UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS **9702/01**

Paper 1 Multiple Choice **October/November 2007**

1 hour

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

* 1 9 4 5 5 4 1 2 4 8 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, 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.

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 rough working should be done in this booklet.

This document consists of **18** printed pages and **2** blank pages.

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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,	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
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 constant,	$u = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of electron,	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton,	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant,	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant,	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
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,	$g = 9.81\,\text{m s}^{-2}$

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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., $v = v_0 \cos \omega t$

$v = \pm \omega \sqrt{(x_0^2 - x^2)}$

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, $W = \frac{1}{2}QV$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

alternating current/voltage, $x = x_0 \sin \omega t$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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1 The equation relating pressure and density is $p = \rho gh$.

How can both sides of this equation be written in terms of base units?

A $[\mathrm{N\,m^{-1}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-1}}]\,[\mathrm{m}]$

B $[\mathrm{N\,m^{-2}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

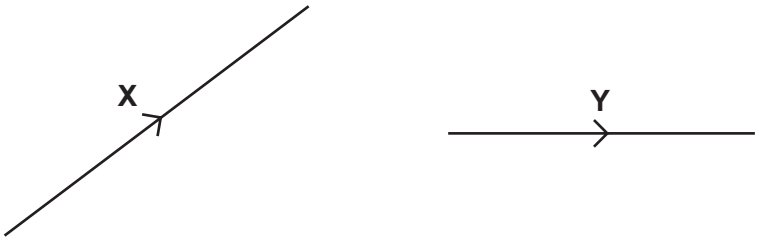
C $[\mathrm{kg\,m^{-1}\,s^{-2}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

D $[\mathrm{kg\,m^{-1}\,s^{-1}}] = [\mathrm{kg\,m^{-1}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

2 What is a reasonable estimate of the diameter of an alpha particle?

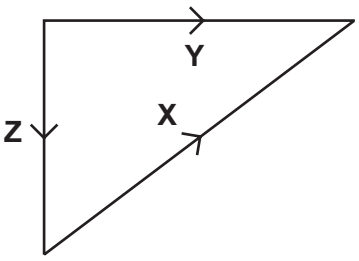
A $10^{-15}\,\mathrm{m}$ **B** $10^{-12}\,\mathrm{m}$ **C** $10^{-9}\,\mathrm{m}$ **D** $10^{-6}\,\mathrm{m}$

3 The diagram shows two vectors **X** and **Y**.

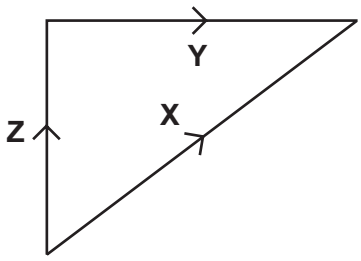


In which vector triangle does the vector **Z** show the magnitude and direction of vector **X**–**Y**?

A



B



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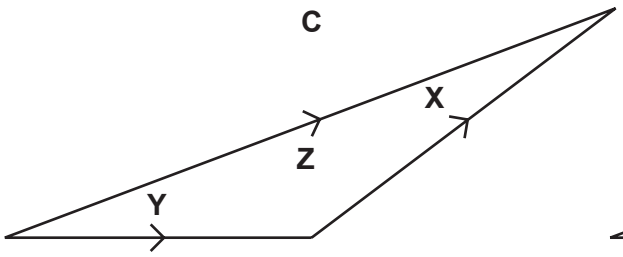
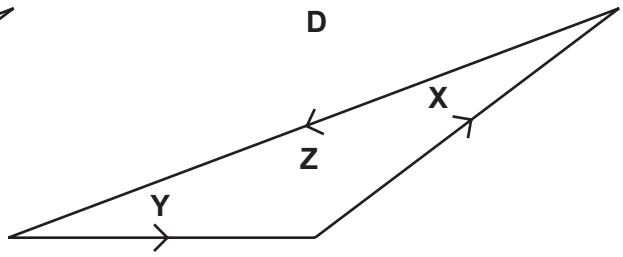


D



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4 A series of measurements of the acceleration of free fall g is shown in the table.

Which set of results is precise but not accurate?

	g / m s^{-2}				
A	9.81	9.79	9.84	9.83	9.79
B	9.81	10.12	9.89	8.94	9.42
C	9.45	9.21	8.99	8.76	8.51
D	8.45	8.46	8.50	8.41	8.47

5 A mass m has acceleration a. It moves through a distance s in time t. The power used in accelerating the mass is equal to the product of force and velocity. The percentage uncertainties are

0.1 % in m,

1 % in a,

1.5 % in s,

0.5 % in t.

What is the percentage uncertainty in the average power?

A 2.1 % **B** 2.6 % **C** 3.1 % **D** 4.1 %

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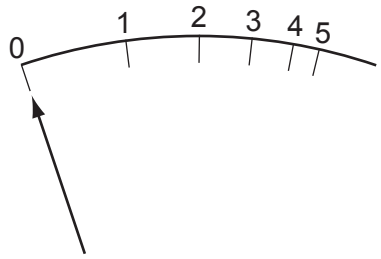
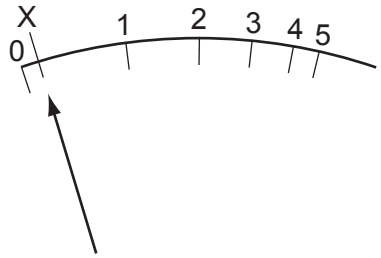
6 The diagram shows the graduations of a correctly calibrated ammeter. When the current is zero, the pointer is at 0.

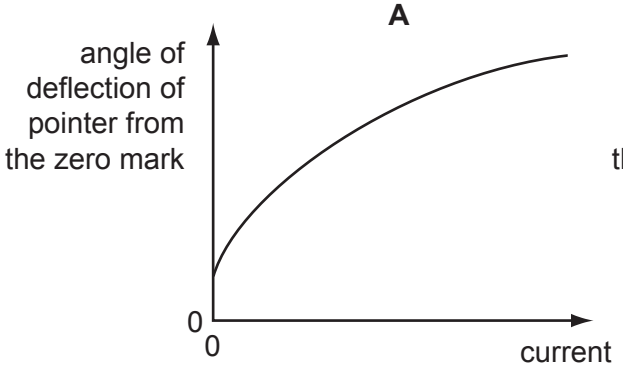


The ammeter is accidentally readjusted so that when the current is zero, the pointer is at X.

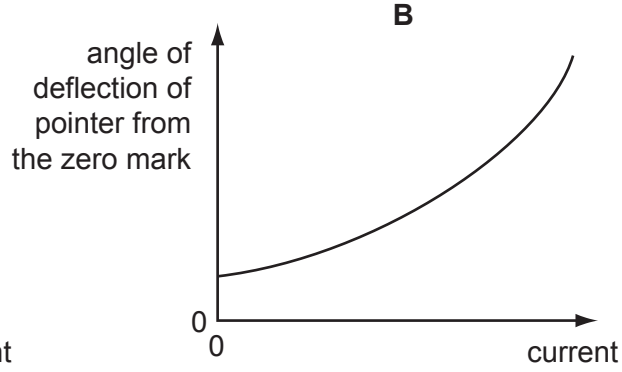


Which calibration graph best represents the response of the readjusted ammeter?

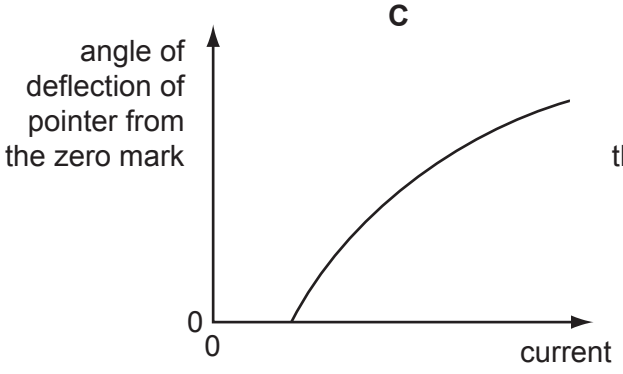
A



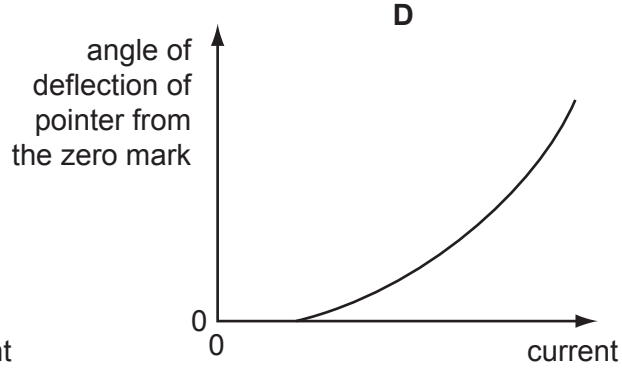
B



C



D



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7 The symbol *g* represents the acceleration of free fall.

Which of these statements is correct?

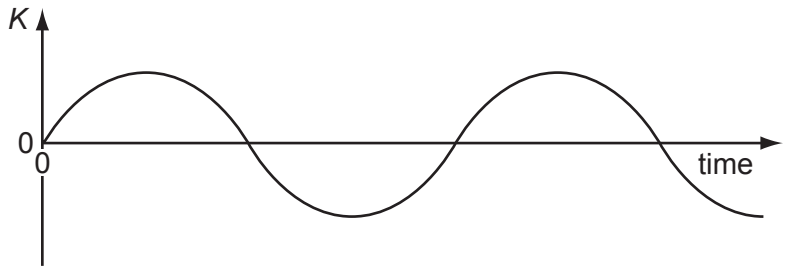
A *g* is gravity.

B *g* is reduced by air resistance.

C *g* is the ratio weight / mass.

D *g* is the weight of an object.

8 A particle moves along a straight line. A particular property *K* of the particle's motion is plotted against time.



At any time, the slope of the graph is the acceleration of the particle.

What is the property *K*?

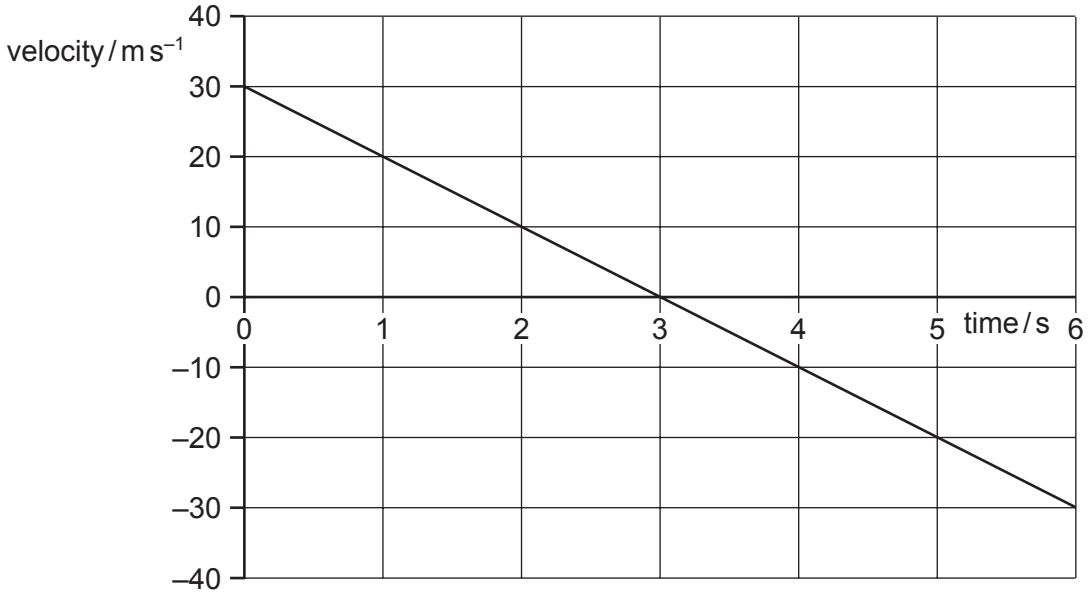
A the displacement of the particle

B the distance travelled by the particle

C the speed of the particle

D the velocity of the particle

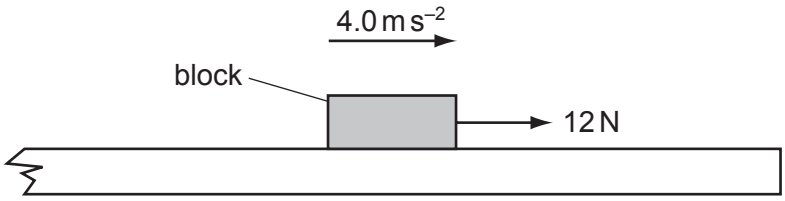
9 A stone is thrown vertically upwards. A student plots the variation with time of its velocity.



What is the vertical displacement of the stone from its starting point after 5 seconds?

A 20 m **B** 25 m **C** 45 m **D** 65 m

10 A block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 m s^{-2}.



What is the magnitude of the frictional force acting on the block?

A 2.4 N **B** 5.3 N **C** 6.7 N **D** 9.6 N

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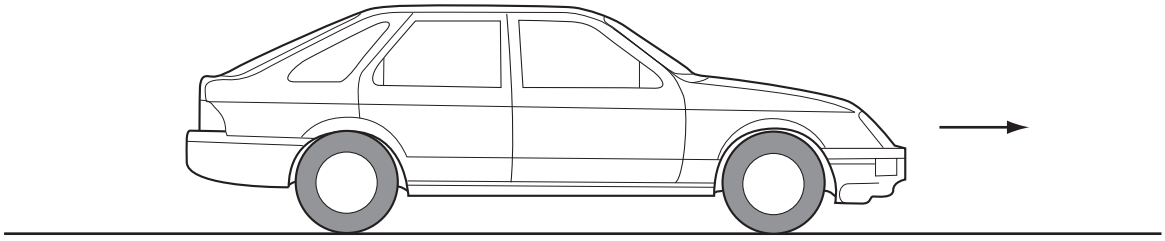
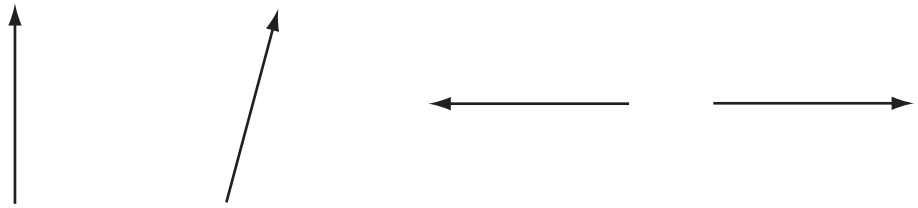
11 A car with front-wheel drive accelerates in the direction shown.

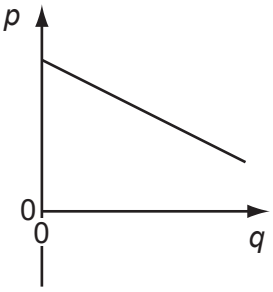


Which diagram best shows the direction of the total force exerted by the road on the front wheels?

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



12 The graph shows how a certain quantity *p* varies with another quantity *q* for a parachutist falling at terminal speed.



What are the quantities *p* and *q*, and what is represented by the magnitude of the gradient of the graph?

	quantity *p*	quantity *q*	magnitude of gradient
A	height	time	terminal speed
B	momentum	time	weight of parachutist
C	height	potential energy	mass of parachutist
D	velocity	time	acceleration of free fall

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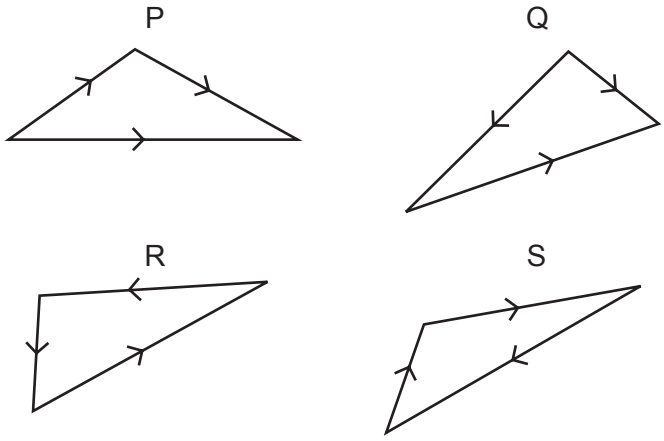
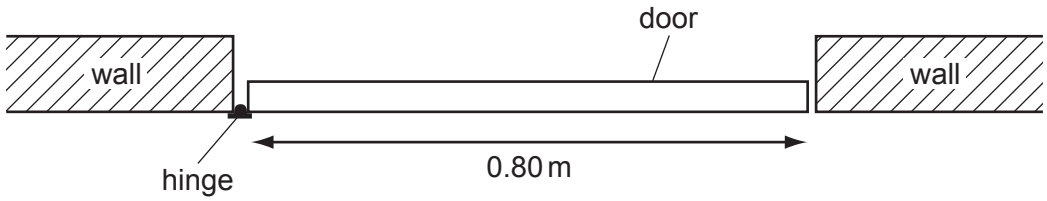
13 Which two vector diagrams represent forces in equilibrium?



A P and Q **B** Q and R **C** R and S **D** S and P

14 The diagram shows a plan view of a door which requires a moment of 12 N m to open it.



What is the minimum force that must be applied at the door's midpoint to ensure it opens?

A 4.8 N **B** 9.6 N **C** 15 N **D** 30 N

15 A car of mass 1000 kg first travels forwards at 25 m s^{-1} and then backwards at 5 m s^{-1}.

What is the change in the kinetic energy of the car?

A 200 kJ **B** 300 kJ **C** 325 kJ **D** 450 kJ

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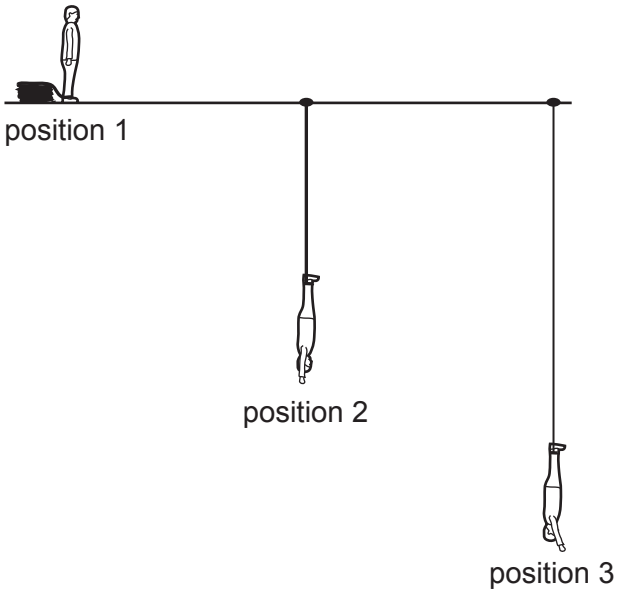
16 When bungee jumping, a student starts with maximum gravitational potential energy (position 1), then falls freely until the rope fully unwinds (position 2), after which the rope starts to stretch until the lowest point of the jump is reached (position 3).



What are the kinetic and elastic potential energies at position 3?

	kinetic energy	elastic potential energy
A	maximum	maximum
B	maximum	minimum
C	minimum	maximum
D	minimum	minimum

17 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. There are n_P and n_Q atoms per unit volume respectively.

It is found by experiment that the density of P is greater than that of Q.

Which deduction from this experiment must be correct?

A $M_P > M_Q$

B $n_P > n_Q$

C $M_P n_P > M_Q n_Q$

D $\frac{M_P}{n_P} > \frac{M_Q}{n_Q}$

18 A submarine carries a pressure meter so that the crew can work out how far they are below the surface of the sea. At the surface, the meter indicates a pressure of 100 kPa. The density of seawater is 1030 kg m^{-3}.

What is the depth below the surface when the meter reads 450 kPa?

A 34.6 m **B** 44.5 m **C** 340 m **D** 437 m

19 What is plastic deformation?

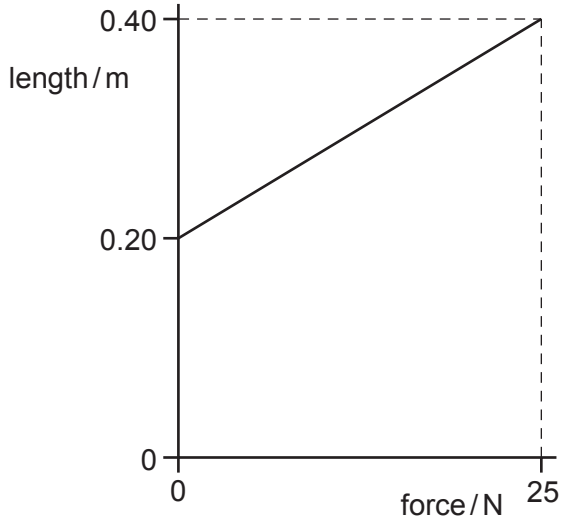
A Plastic deformation occurs when strain is not proportional to stress but when the load is removed the material returns to its original length.

B Plastic deformation occurs if, when the load is removed, the material contracts but a permanent stretching has occurred.

C Plastic deformation occurs until the extension is no longer proportional to the load.

D Plastic deformation occurs when the material extends so that strain is directly proportional to stress.

20 The graph shows how the length of a particular rubber cord varies as force is applied.



What is the maximum strain energy in this deformed rubber cord?

A 2.5 J **B** 5.0 J **C** 7.5 J **D** 10 J

21 What is the relationship between the intensity I and the amplitude a of a wave?

A $\frac{I}{a}$ = constant

B $\frac{I}{a^2}$ = constant

C Ia = constant

D Ia^2 = constant

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22 An electromagnetic wave has a frequency of 10^8 Hz.

In which region of the electromagnetic spectrum does the wave occur?

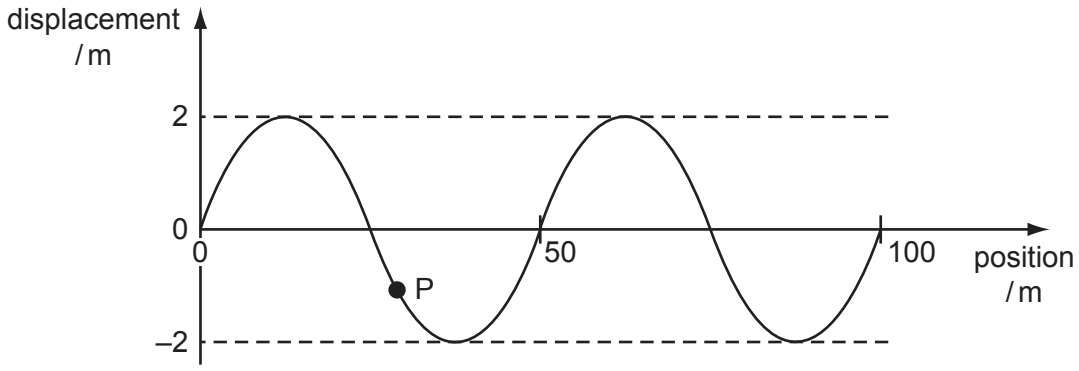
A infra-red

B radio

C ultraviolet

D visible

23 The graph represents a sinusoidal wave in the sea, travelling at a speed of 8.0 m s^{-1}, at one instant of time. The maximum speed of the oscillating particles in the wave is $2\pi af$, where a is the amplitude and f is the frequency.



An object P of mass 2.0×10^{-3} kg floats on the surface.

What is the maximum kinetic energy of P due to the wave? Assume that its motion is vertical.

A 0.026 mJ **B** 4.0 mJ **C** 39 mJ **D** 64 mJ

24 Monochromatic light illuminates two narrow parallel slits. The interference pattern which 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 decreasing the distance between the screen and the slits

B increasing the distance between the slits

C using monochromatic light of higher frequency

D using monochromatic light of longer wavelength

25 A narrow beam of monochromatic light is incident normally on a diffraction grating. Third-order diffracted beams are formed at angles of 45° to the original direction.

What is the highest order of diffracted beam produced by this grating?

A 3rd **B** 4th **C** 5th **D** 6th

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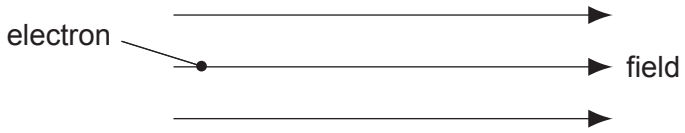
26 An electron is situated in a uniform electric field as shown in the diagram.



What is the direction of the electric force acting on the electron?

A downwards into the paper

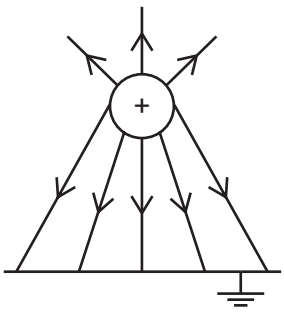
B upwards out of the paper

C to the left

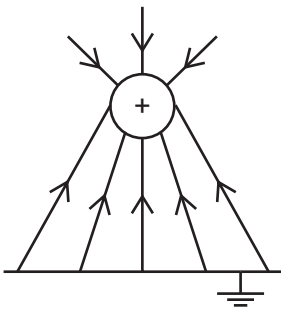
D to the right

27 Which diagram shows the electric field between a positively charged metal sphere and an earthed metal plate?

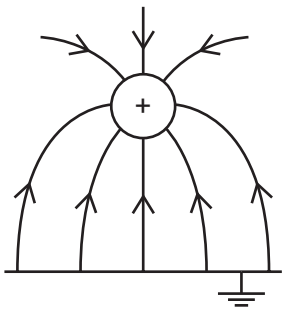
A



B



C



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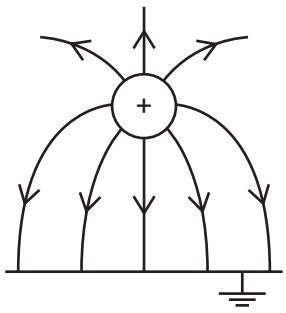

28 Which electrical quantity would be the result of a calculation in which energy transfer is divided by charge?

A current

B potential difference

C power

D resistance

29 Two heating coils X and Y, of resistance R_X and R_Y respectively, deliver the same power when 12 V is applied across X and 6 V is applied across Y.

What is the ratio R_X / R_Y?

A ¼ **B** ½ **C** 2 **D** 4

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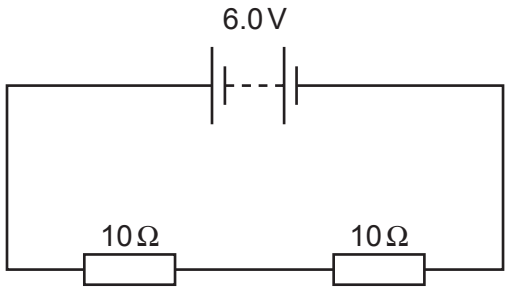
30 A battery of negligible internal resistance is connected to two 10 Ω resistors in series.



What charge flows through each of the 10 Ω resistors in 1 minute?

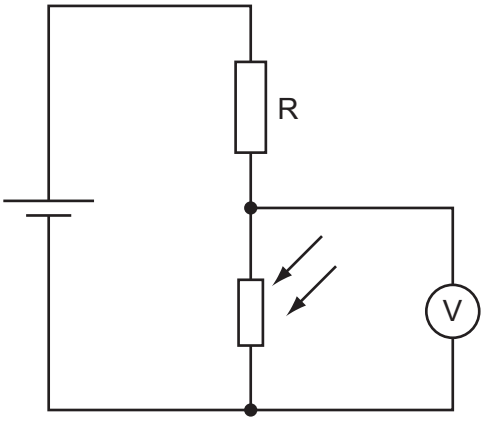
A 0.30 C **B** 0.60 C **C** 3.0 C **D** 18 C

31 Two wires P and Q have resistances R_P and R_Q respectively. Wire P is twice as long as wire Q and has twice the diameter of wire Q. The wires are made of the same material.

What is the ratio $\frac{R_P}{R_Q}$?

A 0.5 **B** 1 **C** 2 **D** 4

32 A potential divider consists of a fixed resistor R and a light-dependent resistor (LDR).



What happens to the voltmeter reading, and why does it happen, when the intensity of light on the LDR increases?

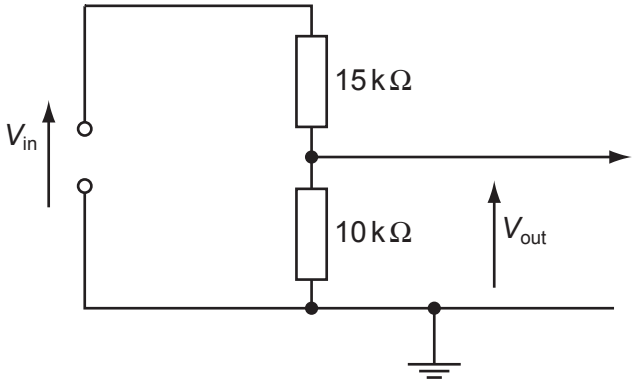
A The voltmeter reading decreases because the LDR resistance decreases.

B The voltmeter reading decreases because the LDR resistance increases.

C The voltmeter reading increases because the LDR resistance decreases.

D The voltmeter reading increases because the LDR resistance increases.

33 The circuit is designed to trigger an alarm system when the input voltage exceeds some preset value. It does this by comparing V_{out} with a fixed reference voltage, which is set at 4.8 V.

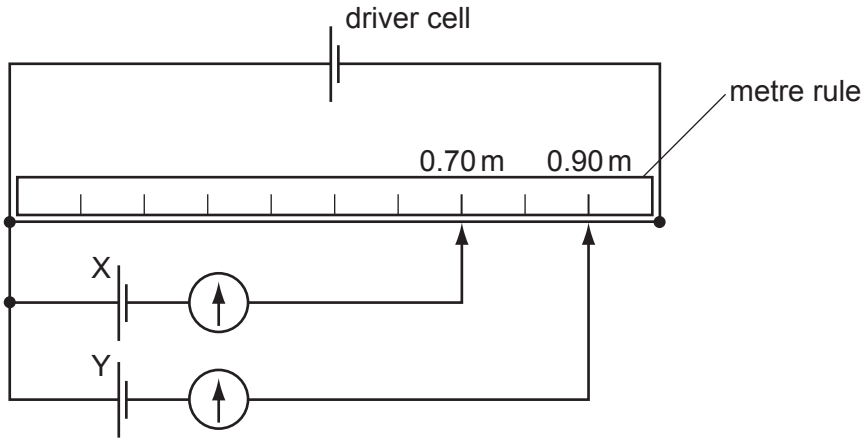


V_{out} is equal to 4.8 V.

What is the input voltage V_{in}?

A 4.8 V **B** 7.2 V **C** 9.6 V **D** 12 V

34 A potentiometer is used as shown to compare the e.m.f.s of two cells.



The balance points for cells X and Y are 0.70 m and 0.90 m respectively.

If the e.m.f. of cell X is 1.1 V, what is the e.m.f. of cell Y?

A 0.69 V **B** 0.86 V **C** 0.99 V **D** 1.4 V

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35 When four identical resistors are connected as shown in diagram 1, the ammeter reads 1.0 A and the voltmeter reads zero.

diagram 1

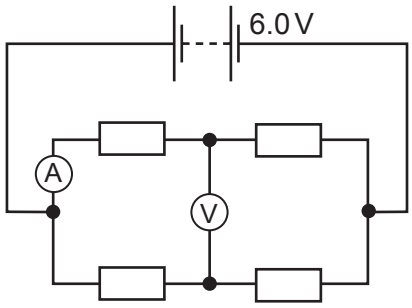
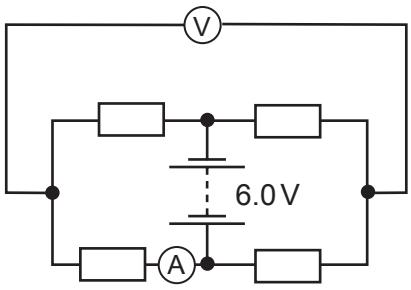


diagram 2



The resistors and meters are reconnected to the supply as shown in diagram 2.

What are the meter readings in diagram 2?

	voltmeter reading / V	ammeter reading / A
A	0	1.0
B	3.0	0.5
C	3.0	1.0
D	6.0	0

36 How is it possible to distinguish between the isotopes of uranium?

A Their nuclei have different charge and different mass, and they emit different particles when they decay.

B Their nuclei have different charge but the same mass.

C Their nuclei have the same charge but different mass.

D Their nuclei have the same charge and mass, but they emit different particles when they decay.

37 What is **not** conserved in nuclear processes?

A energy and mass together

B nucleon number

C neutron number

D charge

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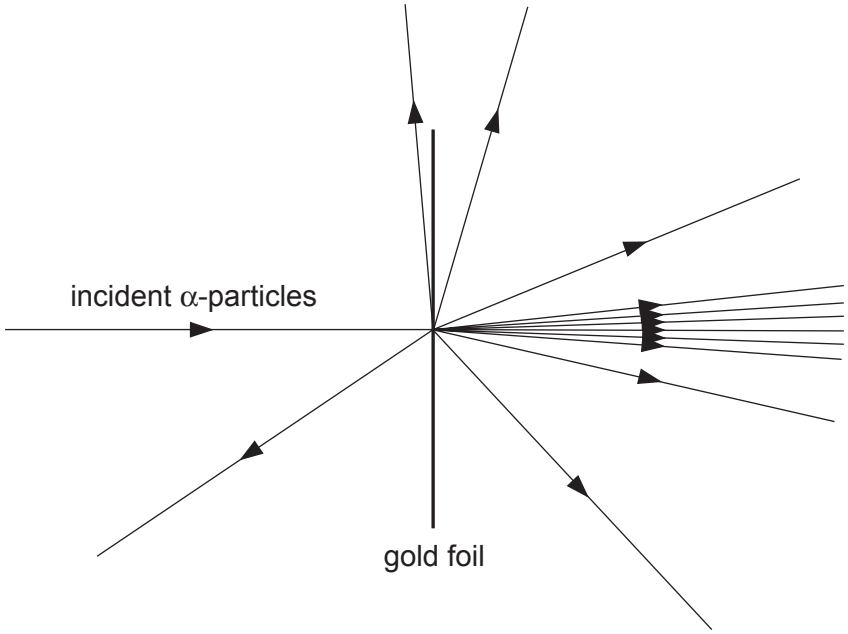
38 A thin gold foil is bombarded with α-particles as shown.



What can be deduced from this experiment?

A the binding energy of a gold nucleus

B the energy levels of electrons in gold atoms

C the small size of a gold nucleus

D the structure of a gold nucleus

39 A zirconium nucleus, $^{100}_{40}Zr$, is a β-emitter. The product nucleus is also a β-emitter.

What is the final resulting nucleus of these two decays?

A $^{100}_{38}Sr$ **B** $^{100}_{42}Mo$ **C** $^{98}_{40}Zr$ **D** $^{102}_{40}Zr$

40 The following particles are each accelerated from rest through the same potential difference.

Which one completes the acceleration with the **greatest** momentum?

A α-particle

B electron

C neutron

D proton

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