Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **October/November 2018**

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

3374435795

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on 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 the instructions on the Answer Sheet very carefully.

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

This document consists of **19** printed pages and **1** blank page.

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[Turn over

Data

speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
unified atomic mass unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\,\text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$

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	$\phi = -\frac{Gm}{r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $v = \pm\omega\sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
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	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

[Turn over

1 A car is travelling at a speed of 20 m s^{-1}. The table contains values for the kinetic energy and the momentum of the car.

Which values are reasonable estimates?

	kinetic energy / J	momentum / kg m s^{-1}
A	3×10^5	3×10^4
B	3×10^5	5×10^6
C	2×10^7	3×10^4
D	2×10^7	5×10^6

mass = 1500 kg
10^5 kg
$1500 \times 20 = 3 \times 10^4$
$\neq 2 \times 10^6$
$\neq 2 \times 10^6$

2 What is the unit of resistance when expressed in SI base units?

A kg m^2 s^{-2} A^{-1}

B kg m^2 s^{-3} A^{-2}

C kg m s^{-2} A^{-1}

D kg m s^{-3} A^{-1}

$R = \frac{V}{I} = \frac{E/Q}{I} = \frac{\text{kg m s}^{-2} \times \text{m} / \text{A s}}{\text{A}}$

$\frac{\text{kg m}^2 \text{s}^{-2}}{\text{A}^2 \text{s}} = \text{kg m}^2 \text{A}^{-2} \text{s}^{-3}$

3 Which list contains both scalar and vector quantities?

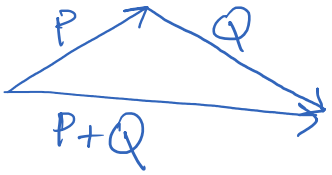
A acceleration, momentum, velocity, weight (V V V V)

B area, current, force, work (S S V S)

C distance, kinetic energy, power, pressure (S S S S)

D mass, temperature, time, speed (S S S S)

4 Vectors P and Q are drawn to scale.



Which diagram represents the vector (P + Q)?

A

B

C

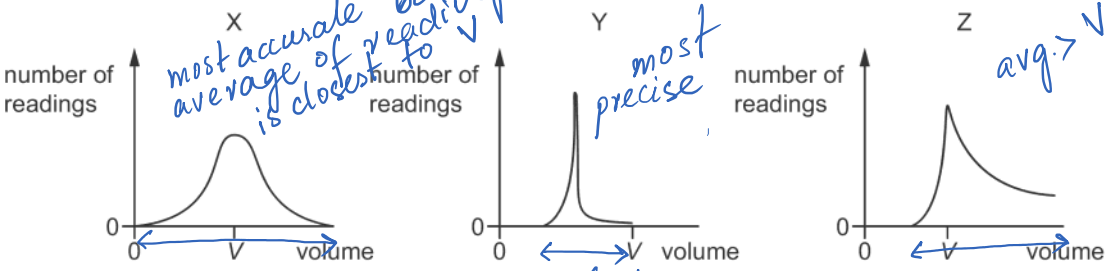
D

EXAMHELP WEB

5 Students take readings of the volume of a liquid using three different pieces of measuring equipment X, Y and Z.

The true value of the volume of the liquid is V.

The students' results are shown.



How many pieces of equipment are precise and how many are accurate?

	number of precise pieces of equipment	number of accurate pieces of equipment
A	1	1
B	1	2
C	2	1
D	2	2

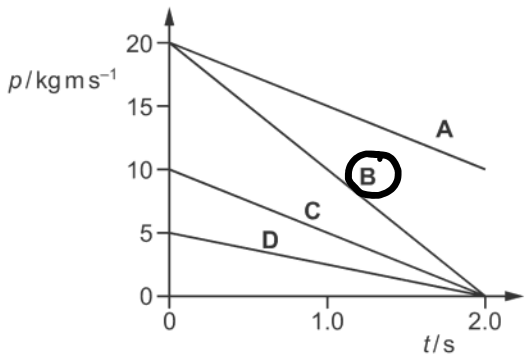
6 A sprinter runs a 100 m race. The sprinter has a constant acceleration from rest of 2.5 $m s^{-2}$ until reaching a speed of 10 $m s^{-1}$. The speed then remains constant until the end of the race.

Which time does it take the sprinter to run the race?

A 8.9 s B 10 s C 12 s D 14 s

7 A resultant force of 10 N acts on a body for a time of 2.0 s. 20Ns of change of momentum over the period of 2.0s

Which graph could show the variation with time t of the momentum p of the body?



8 The acceleration of free fall on the surface of planet P is one tenth of that on the surface of planet Q.

On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N. $g_P = 1 ms^{-2}$ so $g_Q = 10 ms^{-2}$

What are the mass (stays the same) and the weight of the same body on the surface of planet Q?

$g_P \rightarrow \frac{g_Q}{10}$

	mass on Q / kg	weight on Q / N
A	1.0	0.1
B	1.0 ✓	10 ✓
C	10	10
D	10	100

9 Two bodies travelling along the same straight line collide in a perfectly elastic collision.

Which statement **must** be correct?

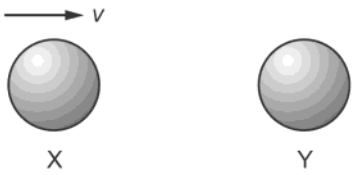
A The initial speed of one body will be the same as the final speed of the other body.

B The relative speed of approach between the two bodies equals their relative speed of separation.

C The total momentum is conserved but the total kinetic energy will be reduced. total k.e is conserved too.

D One of the bodies will be stationary at one instant.

10 The diagram shows two identical spheres X and Y.



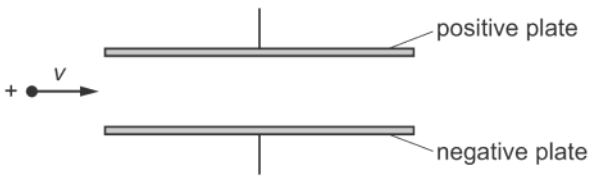
$X_v = Y_v$

Initially, X moves with speed v directly towards Y. Y is stationary. The spheres collide elastically.

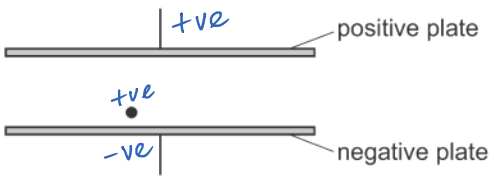
What happens?

	X	Y
A	moves with speed $\frac{1}{2}v$ to the right	moves with speed $\frac{1}{2}v$ to the right not conserved
B	moves with speed v to the left	remains stationary not conserved
C	moves with speed $\frac{1}{2}v$ to the left	moves with speed $\frac{1}{2}v$ to the right not conserved
D	stops	moves with speed v to the right

11 A positively-charged particle of negligible mass, moving at constant velocity v in a vacuum, enters a uniform electric field between two parallel plates, as shown.

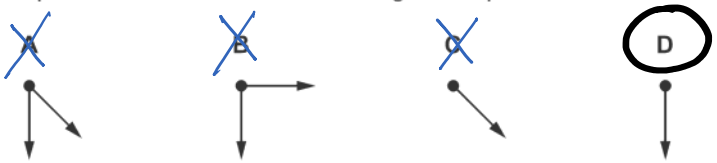


A short time later, the particle is at the position shown.



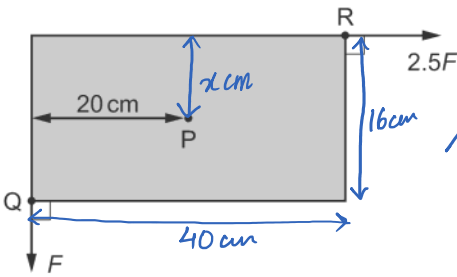
Force only in vertical direction bcz no acceleration in horizontal motion which stays constant.

Which diagram represents the force or forces acting on the particle?



A vertical force due to EFS & particle moves with constant acceleration

12 A uniform rectangular board is supported by a frictionless pivot at its centre point P.



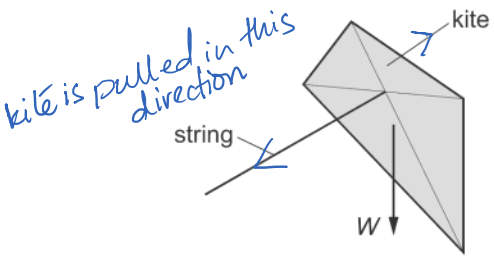
$F \times 20 = 2.5F \times x$
$x = 8\text{cm}$

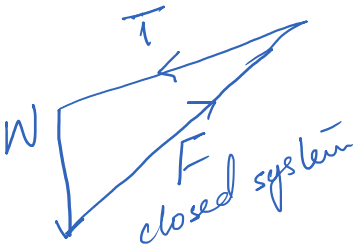
Two forces act in the plane of the board. Force F acts at corner Q and force $2.5F$ acts at corner R. The perpendicular distance between the line of action of force F and point P is 20 cm. The board is in equilibrium.

What is the area of the board? $A = 40 \times 16$

A $160\,\text{cm}^2$ **B** $320\,\text{cm}^2$ **C** $640\,\text{cm}^2$ **D** $1600\,\text{cm}^2$

13 A kite is in equilibrium at the end of a string, as shown.

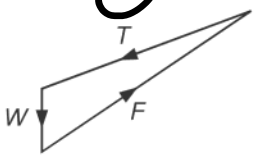




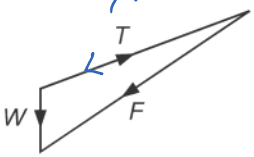
The kite has three forces acting on it: the weight W, the tension T in the string, and the force F from the wind.

Which vector diagram represents the forces acting on the kite?

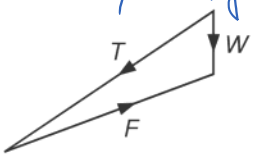
A



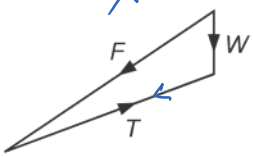
B



C not closed system

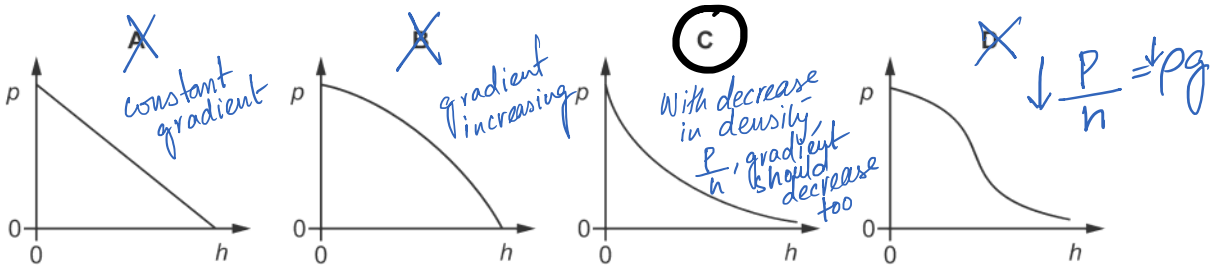


D



14 The density of the air in the atmosphere decreases as the height h above the surface of the Earth increases.

Which graph best shows the variation with height h of the pressure p of the air?



15 A bungee jumper on a platform over a river is attached to an elastic rope that is 20 m long when unstretched. He falls towards the river and his lowest point is 30 m below the platform.

The initial gravitational potential energy of the jumper is transferred to other forms during the jump.

Which other forms of energy do the jumper and rope have when the jumper has fallen half-way and when he is at the lowest point of his jump?

	half-way	lowest point
A	kinetic energy and elastic potential energy	kinetic energy and elastic potential energy
B	kinetic energy and elastic potential energy	elastic potential energy only
C	kinetic energy only	kinetic energy and elastic potential energy
D	kinetic energy only	elastic potential energy only

16 A cylinder contains a fixed mass of gas. The gas, at a constant pressure of 1.3×10^5 Pa, expands from a volume of 900 cm^3 to a volume of 1100 cm^3.

What is the work done by the gas during this expansion?

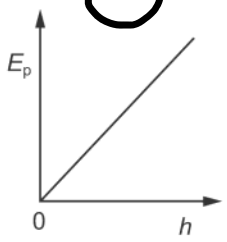
A 26 J **B** 130 J **C** 2600 J **D** 13 000 J

17 An object is thrown into the air.

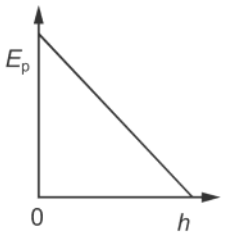
change in E_p with height is linear graph

Which graph shows how the gravitational potential energy E_p of the object varies with height h above the ground?

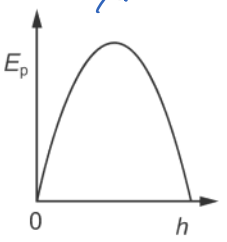
A



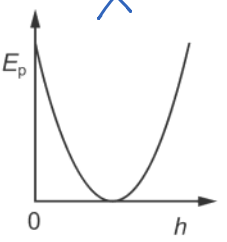
B



C



D



18 A car of mass 1800 kg accelerates along a horizontal road so that its speed increases from 20 m s^{-1} to 25 m s^{-1} in a time of 5.4 s.

avg. speed can be considered

What is the average useful power output of the car's engine?

$F = 1800\left(\frac{25-20}{5.4}\right) = 1666.7\,N$

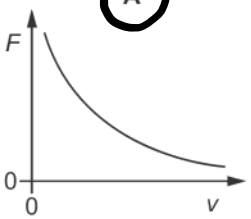
$1666.7 \times \left(\frac{20+25}{2}\right)$ ← avg. speed

A 4.2 kW B 38 kW C 120 kW D 1100 kW

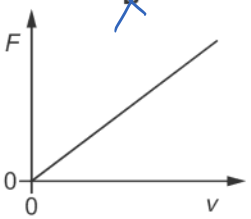
19 A variable force is applied to ensure that a constant power is supplied to a train.

Which graph best shows the variation of the force F applied with the velocity v of the train?

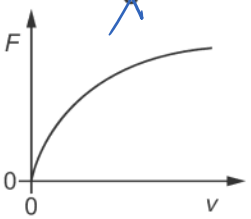
A



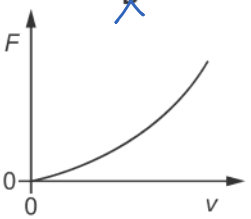
B



C



D



constant $P = \uparrow F \downarrow v$

To maintain constant P, increasing velocity so decreasing force is the idea

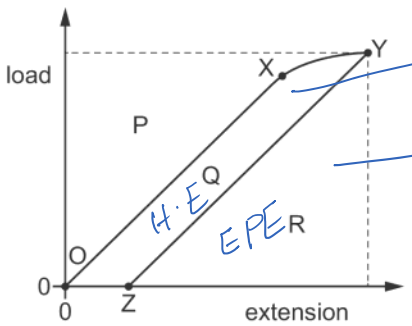
20 A metal cylinder is able to withstand a compressive force of 4.0 kN without deforming plastically.

The cylinder has cross-sectional area A and would be at its elastic limit when a stress σ is applied.

What is a possible pair of values for A and σ?

	A / m^2	σ / MPa
A	1.5×10^{-5}	50
B	1.5×10^{-5}	80
C	7.5×10^{-5}	50
D	7.5×10^{-5}	80

21 A wire has both elastic and plastic properties. When it is slowly loaded, its extension varies with load as shown by line OXY. The removal of the load is represented by line YZ. This creates areas P, Q and R on the graph.



Which area represents the maximum elastic potential energy stored in the wire?

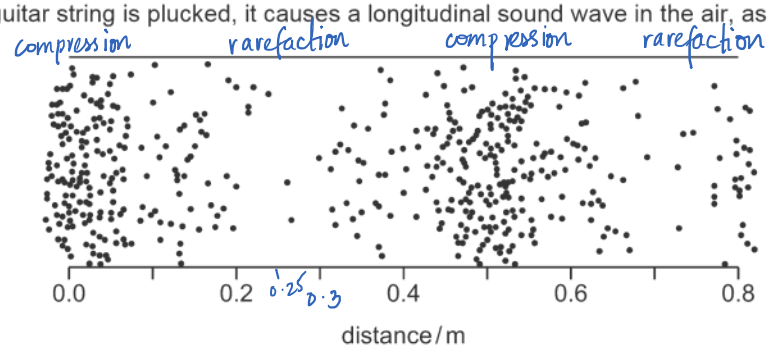
A P B Q C Q + R **D** R

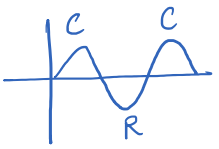
22 A progressive wave on a wire has a frequency of 10 Hz. Two points on the wire, separated by a distance of 0.25 m, have a phase difference of 22.5°.

What is the maximum speed of the wave?

A 2.5 m s^{-1} B 10 m s^{-1} C 20 m s^{-1} **D** 40 m s^{-1}

23 When a guitar string is plucked, it causes a longitudinal sound wave in the air, as shown.





C to R is $\lambda/2$

$\lambda/2 = 0.25$

$\lambda = 0.5\,m$

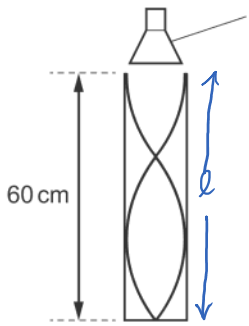
The speed of sound in the air is $340\,m\,s^{-1}$.

What is the approximate frequency of the sound wave shown? $f = c/\lambda$

A 430 Hz B 680 Hz C 1100 Hz D 1400 Hz

24 The sound from a loudspeaker placed above a tube causes resonance of the air in the tube.

A stationary wave is formed with two nodes and two antinodes as shown.



$\ell = \frac{3}{4}\lambda$ so $60 = \frac{3}{4}\lambda$

$\lambda = 80\,cm$

$f = 340/0.8$

The speed of sound in the air is $340\,m\,s^{-1}$.

What is the frequency of the sound?

A 430 Hz B 570 Hz C 850 Hz D 1700 Hz

25 A police car has a two-tone siren emitting sound of frequencies of 700 Hz and 1000 Hz. (f_s, f_s)

The police car is travelling at a speed of $40.0\,m\,s^{-1}$ towards a stationary observer. The speed of sound in the air is $340\,m\,s^{-1}$. (v_s, v)

What is the difference between the two frequencies of the sound that is heard by the observer? (f_o)

A 268 Hz B 300 Hz C 335 Hz D 340 Hz

$f_o = \frac{700 \times 340}{340 - 40} = 793.3\,Hz$ $f_o = \frac{1000 \times 340}{340 - 40} = 1133.3\,Hz$

$\Delta f_o = 1133.3 - 793.3 = 340\,Hz$

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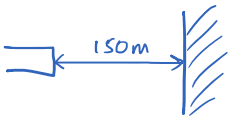


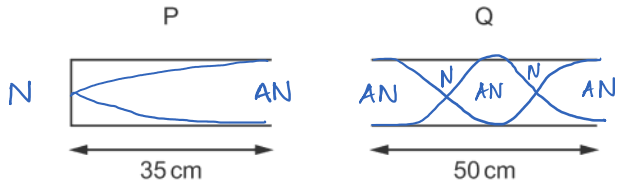
26 A surveyor's device emits a pulse of light. The light is reflected from a wall 150 m away.

What is the time taken for the pulse to travel from the device to the wall and then back to the device?

$t = \frac{\text{distance}}{\text{speed}} = \frac{2\times150}{3\times10^8}$

A 0.05 ns **B** 0.10 ns **C** 0.50 μs **D** 1.0 μs

27 Progressive sound waves of wavelength 20 cm enter the air columns in a closed pipe P and an open pipe Q. The lengths of the pipes are shown.



In which pipe or pipes are stationary waves formed?

A P and Q

B P only

C Q only

D neither P nor Q

28 What happens when waves pass through a gap equal to their wavelength?

A There is diffraction and the wavelength decreases.

B There is diffraction and the wavelength stays the same.

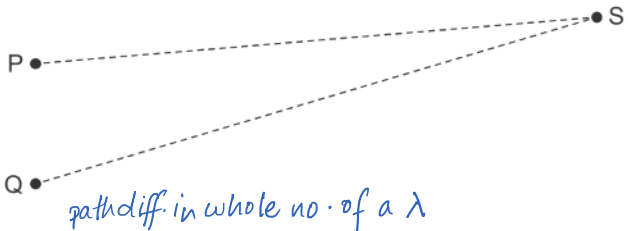
C There is no diffraction and the wavelength decreases.

D There is no diffraction and the wavelength stays the same.

when gap > λ then less diffraction

29 Two sources of microwaves P and Q produce coherent waves with a phase difference of 180°. The waves have the same wavelength λ.

therefore when there is a path diff. in fractions, a maximum forms



path diff. in whole no. of a λ

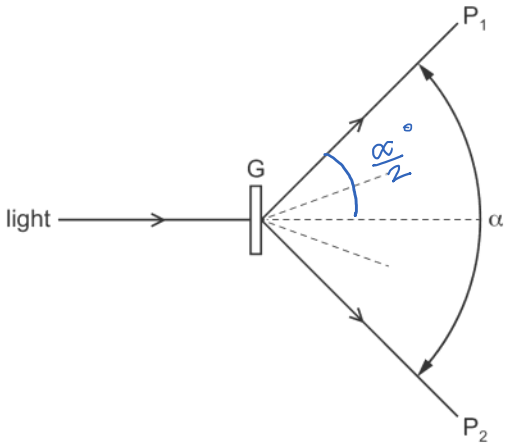
At the point S there is a minimum in the interference pattern produced by waves from the two sources. The distance (QS – PS) is called the path difference.

In the expressions shown, *n* is an integer.

Which expression represents the path difference?

A $n\lambda$ **B** $\frac{1}{2}n\lambda$ for maximum when phase diff. is of 180° **C** $(n + \frac{1}{2})\lambda$ same as (B) **D** $(2n + \frac{1}{2})\lambda$ same as (B)

30 A parallel beam of monochromatic light of wavelength λ is incident normally on a diffraction grating G. The angle between the directions of the two second-order diffracted beams at P_1 and at P_2 is α, as shown.



$d\sin\theta = n\lambda$

$d = \frac{n\lambda}{\sin\theta}$

$d = \frac{2\lambda}{\sin(\frac{\alpha}{2})}$

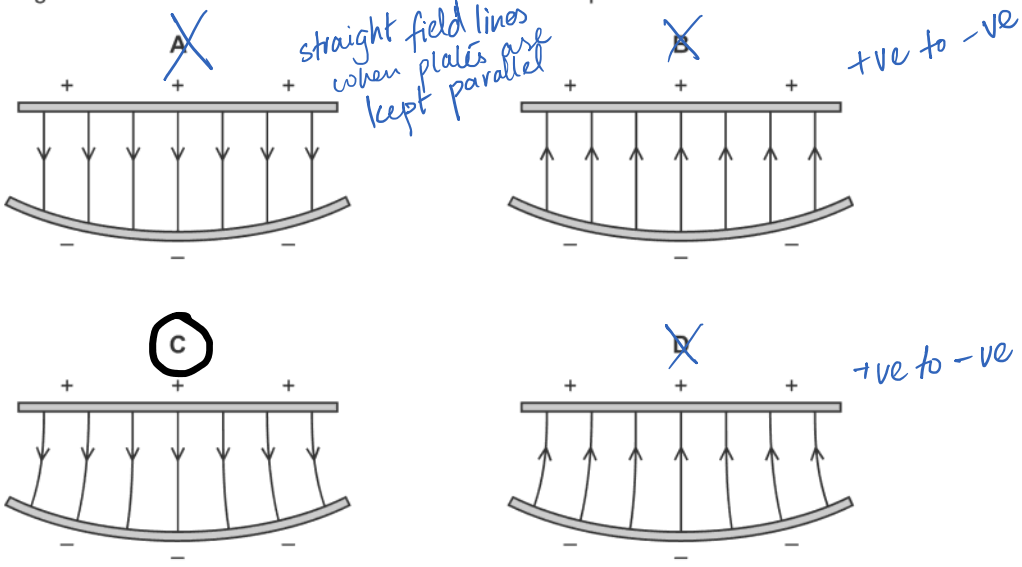
d

What is the spacing of the lines on the grating?

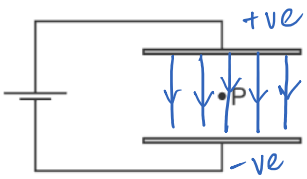
A $\frac{2\lambda}{\sin\alpha}$ **B** $\frac{\lambda}{\sin\alpha}$ **C** $\frac{2\lambda}{\sin(\alpha/2)}$ **D** $\frac{\lambda}{\sin(\alpha/2)}$

31 A flat plate is positively charged and a curved plate is negatively charged.

Which diagram shows the electric field lines between the two plates?



32 Two parallel metal plates are connected to a d.c. supply, as shown.



$EFE = \frac{F}{q} = \frac{V}{d}$

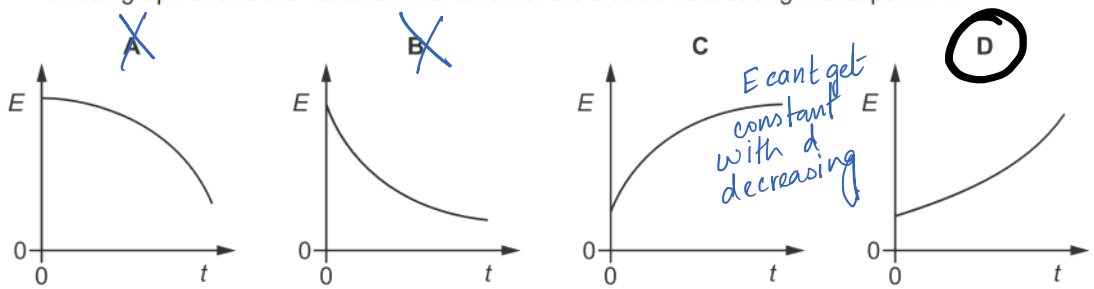
$\uparrow \frac{F}{q} = \frac{V}{d\downarrow}$

The two plates are moved towards each other at constant speed.

It may be assumed that the electric field between the plates is uniform.

Point P is mid-way between the two plates.

Which graph shows the variation with time t of the electric field strength E at point P?



A×s
Q = I×t

33 Which two units are used to define the coulomb?

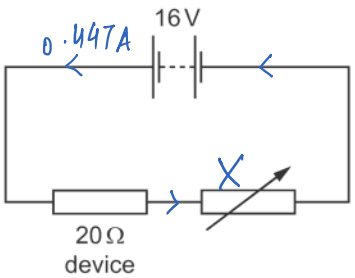
A ampere and second

~~B~~ ampere and volt

~~C~~ volt and ohm

~~D~~ volt and second

34 An electrical device of fixed resistance 20 Ω is connected in series with a variable resistor and a battery of electromotive force (e.m.f.) 16 V and negligible internal resistance.



$R = \frac{16}{0.447} = 35.8\,\Omega$
thus $R_X = 16\,\Omega$

What is the resistance of the variable resistor when the power dissipated in the electrical device is 4.0 W? thus I is $\frac{\sqrt{5}}{5}$ A

A 16 Ω **B** 36 Ω **C** 44 Ω **D** 60 Ω

35 A wire of length L has resistance R. The cross-section of the wire is circular with radius r.

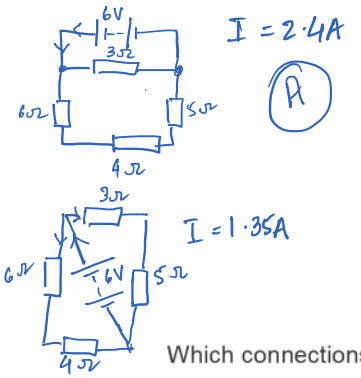
A second wire, also of circular cross-section, and of the same material, has resistance $\frac{1}{2}R$. ← R ↓ by 2 means length ↑ by 2 & radius ↑ by 2

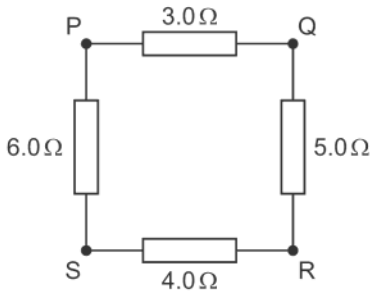
What could be the radius and the length of the second wire?

	radius	length
A	$\frac{r}{2}$	$\frac{L}{2}$
B	$\frac{r}{\sqrt{2}}$	$\frac{L}{2}$
C	$r\sqrt{2}$	$2L$
D	$2r$	$2L$

$\frac{\rho l}{A} \times \frac{1}{2} R = \frac{\rho l \times 2}{A \times 2}$

36 A battery of negligible internal resistance may be connected between any two points P, Q, R and S of the network of resistors shown.





Which connections will give the largest current and the smallest current in the battery?

	largest current	smallest current
A	PQ I = 2·4A	PR I = 1·35A
B	PQ I = 2·4A	QS I = 1·33A
C	RS I = 1·93A	PR I = 1·35A
D	RS I = 1·93A	QS I = 1·33A

37 Kirchhoff's second law is a consequence of a basic principle.

What is this principle?

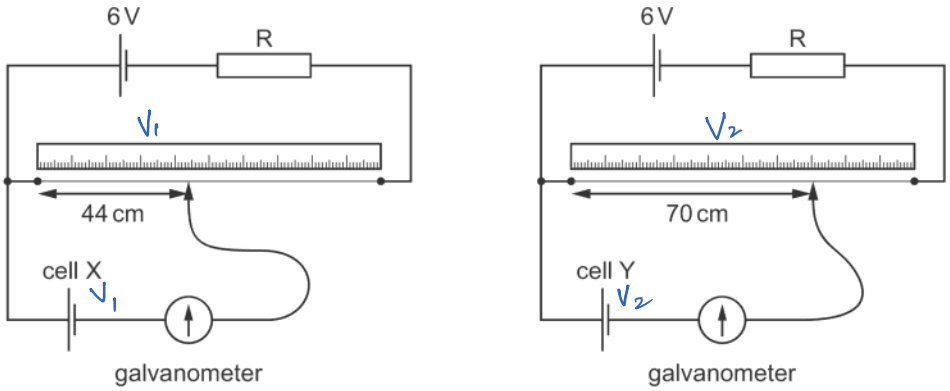
A The charge flowing in an electric circuit is conserved. 1st law

B The energy in an electric circuit is conserved.

C The sum of the electric currents entering a point in an electrical circuit is equal to the sum of the electric currents leaving that point. 1st law

D The sum of the potential differences in a circuit is equal to the sum of the products of the current and resistance.

38 Two cells are investigated using a potentiometer. At the balance point, cell X gives a reading of 44 cm and cell Y gives a reading of 70 cm.



Which statement is **not** correct?

A A potentiometer balance point results in zero current through the galvanometer. ✓

B At the balance point, the current through resistor R in both circuits is the same. ✓

C The electromotive force (e.m.f.) of cell X is larger than that of cell Y.

D The value of the e.m.f. of each of the cells X and Y is less than 6 V. ✓ p.d. across R too

39 A proton in a nucleus undergoes β^+ decay. One of the products is a neutron.

What are the other products? $p \longrightarrow n + \beta^+ + \nu$

A an electron and a neutrino

B an electron and an antineutrino β^- decay

C a positron and a neutrino

D a positron and an antineutrino

40 A certain type of hadron has zero charge. It is composed of a down quark ($-\frac{1}{3}e$), a strange quark ($-\frac{1}{3}e$) and one other quark. x

What could be the other quark?

$-\frac{1}{3}e - \frac{1}{3}e + x = 0$

$x = +\frac{2}{3}e$ (up quark)

A up

B down

C strange

D anti-strange