CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Subsidiary Level
and Advanced Level

PHYSICS 9702/1

PAPER 1 Multiple Choice

OCTOBER/NOVEMBER SESSION 2002

1 hour

Candidates answer on the question paper.
Additional materials:
- Multiple Choice answer sheet
- Soft clean eraser
- Soft pencil (Type B or HB is recommended)

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.

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

Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

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.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\dfrac{Gm}{r}$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm\, \omega \sqrt{(x_0^2 - x^2)}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \dfrac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho g h$
pressure of an ideal gas,	$p = \frac{1}{3}\dfrac{Nm}{V}\langle c^2 \rangle$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \dfrac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \dfrac{\rho v r}{\eta}$

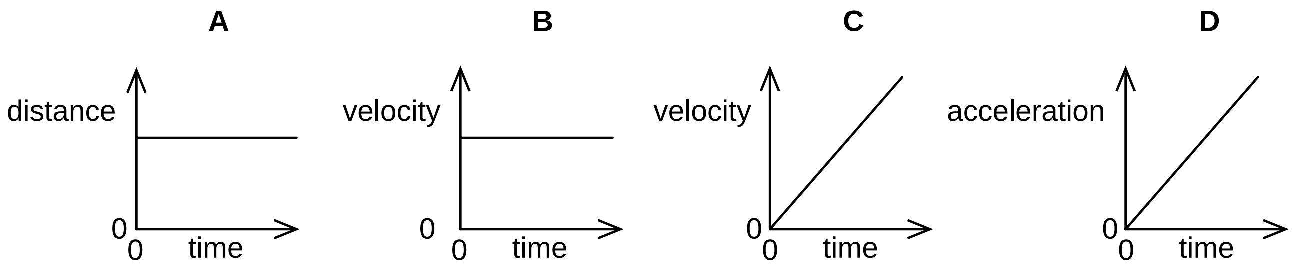
1 The prefix 'centi' indicates x 10^{-2}. That is, 1 centimetre is equal to 1×10^{-2} metre.

Which line in the table correctly indicates the prefixes micro, nano and pico?

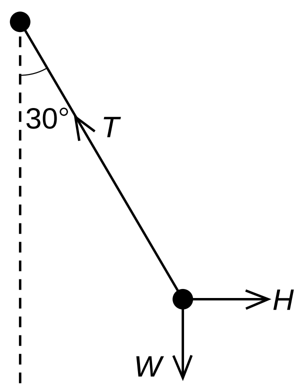
	$\times 10^{-12}$	$\times 10^{-9}$	$\times 10^{-6}$
A	nano	micro	pico
B	micro	pico	nano
C	pico	nano	micro
D	pico	micro	nano

2 A particle is moving in a straight line with uniform acceleration.

Which graph represents the motion of the particle?



3 A pendulum bob is held stationary by a horizontal force *H*. The three forces acting on the bob are shown in the diagram.



The tension in the string of the pendulum is *T*. The weight of the pendulum bob is *W*.

Which statement is correct?

A $H = T \cos 30°$ **B** $T = H \sin 30°$ **C** $W = T \cos 30°$ **D** $W = T \sin 30°$

4 What is meant by the weight of an object?

A the gravitational field acting on the object

B the gravitational force acting on the object

C the mass of the object multiplied by gravity

D the object's mass multiplied by its acceleration

5 A student carries out a series of determinations of the acceleration of free fall g. The table shows the results.

$g/\mathrm{m\,s^{-2}}$
4.91
4.89
4.88
4.90
4.93
4.92

What can be said about this experiment?

A It is accurate and precise.

B It is accurate but not precise.

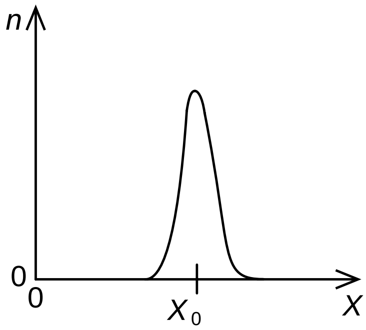
C It is not accurate and not precise.

D It is not accurate but is precise.

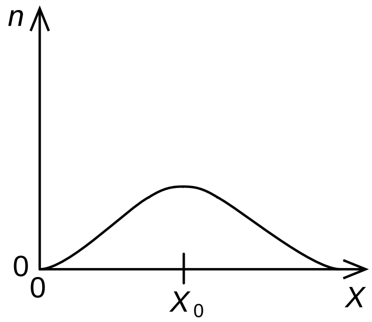
6 A quantity X is measured many times. A graph is plotted showing the number a particular value of X is obtained. X has a true value X_0.

Which graph could be obtained if the measurement of X has a large systematic error but a random error?

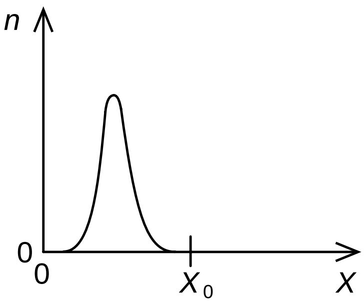
A



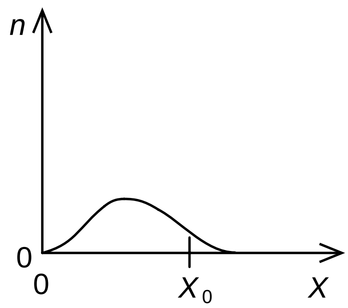
B



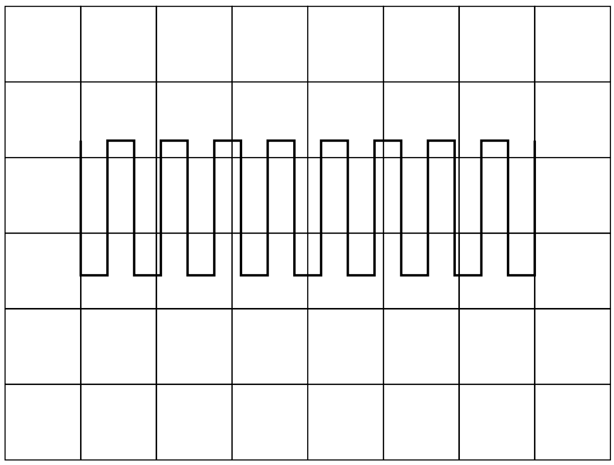
C



D



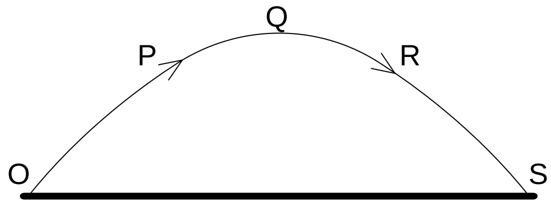
7 The diagram shows a square-wave trace on the screen of a cathode-ray oscilloscope. A grid of 1 cm squares covers the screen. The time-base setting is $10\,\text{ms}\,\text{cm}^{-1}$.



What is the approximate frequency of the square-wave?

A 70 Hz **B** 140 Hz **C** 280 Hz **D** 1400 Hz

8 A projectile is launched at point O and follows the path OPQRS, as shown. Air resist[illegible]e neglected.



Which statement is true for the projectile when it is at the highest point Q of its path?

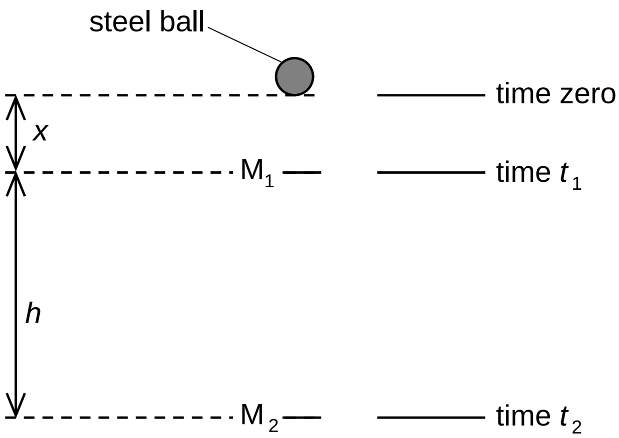
A The horizontal component of the projectile's acceleration is zero.

B The horizontal component of the projectile's velocity is zero.

C The kinetic energy of the projectile is zero.

D The momentum of the projectile is zero.

9 Two markers M_1 and M_2 are set up a vertical distance h apart.

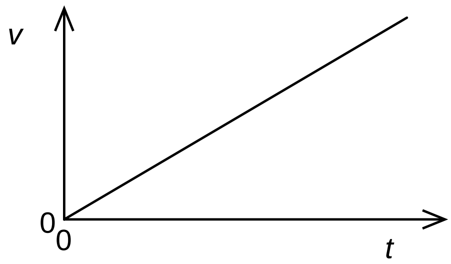


When a steel ball is released from rest from a point a distance x above M_1, it is found that the ball takes time t_1 to reach M_1 and time t_2 to reach M_2.

Which expression gives the acceleration of the ball?

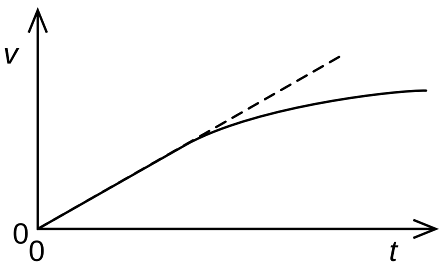
A $\dfrac{2h}{t_2^{\,2}}$ **B** $\dfrac{2h}{(t_2 + t_1)}$ **C** $\dfrac{2h}{(t_2 - t_1)^2}$ **D** $\dfrac{2h}{(t_2^{\,2} - t_1^{\,2})}$

10 A body falls from rest in a vacuum near the Earth's surface. The variation with time *t* [illegible] *v* is shown below.

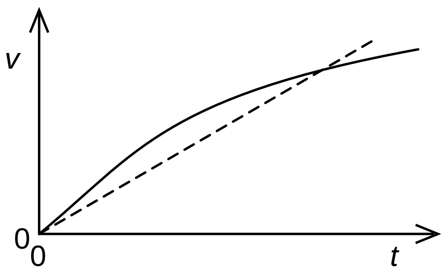


Which graph shows the variation with time *t* of the speed *v* of the same ball falling in air at the same place on Earth?

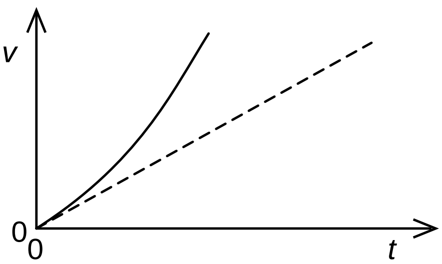
A



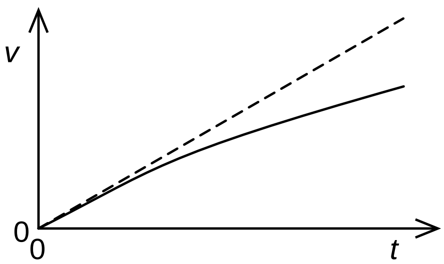
B



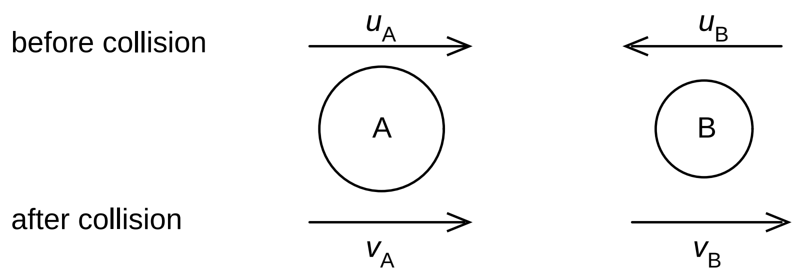
C



D



11 Two spheres A and B approach each other along the same straight line with speed The spheres collide and move off with speeds v_A and v_B, both in the same direction as direction of sphere A, as shown below.



Which equation applies to an elastic collision?

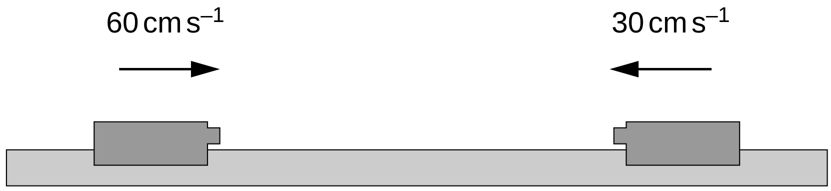
A $u_A + u_B = v_B - v_A$

B $u_A - u_B = v_B - v_A$

C $u_A - u_B = v_B + v_A$

D $u_A + u_B = v_B + v_A$

12 Two equal masses travel towards each other on a frictionless air track at speeds of $60\,\text{cm}\,\text{s}^{-1}$ and $30\,\text{cm}\,\text{s}^{-1}$. They stick together on impact.

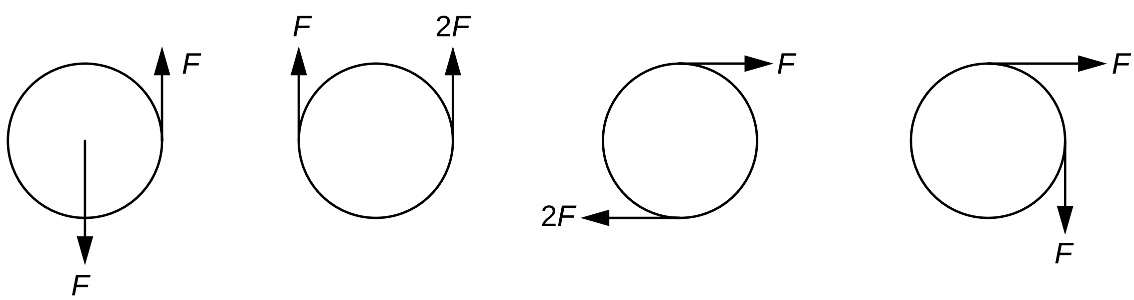


What is the speed of the masses after impact?

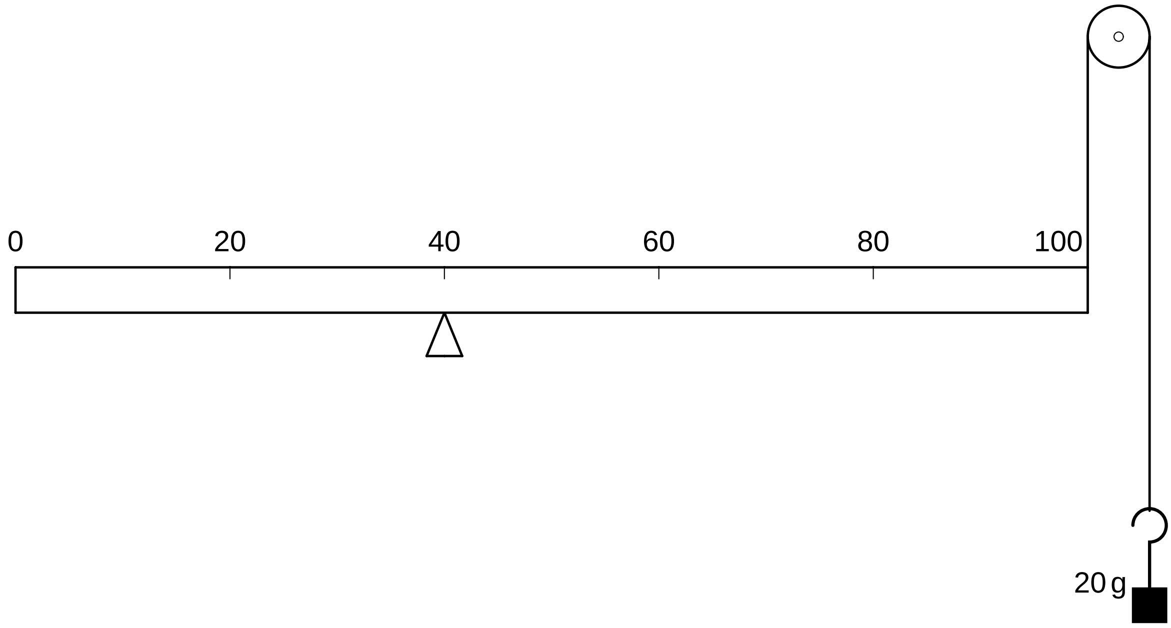
A $15\,\text{cm}\,\text{s}^{-1}$ **B** $20\,\text{cm}\,\text{s}^{-1}$ **C** $30\,\text{cm}\,\text{s}^{-1}$ **D** $45\,\text{cm}\,\text{s}^{-1}$

13 Which of the following pairs of forces, acting on a circular object, constitutes a couple?

A **B** **C** **D**



14 A uniform metre rule of mass 100 g is supported by a knife-edge at the 40 cm mark a[illegible]t the 100 cm mark. The string passes round a frictionless pulley and carries a mass [illegible] shown in the diagram.



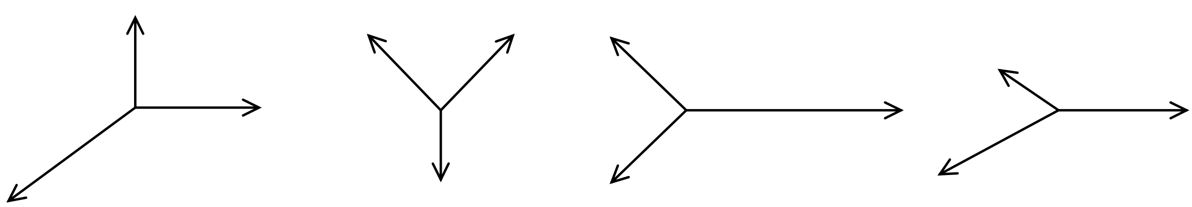
At which mark on the rule must a 50 g mass be suspended so that the rule balances?

A 4 cm **B** 36 cm **C** 44 cm **D** 96 cm

15 The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces.

Which system of forces is in equilibrium?

A **B** **C** **D**



16 Which of the following is an expression for power?

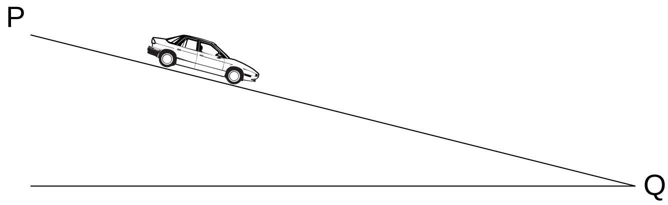
A energy x time

B force x displacement

C force x velocity

D mass x velocity

17 A car driver adjusts the pressure on a car's brakes so that the car travels at constant speed down a hill from P to Q.



The magnitude of the change in the car's kinetic energy is ΔE_k. The magnitude of the change in its gravitational potential energy is ΔE_p.

Which statement is correct?

A $\Delta E_k > \Delta E_p$ **B** $\Delta E_k = \Delta E_p$ **C** $\Delta E_p > \Delta E_k > 0$ **D** $\Delta E_k = 0$

18 An area of land is an average of 2.0 m below sea level. To prevent flooding, pumps are used to lift rainwater up to sea level.

What is the minimum pump output power required to deal with 1.3×10^9 kg of rain per day?

A 15 kW **B** 30 kW **C** 150 kW **D** 300 kW

19 A twig from a tree drops from a 200 m high cliff on to a beach below. During its fall, 40% of the twig's energy is converted into thermal energy.

What is the speed with which the twig hits the beach?

A $35\ \mathrm{m\,s^{-1}}$ **B** $40\ \mathrm{m\,s^{-1}}$ **C** $49\ \mathrm{m\,s^{-1}}$ **D** $63\ \mathrm{m\,s^{-1}}$

20 Pollen grains are suspended in a liquid and are illuminated strongly. When observed under a microscope they are seen to be in continuous random motion.

What is the reason for this?

A convection currents in the liquid

B evaporation of the liquid

C molecules of the liquid colliding with the pollen grains

D pollen grains colliding with each other

21 At a depth of 20 cm in a liquid of density 1800 kg m^{-3}, the pressure due to the liquid is

Another liquid has a density of 1200 kg m^{-3}.

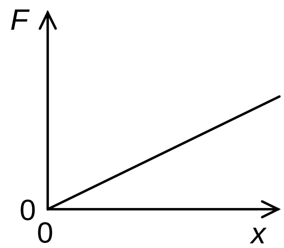
What is the pressure due to this liquid at a depth of 60 cm?

A $\frac{p}{2}$ **B** $\frac{3p}{2}$ **C** $2p$ **D** $3p$

22 Which line in the table gives approximate ratios of density and molecular spacing for a substance in its solid, liquid and gas phases?

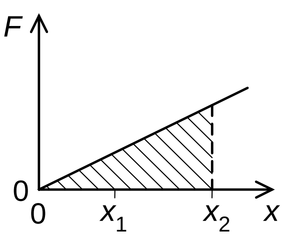
	density	molecular spacing
	solid : liquid : gas	solid : liquid : gas
A	1000 : 1000 : 1	1 : 1 : 10
B	1000 : 100 : 1	1 : 10 : 1000
C	1000 : 1000 : 1	1 : 1 : 1000
D	1000 : 100 : 1	1 : 10 : 100

23 The variation of the extension x of a spring with applied force F is shown.

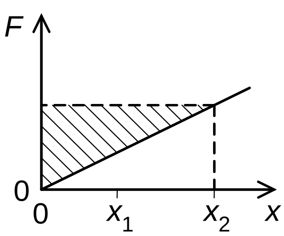


Which shaded area represents the work done when the extension is increased from x_1 to x_2?

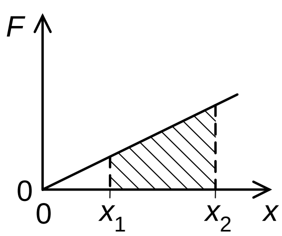
A



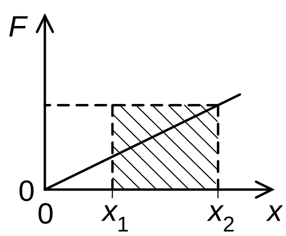
B



C



D



24 Two springs P and Q both obey Hooke's law. They have spring constants $2k$ and k re

The springs are stretched, separately, by a force that is gradually increased from zero certain maximum value, the same for each spring. The work done in stretching spring P is and the work done in stretching spring Q is W_Q.

How is W_P related to W_Q?

A $W_P = \frac{1}{4}W_Q$ **B** $W_P = \frac{1}{2}W_Q$ **C** $W_P = 2W_Q$ **D** $W_P = 4W_Q$

25 Which value is a possible wavelength for radiation in the microwave region of the electromagnetic spectrum?

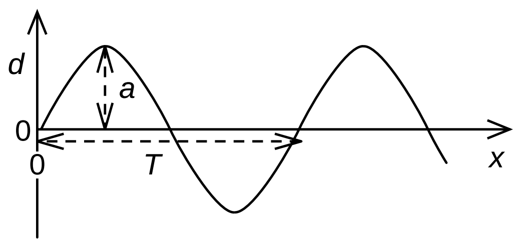
A 3×10^{-2} m **B** 3×10^{-5} m **C** 3×10^{-8} m **D** 3×10^{-10} m

26 The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x.

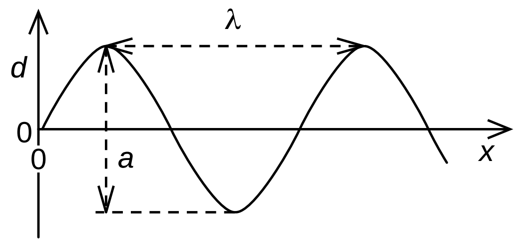
The labels on the graphs are intended to show the wavelength λ, the period T, and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?

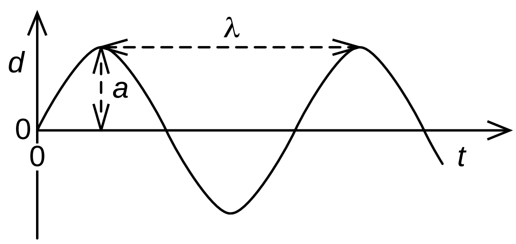
A



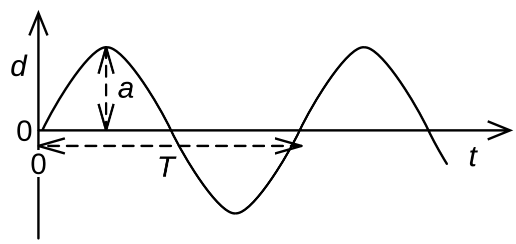
B



C



D



27 A wave of amplitude *a* has an intensity of $3.0\,\text{W}\,\text{m}^{-2}$.

What is the intensity of a wave of the same frequency that has an amplitude 2*a*?

A $4.2\,\text{W}\,\text{m}^{-2}$ **B** $6.0\,\text{W}\,\text{m}^{-2}$ **C** $9.0\,\text{W}\,\text{m}^{-2}$ **D** $12\,\text{W}\,\text{m}^{-2}$

28 Coherent monochromatic light illuminates two narrow parallel slits and the interference pattern that results is observed on a screen some distance beyond the slits.

Which change increases the separation between the dark lines of the interference pattern?

A using monochromatic light of higher frequency

B using monochromatic light of a longer wavelength

C decreasing the distance between the screen and the slits

D increasing the distance between the slits

29 Monochromatic light of wavelength 590 nm is incident normally on a diffraction grating. The angle between the two second-order diffracted beams is 43°.

What is the spacing of the lines on the grating?

A 0.87 µm **B** 1.6 µm **C** 1.7 µm **D** 3.2 µm

30 Which equation is used to define resistance?

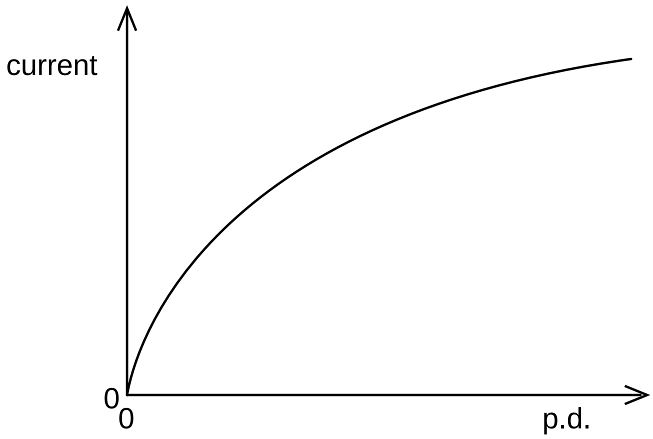
A power = $(\text{current})^2 \times$ resistance

B resistivity = resistance × area ÷ length

C potential difference = current × resistance

D energy = $(\text{current})^2 \times$ resistance × time

31 The graph shows how the current through a lamp filament varies with the potent[illegible]e across it.



Which statement explains the shape of this graph?

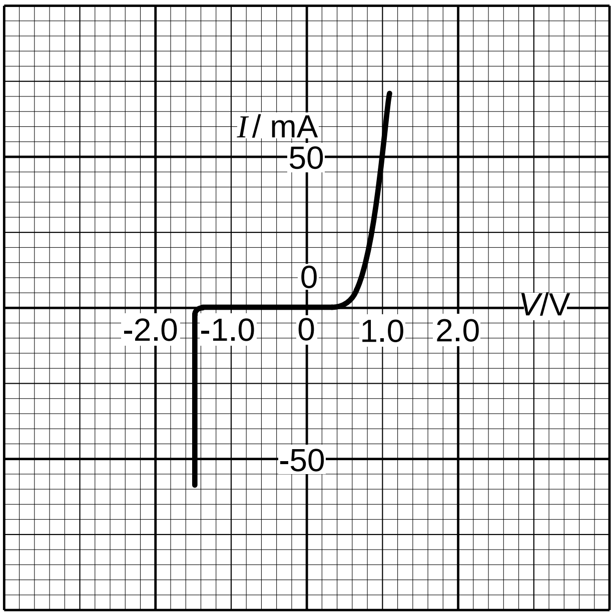
A As the filament temperature rises, electrons can pass more easily through the filament.

B It takes time for the filament to reach its working temperature.

C The power output of the filament is proportional to the square of the current through it.

D The resistance of the filament increases with a rise in temperature.

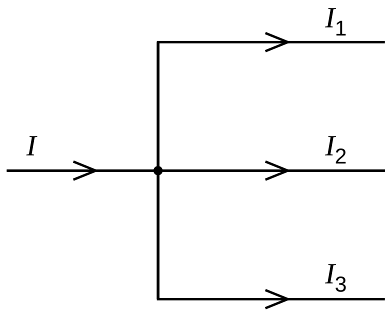
32 The variation with potential difference V of the current I in a semiconductor diode is shown.



What is the resistance of the diode for applied potential differences of +1.0 V and –1.0 V?

	resistance	
	at +1.0 V	at –1.0 V
A	20 Ω	infinite
B	20 Ω	zero
C	0.05 Ω	infinite
D	0.05 Ω	zero

33 At a circuit junction, a current I divides into currents I_1, I_2 and I_3.



These currents are related by the equation

$$I = I_1 + I_2 + I_3.$$

Which law does this statement illustrate and on what principle is the law based?

A Kirchhoff's first law based on conservation of charge

B Kirchhoff's first law based on conservation of energy

C Kirchhoff's second law based on conservation of charge

D Kirchhoff's second law based on conservation of energy

34 The combined resistance R_T of two resistors of resistances R_1 and R_2 connected in parallel is given by the formula

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Which statement is used in the derivation of this formula?

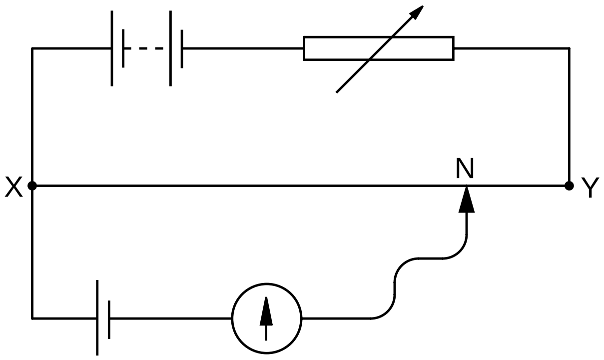
A The currents through the two resistors are equal.

B The potential difference across each resistor is the same.

C The supply current is split between the two resistors in the same ratio as the ratio of their resistances.

D The total power dissipated is the sum of the powers dissipated in the two resistors separately.

35 In the potentiometer circuit below, the moveable contact is placed at N on the bare w[illegible]h that the galvanometer shows zero deflection.

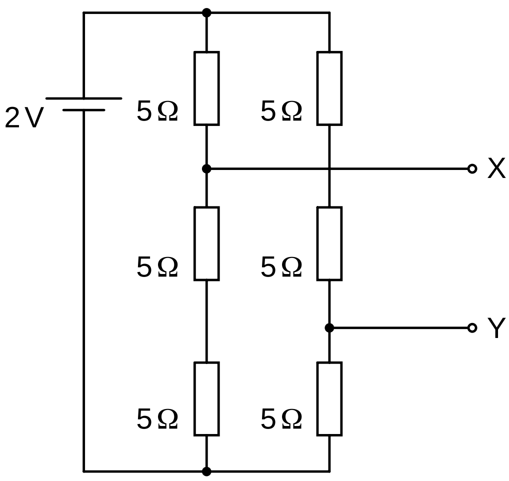


The resistance of the variable resistor is now increased.

What is the effect of this increase on the potential difference across the wire XY and on the position of the moveable contact for zero deflection?

	potential difference across XY	position of moveable contact
A	increases	nearer to X
B	increases	nearer to Y
C	decreases	nearer to X
D	decreases	nearer to Y

36 Six resistors, each of resistance 5 Ω, are connected to a 2 V cell of negligible internal resistance.

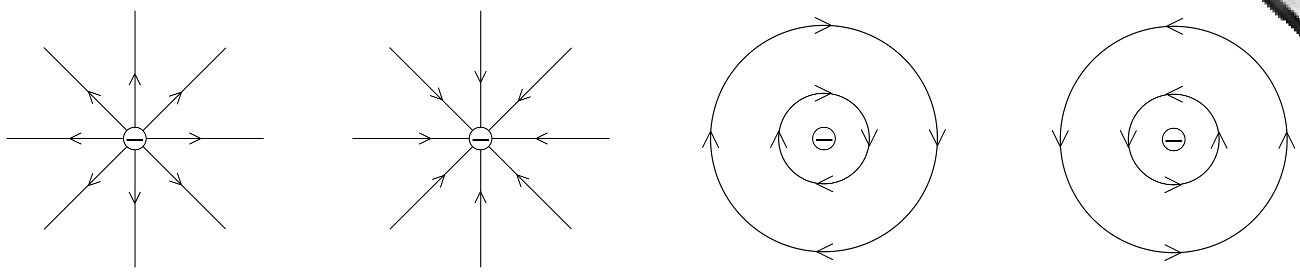


What is the potential difference between terminals X and Y?

A $\frac{2}{3}$ V **B** $\frac{8}{9}$ V **C** $\frac{4}{3}$ V **D** 2 V

37 Which diagram shows the electric field pattern of an isolated negative point charge?

A **B** **C** **D**



38 The numbers of protons, neutrons and nucleons in three nuclei are shown.

nucleus	number of protons	number of neutrons	number of nucleons
X	15	16	31
Y	15	17	32
Z	16	16	32

Which nuclei are isotopes of the same element?

A X and Y **B** X and Z **C** Y and Z **D** none of them

39 In an experiment to investigate the nature of the atom, a very thin gold film was bombarded with α-particles.

What pattern of deflection of the α-particles was observed?

A A few α-particles were deflected through angles greater than a right angle.

B All α-particles were deflected from their original path.

C Most α-particles were deflected through angles greater than a right angle.

D No α-particle was deflected through an angle greater than a right angle.

40 When a nucleus of $^{238}_{92}\text{U}$ absorbs a slow neutron it subsequently emits two β-particles.

What is the resulting nucleus?

A $^{240}_{93}\text{Np}$ **B** $^{240}_{91}\text{Pa}$ **C** $^{239}_{94}\text{Pu}$ **D** $^{239}_{90}\text{Th}$

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