Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **October/November 2024**

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

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Data

acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
unified atomic mass unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of proton	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
Avogadro constant	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$ $\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\text{W m}^{-2}\,\text{K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_\text{o} = \frac{f_\text{s} v}{v \pm v_\text{s}}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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1 What are the SI base units for the moment of a force?

A $\mathrm{kg\,m^{-1}\,s^{2}}$ **B** $\mathrm{kg\,s^{-2}}$ **C** $\mathrm{kg\,m\,s^{-2}}$ **D** $\mathrm{kg\,m^{2}\,s^{-2}}$

2 Which statement about vector quantities is correct?

A Acceleration of free fall is a vector quantity because it has a constant magnitude.

B Temperature in °C is a vector quantity because it can be positive or negative.

C Time is a vector quantity because it can only go in the forwards direction.

D Weight is a vector quantity because it has a direction.

3 The density of the material of a rectangular block is determined by measuring the mass and linear dimensions of the block. The list shows the results obtained, together with their uncertainties.

$$\text{mass} = (25.0 \pm 0.1)\,\text{g}$$
$$\text{length} = (5.00 \pm 0.01)\,\text{cm}$$
$$\text{width} = (2.00 \pm 0.01)\,\text{cm}$$
$$\text{height} = (1.00 \pm 0.01)\,\text{cm}$$

The density is calculated to be $2.50\,\mathrm{g\,cm^{-3}}$.

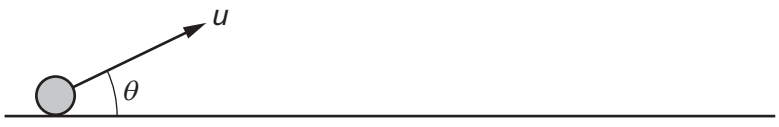
What is the uncertainty in this result?

A $\pm 0.01\,\mathrm{g\,cm^{-3}}$ **B** $\pm 0.02\,\mathrm{g\,cm^{-3}}$ **C** $\pm 0.05\,\mathrm{g\,cm^{-3}}$ **D** $\pm 0.13\,\mathrm{g\,cm^{-3}}$

4 What is a reasonable estimate of the volume of one page from this examination paper?

A $60\,\mathrm{mm^{3}}$ **B** $600\,\mathrm{mm^{3}}$ **C** $6000\,\mathrm{mm^{3}}$ **D** $60\,000\,\mathrm{mm^{3}}$

5 An object is projected from horizontal ground at a velocity of magnitude u and angle θ to the horizontal. It hits the ground at a time t after it is projected. Assume air resistance is negligible.



Which statement does **not** describe the motion of this object?

A The horizontal component of the object's velocity is constant and has the value $u\cos\theta$.

B The horizontal distance travelled by the object is $tu\cos\theta$.

C The time taken for the object to reach maximum height is $\frac{t}{2}$.

D The vertical component of the object's velocity is constant and has the value $u\sin\theta$.

6 A person, travelling on a motorway a total distance of 200 km, travels the first 90 km at an average speed of 80 km h^{-1}.

Which average speed must be obtained for the rest of the journey if the person is to reach the destination in a total time of 2 hours 0 minutes?

A 110 km h^{-1} **B** 120 km h^{-1} **C** 122 km h^{-1} **D** 126 km h^{-1}

7 A car of mass 1200 kg has momentum 18 000 kg m s^{-1}.

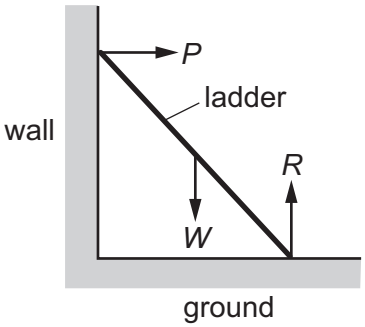
What is the kinetic energy of the car?

A 4.65 kJ **B** 6.57 kJ **C** 135 kJ **D** 270 kJ

8 A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide.

Which diagram shows the directions of the forces *P*, *W* and *R* acting on the ladder as it slides?

A



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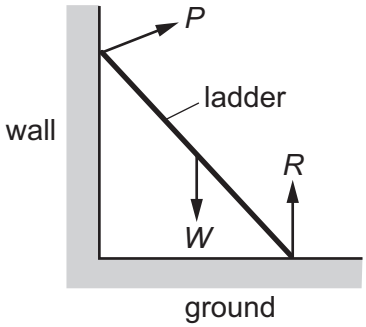

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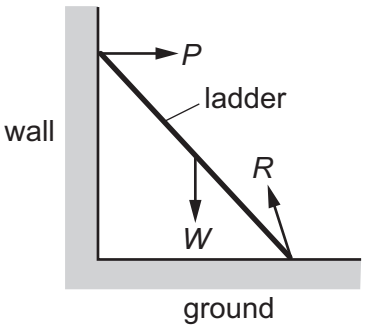

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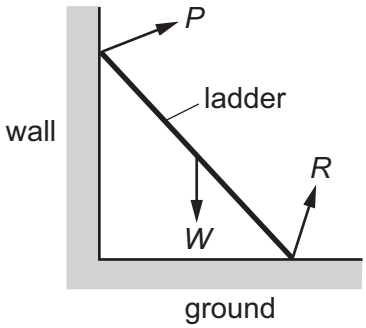

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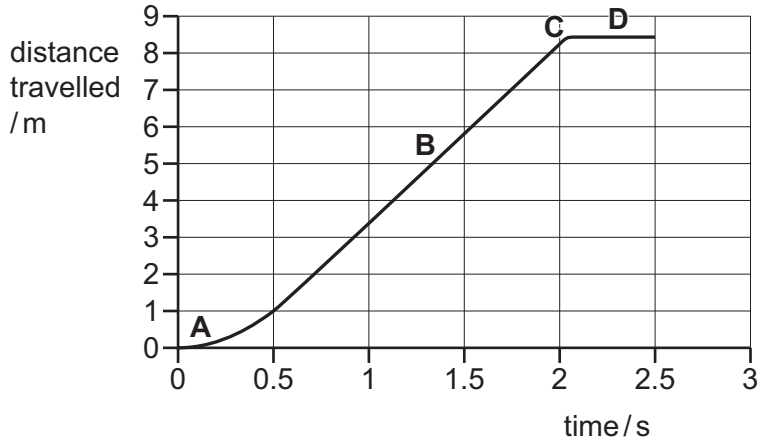
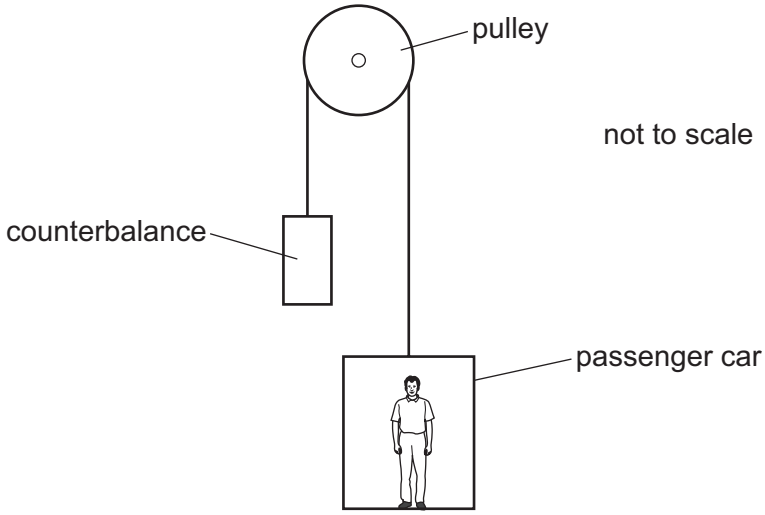
9 A toy parachute is dropped from a bridge and falls vertically through the air.

The graph shows the distance travelled by the parachute against time.

Which region of the graph shows when the parachute is at terminal velocity?



10 A lift (elevator) consists of a passenger car supported by a cable that runs over a light, frictionless pulley to a counterbalance. The counterbalance falls as the passenger car rises.



Some masses are shown in the table.

	mass / kg
passenger car	520
counterbalance	640
passenger	80

What is the magnitude of the acceleration of the car when carrying just one passenger and when the pulley is free to rotate?

A $0.032\,m\,s^{-2}$ **B** $0.32\,m\,s^{-2}$ **C** $0.61\,m\,s^{-2}$ **D** $0.65\,m\,s^{-2}$

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11 A stationary ball of mass m is hit by a bat. The ball leaves the bat with velocity v.

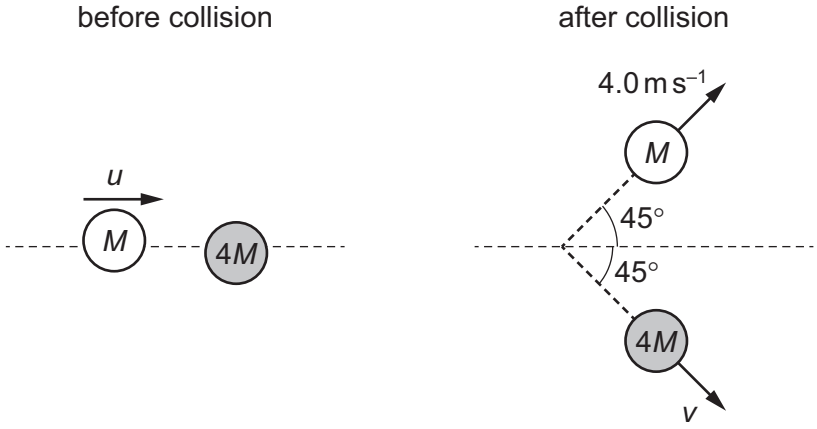
The bat is in contact with the ball for a short time Δt.

What is the average force of the bat on the ball?

A $mv\Delta t$ **B** $\frac{mv}{\Delta t}$ **C** $\frac{1}{2}mv^2\Delta t$ **D** $\frac{\frac{1}{2}mv^2}{\Delta t}$

12 A disc of mass M is moving across a horizontal frictionless surface with constant velocity u. It collides with a stationary disc of mass $4M$.

The diagram shows the view from above of the motion of the two discs before and after the collision.



What is the initial velocity u of the disc of mass M?

A $1.1\,m\,s^{-1}$ **B** $1.4\,m\,s^{-1}$ **C** $3.5\,m\,s^{-1}$ **D** $5.7\,m\,s^{-1}$

13 An object is dropped from rest on the Earth from a height of 2.0 m.

The same object is dropped from rest on the Moon from twice the height.

The acceleration of free fall on the Moon is approximately 16% of the value on the Earth.

Assume that there are no resistive forces acting on the object.

What is the ratio $\frac{\text{speed of the object just before hitting the surface on the Earth}}{\text{speed of the object just before hitting the surface on the Moon}}$?

A 1.8 **B** 2.5 **C** 3.1 **D** 3.5

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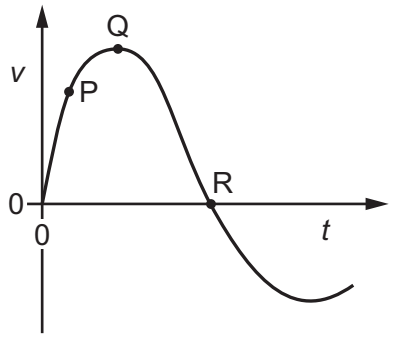
14 The graph shows how velocity v varies with time t for a bungee jumper.



At which point is the bungee jumper momentarily at rest and at which point does she have zero acceleration?

	jumper at rest	jumper with zero acceleration
A	Q	P
B	Q	R
C	R	Q
D	R	R

15 A solid sphere, which is less dense than water, is held completely immersed in water a few metres below the surface. The density of the water is uniform.

The sphere is released. Immediately after release, the sphere rises.

Which row describes the changes in the magnitudes of the upthrust on the sphere and the resultant force on the sphere as it rises?

	upthrust on the sphere	resultant force on the sphere
A	constant	decreasing
B	constant	increasing
C	decreasing	decreasing
D	decreasing	increasing

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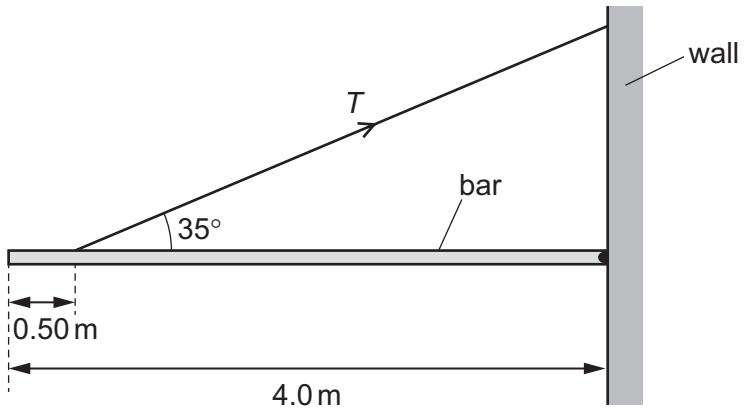
[Turn over

16 A uniform bar of weight 200 N and length 4.0 m is freely hinged on a wall at one end. The bar is horizontal and is held in equilibrium by a cable attached at a distance of 0.50 m from the other end. The cable is at an angle of 35° to the horizontal.

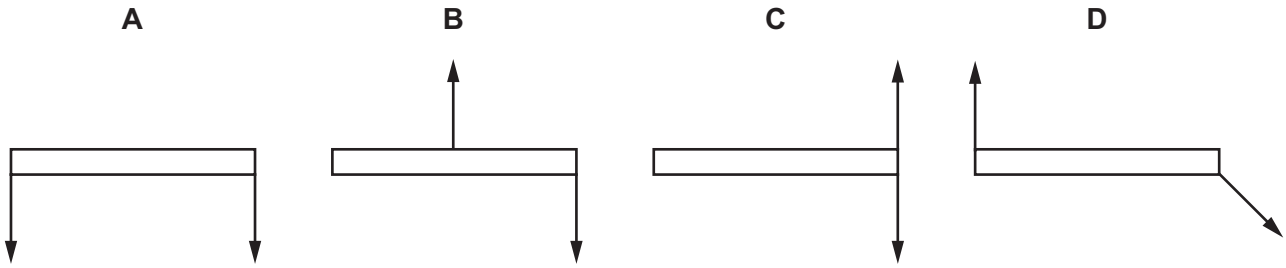


What is the tension T in the cable?

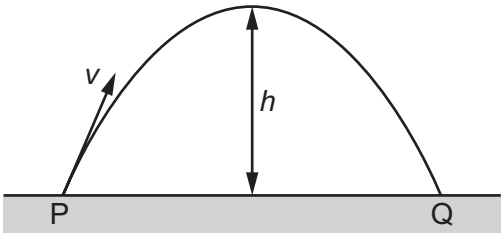
A 140 N **B** 170 N **C** 200 N **D** 400 N

17 The diagrams all show a pair of equal forces acting on a metre rule.

Which diagram shows forces that provide a couple and zero resultant force?



18 A ball of mass m is thrown up to height h in air with an initial velocity v, as shown.



Air resistance is negligible. The acceleration of free fall is g.

What is the **total** work done by the gravitational force on the ball during its flight from P to Q?

A zero **B** $\frac{1}{2}mv^2$ **C** mgh **D** $2mgh$

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19 A spring of spring constant $30\,\text{N}\,\text{m}^{-1}$ is suspended vertically from its top. The spring obeys Hooke's law. Initially the spring is not compressed and not stretched. A mass of 0.50 kg is attached to the bottom of the spring. The mass is released from rest and falls.

Frictional effects are negligible.

In the motion that follows, what is the maximum extension of the spring?

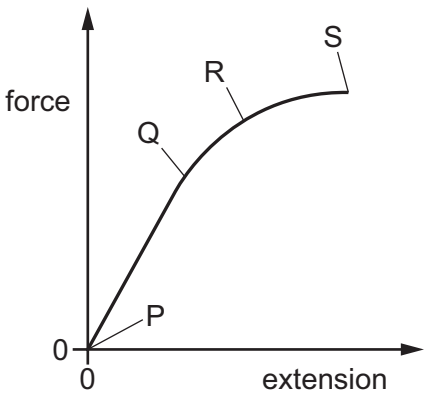
A 0.017 m **B** 0.033 m **C** 0.16 m **D** 0.33 m

20 A wire has original length L and cross-sectional area A. A tensile force F is applied to the wire which causes it to have extension x. The wire obeys Hooke's law.

What is an expression for the Young modulus of the material from which the wire is made?

A $\dfrac{\text{stress} \times x}{L}$ **B** $\dfrac{F}{A \times \text{strain}}$ **C** $\dfrac{F \times x}{A \times L}$ **D** $\dfrac{\text{strain}}{\text{stress}}$

21 A wire is stretched by a gradually increasing force. The force–extension graph for the wire is shown.



Which statement **must** be correct?

A Point Q is the elastic limit.

B Point R is the limit of proportionality.

C The area under the graph from P to S is the elastic potential energy stored in the wire.

D The area under the graph from P to S is the work done in stretching the wire.

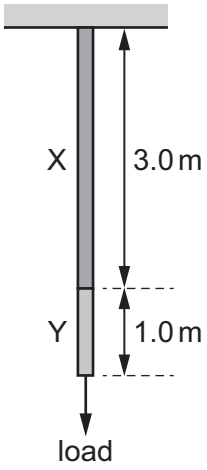
22 A spring has an unstretched length of 0.30 m and a spring constant of $400\,\text{N}\,\text{m}^{-1}$. An object is suspended from the spring and the spring is deformed within its limit of proportionality. The new length of the spring is 0.50 m.

What is the elastic potential energy stored in the spring?

A 8.0 J **B** 16 J **C** 40 J **D** 50 J

23 A wire consists of a 3.0 m length of metal X joined to a 1.0 m length of metal Y.

The cross-sectional area of the wire is uniform.



A load hung from the wire causes metal X to extend by 1.5 mm and metal Y to extend by 1.0 mm.

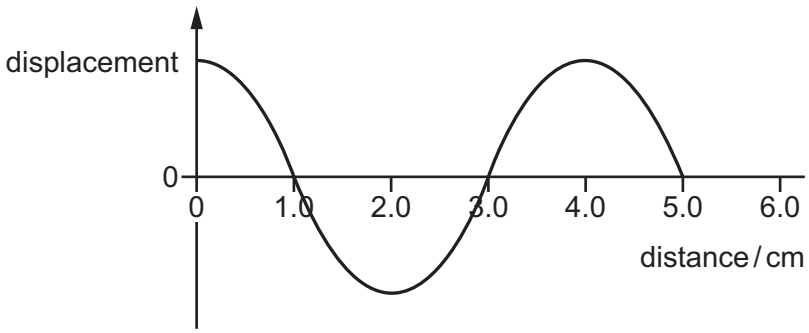
The same load is then hung from a second wire of the same cross-sectional area, consisting of a 1.0 m length of metal X and a 3.0 m length of metal Y.

Both wires are extended within their limit of proportionality.

What is the total extension of this second wire?

A 2.5 mm **B** 3.5 mm **C** 4.8 mm **D** 5.0 mm

24 The graph shows the variation of the displacement with distance for a progressive wave at one instant in time.



The period of the wave is 91 ms.

What can be determined about the wave?

A It has a velocity of 0.44 m s^{-1} and a frequency of 11 Hz.

B It has a velocity of 0.55 m s^{-1} and a wavelength of 5.0 cm.

C It is longitudinal and has a frequency of 11 Hz.

D It is transverse and has a wavelength of 4.0 cm.

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25 Which group of electromagnetic waves is arranged in order from shortest wavelength to longest wavelength?

A radio waves → visible light → gamma rays

B visible light → microwaves → infrared

C visible light → ultraviolet → X-rays

D X-rays → infrared → microwaves

26 A wave has a frequency of 5 GHz.

What is the period of the wave?

A 200 ps **B** 2 ns **C** 20 ns **D** 20 000 μs

27 Three statements about two progressive waves are listed.

1 The waves have the same frequency.

2 The waves have the same amplitude.

3 The waves are emitted with a constant phase difference.

Which statements **must** be correct for the two waves to be coherent?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

28 Waves P and Q have the same amplitude. The waves meet in phase at point X and interfere to give a resultant wave with intensity I.

The amplitude of wave P is doubled.

What is the new intensity of the resultant wave at X, in terms of I?

A $0.44I$ **B** $1.5I$ **C** $2.3I$ **D** $3.0I$

29 Radio waves can be polarised, but sound waves **cannot** be polarised.

Which statement gives the reason for this?

A Radio waves are generally of a higher frequency than sound waves.

B Radio waves are transverse waves, but sound waves are longitudinal waves.

C Radio waves can travel through a vacuum, but sound waves **cannot** travel through a vacuum.

D Radio waves travel at a much higher speed than sound waves.

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30 Light of wavelength λ is incident normally on a diffraction grating with a total number of N lines in width w.

A second order maximum is observed at an angle of diffraction θ.

What is N?

A $\frac{w\lambda}{\sin\theta}$ **B** $\frac{2w\lambda}{\sin\theta}$ **C** $\frac{w\sin\theta}{2\lambda}$ **D** $\frac{w\sin\theta}{\lambda}$

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

What is this principle?

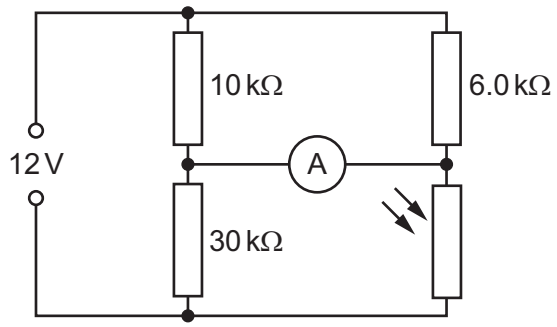
A The charge flowing in an electric circuit is conserved.

B The energy in an electric circuit is conserved.

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

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

32 The diagram shows a circuit with a light-dependent resistor (LDR).



The ammeter reads zero current.

What is the resistance of the LDR?

A 6.0 kΩ **B** 18 kΩ **C** 26 kΩ **D** 30 kΩ

33 A torch uses three lamps connected in parallel and is powered by a cell of electromotive force (e.m.f.) 3.0 V and negligible internal resistance. Each lamp dissipates 0.60 W of power.

What is the current in the cell?

A 0.067 A **B** 0.20 A **C** 0.60 A **D** 0.83 A

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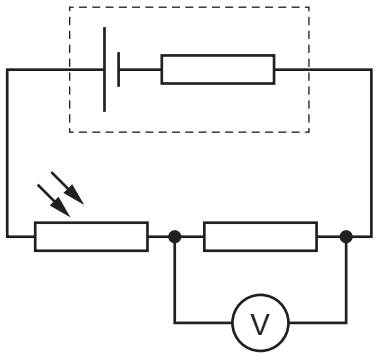
34 A cell with internal resistance is connected to a light-dependent resistor (LDR), a fixed resistor and a voltmeter, as shown.



The voltmeter reading increases.

Which quantity decreases as the voltmeter reading increases?

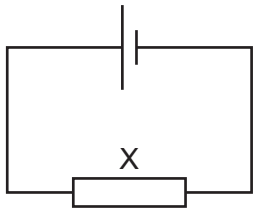
A the charge moving through the cell per unit time

B the energy transferred to the fixed resistor per unit charge

C the intensity of the light incident on the LDR

D the terminal potential difference across the cell

35 The circuit shown contains a cell with negligible internal resistance.



The energy transferred per unit charge in driving charge around the complete circuit is *E*. The potential difference (p.d.) across X is *V*.

The cell is then replaced with a different cell of the same electromotive force (e.m.f.) that has significant internal resistance.

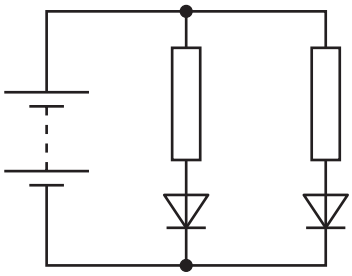
What is the effect on *E* and *V* of replacing the cell?

	effect on *E*	effect on *V*
A	decreases	decreases
B	decreases	increases
C	no change	decreases
D	no change	increases

36 In the circuits shown, the batteries are identical and all have negligible internal resistance. All of the resistors have the same resistance. The diodes have zero resistance when conducting and infinite resistance when not conducting.

In which circuit is the current in the battery greatest?

A



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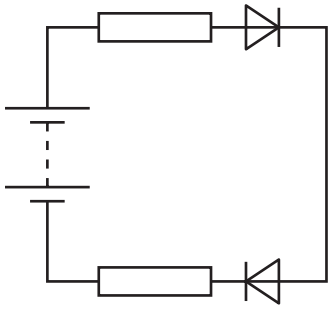

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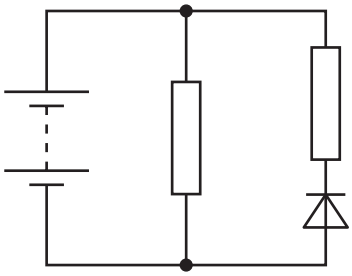

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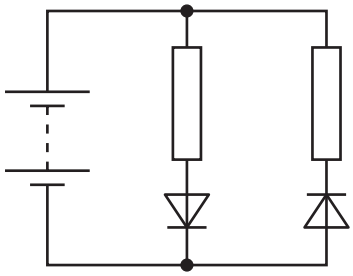
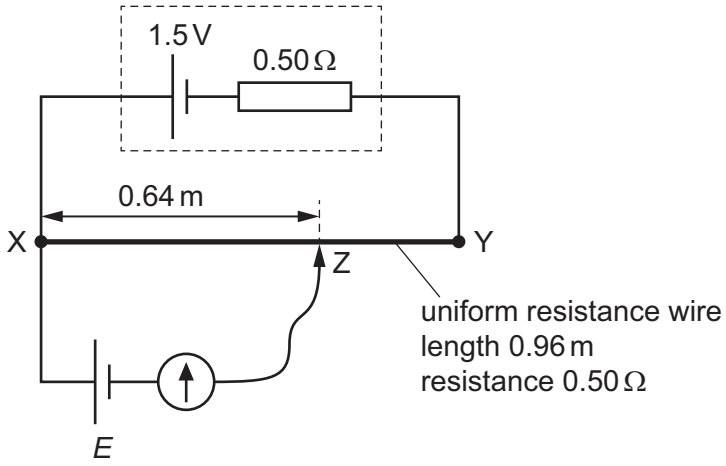


37 A potentiometer circuit is used to determine the electromotive force (e.m.f.) *E* of a cell. The circuit includes a second cell of e.m.f. 1.5 V and internal resistance 0.50 Ω that is connected to a uniform resistance wire XY, as shown.



The resistance wire XY has a length of 0.96 m and a resistance of 0.50 Ω.

The movable connection Z is moved along wire XY. The galvanometer reading is zero when length XZ is 0.64 m.

What is the value of e.m.f. *E*?

A 0.50 V **B** 0.75 V **C** 1.0 V **D** 1.1 V

38 Which particle is **not** a fundamental particle?

A charm quark

B electron

C neutrino

D neutron

39 The isotope fluorine-18, $^{18}_{9}\mathrm{F}$, undergoes β^+ decay to form a stable isotope.

How many neutrons are there in a nucleus of the stable isotope?

A 7 **B** 8 **C** 9 **D** 10

40 Which statement is correct?

A A baryon is a hadron and consists of 2 quarks.

B A meson is a hadron and consists of 3 quarks.

C An electron is a fundamental particle and is a lepton.

D A neutrino is a fundamental particle and is a hadron.

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