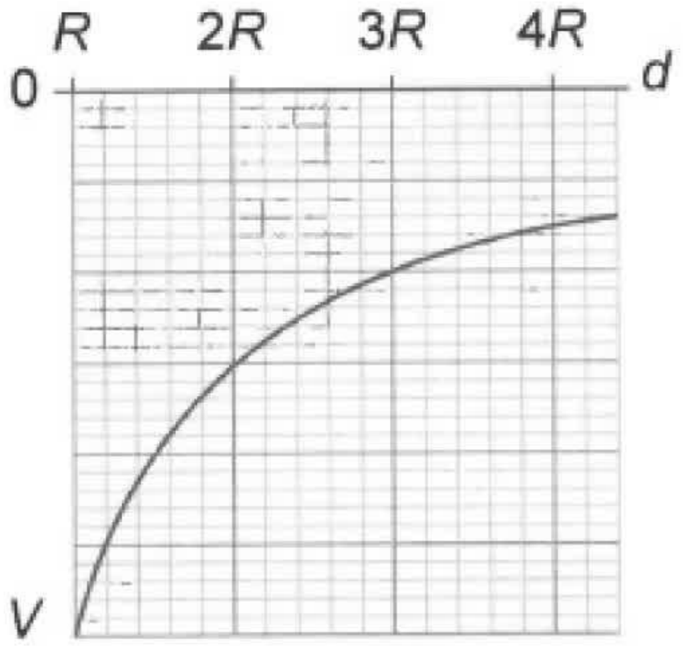
C. $2g$

D. $6g$

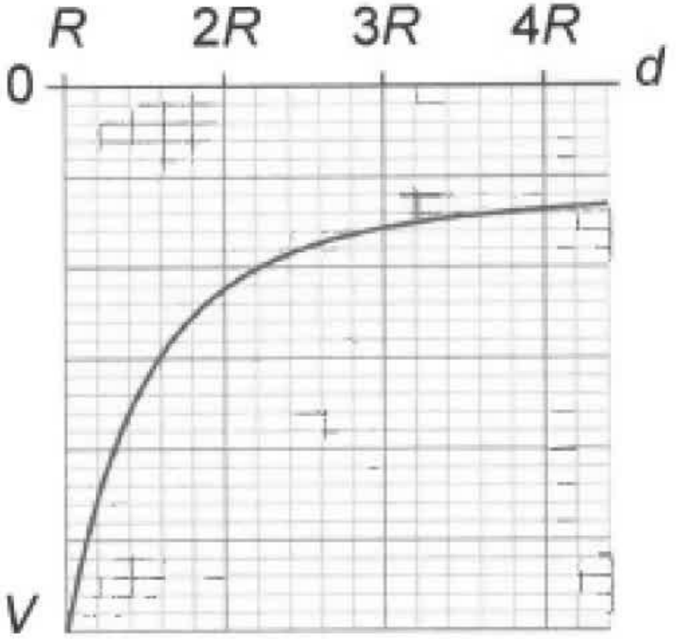
25. Which graph shows the variation of gravitational potential V with distance d from the surface of the Earth?

R is the radius of the Earth.

A.

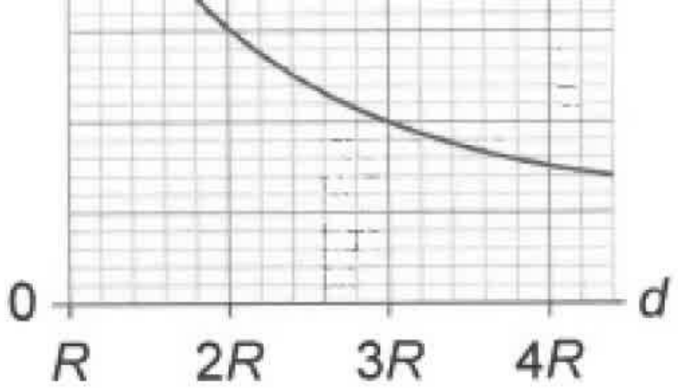


B.



C.

D.



26. The unit of $\mu_0 \times \varepsilon_0$ expressed in fundamental SI units is...

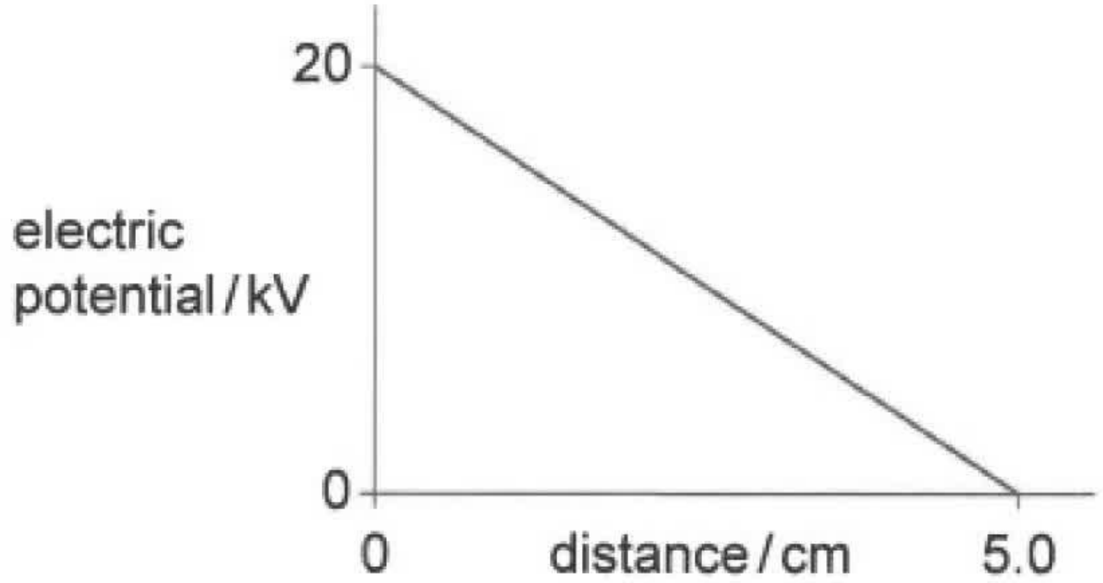
A. $m^{-2}s^2$.

B. $TCN^{-1}m^{-1}s$.

C. m^2s^{-2}.

D. $TC^2A^{-1}N^{-1}m^{-1}$.

27. Two parallel conducting plates are separated by 5.0 cm. The variation of electric potential with distance between the plates is shown.



What is the magnitude of the electric field strength between the plates?

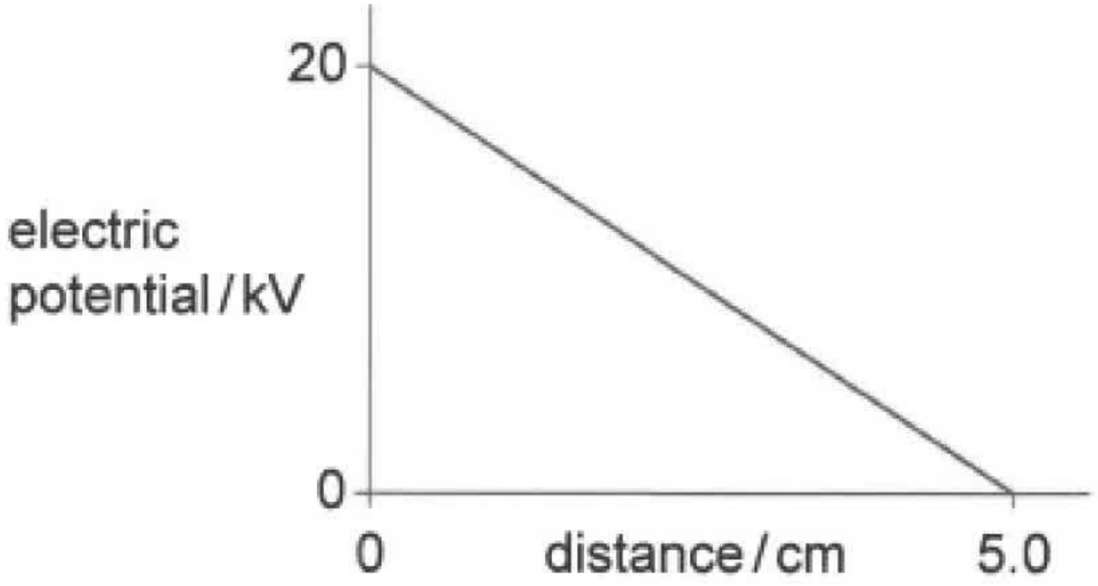
A. $4.0\,NC^{-1}$

B. $1.0 \times 10^{3}\,NC^{-1}$

C. $1.0 \times 10^{5}\,NC^{-1}$

D. $4.0 \times 10^{5}\,NC^{-1}$

distance between the plates is shown.



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B. $1.0 \times 10^{3}\,NC^{-1}$

C. $1.0 \times 10^{5}\,NC^{-1}$

D. $4.0 \times 10^{5}\,NC^{-1}$

C. $1.0 \times 10^5 \, \text{N C}^{-1}$

D. $4.0 \times 10^5 \, \text{N C}^{-1}$

28. Charge is moving in a wire that is at right angles to a uniform magnetic field.

The length of the wire is 0.32 m.

When the current in the wire is increased by 5.0 A, the force acting on the wire increases by 4.0 mN.

What is the strength of the magnetic field?

A. 2.5 mT

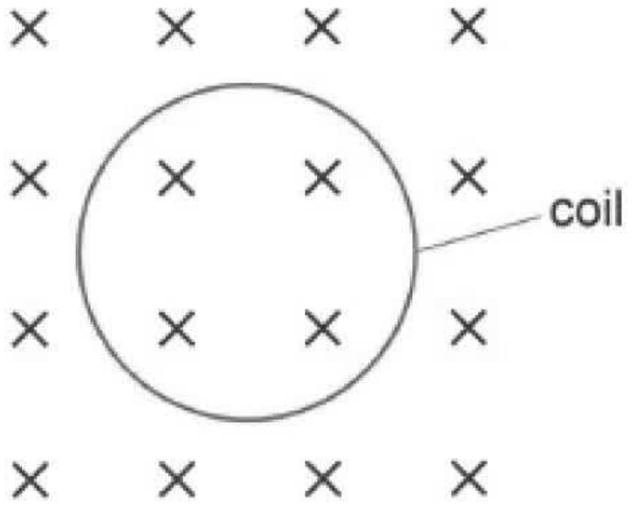
B. 25 mT

C. 40 T

D. 40 kT

29. Negative charge carriers travel counter-clockwise in a circular coil that lies in the plane of the page.

The coil is in a uniform magnetic field directed into the page.



What is the magnetic effect on the coil?

A. The coil will rotate clockwise in the plane of the paper.

B. The coil will rotate counter-clockwise in the plane of the paper.

C. The diameter of the coil will tend to increase.

D. The diameter of the coil will tend to decrease.

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C. The diameter of the coil will tend to increase.

D. The diameter of the coil will tend to decrease.

30. Who was the first scientist to show that electric charge is quantized?

A. Coulomb

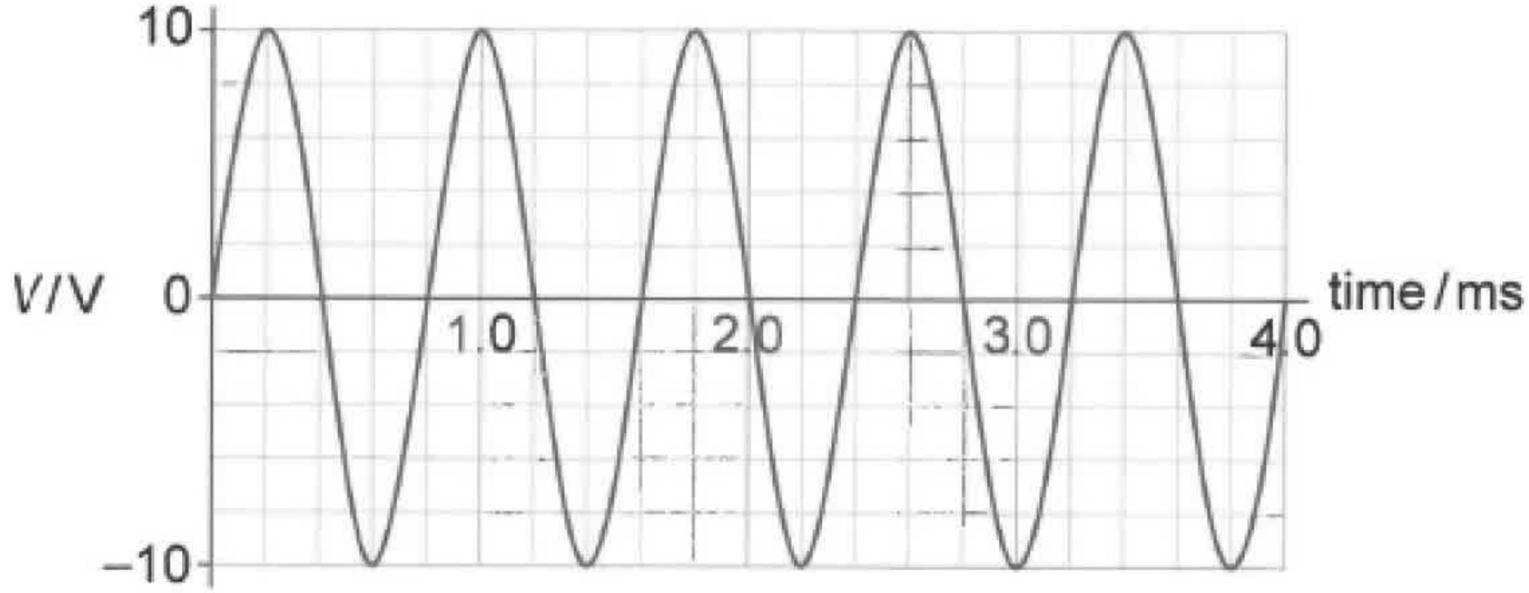
B. Millikan

C. Planck

D. Rutherford

31. A coil of wire rotates at a constant angular speed ω in a uniform magnetic field.

The variation with time of the emf in the coil is shown.



The angular speed is changed to $\frac{3\omega}{4}$.

What is the amplitude of the emf and the time period for the variation of the emf in the coil after the change?

The angular speed is changed to $\frac{3\omega}{4}$.

What is the amplitude of the emf and the time period for the variation of the emf in the coil after the change?

	Amplitude of emf/V	Time period/ms
A.	13	0.60
B.	13	1.1
C.	7.5	0.60
D.	7.5	1.1

32. An ion X contains the following particles:

32. An ion X contains the following particles:

- 53 protons
- 89 neutrons
- 54 electrons.

What is the nuclear notation for X?

A. $^{142}_{53}X$

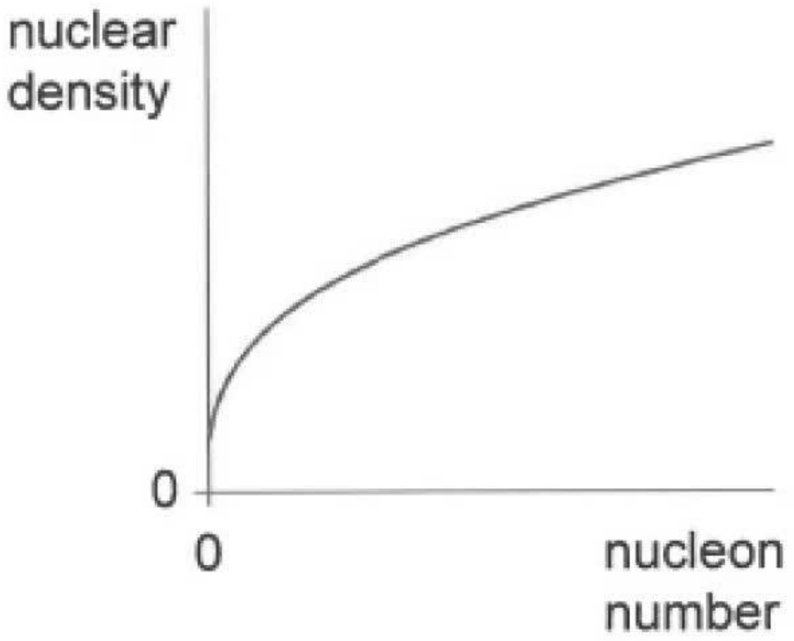
B. $^{89}_{53}X$

C. $^{143}_{54}X$

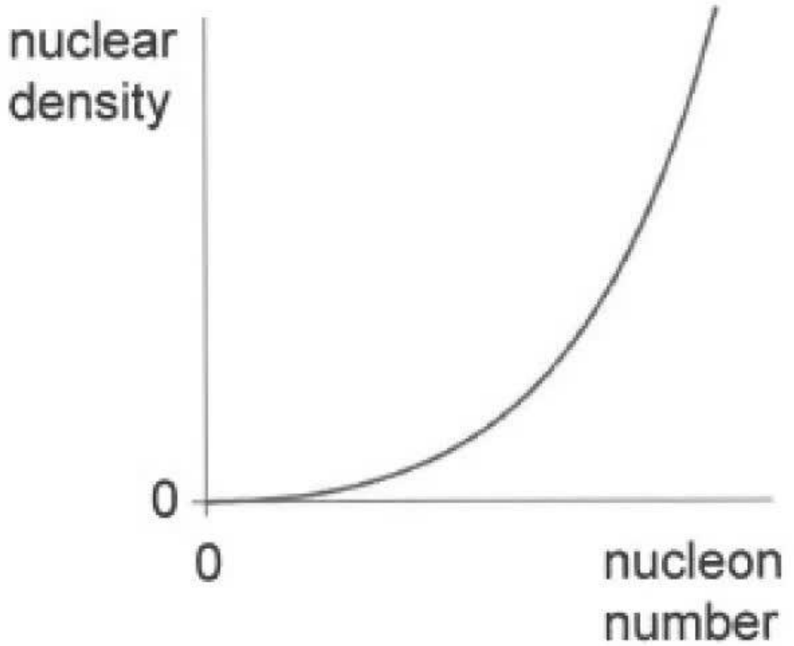
D. $^{107}_{54}X$

33. What is the variation with nucleon number of the density of nuclei?

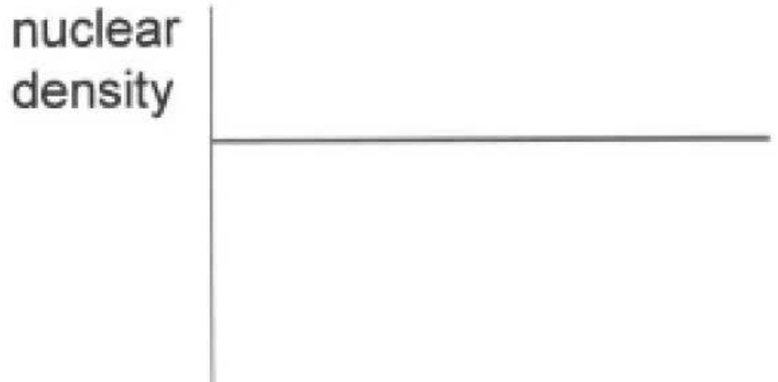
A.



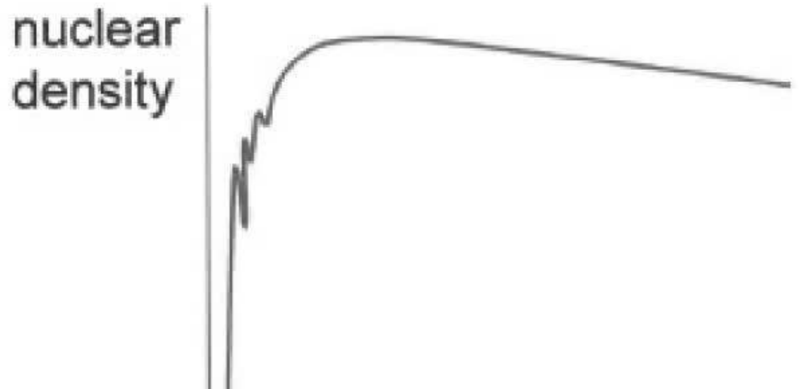
B.



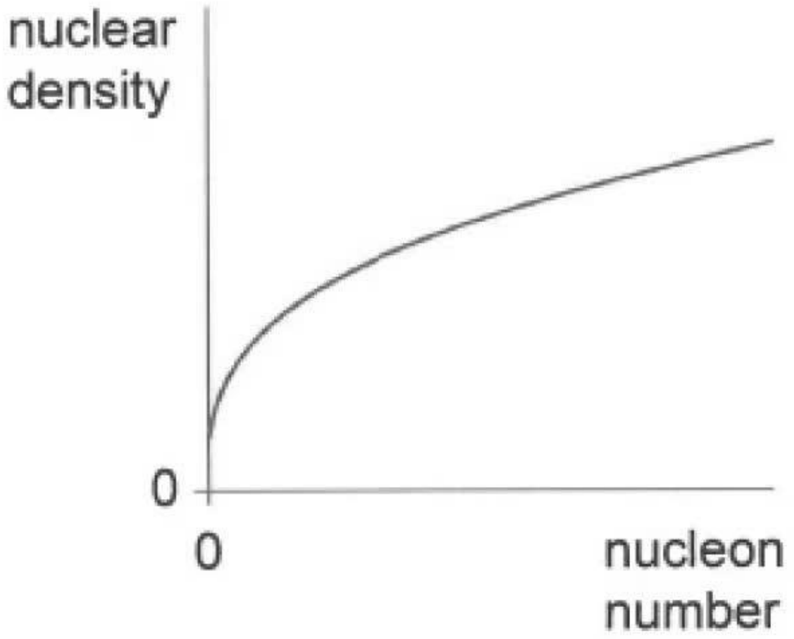
C.



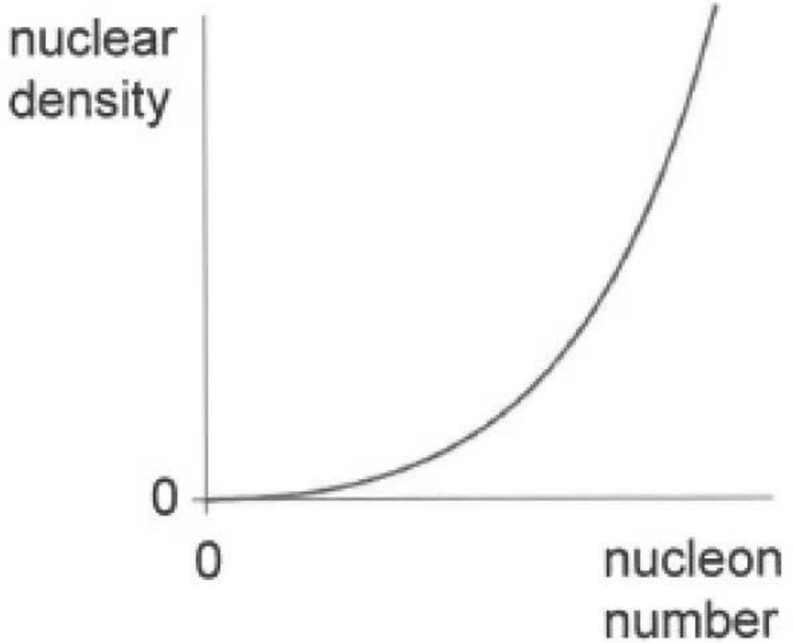
D.



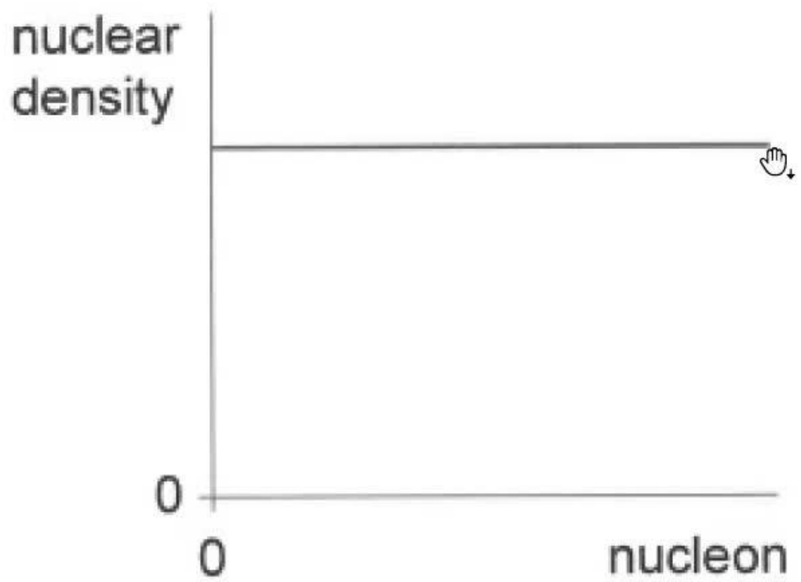
A.


nuclear
density
0
0
nucleon
number

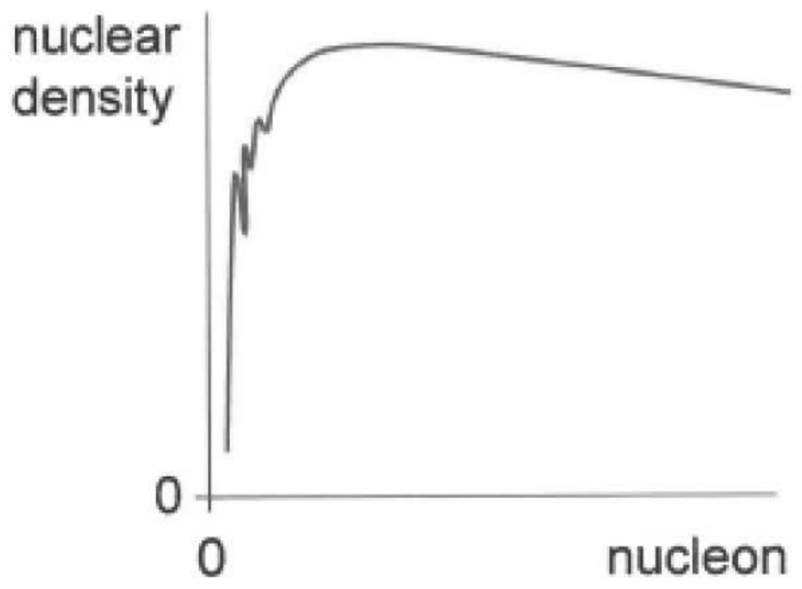
B.


nuclear
density
0
0
nucleon
number

C.


nuclear
density
0
0
nucleon

D.


nuclear
density
0
0
nucleon

34. A photoelectron is emitted when a photon of energy E is incident on a metal surface.

The work function of the surface is Φ.

What is the maximum possible speed of the photoelectron as it leaves the surface?

A. $\sqrt{\frac{2(E-\Phi)}{m_e}}$

B. $\sqrt{\frac{E-\Phi}{m_e}}$

C. $\sqrt{\frac{E-\Phi}{m_e h}}$

D. $\sqrt{\frac{2(E-\Phi)}{m_e h}}$

35. In a Compton scattering experiment a photon of wavelength λ_0 and frequency f_0 interacts with an electron.

After the interaction the wavelength and frequency of the photon are λ and f.

What are $\frac{\lambda}{\lambda_0}$ and $\frac{\lambda \times f}{\lambda_0 \times f_0}$?

	$\frac{\lambda}{\lambda_0}$	$\frac{\lambda \times f}{\lambda_0 \times f_0}$
A.	Greater than 1	Equal to 1
B.	Greater than 1	Less than 1
C.	Less than 1	Equal to 1
D.	Less than 1	Less than 1

36. Three products of radioactive decay are:

I alpha particles

C.	Less than 1	Equal to 1
D.	Less than 1	Less than 1

36. Three products of radioactive decay are:

I. alpha particles

II. beta particles

III. gamma photons.

Which products can be deflected by both magnetic and electric fields?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

37. A nucleus of nuclide X decays.

B. I and III only

C. II and III only

D. I, II and III

37. A nucleus of nuclide X decays.

Which series of emissions will produce an isotope of X?

A. One α and two β^-

B. One α and two β^+

C. Two α and two β^-

D. Two α and two β^+

38. A suitable material for use as a moderator in a nuclear reactor is...

A. cadmium.

B. concrete.

C. uranium-238.

D. water.

39. In a simple model of a nuclear reactor, four neutrons are emitted per fission on average.

The average number of neutrons absorbed by the control rods is N_c per fission.

The average number of neutrons that are lost through the walls of the reactor is N_1 per fission.

Any remaining neutrons induce further fissions.

What are possible values for N_c and N_1 for the reactor to maintain a steady reaction?

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What are possible values for N_c and N_1 for the reactor to maintain a steady reaction?

	N_c	N_1
A.	1	1
B.	1	3
C.	2	1
D.	2	2

B.	1	3
C.	2	1
D.	2	2

40. A star has a parallax angle of 1×10^{-2} arc-second at the orbit of the Earth.

What is the distance from the Sun to the star?

A. 0.01 pc

B. 0.02 pc

C. 50 pc

D. 100 pc

1. B	2. B	3. A	4. C	5. C	6. A	7. B	8. B	9. B	10. A
11. D	12. C	13. C	14. D	15. B	16. C	17. B	18. B	19. D	20. C
21. C	22. C	23. D	24. B	25. A	26. A	27. D	28. A	29. C	30. B
31. D	32. A	33. C	34. A	35. A	36. A	37. A	38. D	39. C	40. D