CAMBRIDGE INTERNATIONAL AS & A LEVEL PHYSICS · 9702

PHYSICS



EXAM QUESTION PACK

1 PHYSICAL QUANTITIES AND UNITS

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Chapter 1

Physical quantities and units

1.1 Physical quantities

1. 9702_m20_qp_12 Q: 1

The table shows some measurable quantities.

Which row gives the correct order of magnitude of the measurable quantity in the stated unit?

	measurable quantity	order of magnitude	unit
A	mass of a coin	10^{-4}	kg
B	thickness of a sheet of paper	10^{-2}	m
C	weight of an apple	10^{0}	N
D	temperature of a person's body	10^{1}	K

---

2. 9702_s20_qp_11 Q: 1

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** $10^{8}\,J$

---

3. 9702_s20_qp_12 Q: 1

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

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

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4. 9702_s20_qp_13 Q: 1

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

---

5. 9702_s19_qp_13 Q: 4

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

---

6. 9702_w19_qp_11 Q: 1

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

---

7. 9702_w19_qp_12 Q: 1

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 1×10^3 J.

B The kinetic energy of the car is 7×10^4 J.

C The momentum of the cyclist is 4×10^2 kg m s^{-1}.

D The momentum of the car is 2×10^5 kg m s^{-1}.

---

8. 9702_s18_qp_11 Q: 1

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

---

9. 9702_s18_qp_12 Q: 1

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

---

10. 9702_s18_qp_13 Q: 1

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

---

11. 9702_w18_qp_11 Q: 1

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

---

12. 9702_w18_qp_12 Q: 1

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

Which values are reasonable estimates?

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

---

13. 9702_w18_qp_13 Q: 1

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.

---

14. 9702_m17_qp_12 Q: 2

What is an approximate value for the speed of sound in air?

A $30\,m\,s^{-1}$ **B** $300\,m\,s^{-1}$ **C** $30\,000\,m\,s^{-1}$ **D** $300\,000\,000\,m\,s^{-1}$

---

15. 9702_s17_qp_11 Q: 1

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

---

16. 9702_s17_qp_12 Q: 1

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** $15\,m\,s^{-1}$

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17. 9702_s17_qp_13 Q: 1

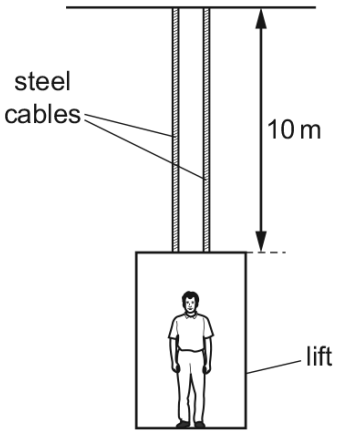
What is the best estimate of the kinetic energy of a family car travelling at $50\,km\,h^{-1}$?

A 1.5×10^3 J **B** 1.5×10^5 J **C** 1.5×10^7 J **D** 1.5×10^9 J

---

18. 9702_s16_qp_11 Q: 3

A lift is supported by two steel cables, each of length 10 m and diameter 0.5 cm.



NOT TO SCALE

The cables extend by 1 mm when a man of mass 80 kg steps into the lift.

What is the best estimate of the value of the Young modulus of the steel?

A $2 \times 10^{10}\,\text{N m}^{-2}$

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

C $2 \times 10^{11}\,\text{N m}^{-2}$

D $4 \times 10^{11}\,\text{N m}^{-2}$

---

19. 9702_s16_qp_12 Q: 1

Which quantity with its unit is correct?

A acceleration of a bicycle = $1.4\,\text{m s}^{-1}$

B electric current in a lamp = $0.25\,\text{A s}^{-1}$

C electric potential difference across a battery = $8.0\,\text{J C}^{-1}$

D kinetic energy of a car = $4500\,\text{N m}^{-1}$

---

20. 9702_w16_qp_11 Q: 1

What is the order of magnitude of the Young modulus for a metal such as copper?

A $10^{-11}\,\text{Pa}$ **B** $10^{-4}\,\text{Pa}$ **C** $10^{4}\,\text{Pa}$ **D** $10^{11}\,\text{Pa}$

---

21. 9702_w16_qp_13 Q: 1

What is the order of magnitude of the Young modulus for a metal such as copper?

A $10^{-11}\,\text{Pa}$ **B** $10^{-4}\,\text{Pa}$ **C** $10^{4}\,\text{Pa}$ **D** $10^{11}\,\text{Pa}$

1.2 SI units

22. 9702_m20_qp_12 Q: 2

A byte (b) comprises 8 bits.

How many bits are there in 1 terabyte (1Tb)?

A 1×10^{9} **B** 8×10^{9} **C** 1×10^{12} **D** 8×10^{12}

---

23. 9702_s20_qp_11 Q: 2

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

$$f = Cm^{p}k^{q}$$

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	$\frac{1}{2}$	$\frac{1}{2}$

---

24. 9702_s20_qp_13 Q: 2

A sample of gas has a mass of $4.8\,\mu g$ 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 $4.0 \times 10^{-8}\,kg\,m^{-3}$

---

25. 9702_m19_qp_12 Q: 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 temperature and b is a constant, characteristic of the solid.
The SI unit of specific heat capacity is $J\,kg^{-1}\,K^{-1}$.

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

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

B $m^2\,s^{-2}\,K^{-4}$

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

D $kg\,m^2\,s^{-2}\,K^{-4}$

---

26. 9702_s19_qp_11 Q: 1

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

A joule

B newton

C pascal

D watt

---

27. 9702_s19_qp_11 Q: 2

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 $W\,m^{-2}\,K^{-4}$.

What are the SI base units of L?

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

---

28. 9702_s19_qp_12 Q: 1

What is equivalent to 2000 microvolts?

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

---

29. 9702_s19_qp_12 Q: 2

What is the number of SI base units required to express electric field strength and power?

	electric field strength	power
A	3	3
B	3	2
C	4	2
D	4	3

---

30. 9702_s19_qp_12 Q: 3

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

---

31. 9702_s19_qp_13 Q: 1

Which is an SI base unit?

A current

B gram

C kelvin

D volt

---

32. 9702_s19_qp_13 Q: 2

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 $2.3 \times 10^{-2}\,kg\,cm^{-3}$

---

33. 9702_w19_qp_11 Q: 2

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** $v = \frac{2\pi g}{L}$

---

34. 9702_w19_qp_12 Q: 2

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

---

35. 9702_w19_qp_13 Q: 1

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}

---

36. 9702_w19_qp_13 Q: 2

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

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37. 9702_m18_qp_12 Q: 1

Which unit is equivalent to the coulomb?

A ampere per second

B joule per volt

C watt per ampere

D watt per volt

---

38. 9702_m18_qp_12 Q: 2

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

---

39. 9702_s18_qp_12 Q: 2

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

---

40. 9702_w18_qp_11 Q: 2

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

---

41. 9702_w18_qp_12 Q: 2

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

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

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

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

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

---

42. 9702_w18_qp_13 Q: 2

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

---

43. 9702_m17_qp_12 Q: 1

Which expression has the same SI base units as pressure?

A $\dfrac{\text{force}}{\text{length} \times \text{speed}}$

B $\dfrac{\text{force}}{\text{length} \times \text{time}}$

C $\dfrac{\text{mass}}{\text{length} \times (\text{time})^2}$

D $\dfrac{\text{mass} \times (\text{time})^2}{\text{length}}$

---

44. 9702_s17_qp_12 Q: 3

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

---

45. 9702_s17_qp_13 Q: 3

Which expression using SI base units is equivalent to the volt?

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

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

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

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

---

46. 9702_w17_qp_11 Q: 1

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

---

47. 9702_w17_qp_12 Q: 1

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 $N\,C^{-1}$

---

48. 9702_w17_qp_12 Q: 3

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_w17_qp_13 Q: 1

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}

---

50. 9702_w17_qp_13 Q: 2

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

---

51. 9702_m16_qp_12 Q: 1

The prefixes nano (n), micro (μ) and pico (p) are often used with units.

Which row shows their correct values?

	n	μ	p
A	10^{-6}	10^{-9}	10^{-12}
B	10^{-6}	10^{-12}	10^{-9}
C	10^{-9}	10^{-6}	10^{-12}
D	10^{-12}	10^{-9}	10^{-6}

---

52. 9702_m16_qp_12 Q: 3

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

What is the unit of specific heat capacity expressed in SI base units?

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

---

53. 9702_s16_qp_11 Q: 2

Which pair of quantities do **not** have the same SI base units?

A electromotive force and electric potential difference

B pressure and stress

C spring constant and moment of a force

D torque and work

---

54. 9702_s16_qp_12 Q: 2

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,

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** $\mathrm{kg\,m^2\,s^{-4}}$

---

55. 9702_s16_qp_13 Q: 1

Which list contains only SI base units?

A ampere, kelvin, joule, gram

B kilogram, newton, metre, ampere

C metre, coulomb, second, kelvin

D second, kelvin, ampere, kilogram

---

56. 9702_s16_qp_13 Q: 2

The stress σ needed to fracture a particular solid is given by the equation

$$\sigma = k\sqrt{\frac{\gamma E}{d}}$$

where E is the Young modulus, d is the distance between planes of atoms, and k is a constant with no units.

What are the SI base units of γ?

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

---

57. 9702_w16_qp_11 Q: 2

The force F between two point charges q_1 and q_2, a distance r apart, is given by the equation

$$F = \frac{kq_1q_2}{r^2}$$

where k is a constant.

What are the SI base units of k?

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

---

58. 9702_w16_qp_12 Q: 1

Concrete has a density of 2400 kg m^{-3}.

Which mass of concrete fills a rectangular space of dimensions $8.0\text{ cm} \times 90\text{ cm} \times 110\text{ cm}$?

A 79 kg **B** 190 kg **C** 790 kg **D** 1900 kg

---

59. 9702_w16_qp_12 Q: 2

The speed v of sound in a gas is given by the equation

$$v = \sqrt{\frac{\gamma P}{\rho}}$$

where P is the pressure of the gas, ρ is its density and γ is a constant.

What are the SI base units of γ?

A $\text{m}^{-1}\text{ s}$ **B** $\text{m}^3\text{ s}^{-3}$ **C** $\text{m}^{-4}\text{ s}^{-4}$ **D** no units

---

60. 9702_w16_qp_13 Q: 2

The force F between two point charges q_1 and q_2, a distance r apart, is given by the equation

$$F = \frac{kq_1q_2}{r^2}$$

where k is a constant.

What are the SI base units of k?

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

---

61. 9702_s15_qp_11 Q: 1

Which is an SI base unit?

A current

B gram

C kelvin

D volt

---

62. 9702_s15_qp_11 Q: 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

$$d = kv^2$$

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** $13.0\,k_1$

---

63. 9702_s15_qp_12 Q: 1

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.

---

64. 9702_s15_qp_12 Q: 2

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

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

where T is the absolute (kelvin) temperature.

What are the SI base units of k?

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

B $\mathrm{kg^{-1}\,m^{-2}\,s^{2}\,K}$

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

D $\mathrm{kg\,m^{2}\,s^{-2}\,K^{-1}}$

---

65. 9702_s15_qp_13 Q: 1

Which statement includes a correct unit?

A energy = 7.8 N s

B force = 3.8 N s

C momentum = 6.2 N s

D torque = 4.7 N s

---

66. 9702_s15_qp_13 Q: 2

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

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

1.3 Scalars and vectors

67. 9702_m20_qp_12 Q: 3

Which pair of quantities contains both a scalar **and** a vector?

A acceleration and momentum

B charge and resistance

C kinetic energy and mass

D temperature and velocity

---

68. 9702_s20_qp_11 Q: 3

The power produced by a force moving an object is given by the equation shown.

$$\text{power} = \frac{\text{work}}{\text{time}} = \frac{\text{force} \times \text{displacement}}{\text{time}}$$

Which quantities are scalars and which are vectors?

	scalars	vectors
A	displacement, time	force, power
B	power, work	displacement, force
C	power, force	displacement, work
D	work, time	power, displacement

---

69. 9702_s20_qp_12 Q: 2

Which quantity is a scalar?

A acceleration

B force

C kinetic energy

D momentum

---

70. 9702_s20_qp_13 Q: 3

Which characteristics are possessed by a vector quantity but **not** by a scalar quantity?

A direction only

B magnitude and direction

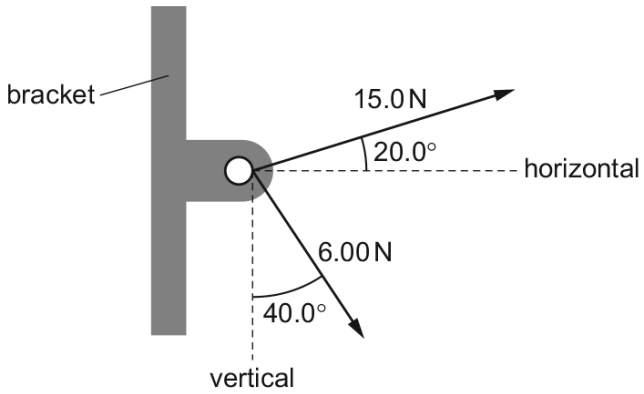
C magnitude and unit

D unit only

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71. 9702_s19_qp_12 Q: 4

Two cables are attached to a bracket and exert forces as shown.

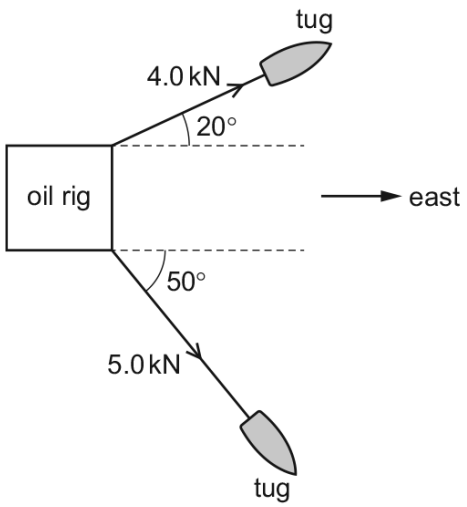


What are the magnitudes of the horizontal and vertical components of the resultant of the two forces?

	horizontal component / N	vertical component / N
A	9.73	0.534
B	9.73	10.2
C	18.0	0.534
D	18.0	10.2

72. 9702_s19_qp_13 Q: 3

Two tugs are towing an oil rig as shown.



The tensions in the towing cables are 4.0 kN and 5.0 kN.

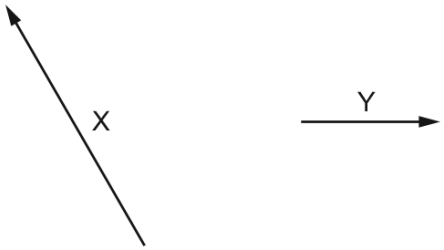
What is the total force acting on the rig due to the cables, in the direction to the east?

A 3.1 kN **B** 5.2 kN **C** 7.0 kN **D** 7.3 kN

---

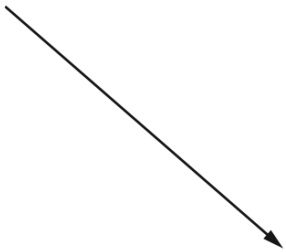
73. 9702_w19_qp_11 Q: 3

The diagram shows two vectors X and Y, drawn to scale.

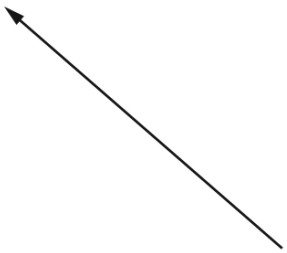


If X = Y – Z, which diagram best represents the vector Z?

A



B



C



D



---

74. 9702_w19_qp_12 Q: 3

Which list contains only scalar quantities?

A area, length, displacement

B kinetic energy, speed, power

C potential energy, momentum, time

D velocity, distance, temperature

---

75. 9702_w19_qp_13 Q: 3

The arrow represents a vector R.



Which diagram does **not** represent R as two perpendicular components?

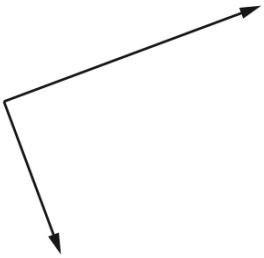
A



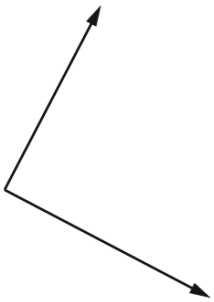
B



C



D



---

76. 9702_m18_qp_12 Q: 3

Two forces of equal magnitude are represented by two coplanar vectors. One is directed towards the east and the other is directed towards the north.

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

---

77. 9702_m18_qp_12 Q: 5

A person calculates the potential difference across a wire by using the measurements shown.

Which measured quantity has the greatest contribution to the percentage uncertainty in the calculated potential difference?

	quantity	value	uncertainty
A	current / A	5.0	± 0.5
B	diameter of wire / mm	0.8	± 0.1
C	length of wire / m	150	± 5
D	resistivity of metal in wire / Ω m	1.6×10^{-8}	$\pm 0.2 \times 10^{-8}$

---

78. 9702_s18_qp_11 Q: 2

Physical quantities can be classed as vectors or as scalars.

Which pair of quantities consists of two vectors?

A kinetic energy and force

B momentum and time

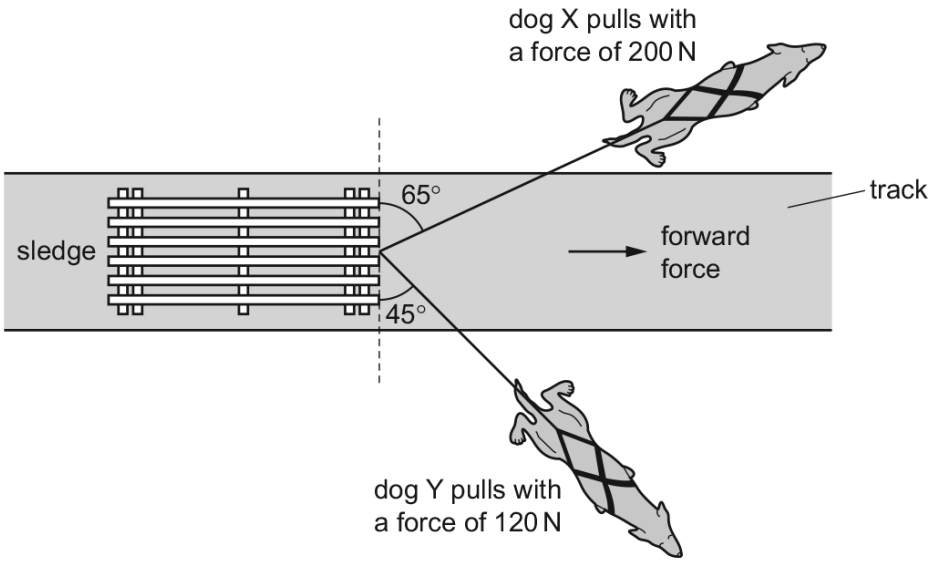
C velocity and electric field strength

D weight and temperature

---

79. 9702_s18_qp_11 Q: 3

Two dogs pull a sledge along an icy track, as shown.



Dog X pulls with a force of 200 N at an angle of 65° to the front edge of the sledge. Dog Y pulls with a force of 120 N at an angle of 45° to the front edge of the sledge.

What is the resultant forward force on the sledge exerted by the two dogs?

A 80 N **B** 170 N **C** 270 N **D** 320 N

---

80. 9702_s18_qp_13 Q: 2

Which pair includes a vector quantity and a scalar quantity?

A displacement and acceleration

B force and kinetic energy

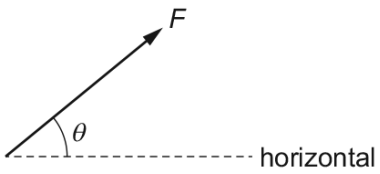
C power and speed

D work and potential energy

---

81. 9702_s18_qp_13 Q: 3

A force F acts at an angle θ to the horizontal.



What are the horizontal and the vertical components of the force?

	horizontal component	vertical component
A	$F\cos\theta$	$F\cos(90^\circ - \theta)$
B	$F\cos\theta$	$F\sin(90^\circ - \theta)$
C	$F\sin\theta$	$F\cos\theta$
D	$F\sin\theta$	$F\cos(90^\circ - \theta)$

---

82. 9702_w18_qp_11 Q: 3

A ship is travelling with a velocity of 8.0 km h^{-1} in a direction 30° east of north.

What are the components of the ship's velocity in the east and north directions?

	component of velocity in east direction / km h^{-1}	component of velocity in north direction / km h^{-1}
A	4.0	4.0
B	4.0	6.9
C	4.6	6.9
D	6.9	4.0

---

83. 9702_w18_qp_12 Q: 3

Which list contains both scalar and vector quantities?

A acceleration, momentum, velocity, weight

B area, current, force, work

C distance, kinetic energy, power, pressure

D mass, temperature, time, speed

---

84. 9702_w18_qp_12 Q: 4

Vectors P and Q are drawn to scale.



Which diagram represents the vector (P + Q)?

A



B



C



D



---

85. 9702_w18_qp_13 Q: 3

Which group of quantities contains only vectors?

A acceleration, displacement, speed

B acceleration, work, electric field strength

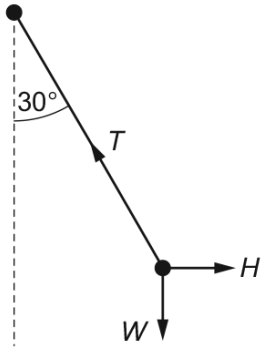
C displacement, force, velocity

D power, electric field strength, force

---

86. 9702_m17_qp_12 Q: 3

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



The tension in the string of the pendulum is *T*. The weight of the pendulum bob is *W*. The string is held at an angle of 30° to the vertical.

Which statement is correct?

A $H = T\cos 30$

B $T = H\sin 30$

C $W = T\sin 30$

D $W = T\cos 30$

---

87. 9702_s17_qp_11 Q: 2

A particle travels in a straight line with speed *v*.

The particle slows down and changes direction. The new speed of the particle is $\frac{v}{2}$.

The new velocity has a component of $\frac{v}{4}$ in the same direction as the initial path of the particle.

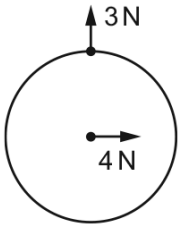
Through which angle has the particle turned?

A 27° **B** 30° **C** 45° **D** 60°

---

88. 9702_s17_qp_12 Q: 2

Two forces act on a circular disc as shown.

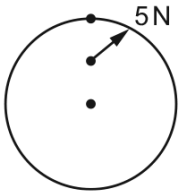


Which diagram shows the line of action of the resultant force?

A



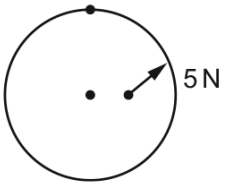
B



C



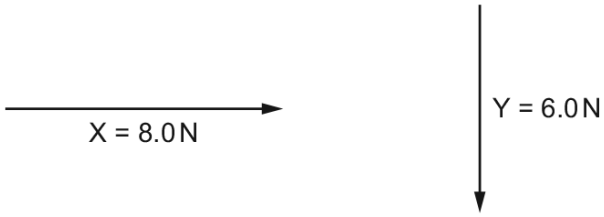
D



---

89. 9702_s17_qp_13 Q: 2

The diagram shows two vectors X and Y. The vectors are perpendicular to one another.



What is the magnitude and direction of vector (X – Y)?

A 10.0 N at an angle of 37° downwards from the direction of X

B 10.0 N at an angle of 37° upwards from the direction of X

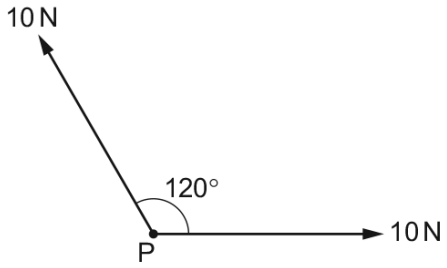
C 14.0 N at an angle of 53° downwards from the direction of X

D 14.0 N at an angle of 53° upwards from the direction of X

---

90. 9702_w17_qp_11 Q: 2

Two forces, each of 10 N, act at a point P as shown. The angle between the directions of the forces is 120°.



What is the magnitude of the resultant force?

A 5 N **B** 10 N **C** 17 N **D** 20 N

---

91. 9702_w17_qp_11 Q: 6

In still air, a bird can fly at a speed of 10 m s^{-1}. The wind is blowing from the east at 8.0 m s^{-1}.

In which direction must the bird fly in order to travel to a destination that is due north of the bird's current location?

A 37° east of north

B 37° west of north

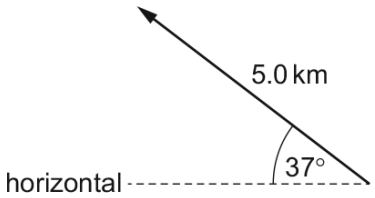
C 53° east of north

D 53° west of north

---

92. 9702_w17_qp_12 Q: 2

What is the vertical component of this displacement vector?

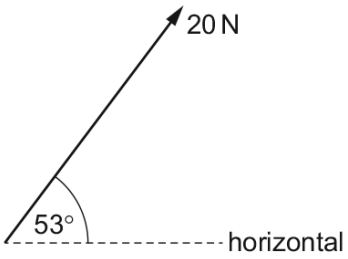


A 3.0 km **B** 3.8 km **C** 4.0 km **D** 5.0 km

---

93. 9702_w17_qp_13 Q: 3

What is the horizontal component of the force shown?

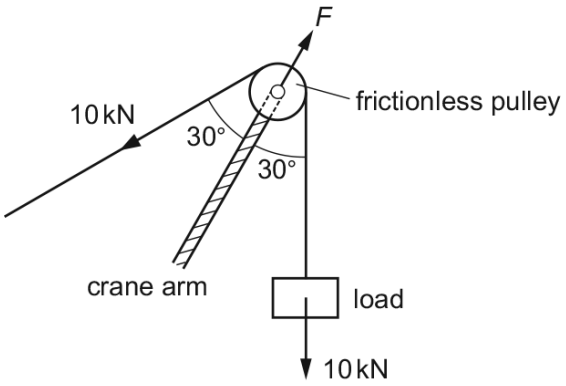


A 12 N **B** 16 N **C** 20 N **D** 27 N

---

94. 9702_m16_qp_12 Q: 2

A crane has an arm to which is attached a frictionless pulley. A cable passes over the pulley and supports a load of 10 kN as shown.



The crane arm exerts a force F on the pulley.

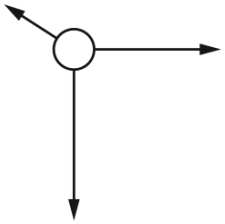
What is the value of F?

A 5.0 kN **B** 8.7 kN **C** 10 kN **D** 17 kN

---

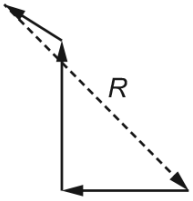
95. 9702_s16_qp_11 Q: 1

Three wires each exert a horizontal force on a vertical pole, as shown.

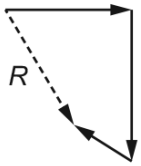


Which vector diagram shows the resultant force *R* acting on the pole?

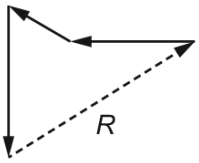
A



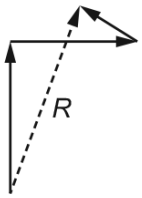
B



C



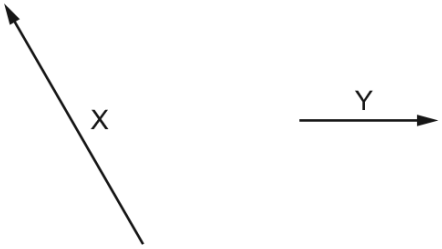
D



---

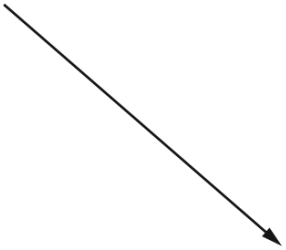
96. 9702_s16_qp_12 Q: 3

The diagram shows two vectors X and Y, drawn to scale.

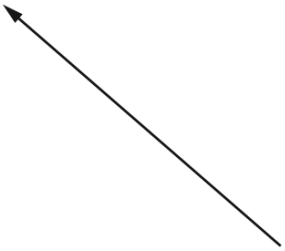


If X = Y – Z, which diagram best represents the vector Z?

A



B



C



D



---

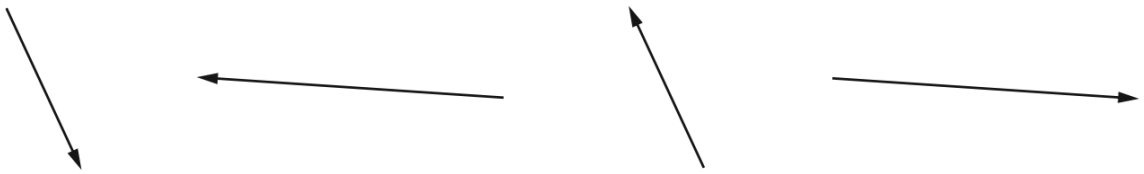
97. 9702_s16_qp_13 Q: 3

Vectors P and Q are drawn to scale.



Which diagram represents the vector (P – Q)?

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



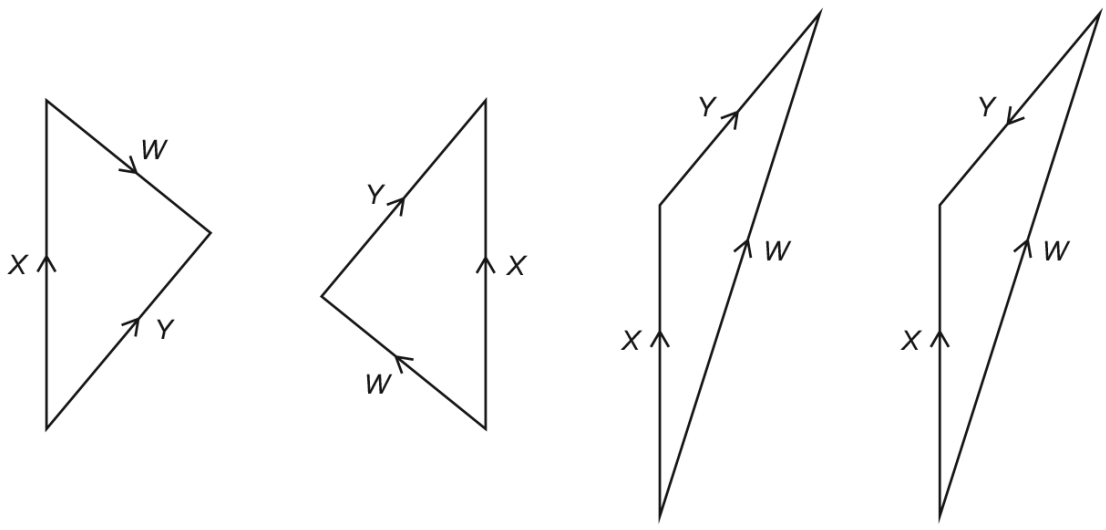
---

98. 9702_w16_qp_11 Q: 3

An aeroplane can fly at a velocity *X* when moving through still air. When flying in wind the aeroplane's velocity relative to the ground is *Y*.

Which vector diagram shows the magnitude and direction of the wind velocity *W*?

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



---

99. 9702_w16_qp_12 Q: 3

The motion of an object moving from rest with a constant acceleration a may be represented by the equation shown.

$$v^2 = 2as$$

Which row describes the quantities represented by the symbols v and s?

	v	s
A	scalar	scalar
B	scalar	vector
C	vector	scalar
D	vector	vector

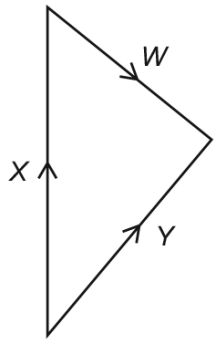
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100. 9702_w16_qp_13 Q: 3

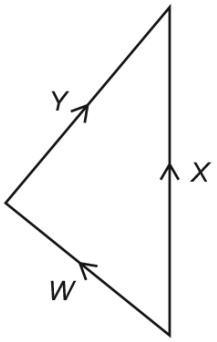
An aeroplane can fly at a velocity X when moving through still air. When flying in wind the aeroplane's velocity relative to the ground is Y.

Which vector diagram shows the magnitude and direction of the wind velocity W?

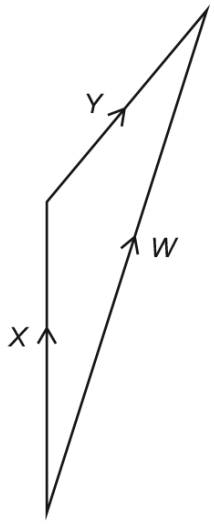
A



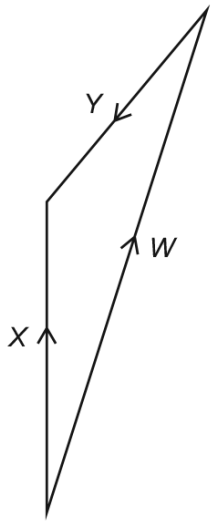
B



C



D



---

101. 9702_s15_qp_11 Q: 2

Which pair contains one vector and one scalar quantity?

A displacement acceleration

B force kinetic energy

C momentum velocity

D power speed

---

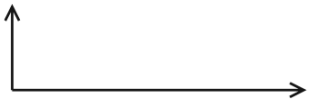
102. 9702_s15_qp_12 Q: 4

The arrow represents the vector R.



Which diagram does **not** represent R as two perpendicular components?

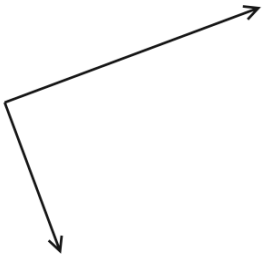
A



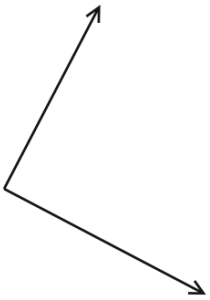
B



C



D



---

103. 9702_s15_qp_13 Q: 3

The speed of an aeroplane in still air is 200 km h^{-1}. The wind blows from the west at a speed of 85.0 km h^{-1}.

In which direction must the pilot steer the aeroplane in order to fly due north?

A 23.0° east of north

B 23.0° west of north

C 25.2° east of north

D 25.2° west of north

Chapter 1

Physical quantities and units

1.1 SI units

1. 9702_m19_qp_22 Q: 1

(a) The ampere, metre and second are SI base units.

State **two** other SI base units.

1. .....

2. .....
[2]

(b) The average drift speed v of electrons moving through a metal conductor is given by the equation:

$$v = \frac{\mu F}{e}$$

where e is the charge on an electron
F is a force acting on the electron
and μ is a constant.

Determine the SI base units of μ.

SI base units .....[3]

[Total: 5]

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2. 9702_s18_qp_22 Q: 1

(a) Define *force*.

.....[1]

(b) State the SI base units of force.

.....[1]

(c) The force F between two point charges is given by

$$F = \frac{Q_1 Q_2}{4\pi r^2 \varepsilon}$$

where Q_1 and Q_2 are the charges,
r is the distance between the charges,
ε is a constant that depends on the medium between the charges.

Use the above expression to determine the base units of ε.

base units .....[2]

[Total: 4]

3. 9702_w17_qp_23 Q: 1

(a) (i) Define *power*.

.....

.....[1]

(ii) Show that the SI base units of power are $kg\,m^2\,s^{-3}$.

[1]

(b) All bodies radiate energy. The power P radiated by a body is given by

$$P = kAT^4$$

where T is the thermodynamic temperature of the body,
A is the surface area of the body
and k is a constant.

(i) Determine the SI base units of k.

base units .....[2]

(ii) On Fig. 1.1, sketch the variation with T^2 of P. The quantity A remains constant.

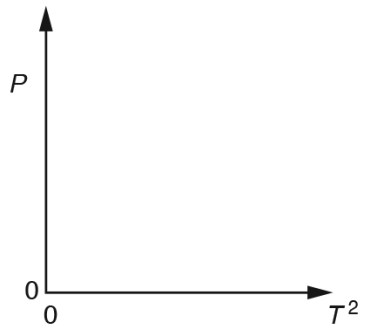


Fig. 1.1

[1]

[Total: 5]

4. 9702_s15_qp_21 Q: 1

(a) Use the definition of power to show that the SI base units of power are $kg\,m^{2}\,s^{-3}$.

[2]

(b) Use an expression for electrical power to determine the SI base units of potential difference.

units .....[2]

5. 9702_w15_qp_23 Q: 1

(a) The intensity of a progressive wave is defined as the average power transmitted through a surface per unit area.

Show that the SI base units of intensity are $kg\,s^{-3}$.

[2]

(b) **(i)** The intensity I of a sound wave is related to the amplitude x_0 of the wave by

$$I = K\rho c f^2 x_0^2$$

where ρ is the density of the medium through which the sound is passing,
c is the speed of the sound wave,
f is the frequency of the sound wave
and K is a constant.

Show that K has no units.

[2]

(ii) Calculate the intensity, in $\mathrm{pW\,m^{-2}}$, of a sound wave where

$K = 20$,
$\rho = 1.2$ in SI base units,
$c = 330$ in SI base units,
$f = 260$ in SI base units
and $x_0 = 0.24\,\mathrm{nm}$.

intensity = ...$\mathrm{pW\,m^{-2}}$ [3]

1.2 Scalars and vectors

6. 9702_w19_qp_22 Q: 1

(a) Distinguish between vector and scalar quantities.

.....

.....

..... [2]

(b) The electric field strength E at a distance x from an isolated point charge Q is given by the equation

$$E = \frac{Q}{x^2 b}$$

where b is a constant.

(i) Use the definition of electric field strength to show that E has SI base units of $\text{kg m A}^{-1}\text{ s}^{-3}$.

[2]

(ii) Use the units for E given in **(b)(i)** to determine the SI base units of b.

SI base units of b ..... [2]

[Total: 6]

7. 9702_s18_qp_21 Q: 1

(a) State what is meant by a *scalar* quantity and by a *vector* quantity.

scalar: .....

.....

vector: .....

.....

[2]

(b) Complete Fig. 1.1 to indicate whether each of the quantities is a vector or a scalar.

quantity	vector or scalar
power	
temperature	
momentum	

Fig. 1.1

[2]

(c) An aircraft is travelling in wind. Fig. 1.2 shows the velocities for the aircraft in still air and for the wind.

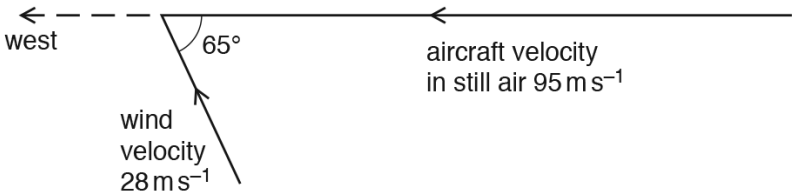


Fig. 1.2

The velocity of the aircraft in still air is 95 m s^{-1} to the west.
The velocity of the wind is 28 m s^{-1} from 65° south of east.

(i) On Fig. 1.2, draw an arrow, labelled R, in the direction of the resultant velocity of the aircraft. [1]

(ii) Determine the magnitude of the resultant velocity of the aircraft.

magnitude of velocity = ... $m\,s^{-1}$ [2]

[Total: 7]

---

8. 9702_s17_qp_23 Q: 1

(a) Two forces, with magnitudes 5.0 N and 12 N, act from the same point on an object. Calculate the magnitude of the resultant force *R* for the forces acting

(i) in opposite directions,

R = ... N [1]

(ii) at right angles to each other.

R = ... N [1]

(b) An object X rests on a smooth horizontal surface. Two horizontal forces act on X as shown in Fig. 1.1.

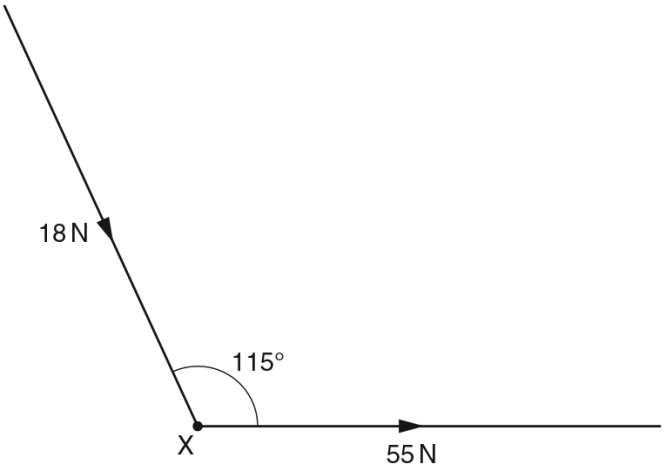


Fig. 1.1 (not to scale)

A force of 55 N is applied to the right. A force of 18 N is applied at an angle of 115° to the direction of the 55 N force.

(i) Use the resolution of forces or a scale diagram to show that the magnitude of the resultant force acting on X is 65 N.

[2]

(ii) Determine the angle between the resultant force and the 55 N force.

angle = ... ° [2]

(c) A third force of 80 N is now applied to X in the opposite direction to the resultant force in **(b)**.

The mass of X is 2.7 kg.

Calculate the magnitude of the acceleration of X.

acceleration = ...$m\,s^{-2}$ [3]

[Total: 9]

9. 9702_s16_qp_23 Q: 1

(a) A list of quantities that are either scalars or vectors is shown in Fig. 1.1.

quantity	scalar	vector
distance	✓	
energy		
momentum		
power		
time		
weight		

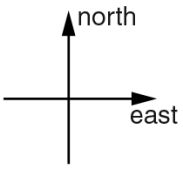
Fig. 1.1

Complete Fig. 1.1 to indicate whether each quantity is a scalar or a vector.

One line has been completed as an example. [2]

(b) A girl runs 120 m due north in 15 s. She then runs 80 m due east in 12 s.

(i) Sketch a vector diagram to show the path taken by the girl. Draw and label her resultant displacement R.



(ii) Calculate, for the girl,

1. the average speed,

average speed = ... $m\,s^{-1}$ [1]

2. the magnitude of the average velocity v and its angle with respect to the direction of the initial path.

magnitude of v = ... $m\,s^{-1}$

angle = ... °
[3]

[Total: 7]

---

10. 9702_w15_qp_22 Q: 1

(a) The frequency of an X-ray wave is 4.6×10^{20} Hz.

Calculate the wavelength in pm.

wavelength = ... pm [3]

(b) The distance from Earth to a star is 8.5×10^{16} m. Calculate the time for light to travel from the star to Earth in Gs.

time = ... Gs [2]

(c) The following list contains scalar and vector quantities.

Underline **all** the scalar quantities.

acceleration force mass power temperature weight [1]

(d) A boat is travelling in a flowing river. Fig. 1.1 shows the velocity vectors for the boat and the river water.



Fig. 1.1

The velocity of the boat in still water is 14.0 m s^{-1} to the east. The velocity of the water is 8.0 m s^{-1} from 60° north of east.

(i) On Fig. 1.1, draw an arrow to show the direction of the resultant velocity of the boat. [1]

(ii) Determine the magnitude of the resultant velocity of the boat.

magnitude of velocity = ... $m\,s^{-1}$ [2]

Appendix A

1 Which of the following pairs of units are both SI base units? 9702/1/M/J/02/Q1

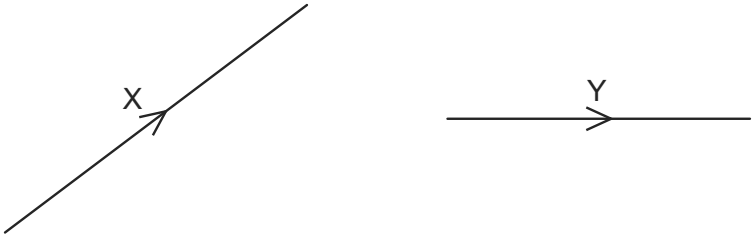
A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

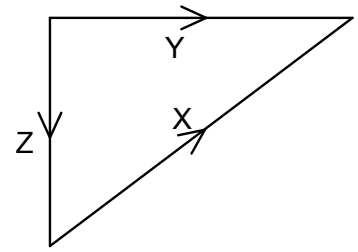
D coulomb, kelvin

2 The diagram shows two vectors X and Y. 9702/1/M/J/02/Q2

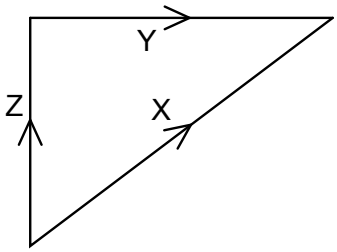


In which vector triangle does the vector Z show the magnitude and direction of vector X – Y?

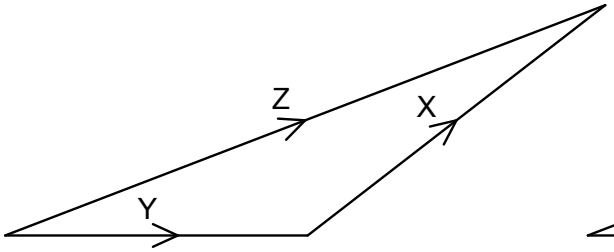
A



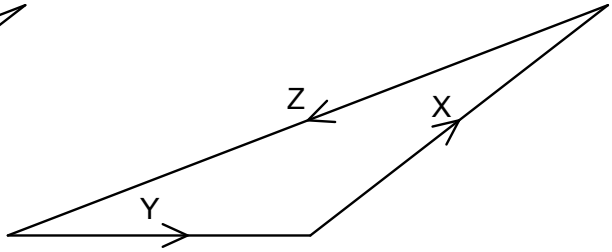
B



C



D



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/Q3

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

4 Which of the following is a scalar quantity? 9702/01/M/J/03/Q1

A acceleration

B mass

C momentum

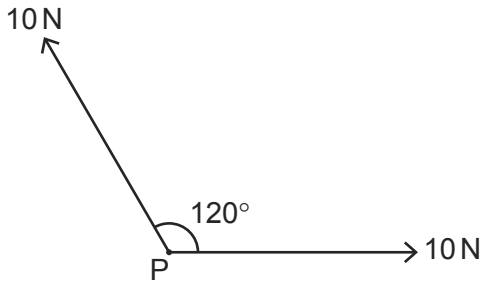
D velocity

5 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/Q2

Express the joule in terms of the base units of mass, length and time, the kg, m and s.

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

6 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/Q3



What is the magnitude of the resultant force?

A 5 N **B** 10 N **C** 17 N **D** 20 N

7 A student measures a current as 0.5 A. 9702/01/O/N/03/Q1

Which of the following correctly expresses this result?

A 50 mA **B** 50 MA **C** 500 mA **D** 500 MA

8 The momentum of an object of mass m is p. 9702/01/O/N/03/Q3

Which quantity has the same base units as $\frac{p^2}{m}$?

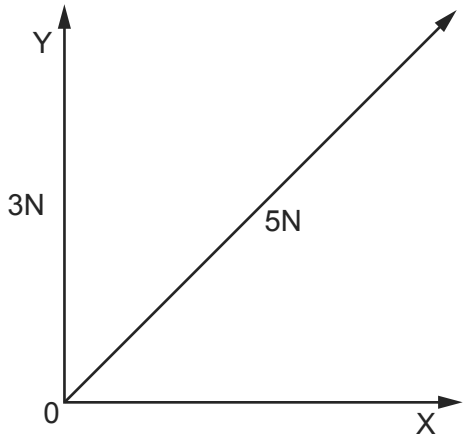
A energy

B force

C power

D velocity

9 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/Q2



OY is of magnitude 3 N.

What is the magnitude of OX?

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

10 Which pair contains one vector and one scalar quantity? 9702/01/M/J/04/Q1

A displacement : acceleration

B force : kinetic energy

C momentum : velocity

D power : speed

11 Which of the following could be measured in the same units as force? 9702/01/M/J/04/Q2

A energy / distance

B energy x distance

C energy / time

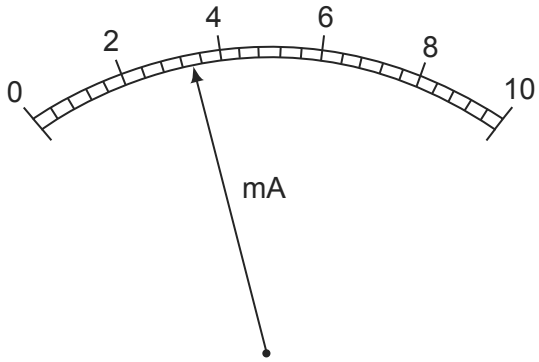
D momentum x distance

12 The notation μs is used as an abbreviation for a certain unit of time. 9702/01/M/J/04/Q3

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

13 What is the reading shown on this milliammeter? 9702/01/M/J/04/Q4



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

14 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/Q1

	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

15 Which of the following definitions is correct and uses only quantities rather than units? 9702/01/O/N/04/Q2

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.

16 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/Q3

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}

17 An Olympic athlete of mass 80 kg competes in a 100 m race. 9702/01/M/J/05/Q3

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

A 4 x 10^{2} J **B** 4 x 10^{3} J **C** 4 x 10^{4} J **D** 4 x 10^{5} J

18 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/Q1

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}

19 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 $F = krv$, where k is a constant. 9702/01/M/J/05/Q2

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}

20 Which pair of units are both SI base units? 9702/01/O/N/05/Q1

A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

D coulomb, kelvin

21 The prefix 'centi' indicates x 10^{-2}. 9702/01/O/N/05/Q2

Which line in the table correctly indicates the prefixes micro, nano and pico?

	x 10^{-12}	x 10^{-9}	x 10^{-6}
A	nano	micro	pico
B	nano	pico	micro
C	pico	nano	micro
D	pico	micro	nano

22 Which expression involving base units is equivalent to the volt? 9702/01/O/N/05/Q3

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

23 Which pair includes a vector quantity and a scalar quantity? 9702/01/M/J/06/Q1

A displacement; acceleration

B force; kinetic energy

C power; speed

D work; potential energy

24 For which quantity is the magnitude a reasonable estimate? 9702/01/M/J/06/Q2

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

25 The following physical quantities can be either positive or negative. 9702/01/M/J/06/Q3

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

26 In the expressions below 9702/01/O/N/06/Q2

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** $\frac{at^2}{2}$

27 Which product-pair of metric prefixes has the greatest magnitude? 9702/01/O/N/06/Q1

A pico × mega

B nano × kilo

C micro × giga

D milli × tera

28 Which row of the table shows a physical quantity and its correct unit? 9702/01/O/N/06/Q3

	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	$\text{kg m}^{-1}\text{ s}^{-3}$

29 Which is a pair of SI base units? 9702/01/M/J/07/Q1

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

30 What is the ratio $\frac{1\,\mu\text{m}}{1\,\text{Gm}}$? 9702/01/M/J/07/Q2

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

31 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/Q3

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

32 Which of the following correctly expresses the volt in terms of SI base units? 9702/01/M/J/08/Q2

A $\text{A}\,\Omega$

B W A^{-1}

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

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

33 The equation relating pressure and density is $p = \rho gh$. 9702/01/O/N/07/Q1

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

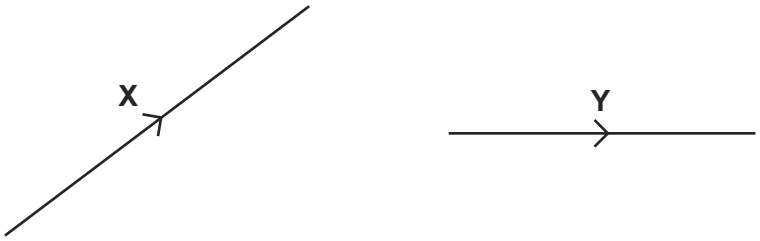
C $[\text{kg m}^{-1}\,\text{s}^{-2}] = [\text{kg m}^{-3}]\,[\text{m s}^{-2}]\,[\text{m}]$

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

34 What is a reasonable estimate of the diameter of an alpha particle? 9702/01/O/N/07/Q2

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

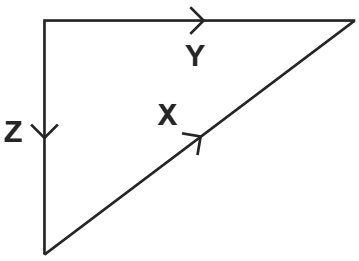
35 The diagram shows two vectors **X** and **Y**.



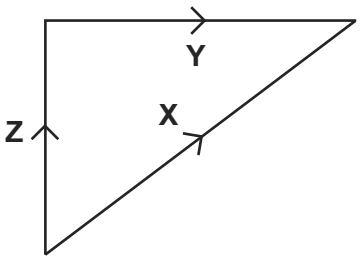
In which vector triangle does the vector **Z** show the magnitude and direction of vector **X**–**Y**?

9702/01/O/N/07/Q3

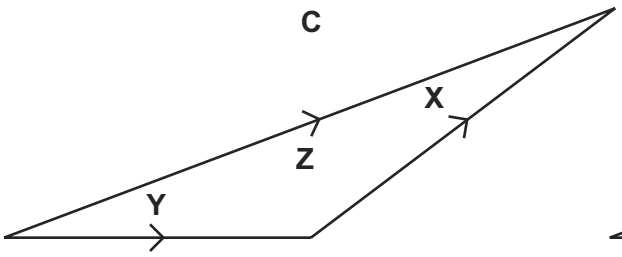
A



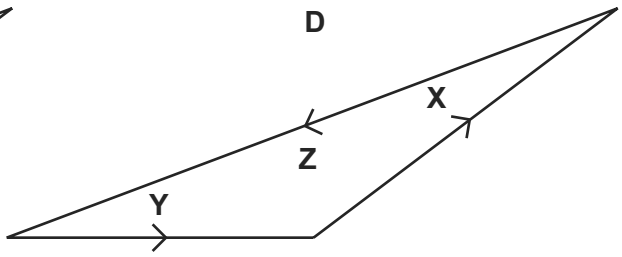
B



C



D



36 Five energies are listed. 9702/01/M/J/08/Q1

5 kJ

5 mJ

5 MJ

5 nJ

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

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

37 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/Q3

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

38 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/Q2

A $m^2 s^{-2} K^{-3}$

B $m^2 s^{-2} K^{-4}$

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

D $kg\, m^2 s^{-2} K^{-4}$

39 The table shows the x-component and y-component of four force vectors. 9702/01/O/N/08/Q3

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

40 A laser emits light of wavelength 600 nm. 9702/01/O/N/08/Q1

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}

41 Which statement, involving multiples and sub-multiples of the base unit metre (m), is correct? 9702/01/M/J/09/Q1

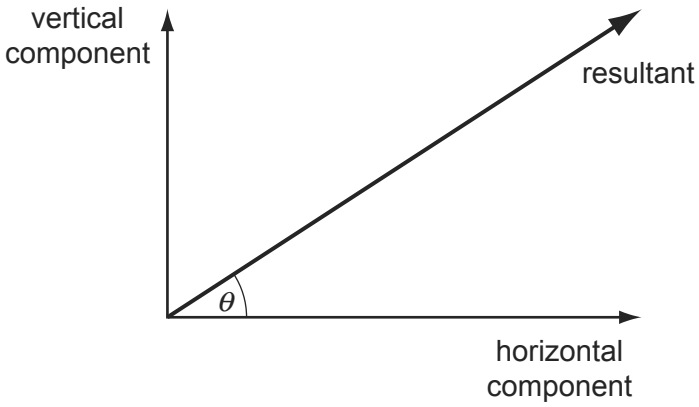
A 1 pm = 10^{-9} m

B 1 nm = 10^{-6} m

C 1 mm = 10^{6} μm

D 1 km = 10^{6} mm

42 The diagram shows a resultant force and its horizontal and vertical components. 9702/01/M/J/09/Q2



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

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

43 The table contains some quantities, together with their symbols and units. 9702/11/O/N/09/Q2

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

Which expression has the units of energy?

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

44 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/Q1

What are the base units of the constant k?

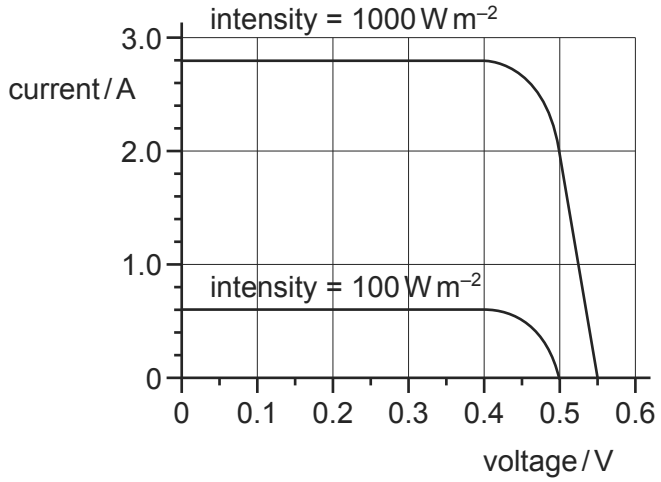
A $kg\,m^5\,s^{-4}$ **B** $kg\,m^{-2}\,s^{-1}$ **C** $kg\,m^{-3}$ **D** $kg\,m^{-4}\,s^2$

45 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/Q1

What are the base units of the constant k?

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

46 The graph shows two current-voltage calibration curves for a solar cell exposed to different light intensities. 9702/12/O/N/09/Q2



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

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

47 The SI unit for potential difference (the volt) is given, in base units, by 9702/11/M/J/10/Q1

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

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

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

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

48 A signal has a frequency of 2.0 MHz. 9702/11/O/N/10/Q1

What is the period of the signal?

A 2 μs **B** 5 μs **C** 200 ns **D** 500 ns

49 The product of pressure and volume has the same SI base units as 9702/11/M/J/10/Q2

A energy.

B force.

C $\frac{\text{force}}{\text{area}}$.

D $\frac{\text{force}}{\text{length}}$.

50 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/Q3

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

51 A micrometer screw gauge is used to measure the diameter of a copper wire. 9702/12/M/J/10/Q1

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.

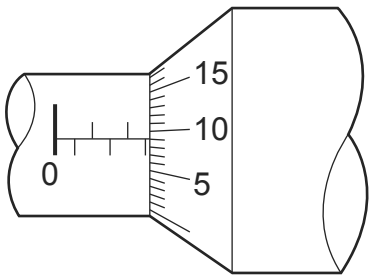


diagram 1

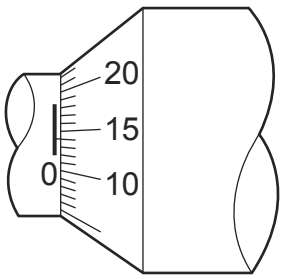


diagram 2

What is the diameter of the wire?

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

52 The SI unit for potential difference (the volt) is given, in base units, by 9702/12/M/J/10/Q2

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

53 The product of pressure and volume has the same SI base units as 9702/13/M/J/10/Q1

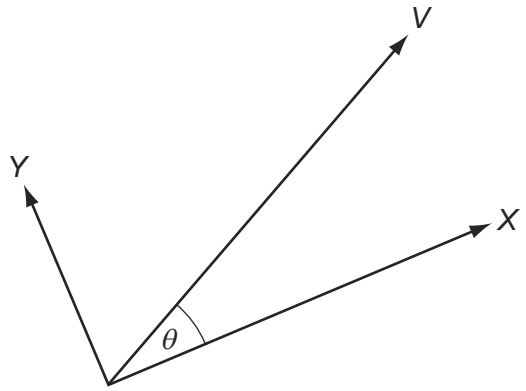
A energy.

B force.

C $\frac{\text{force}}{\text{area}}$.

D $\frac{\text{force}}{\text{length}}$.

54 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/Q2



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

55 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge? 9702/11/O/N/10/Q3

A electric current

B electric energy

C electric field strength

D electric power

56 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 $F = krv$, where k is a constant. 9702/11/O/N/10/Q2

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}

57 Which row shows a base quantity with its correct SI unit? 9702/12/O/N/10/Q1

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

58 The frictional force F on a sphere falling through a fluid is given by the formula 9702/12/O/N/10/Q2

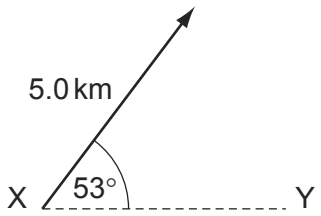
$$F = 6\pi a\eta v$$

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

59 What is the component of this displacement vector in the direction XY? 9702/12/O/N/10/Q3



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

60 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge? 9702/13/O/N/10/Q1

A electric current

B electric energy

C electric field strength

D electric power

61 Which definition is correct and uses only quantities rather than units? 9702/11/M/J/11/Q2

A Density is mass per cubic metre.

B Potential difference is energy per unit current.

C Pressure is force per unit area.

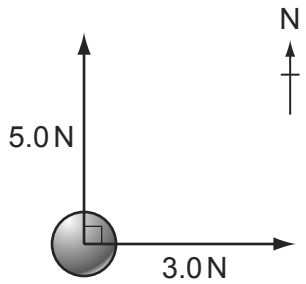
D Speed is distance travelled per second.

62 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/Q1

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

63 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/Q3



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

64 Stress has the same SI base units as 9702/12/M/J/11/Q1

A $\frac{\text{force}}{\text{mass}}$.

B $\frac{\text{force}}{\text{length}}$.

C $\frac{\text{force}}{\text{area}}$.

D energy.

65 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/Q2

A force = 300 J / 6 m

B power = 6000 J × 20 s

C time = 6 m / 30 m s^{-1}

D velocity = 4 m s^{-2} × 30 s

66 In making reasonable estimates of physical quantities, which statement is **not** correct? 9702/12/M/J/11/Q3

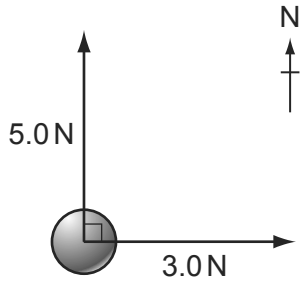
A The frequency of sound can be of the order of GHz.

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.

67 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/Q1



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

68 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/Q2

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

69 Which definition is correct and uses only quantities rather than units? 9702/13/M/J/11/Q3

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.

70 An Olympic athlete of mass 80 kg competes in a 100 m race. 9702/11/O/N/11/Q2

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

71 Which statement using prefixes of the base unit metre (m) is **not** correct? 9702/11/O/N/11/Q1

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 $1\,\text{Gm} = 10^{12}\,\text{m}$

72 Which group of quantities contains only vectors? 9702/11/O/N/11/Q3

A acceleration, displacement, speed

B acceleration, work, electric field strength

C displacement, force, velocity

D power, electric field strength, force

73 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/Q4

Which line gives the correct units for P and Q?

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

74 Which quantity can be measured in electronvolts (eV)? 9702/12/O/N/11/Q1

A electric charge

B electric potential

C energy

D power

75 What is the ratio $\frac{10^{-3}\,\text{THz}}{10^{3}\,\text{kHz}}$? 9702/12/O/N/11/Q2

A 10^{-9} **B** 10^{-6} **C** 10^{0} **D** 10^{3}

76 The following physical quantities can be either positive or negative. 9702/12/O/N/11/Q3

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

77 Which group of quantities contains only vectors? 9702/13/O/N/11/Q1

A acceleration, displacement, speed

B acceleration, work, electric field strength

C displacement, force, velocity

D power, electric field strength, force

78 Which statement using prefixes of the base unit metre (m) is **not** correct? 9702/13/O/N/11/Q2

A 1 pm = 10^{-12} m

B 1 nm = 10^{-9} m

C 1 Mm = 10^{6} m

D 1 Gm = 10^{12} m

79 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/Q1

$$W = Fs.$$

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

80 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/Q3

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

81 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/Q2

A newton per second ($N\,s^{-1}$)

B newton second ($N\,s$)

C newton metre ($N\,m$)

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

82 What is the unit watt in terms of SI base units? 9702/12/M/J/12/Q1

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

83 For which quantity is the magnitude a reasonable estimate? 9702/12/M/J/12/Q2

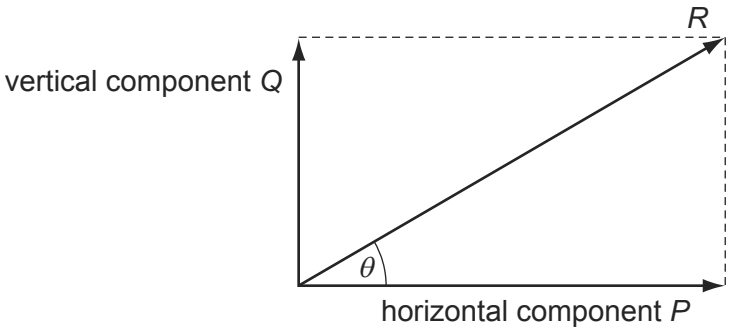
A frequency of a radio wave 500 pHz

B mass of an atom 500 μg

C the Young modulus of a metal 500 kPa

D wavelength of green light 500 nm

84 A vector has magnitude R and perpendicular components P and Q, as shown in the diagram. 9702/12/M/J/12/Q3



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	$R\sin\theta$	$R\cos\theta$

85 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/Q1

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

86 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/Q2

$$W = Fs.$$

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

87 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/Q3

A newton per second ($\mathrm{N\,s^{-1}}$)

B newton second ($\mathrm{N\,s}$)

C newton metre ($\mathrm{N\,m}$)

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

88 What is the unit of weight in terms of SI base unit(s)?

9702/11/O/N/12/Q1

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

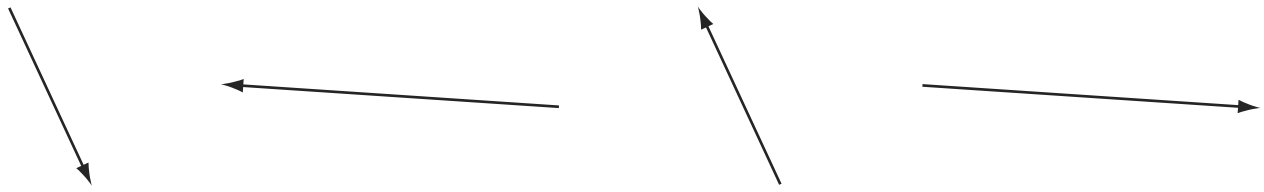
89 Vectors P and Q are drawn to scale.

9702/11/O/N/12/Q2



Which diagram represents the vector (P – Q)?

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



90 What is the approximate temperature of a red-hot ring on an electric cooker?

9702/11/O/N/12/Q3

A 100 °C **B** 200 °C **C** 400 °C **D** 800 °C

91 Which quantity has the same base units as momentum? 9702/12/O/N/12/Q1

A density × energy

B density × volume × velocity

C pressure × area

D weight ÷ area

92 Vectors P and Q are drawn to scale. 9702/12/O/N/12/Q2



Which diagram represents the vector (P + Q)?

A



B



C



D



93 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/Q3

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

94 Physical quantities can be classed as vectors or as scalars. 9702/12/O/N/12/Q4

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

95 Which list contains only scalar quantities? 9702/11/O/N/12/Q4

A area, length, displacement

B kinetic energy, speed, power

C potential energy, momentum, time

D velocity, distance, temperature

96 The units of all physical quantities can be expressed in terms of SI base units. 9702/13/O/N/12/Q1

Which pair contains quantities with the same base units?

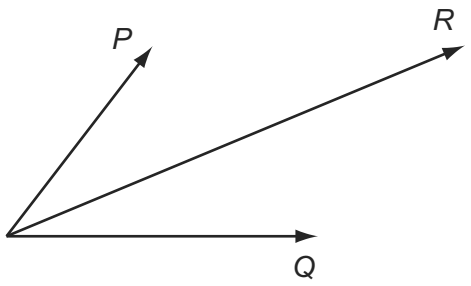
A force and momentum

B pressure and Young modulus

C power and kinetic energy

D mass and weight

97 Two physical quantities *P* and *Q* are added. The sum of *P* and *Q* is *R*, as shown. 9702/13/O/N/12/Q2



Which quantity could be represented by *P* and by *Q*?

A kinetic energy

B power

C speed

D velocity

98 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/Q3

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

99 Three of these quantities have the same unit. 9702/13/O/N/12/Q4

Which quantity has a different unit?

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

B force

C power × time

D rate of change of momentum

100 Which pair of quantities contains one vector and one scalar quantity? 9702/11/M/J/13/Q1

A displacement; force

B kinetic energy; power

C acceleration; momentum

D velocity; distance

101 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/Q2

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

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

102 Which pair includes a vector quantity and a scalar quantity? 9702/12/M/J/13/Q1

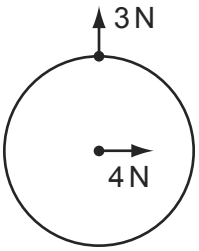
A displacement; acceleration

B force; kinetic energy

C power; speed

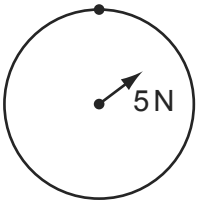
D work; potential energy

103 Two forces act on a circular disc as shown. 9702/12/M/J/13/Q3

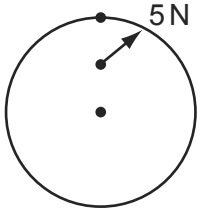


Which diagram shows the line of action of the resultant force?

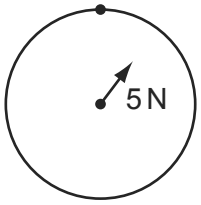
A



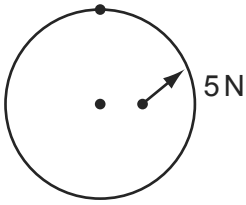
B



C



D



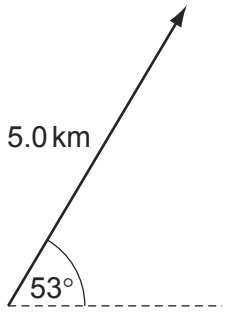
104 The unit of resistivity, expressed in terms of base units, is given by 9702/12/M/J/13/Q2

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

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

105 The diagram shows a displacement vector. 9702/13/M/J/13/Q1



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

106 What is the unit of power, expressed in SI base units? 9702/13/M/J/13/Q2

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

107 Which statement is **incorrect** by a factor of 100 or more? 9702/13/M/J/13/Q3

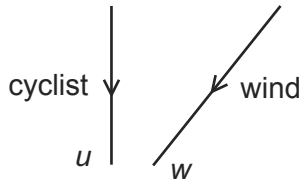
A Atmospheric pressure is about 1×10^5 Pa.

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.

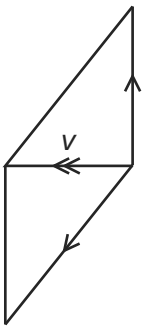
108 A cyclist is travelling due south with velocity u. The wind is blowing from the north-east with velocity w. 9702/13/M/J/13/Q4



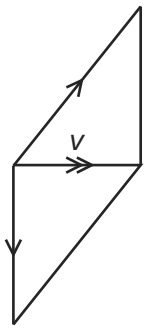
The wind has a velocity v relative to the cyclist, where $v = w - u$.

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

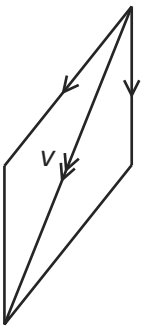
A



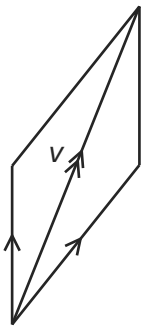
B



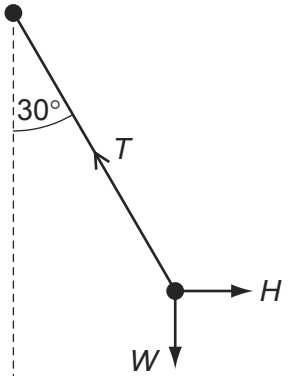
C



D



109 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/Q2



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

Which statement is correct?

A $H = T\cos 30°$

B $T = H\sin 30°$

C $W = T\cos 30°$

D $W = T\sin 30°$

110 Which row shows an SI base quantity with its correct unit? 9702/11/O/N/13/Q1

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

111 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/Q3

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

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

112 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/Q3

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

113 The spring constant k of a coiled wire spring is given by the equation 9702/13/O/N/13/Q4

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

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

114 Which estimate is realistic? 9702/13/O/N/13/Q1

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.

115 Which unit is equivalent to the coulomb? 9702/13/O/N/13/Q2

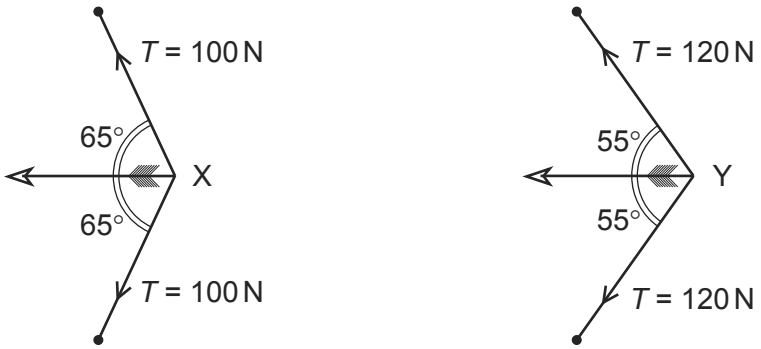
A ampere per second

B joule per volt

C watt per ampere

D watt per volt

116 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/Q14



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

117 The maximum theoretical power P of a wind turbine is given by the equation 9702/12/M/J/14/Q1

$$P = k\rho A v^n$$

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

118 Which pair of units contains one derived unit and one SI base unit? 9702/11/M/J/14/Q1

A ampere coulomb

B kilogram kelvin

C metre second

D newton pascal

119 What is equivalent to 2000 microvolts? 9702/11/M/J/14/Q2

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

120 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/Q3

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

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

121 What is the unit of resistance when expressed in SI base units? 9702/12/M/J/14/Q2

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

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

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

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

122 Which quantity can be measured in electronvolts (eV)? 9702/13/M/J/14/Q1

A electric charge

B electric potential

C energy

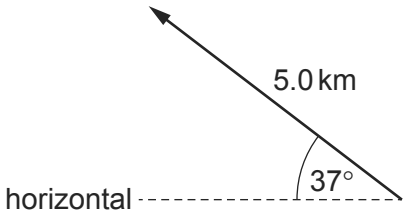
D power

123 The unit of specific heat capacity is $J\,kg^{-1}\,K^{-1}$. 9702/13/M/J/14/Q2

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** $m^2\,s^{-2}\,K^{-1}$

124 What is the vertical component of this displacement vector? 9702/13/M/J/14/Q3



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

125 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/Q1

$$d = kv^2$$

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** $m^{-1}s$

126 Which list contains one vector quantity and two scalar quantities? 9702/13/O/N/14/Q2

A displacement, weight, velocity

B force, acceleration, time

C momentum, mass, speed

D work, density, energy

127 What is equivalent to the unit of electric field strength? 9702/11/O/N/14/Q2

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

128 Which statement includes a correct unit? 9702/13/M/J/15/Q1

A energy = 7.8 N s

B force = 3.8 N s

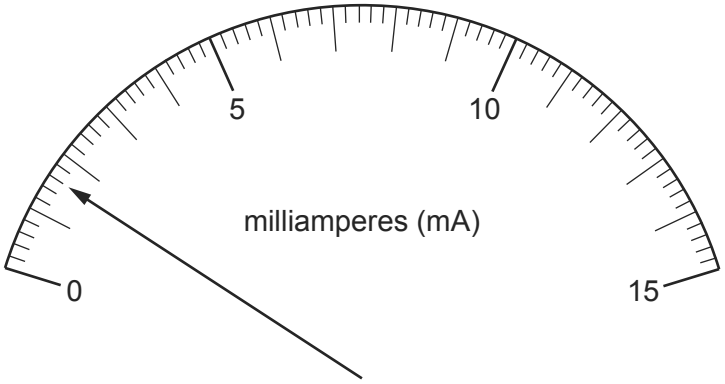
C momentum = 6.2 N s

D torque = 4.7 N s

129 What is the joule (J) in SI base units? 9702/13/M/J/15/Q2

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

130 The diagram shows the reading on an analogue ammeter. 9702/11/O/N/14/Q3



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

131 Which definition is correct and uses only quantities rather than units? 9702/12/M/J/15/Q1

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.

132 The average kinetic energy E of a gas molecule is given by the equation 9702/12/M/J/15/Q2

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

where T is the absolute (kelvin) temperature.

What are the SI base units of k?

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

B $\mathrm{kg^{-1}\,m^{-2}\,s^{2}\,K}$

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

D $\mathrm{kg\,m^{2}\,s^{-2}\,K^{-1}}$

133 Which is an SI base unit? 9702/11/M/J/15/Q1

A current

B gram

C kelvin

D volt

134 Which pair contains one vector and one scalar quantity? 9702/11/M/J/15/Q2

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

135 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/Q3

$$d = kv^2$$

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** $13.0\,k_1$

Physical Quantities and Units – 2021 AS

1. June/2021/Paper_11/No.1

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** $2.0\,m^3$

2. June/2021/Paper_11/No.2

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 ($N\,m\,s^{-1}$)

3. June/2021/Paper_12/No.1

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

A $2 \times 10^3\,W$ for the power dissipated by the heating element of an electric kettle

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

C $5 \times 10^5\,N\,s$ for the momentum of a lorry moving along a road

D $6 \times 10^2\,N$ for the weight of a fully grown racehorse

4. June/2021/Paper_12/No.2

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

A acceleration

B charge

C current

D resistance

5. Nov/2021/Paper_11/No.1

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

6. Nov/2021/Paper_11/No.2

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

7. Nov/2021/Paper_12/No.1

Which row shows what all physical quantities must have?

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

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8. Nov/2021/Paper_12/No.2

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

A 4.3×10^{3} mJ

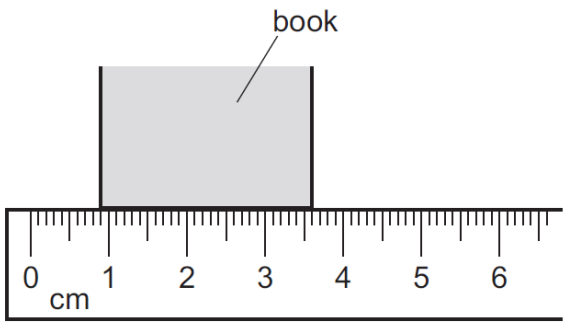
B 4.3×10^{3} MJ

C 4.3×10^{-3} mJ

D 4.3×10^{-3} MJ

9. Nov/2021/Paper_13/No.1

A paperback book contains 210 sheets of paper (pages). Its thickness is measured with a ruler, as shown.



What is the average thickness of one sheet of the paper in the book?

A 0.013 mm **B** 0.017 mm **C** 0.13 mm **D** 0.17 mm

10. Nov/2021/Paper_13/No.2

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

11. Nov/2021/Paper_13/No.3

Which list consists only of scalar quantities?

A acceleration, displacement, force, weight

B density, energy, frequency, velocity

C distance, pressure, temperature, time

D momentum, power, volume, wavelength

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1. Nov/2021/Paper_23/No.2

(a) State what is meant by *work done*.

.....

..... [1]

(b) Use your answer in **(a)** to show that the SI base units of energy are $kg\,m^2\,s^{-2}$.

[1]

(c) A metal rod is heated at one end so that thermal energy flows to the other end. The thermal energy E that flows through the rod in time t is given by

$$E = \frac{cA(T_1 - T_2)t}{L}$$

where A is the cross-sectional area of the rod,
T_1 and T_2 are the temperatures of the ends of the rod,
L is the length of the rod,
and c is a constant.

Determine the SI base units of c.

SI base units ..... [3]

[Total: 5]

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2. March/2021/Paper_22/No.1a

(a) Complete Table 1.1 by stating whether each of the quantities is a vector or a scalar.

Table 1.1

quantity	vector or scalar
acceleration	
power	
work	

[2]

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Physical Quantities and Units – 2023 June AS Physics 9702

1. June/2023/Paper_ 9702/11/No.1

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

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

2. June/2023/Paper_ 9702/11/No.2

What is the best estimate of the number of atoms in a piece of metal of volume 50 cm^3?

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

3. June/2023/Paper_ 9702/12/No.1

A stone sinks in water.

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

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

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

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

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

4. June/2023/Paper_ 9702/12/No.2

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

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5. June/2023/Paper_ 9702/13/No.1

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

6. June/2023/Paper_ 9702/13/No.2

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** $W\,A^{-2}$

7. June/2023/Paper_ 9702/21/No.1

(a) **(i)** Define power.

.....

..... [1]

(ii) Use the definition of power to show that the SI base units of power are $kg\,m^2\,s^{-3}$.

[1]

(b) The intensity I of a sound wave moving through a gas is given by

$$I = f^2A^2vk$$

where f is the frequency of the wave,
A is the amplitude of the wave,
v is the speed of the wave
and k is a constant that depends on the gas.

Determine the SI base units of k.

SI base units ..... [3]

[Total: 5]

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8. June/2023/Paper_ 9702/22/No.1(a, b)

(a) **(i)** Define pressure.

.....

..... [1]

(ii) Use the answer to **(a)(i)** to show that the SI base units of pressure are $kg\,m^{-1}\,s^{-2}$.

[1]

(b) A horizontal pipe has length L and a circular cross-section of radius R. A liquid of density ρ flows through the pipe. The mass m of liquid flowing through the pipe in time t is given by

$$m = \frac{\pi(p_2 - p_1)R^4\rho t}{8kL}$$

where p_1 and p_2 are the pressures at the ends of the pipe and k is a constant.

Determine the SI base units of k.

SI base units ..... [3]

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9. June/2023/Paper_ 9702/23/No.1

A well has a depth of 36 m from ground level to the surface of the water in the well, as shown in Fig. 1.1.

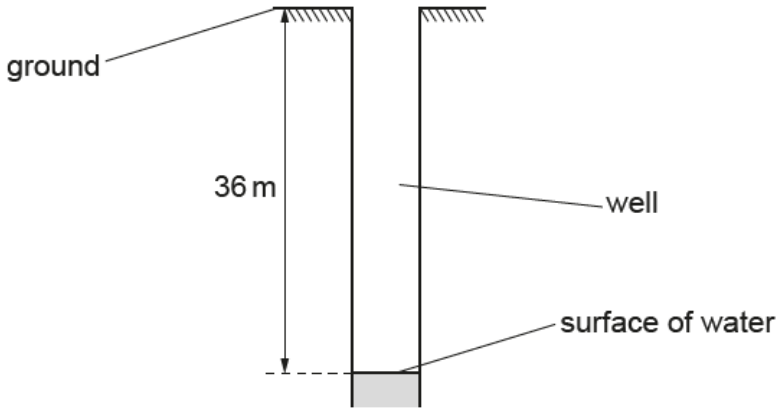


Fig. 1.1 (not to scale)

A student wishes to find the depth of the well. The student plans to drop a stone down the well and record the time taken from releasing the stone to hearing the splash made by the stone as it enters the water.

(a) Assume that air resistance is negligible and that the stone is released from rest.

Calculate the time taken for the stone to fall from ground level to the surface of the water.

time = ... s [2]

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(b) The time recorded by the student using a stop-watch is not equal to the time in **(a)**.

Suggest **three** possible reasons, other than the effect of air resistance, for this difference.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(c) The student repeats the experiment three times and uses the results to calculate the depth of the well. The values are shown in Table 1.1.

Table 1.1

	1st experiment	2nd experiment	3rd experiment
depth/m	54.4	53.9	54.1

The true depth of the well is 36.0 m. Explain why these results may be described as precise but not accurate.

.....

.....

.....

..... [2]

[Total: 7]

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10. March/2023/Paper_ 9702/12/No.1

What represents a physical quantity?

A 3.0

B kilogram

C 7.0 N

D 40%

11. March/2023/Paper_ 9702/12/No.2

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}

12. March/2023/Paper_ 9702/22/No.1(a)

(a) Underline **all** the SI base units in the following list.

ampere coulomb current kelvin newton [1]

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Physical Quantities and Units – 2023 Nov AS Physics 9702

1. Nov/2023/Paper_ 9702/11/No.1

What is a reasonable estimate of the cross-sectional area of the wire in a paper clip?

A $1 \times 10^{-3}\,m^2$ **B** $8 \times 10^{-5}\,m^2$ **C** $8 \times 10^{-7}\,m^2$ **D** $1 \times 10^{-9}\,m^2$

2. Nov/2023/Paper_ 9702/11/No.2

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

A charge

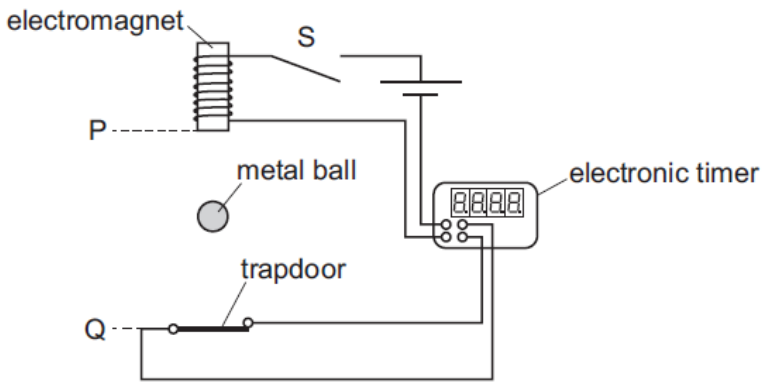
B mass

C temperature

D time

3. Nov/2023/Paper_ 9702/11/No.3

A student determines the acceleration of free fall by using a small metal ball, as shown.



When switch S is opened, the ball is released from an electromagnet and an electronic timer is started. The ball then falls vertically downwards. The timer stops when the ball hits a trapdoor. The student measures the distance PQ between the electromagnet and the trapdoor. This distance and the reading on the timer are then used to calculate the acceleration of free fall.

Which statement about errors in the experiment is correct?

A The random error can be reduced by adding the diameter of the ball to the distance PQ.

B The random error can be reduced by subtracting the diameter of the ball from the distance PQ.

C The systematic error can be reduced by adding the diameter of the ball to the distance PQ.

D The systematic error can be reduced by subtracting the diameter of the ball from the distance PQ.

4. Nov/2023/Paper_ 9702/12/No.1

A student estimates the maximum speed of some different moving objects.

Which maximum speed is **not** a reasonable estimate?

A container ship: $10\,m\,s^{-1}$

B Olympic sprinter: $0.1\,km\,s^{-1}$

C racing car: $9000\,cm\,s^{-1}$

D snail: $0.01\,km\,h^{-1}$

5. Nov/2023/Paper_ 9702/12/No.2

Which quantity is an SI base quantity?

A force

B newton

C second

D time

6. Nov/2023/Paper_ 9702/12/No.3

A student takes measurements to determine the constant acceleration of a model car moving from rest in a straight line. The measured values with their absolute uncertainties are shown.

quantity	measured value	uncertainty
displacement	16.5 m	± 0.1 m
time	15.0 s	± 1.0 s

The student uses the equation $s = \frac{1}{2}at^2$ to calculate the acceleration of the car.

What is the acceleration and its absolute uncertainty?

A $(0.11 \pm 0.01)\,m\,s^{-2}$

B $(0.11 \pm 0.02)\,m\,s^{-2}$

C $(0.15 \pm 0.01)\,m\,s^{-2}$

D $(0.15 \pm 0.02)\,m\,s^{-2}$

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7. Nov/2023/Paper_ 9702/13/No.3

A set of repeated measurements is made of a fixed quantity. An average of these measurements is calculated.

What is the effect of averaging on the random error and the systematic error in the measurements?

A Random error and systematic error are both reduced.

B Random error and systematic error are both unaffected.

C Random error is reduced but systematic error is unaffected.

D Random error is unaffected but systematic error is reduced.

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8. Nov/2023/Paper_ 9702/21/No.1

(a) Compare scalar and vector quantities.

.....

.....

..... [2]

(b) The radius of a small sphere is determined from a measurement of the volume of the sphere. The sphere is submerged in water, displacing some of the water into a measuring cylinder as shown in Fig. 1.1.

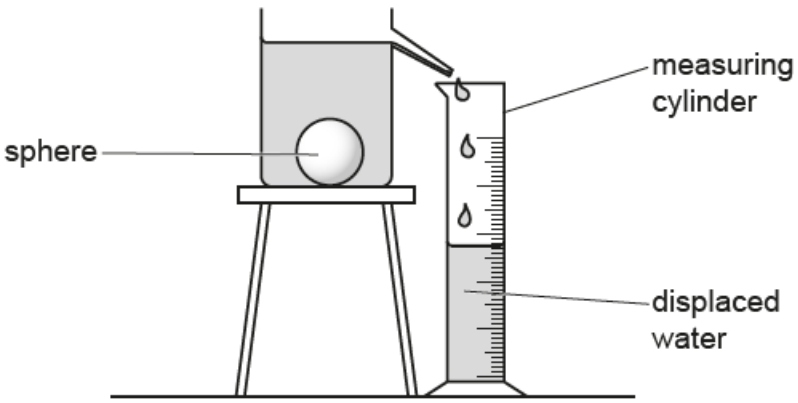


Fig. 1.1 (not to scale)

The measured volume of displaced water is $(28.0 \pm 0.5)\,cm^3$.

Calculate:

(i) the radius, in cm, of the sphere

radius = ... cm [1]

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(ii) the percentage uncertainty in the radius of the sphere.

percentage uncertainty = ... % [2]

[Total: 5]

9. Nov/2023/Paper_ 9702/22/No.1(a)

(a) In the following list, underline **all** quantities that are SI base quantities.

charge electric current force time [1]

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10. Nov/2023/Paper_ 9702/23/No.1

(a) Table 1.1 lists some physical quantities. Complete the table by placing a tick (✓) next to the scalar quantities.

Table 1.1

acceleration	
charge	
momentum	
power	
upthrust	

[1]

(b) A uniform cylinder has diameter D, length L and mass M.
The density ρ of the cylinder is given by

$$\rho = \frac{4M}{\pi D^2 L}.$$

Table 1.2 shows the data obtained from an experiment to determine the density of the cylinder.

Table 1.2

quantity	measurement	percentage uncertainty
D	(26.2 ± 0.1) mm	.....%
L	(162 ± 1) mm	.....%
M	(247 ± 1) g	0.4%

(i) Calculate the percentage uncertainties in D and L. Write your answers in Table 1.2.

[1]

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(ii) Calculate the density of the cylinder. Give your answer to three significant figures.

density = ... $kg\,m^{-3}$ [2]

(iii) Calculate the percentage uncertainty in the density.

percentage uncertainty = ...% [2]

[Total: 6]

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