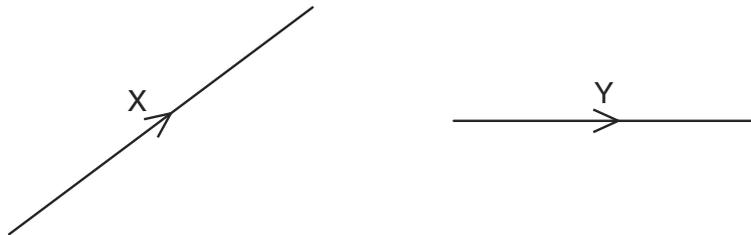


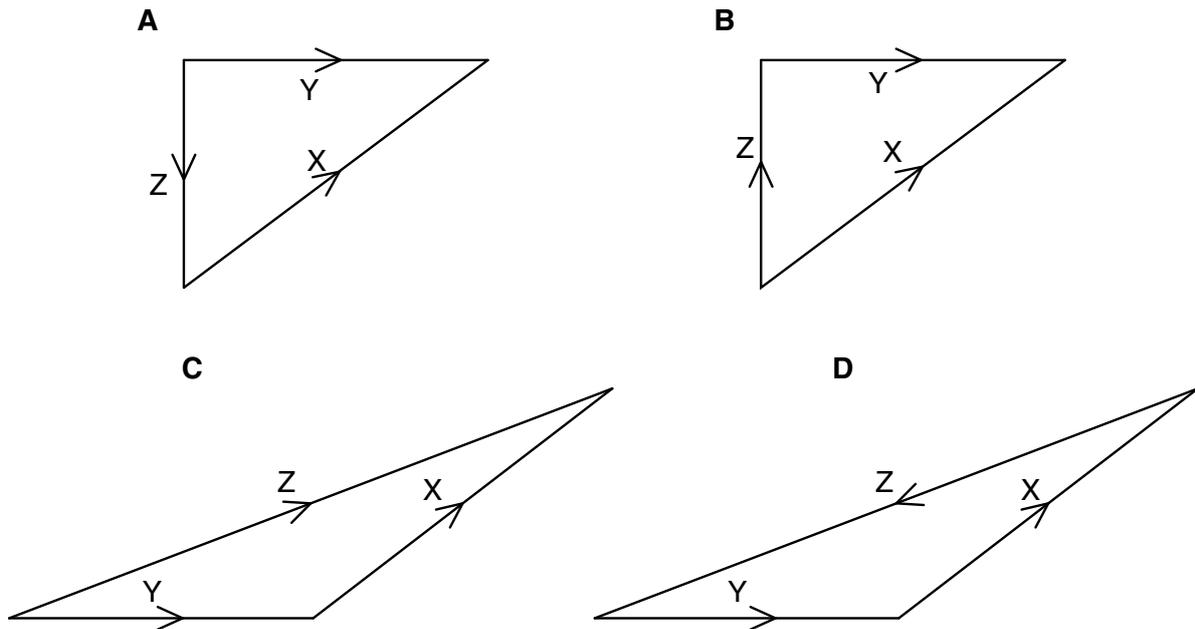
1 Which of the following pairs of units are both SI base units? 9702/1/M/J/02

- A ampere, degree celsius
- B ampere, kelvin
- C coulomb, degree celsius
- D coulomb, kelvin

2 The diagram shows two vectors X and Y. 9702/1/M/J/02



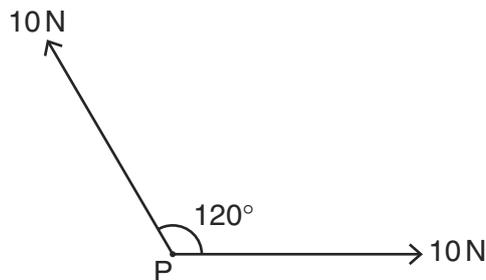
In which vector triangle does the vector Z show the magnitude and direction of vector $X - Y$?



3 Which formula could be correct for the speed v of ocean waves in terms of the density ρ of sea-water, the acceleration of free fall g , the depth h of the ocean and the wavelength λ ? 9702/1/M/J/02

- A $v = \sqrt{g\lambda}$
- B $v = \sqrt{\frac{g}{h}}$
- C $v = \sqrt{\rho gh}$
- D $v = \sqrt{\frac{g}{\rho}}$

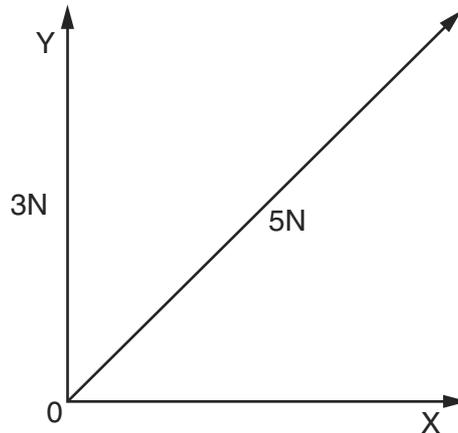
- 1 Which of the following is a scalar quantity? 9702/01/M/J/03
- A acceleration
B mass
C momentum
D velocity
- 2 The unit of work, the joule, may be defined as the work done when the point of application of a force of 1 newton is moved a distance of 1 metre in the direction of the force. 9702/01/M/J/03
- Express the joule in terms of the base units of mass, length and time, the kg, m and s.
- A $\text{kg m}^{-1} \text{s}^2$ B $\text{kg m}^2 \text{s}^{-2}$ C $\text{kg m}^2 \text{s}^{-1}$ D kg s^{-2}
- 3 Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120° . 9702/01/M/J/03



What is the magnitude of the resultant force?

- A 5 N B 10 N C 17 N D 20 N
- 1 A student measures a current as 0.5 A. 9702/01/O/N/03
- Which of the following correctly expresses this result?
- A 50 mA B 50 MA C 500 mA D 500 MA
- 3 The momentum of an object of mass m is p . 9702/01/O/N/03
- Which quantity has the same base units as $\frac{p^2}{m}$?
- A energy
B force
C power
D velocity

- 2 A force of 5 N may be represented by two perpendicular components OY and OX as shown in the diagram, which is **not** drawn to scale. 9702/01/O/N/03



OY is of magnitude 3 N.

What is the magnitude of OX?

- A** 2 N **B** 3 N **C** 4 N **D** 5 N

- 1 Which pair contains one vector and one scalar quantity? 9702/01/M/J/04

- A** displacement : acceleration
B force : kinetic energy
C momentum : velocity
D power : speed

- 2 Which of the following could be measured in the same units as force? 9702/01/M/J/04

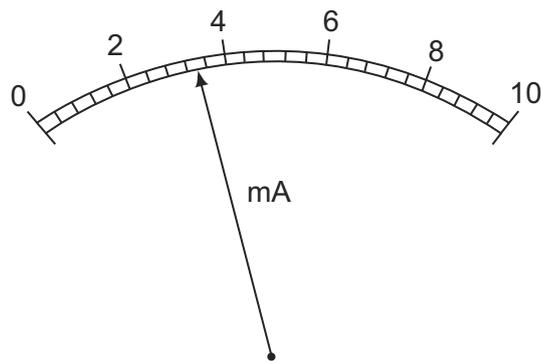
- A** energy / distance
B energy x distance
C energy / time
D momentum x distance

- 3 The notation μs is used as an abbreviation for a certain unit of time. 9702/01/M/J/04

What is the name and value of this unit?

	name	value
A	microsecond	10^{-6} s
B	microsecond	10^{-3} s
C	millisecond	10^{-6} s
D	millisecond	10^{-3} s

- 4 What is the reading shown on this milliammeter? 9702/01/M/J/04



- A 2.35 mA B 2.7 mA C 3.4 mA D 3.7 mA

- 1 Which line of the table gives values that are equal to a time of 1 ps (one picosecond) and a distance of 1 Gm (one gigametre)? 9702/01/O/N/04

	time of 1 ps	distance of 1 Gm
A	10^{-9} s	10^9 m
B	10^{-9} s	10^{12} m
C	10^{-12} s	10^9 m
D	10^{-12} s	10^{12} m

- 2 Which of the following definitions is correct and uses only quantities rather than units? 9702/01/O/N/04

- A Density is mass per cubic metre.
 B Potential difference is energy per unit current.
 C Pressure is force per unit area.
 D Speed is distance travelled per second.

- 3 When a beam of light is incident on a surface, it delivers energy to the surface. The intensity of the beam is defined as the energy delivered per unit area per unit time. 9702/01/O/N/04

What is the unit of intensity, expressed in SI base units?

- A $\text{kg m}^{-2} \text{ s}^{-1}$ B $\text{kg m}^2 \text{ s}^{-3}$ C kg s^{-2} D kg s^{-3}

- 3 An Olympic athlete of mass 80 kg competes in a 100 m race. 9702/01/M/J/05

What is the best estimate of his mean kinetic energy during the race?

- A 4×10^2 J B 4×10^3 J C 4×10^4 J D 4×10^5 J

- 1 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} . 9702/01/M/J/05

Which of the following gives the sub-multiples or multiples represented by pico (p) and giga (G)?

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

- 2 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v , it experiences a drag force F given by $F = kr v$, where k is a constant. 9702/01/M/J/05

What are the SI base units of k ?

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

- 1 Which pair of units are both SI base units? 9702/01/O/N/05

- A** ampere, degree celsius
B ampere, kelvin
C coulomb, degree celsius
D coulomb, kelvin

- 2 The prefix 'centi' indicates $\times 10^{-2}$. 9702/01/O/N/05

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	nano	pico	micro
C	pico	nano	micro
D	pico	micro	nano

- 3 Which expression involving base units is equivalent to the volt? 9702/01/O/N/05

- A** $\text{kg m}^2 \text{s}^{-1} \text{A}^{-1}$
B $\text{kg m s}^{-2} \text{A}$
C $\text{kg m}^2 \text{s}^{-1} \text{A}$
D $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$

- 1 Which pair includes a vector quantity and a scalar quantity? 9702/01/M/J/06
- A displacement; acceleration
 - B force; kinetic energy
 - C power; speed
 - D work; potential energy

- 2 For which quantity is the magnitude a reasonable estimate? 9702/01/M/J/06
- A frequency of a radio wave 500 pHz
 - B mass of an atom 500 μg
 - C the Young modulus of a metal 500 kPa
 - D wavelength of green light 500 nm

- 3 The following physical quantities can be either positive or negative. 9702/01/M/J/06

s : displacement of a particle along a straight line

θ : temperature on the Celsius scale

q : electric charge

V : readings on a digital voltmeter

Which of these quantities are vectors?

- A s, θ, q, V
 - B s, q, V
 - C θ, V
 - D s only
- 2 In the expressions below 9702/01/O/N/06

a is acceleration,

F is force,

m is mass,

t is time,

v is velocity.

Which expression represents energy?

- A Ft
- B Fvt
- C $\frac{2mv}{t}$
- D $\frac{at^2}{2}$

1 Which product-pair of metric prefixes has the greatest magnitude? 9702/01/O/N/06

- A pico \times mega
- B nano \times kilo
- C micro \times giga
- D milli \times tera

3 Which row of the table shows a physical quantity and its correct unit? 9702/01/O/N/06

	physical quantity	unit
A	electric field strength	$\text{kg m s}^{-2} \text{C}^{-1}$
B	specific heat capacity	$\text{kg}^{-1} \text{m}^2 \text{s}^{-2} \text{K}^{-1}$
C	tensile strain	$\text{kg m}^{-1} \text{s}^{-2}$
D	the Young modulus	$\text{kg m}^{-1} \text{s}^{-3}$

1 Which is a pair of SI base units? 9702/01/M/J/07

A	ampere	joule
B	coulomb	second
C	kilogram	kelvin
D	metre	newton

2 What is the ratio $\frac{1\mu\text{m}}{1\text{Gm}}$? 9702/01/M/J/07

- A 10^{-3}
- B 10^{-9}
- C 10^{-12}
- D 10^{-15}

3 Which formula could be correct for the speed v of ocean waves in terms of the density ρ of sea-water, the acceleration of free fall g , the depth h of the ocean and the wavelength λ ? 9702/01/M/J/07

- A $v = \sqrt{g\lambda}$
- B $v = \sqrt{\frac{g}{h}}$
- C $v = \sqrt{\rho gh}$
- D $v = \sqrt{\frac{g}{\rho}}$

2 Which of the following correctly expresses the volt in terms of SI base units? 9702/01/M/J/08

- A $\text{A}\Omega$
- B WA^{-1}
- C $\text{kg m}^2 \text{s}^{-1} \text{A}^{-1}$
- D $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$

1 The equation relating pressure and density is $p = \rho gh$. 9702/01/O/N/07

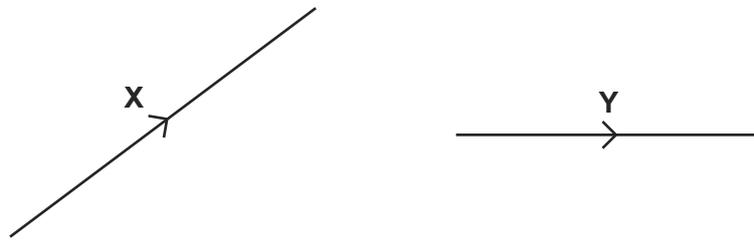
How can both sides of this equation be written in terms of base units?

- A $[\text{N m}^{-1}] = [\text{kg m}^{-3}] [\text{m s}^{-1}] [\text{m}]$
- B $[\text{N m}^{-2}] = [\text{kg m}^{-3}] [\text{m s}^{-2}] [\text{m}]$
- C $[\text{kg m}^{-1} \text{s}^{-2}] = [\text{kg m}^{-3}] [\text{m s}^{-2}] [\text{m}]$
- D $[\text{kg m}^{-1} \text{s}^{-1}] = [\text{kg m}^{-1}] [\text{m s}^{-2}] [\text{m}]$

2 What is a reasonable estimate of the diameter of an alpha particle? 9702/01/O/N/07

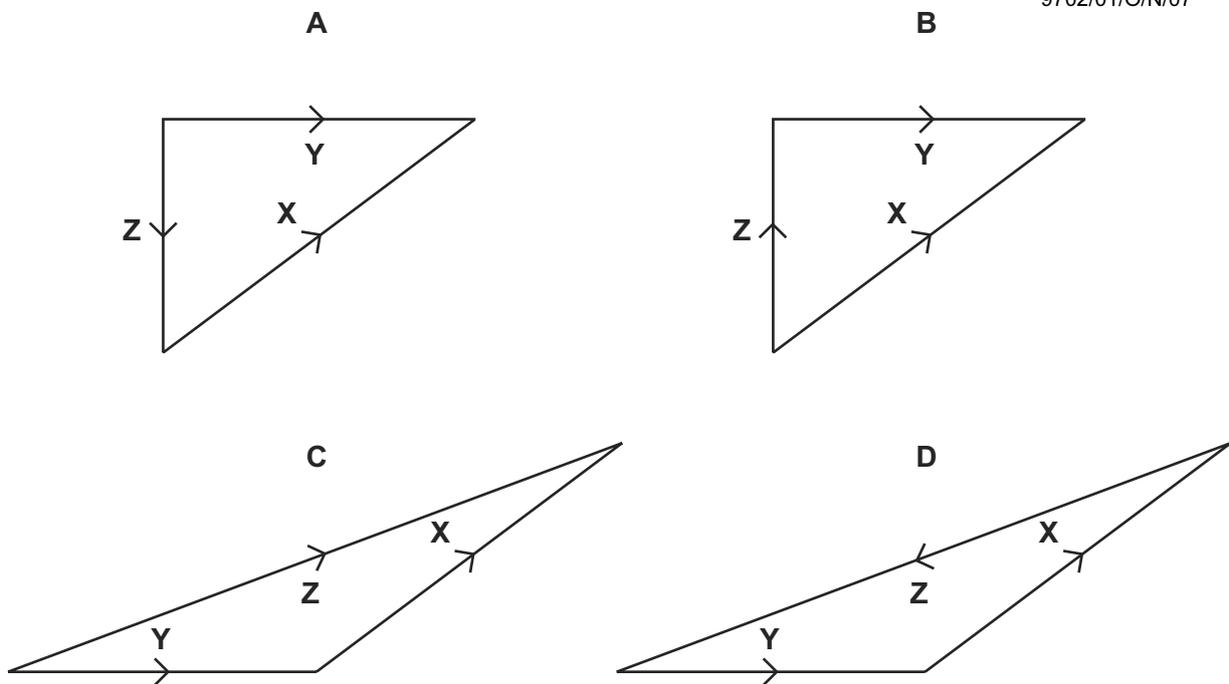
- A 10^{-15} m
- B 10^{-12} m
- C 10^{-9} m
- D 10^{-6} m

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**?

9702/01/O/N/07



- 1 Five energies are listed. 9702/01/M/J/08

5 kJ
5 mJ
5 MJ
5 nJ

Starting with the smallest first, what is the order of increasing magnitude of these energies?

9702/01/M/J/08

- A 5 kJ → 5 mJ → 5 MJ → 5 nJ
B 5 nJ → 5 kJ → 5 MJ → 5 mJ
C 5 nJ → 5 mJ → 5 kJ → 5 MJ
D 5 mJ → 5 nJ → 5 kJ → 5 MJ

- 3 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s? 9702/01/M/J/08

A 40 J B 400 J C 4000 J D 40 000 J

- 2 At temperatures close to 0 K, the specific heat capacity c of a particular solid is given by $c = bT^3$, where T is the thermodynamic temperature and b is a constant characteristic of the solid.

What are the units of constant b , expressed in SI base units?

9702/01/O/N/08

- A $\text{m}^2 \text{s}^{-2} \text{K}^{-3}$
B $\text{m}^2 \text{s}^{-2} \text{K}^{-4}$
C $\text{kg m}^2 \text{s}^{-2} \text{K}^{-3}$
D $\text{kg m}^2 \text{s}^{-2} \text{K}^{-4}$
- 3 The table shows the x -component and y -component of four force vectors. 9702/01/O/N/08

Which force vector has the largest magnitude?

	x -component/N	y -component/N
A	2	9
B	3	8
C	4	7
D	5	6

- 1 A laser emits light of wavelength 600 nm.

9702/01/O/N/08

What is the distance, expressed as a number of wavelengths, travelled by the light in one second?

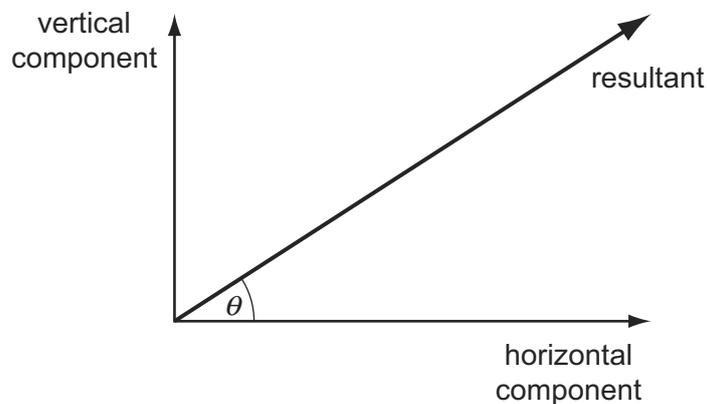
- A 5×10^8 B 5×10^{11} C 5×10^{14} D 5×10^{17}

- 1 Which statement, involving multiples and sub-multiples of the base unit metre (m), is correct?

9702/01/M/J/09

- A $1 \text{ pm} = 10^{-9} \text{ m}$
 B $1 \text{ nm} = 10^{-6} \text{ m}$
 C $1 \text{ mm} = 10^6 \mu\text{m}$
 D $1 \text{ km} = 10^6 \text{ mm}$

- 2 The diagram shows a resultant force and its horizontal and vertical components. 9702/01/M/J/09



The horizontal component is 20.0 N and $\theta = 30^\circ$. What is the vertical component?

- A 8.7 N B 10.0 N C 11.5 N D 17.3 N

- 2 The table contains some quantities, together with their symbols and units. 9702/11/O/N/09

quantity	symbol	unit
gravitational field strength	g	N kg^{-1}
density of liquid	ρ	kg m^{-3}
vertical height	h	m
volume of part of liquid	V	m^3

Which expression has the units of energy? 9702/11/O/N/09

- A $g\rho hV$ B $\frac{\rho hV}{g}$ C $\frac{\rho g}{hV}$ D $\rho g^2 h$

- 1 The drag force F acting on a moving sphere obeys an equation of the form $F = kAv^2$, where A represents the sphere's frontal area and v represents its speed. 9702/11/O/N/09

What are the base units of the constant k ?

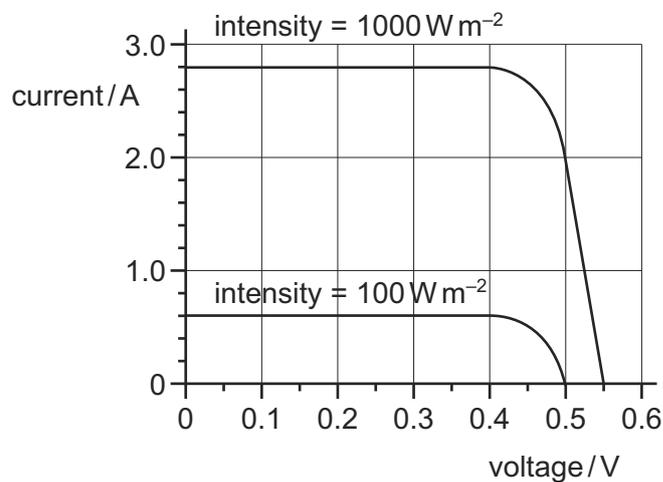
- A** $\text{kg m}^5 \text{s}^{-4}$ **B** $\text{kg m}^{-2} \text{s}^{-1}$ **C** kg m^{-3} **D** $\text{kg m}^{-4} \text{s}^2$

- 1 The drag force F acting on a moving sphere obeys an equation of the form $F = kAv^2$, where A represents the sphere's frontal area and v represents its speed. 9702/12/O/N/09

What are the base units of the constant k ?

- A** $\text{kg m}^5 \text{s}^{-4}$ **B** $\text{kg m}^{-2} \text{s}^{-1}$ **C** kg m^{-3} **D** $\text{kg m}^{-4} \text{s}^2$

- 2 The graph shows two current-voltage calibration curves for a solar cell exposed to different light intensities. 9702/12/O/N/09



At zero voltage, what is the ratio $\frac{\text{current at } 1000 \text{ W m}^{-2}}{\text{current at } 100 \text{ W m}^{-2}}$?

- A** 1.1 **B** 4.7 **C** 8.0 **D** 10

- 1 The SI unit for potential difference (the volt) is given, in base units, by 9702/11/M/J/10

- A** $\text{kg m A}^{-1} \text{s}^{-3}$.
B $\text{m}^2 \text{A}^{-1} \text{s}^{-2}$.
C $\text{kg m}^2 \text{s}^{-2}$.
D $\text{kg m}^2 \text{A}^{-1} \text{s}^{-3}$.

- 1 A signal has a frequency of 2.0 MHz. 9702/11/O/N/10

What is the period of the signal?

- A** $2 \mu\text{s}$ **B** $5 \mu\text{s}$ **C** 200 ns **D** 500 ns

2 The product of pressure and volume has the same SI base units as 9702/11/M/J/10

- A energy.
- B force.
- C $\frac{\text{force}}{\text{area}}$.
- D $\frac{\text{force}}{\text{length}}$.

3 An ion is accelerated by a series of electrodes in a vacuum. A graph of the power supplied to the ion is plotted against time. 9702/11/M/J/10

What is represented by the area under the graph between two times?

- A the change in kinetic energy of the ion
- B the average force on the ion
- C the change in momentum of the ion
- D the change in velocity of the ion

1 A micrometer screw gauge is used to measure the diameter of a copper wire. 9702/12/M/J/10

The reading with the wire in position is shown in diagram 1. The wire is removed and the jaws of the micrometer are closed. The new reading is shown in diagram 2.

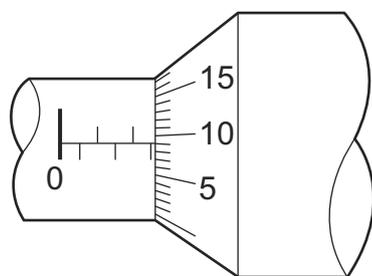


diagram 1

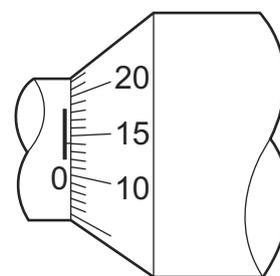


diagram 2

What is the diameter of the wire?

- A 1.90 mm
- B 2.45 mm
- C 2.59 mm
- D 2.73 mm

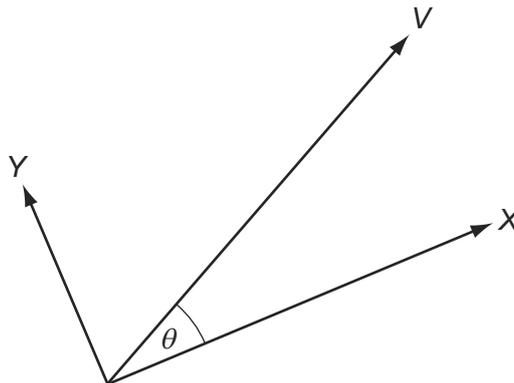
2 The SI unit for potential difference (the volt) is given, in base units, by 9702/12/M/J/10

- A $\text{kg m A}^{-1} \text{s}^{-3}$.
- B $\text{m}^2 \text{A}^{-1} \text{s}^{-2}$.
- C $\text{kg m}^2 \text{s}^{-2}$.
- D $\text{kg m}^2 \text{A}^{-1} \text{s}^{-3}$.

1 The product of pressure and volume has the same SI base units as 9702/13/M/J/10

- A energy.
- B force.
- C $\frac{\text{force}}{\text{area}}$.
- D $\frac{\text{force}}{\text{length}}$.

2 A vector quantity V is resolved into two perpendicular components X and Y . The angle between V and component X is θ . 9702/13/M/J/10



The angle between component X and the vector V is increased from 0° to 90° .

How do the magnitudes of X and Y change as the angle θ is increased in this way?

	X	Y
A	increase	increase
B	increase	decrease
C	decrease	increase
D	decrease	decrease

3 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge? 9702/11/O/N/10

- A electric current
- B electric energy
- C electric field strength
- D electric power

2 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v , it experiences a drag force F given by $F = kr v$, where k is a constant. 9702/11/O/N/10

What are the SI base units of k ?

- A $\text{kg m}^2 \text{s}^{-1}$
- B $\text{kg m}^{-2} \text{s}^{-2}$
- C $\text{kg m}^{-1} \text{s}^{-1}$
- D kg m s^{-2}

- 1 Which row shows a base quantity with its correct SI unit? 9702/12/O/N/10

	quantity	unit
A	current	A
B	mass	g
C	temperature	°C
D	weight	N

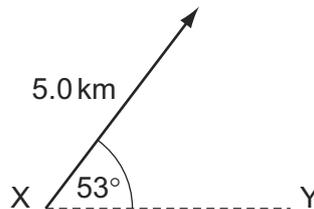
- 2 The frictional force F on a sphere falling through a fluid is given by the formula 9702/12/O/N/10

$$F = 6\pi a\eta v$$

where a is the radius of the sphere, η is a constant relating to the fluid and v is the velocity of the sphere.

What are the units of η ?

- A** kg m s^{-1} **B** $\text{kg m}^{-1} \text{s}^{-1}$ **C** kg m s^{-3} **D** $\text{kg m}^3 \text{s}^{-3}$
- 3 What is the component of this displacement vector in the direction XY? 9702/12/O/N/10



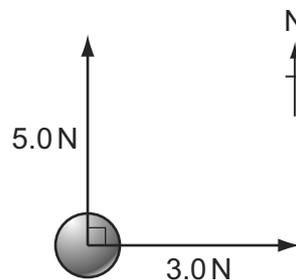
- A** 3.0 km **B** 4.0 km **C** 5.0 km **D** 6.6 km
- 1 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge? 9702/13/O/N/10
- A** electric current
B electric energy
C electric field strength
D electric power
- 2 Which definition is correct and uses only quantities rather than units? 9702/11/M/J/11
- A** Density is mass per cubic metre.
B Potential difference is energy per unit current.
C Pressure is force per unit area.
D Speed is distance travelled per second.

- 1 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} .

Which row gives the sub-multiples or multiples represented by pico (p) and giga (G)? 9702/11/M/J/11

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

- 3 A force of 5.0 N pushes a ball due north and another force of 3.0 N pushes it due east. 9702/11/M/J/11



What is the magnitude of the net force acting on the ball?

- A** 2.8 N **B** 4.0 N **C** 5.8 N **D** 8.0 N
- 1 Stress has the same SI base units as 9702/12/M/J/11

- A** $\frac{\text{force}}{\text{mass}}$.
- B** $\frac{\text{force}}{\text{length}}$.
- C** $\frac{\text{force}}{\text{area}}$.
- D** energy.

- 2 To check calculations, the units are put into the following equations together with the numbers.

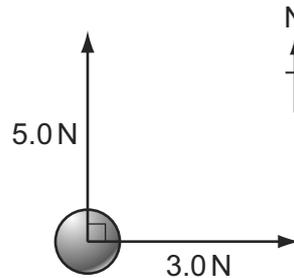
Which equation must be **incorrect**? 9702/12/M/J/11

- A** force = 300 J / 6 m
- B** power = 6000 J \times 20 s
- C** time = 6 m / 30 m s⁻¹
- D** velocity = 4 m s⁻² \times 30 s

3 In making reasonable estimates of physical quantities, which statement is **not** correct? 9702/12/M/J/11

- A The frequency of sound can be of the order of GHz.
- B The wavelength of light can be of the order of 600 nm.
- C The Young modulus can be of the order of 10^{11} Pa.
- D Beta radiation is associated with one unit of negative charge.

1 A force of 5.0 N pushes a ball due north and another force of 3.0 N pushes it due east. 9702/13/M/J/11



What is the magnitude of the net force acting on the ball?

- A 2.8 N B 4.0 N C 5.8 N D 8.0 N

2 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} .

Which row gives the sub-multiples or multiples represented by pico (p) and giga (G)? 9702/13/M/J/11

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

3 Which definition is correct and uses only quantities rather than units? 9702/13/M/J/11

- A Density is mass per cubic metre.
- B Potential difference is energy per unit current.
- C Pressure is force per unit area.
- D Speed is distance travelled per second.

2 An Olympic athlete of mass 80 kg competes in a 100 m race. 9702/11/O/N/11

What is the best estimate of his mean kinetic energy during the race?

- A 4×10^2 J B 4×10^3 J C 4×10^4 J D 4×10^5 J

- 1 Which statement using prefixes of the base unit metre (m) is **not** correct? 9702/11/O/N/11
- A $1 \text{ pm} = 10^{-12} \text{ m}$
- B $1 \text{ nm} = 10^{-9} \text{ m}$
- C $1 \text{ Mm} = 10^6 \text{ m}$
- D $1 \text{ Gm} = 10^{12} \text{ m}$
- 3 Which group of quantities contains only vectors? 9702/11/O/N/11
- A acceleration, displacement, speed
- B acceleration, work, electric field strength
- C displacement, force, velocity
- D power, electric field strength, force
- 4 A cylindrical tube rolling down a slope of inclination θ moves a distance L in time T . The equation relating these quantities is

$$L \left(3 + \frac{a^2}{P} \right) = QT^2 \sin \theta$$

Where a is the internal radius of the tube and P and Q are constants. 9702/11/O/N/11

Which line gives the correct units for P and Q ?

	P	Q
A	m^2	$\text{m}^2 \text{s}^{-2}$
B	m^2	m s^{-2}
C	m^2	$\text{m}^3 \text{s}^{-2}$
D	m^3	m s^{-2}

- 1 Which quantity can be measured in electronvolts (eV)? 9702/12/O/N/11
- A electric charge
- B electric potential
- C energy
- D power
- 2 What is the ratio $\frac{10^{-3} \text{ THz}}{10^3 \text{ kHz}}$? 9702/12/O/N/11
- A 10^{-9} B 10^{-6} C 10^0 D 10^3

- 3 The following physical quantities can be either positive or negative. 9702/12/O/N/11
- s : displacement of a particle along a straight line
 θ : temperature on the Celsius scale
 q : electric charge
 V : readings on a digital voltmeter
- Which of these quantities are vectors?
- A** s, θ, q, V **B** s, q, V only **C** θ, V only **D** s only
- 1 Which group of quantities contains only vectors? 9702/13/O/N/11
- A** acceleration, displacement, speed
B acceleration, work, electric field strength
C displacement, force, velocity
D power, electric field strength, force
- 2 Which statement using prefixes of the base unit metre (m) is **not** correct? 9702/13/O/N/11
- A** $1 \text{ pm} = 10^{-12} \text{ m}$
B $1 \text{ nm} = 10^{-9} \text{ m}$
C $1 \text{ Mm} = 10^6 \text{ m}$
D $1 \text{ Gm} = 10^{12} \text{ m}$
- 1 When a force F moves its point of application through a displacement s in the direction of the force, the work W done by the force is given by 9702/11/M/J/12
- $$W = Fs.$$
- How many vector quantities and scalar quantities does this equation contain?
- A** one scalar quantity and two vector quantities
B one vector quantity and two scalar quantities
C three scalar quantities
D three vector quantities
- 3 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s? 9702/11/M/J/12
- A** 40 J **B** 400 J **C** 4000 J **D** 40 000 J

2 What is a possible unit for the product VI , where V is the potential difference across a resistor and I is the current through the same resistor? 9702/11/M/J/12

- A newton per second (Ns^{-1})
- B newton second (Ns)
- C newton metre (Nm)
- D newton metre per second (Nms^{-1})

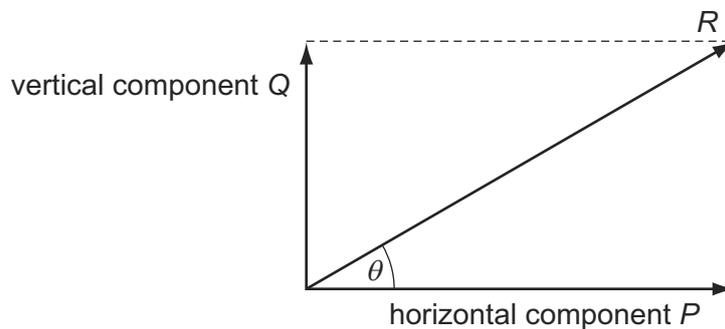
1 What is the unit watt in terms of SI base units? 9702/12/M/J/12

- A Js^{-1}
- B $\text{m}^2\text{kg s}^{-1}$
- C $\text{m}^2\text{kg s}^{-3}$
- D Nms^{-1}

2 For which quantity is the magnitude a reasonable estimate? 9702/12/M/J/12

- A frequency of a radio wave 500 pHz
- B mass of an atom 500 μg
- C the Young modulus of a metal 500 kPa
- D wavelength of green light 500 nm

3 A vector has magnitude R and perpendicular components P and Q , as shown in the diagram. 9702/12/M/J/12



Which row correctly describes the perpendicular components?

	vertical component	horizontal component
A	Q	$R \sin \theta$
B	$R \cos \theta$	P
C	$R \cos \theta$	$R \sin \theta$
D	$R \sin \theta$	$R \cos \theta$

1 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s? 9702/13/M/J/12

- A 40 J
- B 400 J
- C 4000 J
- D 40 000 J

- 2 When a force F moves its point of application through a displacement s in the direction of the force, the work W done by the force is given by 9702/13/M/J/12

$$W = Fs.$$

How many vector quantities and scalar quantities does this equation contain?

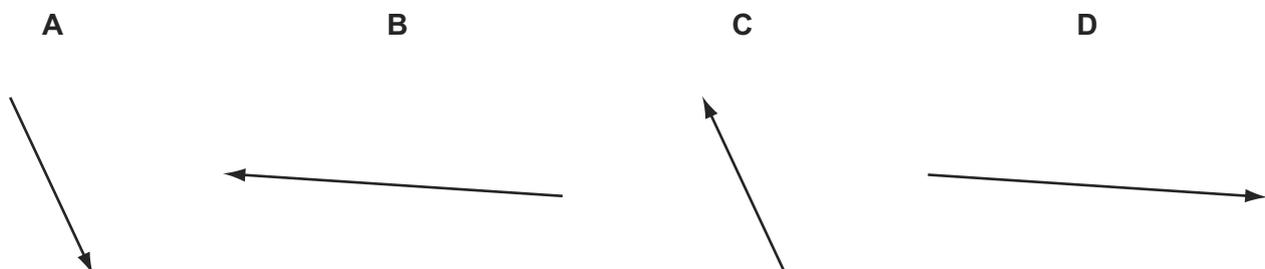
- A** one scalar quantity and two vector quantities
B one vector quantity and two scalar quantities
C three scalar quantities
D three vector quantities
- 3 What is a possible unit for the product VI , where V is the potential difference across a resistor and I is the current through the same resistor? 9702/13/M/J/12
- A** newton per second (Ns^{-1})
B newton second (Ns)
C newton metre (Nm)
D newton metre per second (Nms^{-1})

- 1 What is the unit of weight in terms of SI base unit(s)? 9702/11/O/N/12
- A** kgms^{-1} **B** kgms^{-2} **C** N **D** Jm^{-1}

- 2 Vectors P and Q are drawn to scale. 9702/11/O/N/12



Which diagram represents the vector $(P - Q)$?



- 3 What is the approximate temperature of a red-hot ring on an electric cooker? 9702/11/O/N/12
- A** 100°C **B** 200°C **C** 400°C **D** 800°C

1 Which quantity has the same base units as momentum?

9702/12/O/N/12

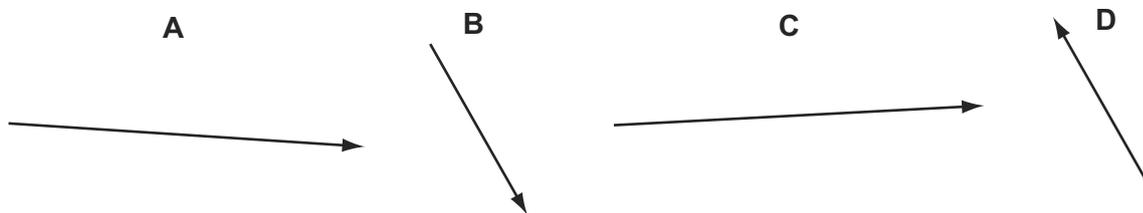
- A density \times energy
- B density \times volume \times velocity
- C pressure \times area
- D weight \div area

2 Vectors P and Q are drawn to scale.

9702/12/O/N/12



Which diagram represents the vector $(P + Q)$?



3 What is the approximate kinetic energy of an Olympic athlete when running at maximum speed during a 100 m race?

9702/12/O/N/12

- A 400 J
- B 4000 J
- C 40 000 J
- D 400 000 J

4 Physical quantities can be classed as vectors or as scalars.

9702/12/O/N/12

Which pair of quantities are both vectors?

- A kinetic energy and elastic force
- B momentum and time
- C velocity and electric field strength
- D weight and temperature

4 Which list contains only scalar quantities?

9702/11/O/N/12

- A area, length, displacement
- B kinetic energy, speed, power
- C potential energy, momentum, time
- D velocity, distance, temperature

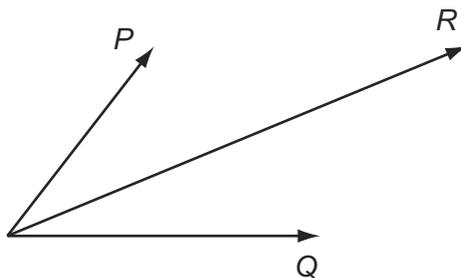
- 1 The units of all physical quantities can be expressed in terms of SI base units.

9702/13/O/N/12

Which pair contains quantities with the same base units?

- A force and momentum
B pressure and Young modulus
C power and kinetic energy
D mass and weight
- 2 Two physical quantities P and Q are added. The sum of P and Q is R , as shown.

9702/13/O/N/12



Which quantity could be represented by P and by Q ?

- A kinetic energy
B power
C speed
D velocity
- 3 A 1.5 V cell supplies 0.20 A to a lamp for seven hours before the lamp goes out.

9702/13/O/N/12

What is a sensible estimate for the initial chemical energy content of the cell?

- A 1×10^2 J B 1×10^4 J C 1×10^6 J D 1×10^8 J

- 4 Three of these quantities have the same unit.

9702/13/O/N/12

Which quantity has a different unit?

- A $\frac{\text{energy}}{\text{distance}}$
B force
C power \times time
D rate of change of momentum

1 Which pair of quantities contains one vector and one scalar quantity?

9702/11/M/J/13

- A displacement; force
- B kinetic energy; power
- C acceleration; momentum
- D velocity; distance

2 One property Q of a material is used to describe the behaviour of sound waves in the material. Q is defined as the pressure P of the sound wave divided by the speed v of the wave and the surface area A of the material through which the wave travels:

9702/11/M/J/13

$$Q = \frac{P}{vA}$$

What are the SI base units of Q ?

- A $\text{kg m}^2 \text{s}^{-3}$
- B $\text{kg m}^{-3} \text{s}^{-1}$
- C $\text{kg m}^{-4} \text{s}^{-1}$
- D $\text{kg m}^{-2} \text{s}^{-2}$

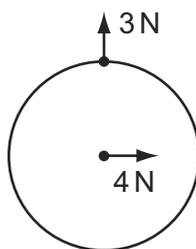
1 Which pair includes a vector quantity and a scalar quantity?

9702/12/M/J/13

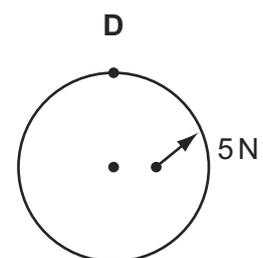
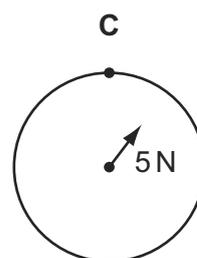
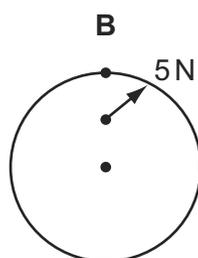
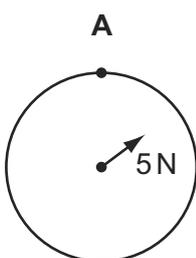
- A displacement; acceleration
- B force; kinetic energy
- C power; speed
- D work; potential energy

3 Two forces act on a circular disc as shown.

9702/12/M/J/13



Which diagram shows the line of action of the resultant force?



- 2 The unit of resistivity, expressed in terms of base units, is given by

9702/12/M/J/13

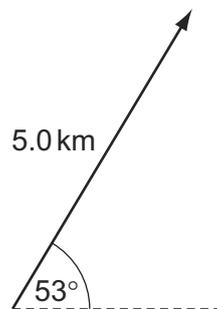
$$\text{kg x}^3 \text{y}^{-2} \text{z}^{-3}.$$

Which base units are x, y and z?

	x	y	z
A	ampere	metre	second
B	metre	ampere	second
C	metre	second	ampere
D	second	ampere	metre

- 1 The diagram shows a displacement vector.

9702/13/M/J/13



What is the vertical component of this displacement vector?

- A** 3.0 km **B** 4.0 km **C** 5.0 km **D** 6.6 km

- 2 What is the unit of power, expressed in SI base units?

9702/13/M/J/13

- A** $\text{kg m}^2 \text{s}^{-3}$ **B** kg m s^{-3} **C** kg m s^{-2} **D** $\text{kg m}^2 \text{s}^{-1}$

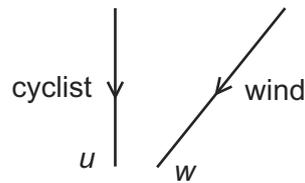
- 3 Which statement is **incorrect** by a factor of 100 or more?

9702/13/M/J/13

- A** Atmospheric pressure is about 1×10^5 Pa.
B Light takes 5×10^2 s to reach us from the Sun.
C The frequency of ultra-violet light is 3×10^{12} Hz.
D The life-span of a man is about 2×10^9 s.

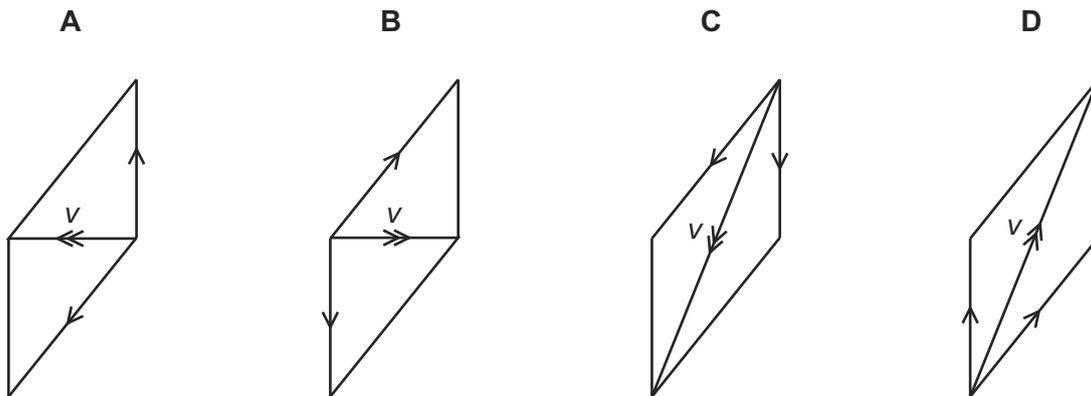
- 4 A cyclist is travelling due south with velocity u . The wind is blowing from the north-east with velocity w .

9702/13/M/J/13



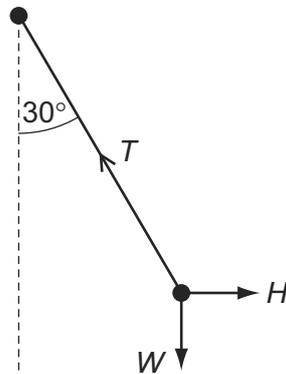
The wind has a velocity v relative to the cyclist, where $v = w - u$.

Which vector diagram shows the magnitude and direction of velocity v ?



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

9702/11/O/N/13



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

Which statement is correct?

- A $H = T \cos 30^\circ$
- B $T = H \sin 30^\circ$
- C $W = T \cos 30^\circ$
- D $W = T \sin 30^\circ$

- 1 Which row shows an SI base quantity with its correct unit?

9702/11/O/N/13

	SI base quantity	unit
A	charge	coulomb
B	current	ampere
C	potential difference	volt
D	temperature	degree Celsius

- 3 The drag coefficient C_d is a number with no units. It is used to compare the drag on different cars at different speeds. It is given by the equation

9702/11/O/N/13

$$C_d = \frac{2F}{\rho v^n A}$$

where F is the drag force on the car, ρ is the density of the air, A is the cross-sectional area of the car and v is the speed of the car.

What is the value of n ?

- A** 1 **B** 2 **C** 3 **D** 4
- 3 Two forces of equal magnitude are represented by two coplanar vectors. One is directed eastwards and the other is directed northwards.

9702/13/O/N/13

What is the direction of a single force that will balance these two forces?

- A** towards the north-east
B towards the north-west
C towards the south-east
D towards the south-west
- 4 The spring constant k of a coiled wire spring is given by the equation

9702/13/O/N/13

$$k = \frac{Gr^4}{4nR^3}$$

where r is the radius of the wire, n is the number of turns of wire and R is the radius of each of the turns of wire. The quantity G depends on the material from which the wire is made.

What is a suitable unit for G ?

- A** Nm^{-2} **B** Nm^{-1} **C** Nm **D** Nm^2

1 Which estimate is realistic?

9702/13/O/N/13

- A The kinetic energy of a bus travelling on an expressway is 30 000 J.
- B The power of a domestic light is 300 W.
- C The temperature of a hot oven is 300 K.
- D The volume of air in a car tyre is 0.03 m^3 .

2 Which unit is equivalent to the coulomb?

9702/13/O/N/13

- A ampere per second
- B joule per volt
- C watt per ampere
- D watt per volt

14 An archer draws his bowstring back to position X. The bowstring and arrow are shown. The tension T in the string is also shown. Then he draws the bowstring back further to position Y.

9702/11/O/N/13



The resultant force on the arrow is greater when the arrow is released from position Y.

What is the increase in force?

- A 15 N
- B 27 N
- C 40 N
- D 53 N

1 The maximum theoretical power P of a wind turbine is given by the equation

9702/12/M/J/14

$$P = k\rho Av^n$$

where ρ is the density of air, A is the area swept by the turbine blades, v is the speed of the air and k is a constant with no units.

What is the value of n ?

- A 1
- B 2
- C 3
- D 4

- 1 Which pair of units contains one derived unit and one SI base unit? 9702/11/M/J/14
- A ampere coulomb
B kilogram kelvin
C metre second
D newton pascal

- 2 What is equivalent to 2000 microvolts? 9702/11/M/J/14
- A $2\mu\text{JC}^{-1}$ B 2mV C 2pV D 2000mV

- 3 The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation 9702/11/M/J/14

$$v = k \left(\frac{\Delta P}{\rho} \right)^n$$

where k is a constant that has no units.

What is the value of n ?

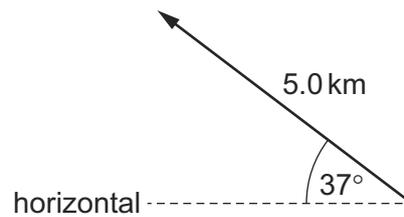
- A $\frac{1}{2}$ B 1 C $\frac{3}{2}$ D 2
- 2 What is the unit of resistance when expressed in SI base units? 9702/12/M/J/14
- A $\text{kg m}^2 \text{s}^{-2} \text{A}^{-1}$
B $\text{kg m}^2 \text{s}^{-3} \text{A}^{-2}$
C $\text{kg m s}^{-2} \text{A}^{-1}$
D $\text{kg m s}^{-3} \text{A}^{-1}$

- 1 Which quantity can be measured in electronvolts (eV)? 9702/13/M/J/14
- A electric charge
B electric potential
C energy
D power

- 2 The unit of specific heat capacity is $\text{J kg}^{-1} \text{K}^{-1}$. 9702/13/M/J/14
- What is its equivalent in terms of SI base units?
- A $\text{kg}^{-1} \text{m}^2 \text{K}^{-1}$ B $\text{ms}^{-1} \text{K}^{-1}$ C $\text{ms}^{-2} \text{K}^{-1}$ D $\text{m}^2 \text{s}^{-2} \text{K}^{-1}$

- 3 What is the vertical component of this displacement vector?

9702/13/M/J/14



- A 3.0 km B 3.8 km C 4.0 km D 5.0 km

- 1 When the brakes are applied on a vehicle moving at speed v , the distance d moved by the vehicle in coming to rest is given by the expression

9702/13/O/N/14

$$d = kv^2$$

where k is a constant.

What is the unit of k expressed in SI base units?

- A m^{-1}s^2 B ms^{-2} C m^2s^{-2} D m^{-1}s

- 2 Which list contains one vector quantity and two scalar quantities?

9702/13/O/N/14

- A displacement, weight, velocity
 B force, acceleration, time
 C momentum, mass, speed
 D work, density, energy

- 2 What is equivalent to the unit of electric field strength?

9702/11/O/N/14

- A JCm^{-1} B NsA^{-1} C $\text{kgms}^{-3}\text{A}^{-1}$ D $\text{kgm}^3\text{s}^{-3}\text{A}^{-1}$

- 1 Which statement includes a correct unit?

9702/13/M/J/15

- A energy = 7.8 N s
 B force = 3.8 N s
 C momentum = 6.2 N s
 D torque = 4.7 N s

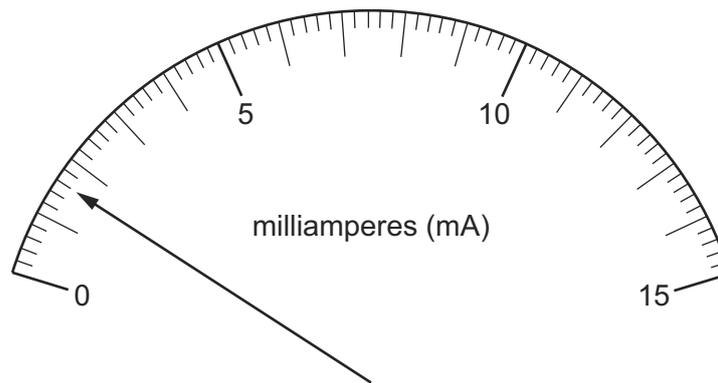
- 2 What is the joule (J) in SI base units?

9702/13/M/J/15

- A kgms^{-1} B $\text{kgm}^2\text{s}^{-1}$ C kgms^{-2} D $\text{kgm}^2\text{s}^{-2}$

- 3 The diagram shows the reading on an analogue ammeter.

9702/11/O/N/14



Which digital ammeter reading is the same as the reading on the analogue ammeter?

	display units	display reading
A	μA	1600
B	μA	160
C	mA	16.0
D	A	1.60

- 1 Which definition is correct and uses only quantities rather than units?

9702/12/M/J/15

- A** Density is mass per cubic metre.
- B** Potential difference is energy per unit current.
- C** Pressure is force per unit area.
- D** Speed is distance travelled per second.

- 2 The average kinetic energy E of a gas molecule is given by the equation

9702/12/M/J/15

$$E = \frac{3}{2} kT$$

where T is the absolute (kelvin) temperature.

What are the SI base units of k ?

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

1 Which is an SI base unit?

9702/11/M/J/15

- A current
- B gram
- C kelvin
- D volt

2 Which pair contains one vector and one scalar quantity?

9702/11/M/J/15

- A displacement acceleration
- B force kinetic energy
- C momentum velocity
- D power speed

3 When a constant braking force is applied to a vehicle moving at speed v , the distance d moved by the vehicle in coming to rest is given by the expression

9702/11/M/J/15

$$d = kv^2$$

where k is a constant.

When d is measured in metres and v is measured in metres per second, the constant has a value of k_1 .

What is the value of the constant when the distance is measured in metres, and the speed is measured in kilometres per hour?

- A $0.0772 k_1$ B $0.278 k_1$ C $3.60 k_1$ D $13.0 k_1$