FOR CAMBRIDGE 2022 AND ONWARDS EXAMS

AS LEVEL 9702

PHYSICS

TOPICAL PAPER 1

- ✓ JUNE 2013-JUNE 2023
- ✓ All Variants
- ✓ Arranged Sub-Topic Wise
- ✓ Answer Keys
- ✓ Cambridge 2022-2024 Syllabus

YouTube

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Content

Content

Data

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

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
gravitational potential	$\phi = -\dfrac{Gm}{r}$
hydrostatic pressure	$p = \rho g h$
pressure of an ideal gas	$p = \frac{1}{3}\dfrac{Nm}{V}\langle c^2\rangle$
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	$f_o = \dfrac{f_s v}{v \pm v_s}$
electric potential	$V = \dfrac{Q}{4\pi\varepsilon_0 r}$
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	$V_H = \dfrac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$

Topic 1.1.1: Physical Quantity & Units

2023

1 **9702/13/M/J/23/Q1**

What **must** be included in a record of a physical quantity?

A an integer value for the quantity

B an SI unit

C a numerical value for the quantity

D a unit expressed in base units

2 **9702/13/M/J/23/Q2**

What is the ohm expressed in SI base units?

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

3 **9702/11/M/J/23/Q1**

Which unit is **not** an SI base unit?

A A **B** kg **C** C **D** s

4 **9702/12/F/M/23/Q1**

What represents a physical quantity?

A 3.0 **B** kilogram **C** 7.0 N **D** 40%

5 **9702/12/F/M/23/Q2**

The relationship between the variables *D* and *T* is given by the equation

$$\frac{1}{T} = \frac{b}{\sqrt{D}} + c$$

where *b* and *c* are constants.

The unit of *D* is m^2 and the unit of *T* is s.

What are the units of *b* and *c*?

	unit of *b*	unit of *c*
A	m s	s
B	$m\,s^{-1}$	s^{-1}
C	$m^{-1}\,s$	s
D	$m^{-1}\,s^{-1}$	s^{-1}

2022

6 **9702/13/O/N/22/Q2**

What are the SI base units of electromotive force (e.m.f.)?

A $kg\,m^2\,s^{-1}\,A^{-1}$

B $kg\,m^2\,s^{-3}\,A^{-1}$

C $kg\,m^2\,s^{-1}\,A$

D $kg\,m\,s^{-3}\,A^{-1}$

7 **9702/12/O/N/22/Q1**

Which quantity is a physical quantity?

A flavour **B** kelvin **C** minute **D** potential difference

8 **9702/11/O/N/22/Q1**

What is needed to accurately represent all physical quantities?

A a base unit and a number

B a unit and a number expressed in standard form (scientific notation)

C a unit and a numerical magnitude

D an SI unit and a numerical magnitude

9 **9702/13/M/J/22/Q1**

Which pair of quantities are physical quantities?

A charge and ampere

B efficiency and kilogram

C pascal and strain

D period and potential difference

10 **9702/13/M/J/22/Q3**

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

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

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

11 **9702/12/M/J/22/Q2**

What is the symbol for the SI base unit of temperature?

A C **B** K **C** °C **D** °K

12 **9702/11/M/J/22/Q1**

Which term represents a physical quantity?

A metre

B percentage uncertainty

C quark flavour

D spring constant

13 9702/11/M/J/22/Q2

Which two units are identical when expressed in terms of SI base units?

A $J\,C^{-1}$ and $kg\,m^2\,A^{-1}\,s^{-2}$

B $J\,s$ and $kg\,m^2\,s^{-1}$

C $N\,m$ and $kg\,m^3\,s^{-2}$

D $N\,s$ and $kg\,m\,s^{-3}$

14 9702/12/F/M/22/Q1

What could **not** be a measurement of a physical quantity?

A 10 K **B** $11\,J\,N^{-1}\,m^{-1}$ **C** $17\,Pa\,m^3\,N^{-1}$ **D** 25 T m

2021

15 9702/13/O/N/21/Q2

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

A $kg^{-1}\,m^{-2}\,s\,A^2$

B $kg^{-1}\,m^{-2}\,s^3\,A^2$

C $kg\,m^2\,s^{-1}\,A^{-2}$

D $kg\,m^2\,s^{-3}\,A^{-2}$

16 9702/12/O/N/21/Q1

Which row shows what all physical quantities must have?

	magnitude	direction	unit
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✗	✓

17 9702/11/O/N/21/Q1

What is essential when recording a measurement of a physical quantity?

A the measurement has an SI unit

B the measurement has a unit and a number

C the measurement has a unit given as a base unit

D the measurement is from an analogue scale

18 9702/11/O/N/21/Q1

The mobility μ of electrons travelling through a metal conductor can be calculated using the equation

$$\mu = \left(\frac{e}{m}\right)\tau$$

where e is the charge on an electron and m is its mass. The average time between the collisions of an electron with the atoms in the metal is τ.

What are the SI base units of μ?

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

19 **9702/13/M/J/21/Q2**

What is a unit of momentum?

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

20 **9702/12/M/J/21/Q2**

Which quantity could have units of $N\,m\,V^{-1}$?

A acceleration **B** charge **C** current **D** resistance

21 **9702/11/M/J/21/Q2**

Which combination of units could be used for expressing the power dissipated in a resistor?

A newton per second ($N\,s^{-1}$)
B newton second ($N\,s$)
C newton metre ($N\,m$)
D newton metre per second ($N\,m\,s^{-1}$)

22 **9702/12/F/M/21/Q2**

Which physical quantity could have units of $N\,s^2\,m^{-1}$?

A acceleration **B** force **C** mass **D** momentum

2020

23 **9702/13/O/N/20/Q2**

What is **not** an SI base unit?

A coulomb **B** kelvin **C** kilogram **D** second

24 **9702/12/O/N/20/Q2**

The speed v of waves on a stretched wire is given by the equation

$$v = T^p \mu^q$$

where T is the tension in the wire and μ is the mass per unit length of the wire.

What are the values of p and q?

	p	q
A	$-\frac{1}{2}$	$-\frac{1}{2}$
B	$-\frac{1}{2}$	$\frac{1}{2}$
C	$\frac{1}{2}$	$-\frac{1}{2}$
D	$\frac{1}{2}$	$\frac{1}{2}$

25 **9702/11/O/N/20/Q1**

Which quantity is a physical quantity?

A atomic number

B efficiency

C number density of charge carriers

D strain

26 **9702/11/M/J/20/Q2**

The frequency f of vibration of a mass m supported by a spring with spring constant k is given by the equation

$$f = Cm^pk^q$$

where C is a constant with no units.

What are the values of p and q?

	p	q
A	$-\frac{1}{2}$	$-\frac{1}{2}$
B	$-\frac{1}{2}$	$\frac{1}{2}$
C	$\frac{1}{2}$	$-\frac{1}{2}$
D	$\frac{1}{2}$	$\frac{1}{2}$

2019

27 **9702/13/O/N/19/Q2**

Which two units are **not** equivalent to each other?

A N m and kg m^2 s^{-2}

B N s and kg m s^{-1}

C J s^{-1} and kg m^2 s^{-3}

D Pa and kg m s^{-2}

28 **9702/13/O/N/19/Q1**

Which quantity with its unit is correct?

A acceleration of a bicycle = 1.4 m s^{-1}

B electric current in a lamp = 0.25 A s^{-1}

C electric potential difference across a battery = 8.0 J C^{-1}

D kinetic energy of a car = 4500 N m^{-1}

29 **9702/12/O/N/19/Q2**

Which expression gives an SI base quantity?

A charge per unit time

B force per unit area

C mass per unit volume

D work done per unit distance

30 9702/13/M/J/19/Q32

Which two units are used to define the volt?

A ampere and ohm
B coulomb and joule
C coulomb and ohm
D coulomb and second

31 9702/11/O/N/19/Q32

What could **not** be used as a unit of potential difference?

A $A\Omega$ **B** $N\,m^{-1}\,C^{-1}$ **C** $W\,A^{-1}$ **D** $(\Omega W)^{\frac{1}{2}}$

32 9702/11/O/N/19/Q2

The speed of a wave in deep water depends on its wavelength L and the acceleration of free fall g.

What is a possible equation for the speed v of the wave?

A $v = \sqrt{\left(\frac{gL}{2\pi}\right)}$ **B** $v = \frac{gL}{4\pi^2}$ **C** $v = 2\pi\sqrt{\left(\frac{g}{L}\right)}$ **D** $v = \frac{2\pi g}{L}$

33 9702/13/M/J/19/Q1

Which is an SI base unit?

A current
B gram
C kelvin
D volt

34 9702/12/M/J/19/Q3

The Planck constant h has SI units J s.

Which equation could be used to calculate the Planck constant?

A $h = \frac{DE}{v}$ where D is distance, E is energy and v is velocity

B $h = \frac{v}{D}$ where v is velocity and D is distance

C $h = \frac{1}{4\pi E}$ where E is electric field strength

D $h = \frac{Fr^2}{m}$ where F is force, r is radius and m is mass

35 **9702/11/M/J/19/Q2**

The luminosity L of a star is given by

$$L = 4\pi r^2 \sigma T^4$$

where

r is the radius of the star,

T is the temperature of the star and

σ is a constant with units $\mathrm{W\,m^{-2}\,K^{-4}}$.

What are the SI base units of L?

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

36 **9702/11/M/J/19/Q1**

Which unit can be expressed in base units as $\mathrm{kg\,m^2\,s^{-2}}$?

A joule

B newton

C pascal

D watt

2018

37 **9702/13/O/N/18/Q14**

What is a unit for density?

A $\mathrm{N\,m^{-3}}$ **B** $\mathrm{g\,mm^{-1}}$ **C** $\mathrm{kg\,cm^{-2}}$ **D** $\mathrm{\mu g\,mm^{-3}}$

38 **9702/13/O/N/18/Q2**

Three of these quantities have the same unit.

Which quantity has a different unit?

A $\dfrac{\text{energy}}{\text{distance}}$

B force

C power $\times$ time

D rate of change of momentum

39 **9702/12/O/N/18/Q33**

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

40 **9702/12/O/N/18/Q2**

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 $kg\,m\,s^{-3}\,A^{-1}$

41 **9702/11/O/N/18/Q2**

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.

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

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

42 **9702/12/F/M/18/Q2**

Which row shows a quantity and an **incorrect** unit?

	quantity	unit
A	efficiency	no unit
B	moment of force	$N\,m^{-1}$
C	momentum	N s
D	work done	J

43 **9702/12/F/M/18/Q1**

Which unit is equivalent to the coulomb?

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

44 **9702/13/M/J/18/Q1**

What is the best way of describing a physical quantity?

A a quantity with a magnitude and a direction but no unit

B a quantity with a magnitude and a unit

C a quantity with a magnitude but no direction

D a quantity with a unit but no magnitude

45 **9702/12/M/J/18/Q2**

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

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

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

46 **9702/11/M/J/18/Q1**

What is a unit for stress?

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

2017

47 **9702/13/O/N/17/Q2**

The maximum theoretical power *P* of a wind turbine is given by the equation $P = k\rho A v^n$

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

48 **9702/12/O/N/17/Q3**

The units of specific heat capacity are $J\,kg^{-1}\,K^{-1}$.

What are the SI base units of specific heat capacity?

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

49 **9702/12/O/N/17/Q1**

Which pair of units are **not** the same when expressed in SI base units?

A $m\,s^{-2}$ and $N\,kg^{-1}$

B $N\,s$ and $kg\,m\,s^{-1}$

C Pa and $N\,m^{-2}$

D $V\,m^{-2}$ and $N\,C^{-1}$

50 **9702/11/O/N/17/Q1**

Which SI unit, expressed in base units, is **not** correct?

A unit of force, $kg\,m\,s^{-2}$

B unit of momentum, $kg\,m\,s^{-1}$

C unit of pressure, $kg\,m^{-2}\,s^{-2}$

D unit of work, $kg\,m^2\,s^{-2}$

51 **9702/12/M/J/17/Q3**

What correctly expresses the volt in terms of SI base units?

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

52 **9702/12/M/J/17/Q13**

What are the SI base units of the quantity $\dfrac{\text{pressure}}{\text{density}}$?

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

53 9702/11/M/J/17/Q3

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

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

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

2015

54 9702/13/O/N/15/Q6

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.

Which line gives the correct units for P and Q?

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

55 9702/13/M/J/15/Q2

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

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

56 9702/13/M/J/15/Q1

Which statement includes a correct unit?

A energy = 7.8 N s **C** momentum = 6.2 N s

B force = 3.8 N s **D** torque = 4.7 N s

57 9702/12/M/J/15/Q31

Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

A ampere **B** joule **C** ohm **D** second

58 9702/12/M/J/15/Q2

The average kinetic energy E of a gas molecule is given by the equation $E = \frac{3}{2}kT$

where T is the absolute (kelvin) temperature.

What are the SI base units of k?

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

59 **9702/12/M/J/15/Q1**

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

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.

60 **9702/11/M/J/15/Q3**

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

$$d = kv^2$$

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** $13.0\,k_1$

61 **9702/11/M/J/15/Q1**

Which is an SI base unit?

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

2014

62 **9702/13/O/N/14/Q1**

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

$$d = kv^2$$

where k is a constant.

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

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

63 **9702/13/O/N/14/Q1**

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

$$d = kv^2$$

where k is a constant.

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

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

64 **9702/13/M/J/14/Q2**

The unit of specific heat capacity is $J\,kg^{-1}\,K^{-1}$.

What is its equivalent in terms of SI base units?

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

65 **9702/13/M/J/14/Q1***

Which quantity can be measured in electronvolts (eV)?

A electric charge **B** electric potential **C** energy **D** power

66 **9702/12/M/J/14/Q2**

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** $kg\,m\,s^{-3}\,A^{-1}$

67 **9702/12/M/J/14/Q1***

The maximum theoretical power P of a wind turbine is given by the equation $P = k\rho Av^n$
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

68 **9702/11/M/J/14/Q3**

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

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

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

69 **9702/11/M/J/14/Q1**

Which pair of units contains one derived unit and one SI base unit?

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

2013

70 **9702/13/O/N/13/Q4**

The spring constant k of a coiled wire spring is given by the equation $k = \dfrac{Gr^4}{4nR^3}$

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 $N\,m^{-2}$ **B** $N\,m^{-1}$ **C** $N\,m$ **D** $N\,m^2$

71 **9702/13/O/N/13/Q2***

Which unit is equivalent to the coulomb?

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

72 9702/12/O/N/13/Q3*

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

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

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

73 9702/12/O/N/13/Q1

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

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

74 9702/13/M/J/13/Q2

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

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

75 9702/12/M/J/13/Q2

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

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

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

76 9702/11/M/J/13/Q2

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:

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

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** $\text{kg m}^{-2}\text{s}^{-2}$

Topic 1.1.2: Estimates

2023

1 9702/12/M/J/23/Q1

A stone sinks in water.

What is a possible value for the density of the stone?

A $8 \times 10^{2}\,\text{kg}\,\text{m}^{-3}$

B $2 \times 10^{3}\,\text{kg}\,\text{m}^{-3}$

C $8 \times 10^{3}\,\text{N}\,\text{m}^{-3}$

D $2 \times 10^{4}\,\text{N}\,\text{m}^{-3}$

2 9702/11/M/J/23/Q2

What is the best estimate of the number of atoms in a piece of metal of volume $50\,\text{cm}^3$?

A 5×10^{15} **B** 5×10^{25} **C** 5×10^{29} **D** 5×10^{31}

2022

3 9702/13/O/N/22/Q1

A train of mass 600 000 kg moves with a speed of $100\,\text{km}\,\text{h}^{-1}$.

What is the order of magnitude of the kinetic energy of the train?

A 10^{6} J **B** 10^{8} J **C** 10^{10} J **D** 10^{12} J

4 9702/12/M/J/22/Q1

Which estimate is reasonable?

A 1×10^{-3} kg for the mass of a grain of sand

B $1 \times 10^{-2}\,\text{m}^3$ for the volume of a tennis ball

C 1×10^{0} J for the work done lifting an apple from waist height to head height

D 1×10^{4} W for the power of a light bulb in a house

2021

5 9702/13/M/J/21/Q1

What is a reasonable estimate of the kinetic energy of an Olympic athlete sprinting in a 100 m race?

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

6 9702/12/M/J/21/Q1

What is **not** a reasonable estimate of the physical property indicated?

A 2×10^{3} W for the power dissipated by the heating element of an electric kettle

B $4 \times 10^{2}\,\text{m}^3$ for the volume of water in a swimming pool

C 5×10^{5} N s for the momentum of a lorry moving along a road

D 6×10^{2} N for the weight of a fully grown racehorse

7 **9702/11/M/J/21/Q1**

What is a reasonable estimate of the volume of an adult person?

A $0.10\,m^3$ **B** $0.50\,m^3$ **C** $1.0\,m^3$ **D** $2.0\,m^3$

8 **9702/12/F/M/21/Q1**

What is a reasonable estimate for the density of sand?

A $2 \times 10^2\,g\,cm^{-3}$ **B** $2 \times 10^3\,g\,cm^{-3}$ **C** $2 \times 10^1\,kg\,m^{-3}$ **D** $2 \times 10^3\,kg\,m^{-3}$

2020

9 **9702/13/O/N/20/Q1**

What is a reasonable estimate of the volume of a fully inflated standard football?

A $600\,cm^3$ **B** $6000\,cm^3$ **C** $60\,000\,cm^3$ **D** $600\,000\,cm^3$

10 **9702/12/O/N/20/Q1**

A student uses the volume of a metal coin in order to determine the density of the metal.

What is **not** needed in order to determine an estimate of the volume of the coin?

A estimate of the diameter

B estimate of the mass

C estimate of the thickness

D use of the formula for the volume of a cylinder

11 **9702/13/M/J/20/Q1**

A man is running a race in a straight line.

What is an approximate value of his kinetic energy?

A 10 J **B** 100 J **C** 1000 J **D** 10 000 J

12 **9702/12/M/J/20/Q1**

What is a reasonable estimate of the mass of a raindrop?

A $10^1\,kg$ **B** $10^{-1}\,kg$ **C** $10^{-3}\,kg$ **D** $10^{-5}\,kg$

13 **9702/11/M/J/20/Q1**

What is a reasonable estimate of the kinetic energy of a car travelling at a speed of $30\,m\,s^{-1}$?

A $10^2\,J$ **B** $10^4\,J$ **C** $10^6\,J$ **D** $10^8\,J$

2019

14 **9702/12/O/N/19/Q1**

A cyclist has a speed of $5\,m\,s^{-1}$ and a small car has a speed of $12\,m\,s^{-1}$.

Which statement does **not** give a reasonable estimate?

A The kinetic energy of the cyclist is $1 \times 10^3\,J$.

B The kinetic energy of the car is $7 \times 10^4\,J$.

C The momentum of the cyclist is $4 \times 10^2\,kg\,m\,s^{-1}$.

D The momentum of the car is $2 \times 10^5\,kg\,m\,s^{-1}$.

15 9702/11/O/N/19/Q1

For which quantity is the magnitude a reasonable estimate?

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

16 9702/13/M/J/19/Q39

What is a correct estimate of the order of magnitude of the diameter of a typical atomic nucleus?

A 10^{-14} m **B** 10^{-18} m **C** 10^{-22} m **D** 10^{-26} m

17 9702/13/M/J/19/Q4

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

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

2018

18 9702/13/O/N/18/Q1

Which statement is **not** a reasonable estimate?

A Atmospheric pressure at sea level is about 1×10^5 Pa.

B Light takes 5×10^2 s to reach us from the Sun.

C The frequency of ultraviolet light is 3×10^{12} Hz.

D The lifespan of a man is about 2×10^9 s.

19 9702/12/O/N/18/Q1

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

20 **9702/11/O/N/18/Q1**

The radius of the Earth is approximately 6.4×10^6 m, and the radius of the Moon is approximately 1.7×10^6 m. A student wishes to build a scale model of the Solar System in the classroom, using a football of radius 0.12 m to represent the Earth.

Which object would best represent the Moon?

A basketball
B cherry
C golf ball
D tennis ball

21 **9702/12/M/J/18/Q1**

A sheet of gold leaf has a thickness of 0.125 μm. A gold atom has a radius of 174 pm.

Approximately how many layers of atoms are there in the sheet?

A 4 **B** 7 **C** 400 **D** 700

22 **9702/12/F/M/18/Q4**

The density of paper is 800 kg m^{-3}. A typical sheet of paper has a width of 210 mm and a length of 300 mm.

The thickness of a pack of 500 sheets of paper is 50 mm.

What is the mass of a single sheet of paper?

A 0.5 g **B** 5 g **C** 50 g **D** 500 g

2017

23 **9702/11/O/N/17/Q4**

What is a typical value of the wavelength of a microwave travelling in a vacuum?

A 3 000 000 pm **B** 30 nm **C** 30 000 μm **D** 3000 mm

24 **9702/12/M/J/17/Q1**

What is the approximate average speed of a winning female Olympic athlete running a 100 m race?

A 6 m s^{-1} **B** 9 m s^{-1} **C** 12 m s^{-1} **D** 15 m s^{-1}

25 **9702/11/M/J/17/Q1**

A student creates a table to show reasonable estimates of some physical quantities.

Which row is **not** a reasonable estimate?

	quantity	value
A	current in a fan heater	12 A
B	mass of an adult person	70 kg
C	speed of an Olympic sprint runner	10 m s^{-1}
D	water pressure at the bottom of a garden pond	10^6 Pa

2015

26 9702/11/M/J/15/Q10

What is a reasonable estimate of the average gravitational force acting on a fully grown woman standing on the Earth?

A 60 N **B** 250 N **C** 350 N **D** 650 N

2014

27 9702/12/O/N/14/Q40

What is the approximate mass of a nucleus of uranium?

A 10^{-15} kg **B** 10^{-20} kg **C** 10^{-25} kg **D** 10^{-30} kg

2013

28 9702/13/O/N/13/Q1

Which estimate is realistic?

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.

29 9702/13/M/J/13/Q3

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

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.

30 9702/12/M/J/13/Q39

What is the approximate mass of an alpha particle?

A 10^{-28} kg **B** 10^{-26} kg **C** 10^{-24} kg **D** 10^{-22} kg

Topic 1.2: Prefixes

2023

1 **9702/12/M/J/23/Q2**

Gm, Tm, μm and pm are all units of length.

Which unit is the largest and which unit is the smallest?

	largest unit	smallest unit
A	Gm	μm
B	Gm	pm
C	Tm	μm
D	Tm	pm

2022

2 **9702/12/O/N/22/Q2**

What is a power of 3.7 MW when expressed in kilowatts?

A 3.7×10^{-3} kW

B 3.7×10^{-3} KW

C 3.7×10^{3} kW

D 3.7×10^{3} KW

3 **9702/11/O/N/22/Q2**

A voltmeter connected across a resistor in a circuit reads 3.6 V.

What could be the current in the resistor and the resistance of the resistor?

	current	resistance
A	150 mA	0.24 kΩ
B	15 mA	2.4 kΩ
C	1.5 mA	0.24 MΩ
D	15 μA	240 kΩ

4 **9702/13/M/J/22/Q2**

Which list of unit prefixes decreases in magnitude from left to right?

A centi, deci, milli

B deci, milli, centi

C pico, kilo, milli

D kilo, milli, pico

5 **9702/12/F/M/22/Q2**

A computer memory stick is labelled as having a storage capacity of 128 GB.

The letter B stands for byte, which is a unit.

What is the equivalent storage capacity?

A 1.28×10^{8} B

B 1.28×10^{11} B

C 1.28×10^{14} B

D 1.28×10^{17} B

2021

6 **9702/12/O/N/21/Q2**

What is an alternative way of expressing an energy of 43 dJ?

A 4.3×10^{3} mJ

B 4.3×10^{3} MJ

C 4.3×10^{-3} mJ

D 4.3×10^{-3} MJ

2020

7 **9702/11/O/N/20/Q2**

Which time interval is the shortest?

A 0.05 ms **B** 50 ns **C** 500 000 ps **D** 0.5 μs

8 **9702/13/M/J/20/Q2**

A sample of gas has a mass of 4.8 μg and occupies a volume of 1.2 dm^3.

What is the density of the sample of gas?

A $4.0 \times 10^{-3}\,kg\,m^{-3}$ **B** $4.0 \times 10^{-5}\,kg\,m^{-3}$ **C** $4.0 \times 10^{-6}\,kg\,m^{-3}$ **D** $4.0 \times 10^{-8}\,kg\,m^{-3}$

2019

9 **9702/13/M/J/19/Q2**

Osmium, a naturally occurring element, has a density of 23 000 $kg\,m^{-3}$.

What is also a value of the density of osmium?

A $2.3 \times 10^{4}\,\mu g\,cm^{-3}$ **B** $2.3 \times 10^{4}\,g\,cm^{-3}$ **C** $2.3\,kg\,cm^{-3}$ **D** $2.3 \times 10^{-2}\,kg\,cm^{-3}$

10 **9702/12/M/J/19/Q1**

What is equivalent to 2000 microvolts?

A $2\,\mu J\,C^{-1}$ **B** 2 mV **C** 2 pV **D** 2000 mV

2017

11 **9702/13/O/N/17/Q1**

How many cubic nanometres, nm^3, are in a cubic micrometre, μm^3?

A 10^{3} **B** 10^{6} **C** 10^{9} **D** 10^{12}

2014

12 **9702/11/M/J/14/Q2**

What is equivalent to 2000 microvolts?

A $2\,\mu J\,C^{-1}$ **B** 2 mV **C** 2 pV **D** 2000 mV

2013

13 **9702/11/M/J/13/Q4**

A wave has a frequency of 5 GHz.

What is the period of the wave?

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

Topic 1.3.1: Uncertainty

2023

1 **9702/12/M/J/23/Q3**

Two measurements for a solid sphere are shown.

mass = (32.5 ± 0.1) g

diameter = (1.87 ± 0.04) cm

These values are used to determine the density of the sphere.

What is the percentage uncertainty in the density?

A 2.4% **B** 4.6% **C** 6.1% **D** 6.7%

2 **9702/12/F/M/23/Q3**

A hollow cylinder, which is open at both ends, has a radius of (3.0 ± 0.1) cm and a length of (15.0 ± 0.1) cm.

What is the value, with its absolute uncertainty, of the surface area of the cylinder?

A (280 ± 10) cm^2

B (282.7 ± 0.2) cm^2

C (420 ± 30) cm^2

D (424.1 ± 0.3) cm^2

2022

3 **9702/13/O/N/22/Q3**

A digital meter is used to measure the current in an electric circuit.

The reading on the meter fluctuates (varies) between 3.04 A and 3.08 A. The readings on the meter have an accuracy of ±1%.

What is the true value of the current, with its uncertainty?

A (3.06 ± 0.02) A

B (3.06 ± 0.04) A

C (3.06 ± 0.05) A

D (3.06 ± 0.07) A

4 **9702/12/O/N/22/Q3**

A spring is suspended from a fixed point and a force is applied. The position of a pointer attached to the bottom of the spring against a vertical ruler is recorded.

Before the force is applied, the position of the pointer is (225 ± 2) mm.

After the force is applied, the position of the pointer is (250 ± 2) mm.

The extension of the spring is determined.

What is the percentage uncertainty in the extension?

A 1.6% **B** 1.8% **C** 8.0% **D** 16%

5 9702/11/O/N/22/Q3

In an experiment to determine the acceleration of free fall g, the time t taken for a ball to fall through distance s is measured. The percentage uncertainty in the measurement of s is 2%. The percentage uncertainty in the measurement of t is 3%.

The value of g is determined using the equation shown.

$$g = \frac{2s}{t^2}$$

What is the percentage uncertainty in the calculated value of g?

A 1% **B** 5% **C** 8% **D** 11%

6 9702/13/M/J/22/Q4

A micrometer screw gauge is used to measure the diameter of a small uniform steel sphere. The measurement of the diameter is 5.00 mm ± 0.01 mm.

What is the percentage uncertainty in the calculated volume of the sphere, using these values?

A 0.2% **B** 0.4% **C** 0.6% **D** 1.2%

2021

7 9702/12/O/N/21/Q5

A student measures the time T for one complete oscillation of a pendulum of length l.

Her results are shown in the table.

l / m	T / s
0.420 ± 0.001	1.3 ± 0.1

She uses the formula

$$T = 2\pi\sqrt{\frac{l}{g}}$$

to calculate the acceleration of free fall g.

What is the best estimate of the percentage uncertainty in the value of g?

A 0.02% **B** 4% **C** 8% **D** 16%

8 9702/13/M/J/21/Q5

The diameter of a circular disc is measured as (7.0 ± 0.1) mm.

What is the area of the disc and the absolute uncertainty in the area?

	area of disc / mm^2	absolute uncertainty / mm^2
A	38.5	±0.5
B	38	±1
C	154	±2
D	154	±4

9 **9702/12/F/M/21/Q5**

A student measures the current and the potential difference for a resistor in a circuit.

current = (50.00 ± 0.01) mA

potential difference = (500.0 ± 0.1) mV

The measurements are used to calculate the resistance of the resistor.

What is the percentage uncertainty in the calculated resistance?

A 0.0002% **B** 0.0004% **C** 0.02% **D** 0.04%

2020

10 **9702/13/O/N/20/Q5**

A student measures the length l and the period T of oscillation of a simple pendulum. He then uses the equation shown to calculate the acceleration of free fall g.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

His measurements are shown.

l	(87.3 ± 0.2) cm
T	(1.9 ± 0.05) s

What is the percentage uncertainty in his calculated value of g?

A 2.4% **B** 2.9% **C** 5.5% **D** 7.2%

11 **9702/12/O/N/20/Q5**

A steel ball is dropped and falls through a vertical height h. The time t taken to fall is measured using light gates.

The results are given in the table.

h	(4.05 ± 0.01) m
t	(0.91 ± 0.02) s

The acceleration of free fall g is calculated using the equation shown.

$$h = \tfrac{1}{2}gt^2$$

What is the percentage uncertainty in the value of g?

A 2.4% **B** 4.6% **C** 5.1% **D** 9.3%

12 9702/11/O/N/20/Q5

The diameter of a spherical golf ball is measured with calipers and found to be (4.11 ± 0.01) cm.

The volume of a sphere is $V = \frac{1}{6}\pi d^3$, where d is the diameter of the sphere.

What is the volume of the golf ball?

A $(36.35 \pm 0.01)\,\text{cm}^3$

B $(36.35 \pm 0.03)\,\text{cm}^3$

C $(36.35 \pm 0.09)\,\text{cm}^3$

D $(36.4 \pm 0.3)\,\text{cm}^3$

2019

13 9702/13/O/N/19/Q5

The power loss P in a resistor is calculated using the formula $P = \frac{V^2}{R}$.

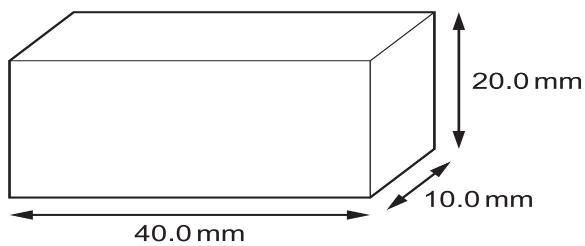
The percentage uncertainty in the potential difference V is 3% and the percentage uncertainty in the resistance R is 2%.

What is the percentage uncertainty in P?

A 4% **B** 7% **C** 8% **D** 11%

14 9702/12/O/N/19/Q5

The sides of a wooden block are measured with calipers. The lengths of the sides are measured as 20.0 mm, 40.0 mm and 10.0 mm.



The calipers can measure with an absolute uncertainty of ±0.1 mm.

What is the percentage uncertainty in the calculated volume of the block?

A 0.3% **B** 1.8% **C** 3.8% **D** 30%