Questions compiled and answered prepared by Leong Yee Pak

Physical Quantities and Units

Section A (MCQ)

***1 June 02 P1 Q1**
Which of the following pairs of units are both SI base units?

A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

D coulomb, kelvin

***2 June 02 P1 Q3**
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?

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

***3 Nov 02 P1 Q1**

The prefix 'centi' indicates x 10^{-2}. That is, 1 centimetre is equal to 1×10^{-2} metre.

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

	$\times 10^{-12}$	$\times 10^{-9}$	$\times 10^{-6}$
A	nano	micro	pico
B	micro	pico	nano
C	pico	nano	micro
D	pico	micro	nano

***4 June 03 P1 Q1**
Which of hte following is a scalar quantity?
A acceleration **B** mass **C** momentum **D** velocity

***5 June 03 P1 Q2**

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.

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 Nov 03 P1 Q1**

A student measures a current as 0.5 A.

Which of the following correctly expresses this result?

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

****7 Nov 03 P1 Q3**

The momentum of an object of mass m is p.
Which quantity has the same base units as p^2/m?

A energy B force C power D velocity

***8 June 04 P1 Q2**

Which of the following could be measured in the same units as force?

A energy / distance

B energy x distance

C energy / time

D momentum x distance

***9 June 04 P1 Q3**

The notation μs is used as an abbreviation for a certain unit of time. 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

***10 June 04 P1 Q1**

Which pair contains one vector and one scalar quantity?

A displacement : acceleration

B force : kinetic energy

C momentum : velocity

D power : speed

***11 Nov 04 P1 Q1**

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)?

	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

***12 Nov 04 P1 Q2**

Which of the following defnitions is corret and uses only quantities rather than uints?

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.

***13 Nov 04 P1 Q3**

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** $\mathrm{kg\,s^{-3}}$

***14 June 05 P1 Q1**

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 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}

***15 June 05 P1 Q2**

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.

What are the SI base units of k?

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

**16 June 05 P1 Q3

An Olympic athlete of mass 80 kg competes in a 100 m race.

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

*17 Nov 05 P1 Q1

Which pair of units are both SI base units?

A ampere, degree celsius

B ampere, kelvin

C coulomb, degree celsius

D coulomb, kelvin

*18 Nov 05 P1 Q2

The prefix 'centi' indicates x 10^{-2}.

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

*19 Nov 05 P1 Q3

Which expression involving 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}

**20 June 06 P1 Q2

For which quantity is the magnitude a resonable 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

***21 Nov 06 P1 Q1**

Which product-pair of metric prefixes has the greatest magnitude?

A pico × mega

B nano × kilo

C micro × giga

D milli × tera

***22 Nov 06 P1 Q2**

In the expressions below

a is cceleration,
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 $\frac{at^2}{2}$

****23 Nov 06 P1 Q3**

3 Which row of the table shows a physical quantity and its correct unit?

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

***24 June 07 P1 Q1**

1 Which is a pair of SI base units?

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

***25 June 07 P1 Q2**

2 What is the ratio $\frac{1\mu m}{1Gm}$?

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

***26 June 07 P1 Q2**

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?

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

***27 Nov 07 P1 Q1**

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

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

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

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

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

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

****28 Nov 07 P1 Q1**

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

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

***29 June 08 P1 Q1**

1 Five energies are listed.

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

****30 June 08 P1 Q2**

2 Which of the following correctly expresses the volt in terms of SI base units?

A $A\Omega$

B WA^{-1}

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

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

****31 June 08 P1 Q3**

3 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s?

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

****32 Nov 08 P1 Q1**

1 A laser emits light of wavelength 600 nm.

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}

****33 Nov 08 P1 Q2**

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

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

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

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

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

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

***34 June 09 P1 Q1**

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

A $1\,pm = 10^{-9}\,m$

B $1\,nm = 10^{-6}\,m$

C $1\,mm = 10^{6}\,\mu m$

D $1\,km = 10^{6}\,mm$

Section B (Structure Questions)

1 June 02 P2 Q1

Make reasonable estimates of the following quantities.

(a) mass of an apple

mass = ... kg [1]

(b) number of joules of energy in 1 kilowatt-hour

number = ... [1]

(c) wavelength of red light in a vacuum

wavelength = ... m [1]

(d) pressure due to a depth of 10 m of water

pressure = ... Pa [1]

2 Nov 02 Paper 2 Q1

1 (a) (i) Define *density*.

.....

.....

(ii) State the base units in which density is measured.

.....

[2]

(b) The speed v of sound in a gas is given by the expression

$$v = \sqrt{\left(\frac{\gamma p}{\rho}\right)},$$

where p is the pressure of the gas of density ρ. γ is a constant.

Given that p has the base units of $\mathrm{kg\,m^{-1}\,s^{-2}}$, show that the constant γ has no unit. [3]

3 June 03 Paper 2 Q1

1 Complete Fig. 1.1 to show each quantity and its unit. [4]

quantity	*unit*
speed	$m\,s^{-1}$
density	.....
.....	s^{-1}
electric field strength	.....
.....	$kg\,m\,s^{-1}$

Fig. 1.1

4 June 05 P2 Q1

1 Make estimates of the following quantities.

(a) the speed of sound in air

speed = ... [1]

(b) the density of air at room temperature and pressure

density = ... [1]

(c) the mass of a protractor

mass = ... [1]

(d) the volume, in cm^3, of the head of an adult person

volume = ... cm^3 [1]

5 Nov 05 P2
Q1

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

.....

..... [1]

(ii) State the units of pressure in base units.

..... [1]

(b) The pressure p at a depth h in an incompressible fluid of density ρ is given by

$$p = \rho g h,$$

where g is the acceleration of free fall.
Use base units to check the homogeneity of this equation.

.....

.....

.....

..... [3]

6 June 06 P2 Q1

(a) Derive the SI base unit of force.

SI base unit of force = ... [1]

(b) A spherical ball of radius r experiences a resistive force F due to the air as it moves through the air at speed v. The resistive force F is given by the expression

$$F = crv,$$

where c is a constant.

Derive the SI base unit of the constant c.

SI base unit of c = ... [1]

7 June 08 P2 Q1

1 Make reasonable estimates of the following quantities.

(a) the frequency of an audible sound wave

frequency = ... Hz [1]

(b) the wavelength, in nm, of ultraviolet radiation

wavelength = ... nm [1]

(c) the mass of a plastic 30 cm ruler

mass = ... g [1]

(d) the density of air at atmospheric pressure

density = ... kg m^{-3} [1]

8 Nov 08 P2 Q1

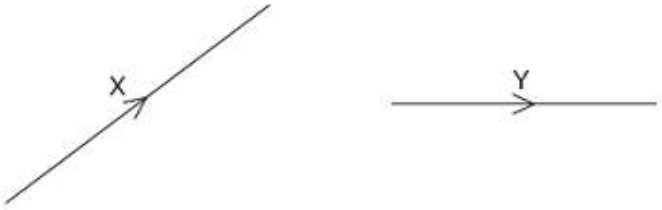
(a) The current in a wire is I. Charge Q passes one point in the wire in time t. State
(i) the relation between I, Q and t, [1]
(ii) which of the quantities I, Q and t are base quantities. [2]
(b) The current in the wire is due to electrons, each with charge q, that move with speed v along the wire. There are n of these electrons per unit volume.
For a wire having a cross-sectional area S, the current I is given by the equation

$$I = nSqv^k ,$$

where k is a constant.
(i) State the units of I, n, S, q and v in terms of the base units. [3]
(ii) By considering the homogeneity of the equation, determine the value of k. [2]

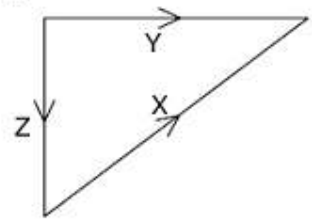
Scalar and Vector quantities.
Section A

***1 June 02 P1 Q2**
The diagram shows two vectors X and Y.

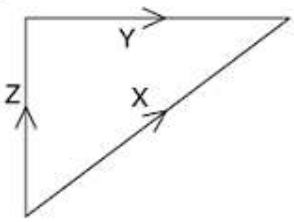


In which vector triangle does the vector Z show the magnitude and direction of vector X – Y?

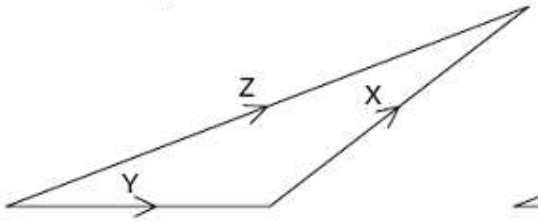
A



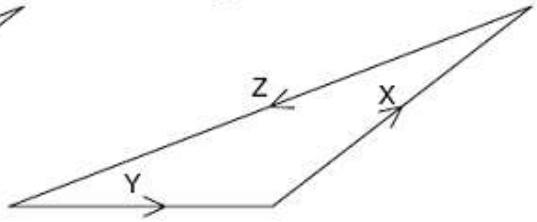
B



C

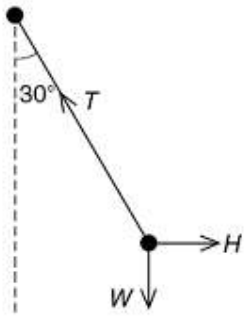


D



***2 Nov 02 P1 Q3**

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



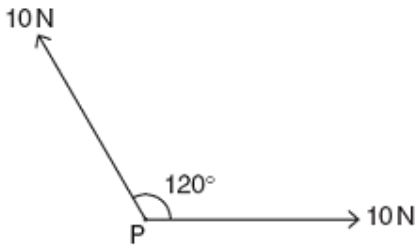
The tension in the string of the pendulum is *T*. The weight of the pendulum bob is *W*.

Which statement is correct?

A $H = T\cos30°$ **B** $T = H\sin30°$ **C** $W = T\cos30°$ **D** $W = T\sin30°$

****3 June 03 P1 Q3**

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°.

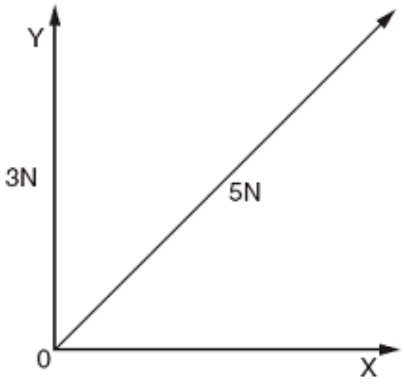


What is the magnitude of the resultant force?

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

***4 Nov 03 P1 Q2**

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.



OY is of magnitude 3 N.

What is the magnitude of OX?

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

***5 June 06 P1 Q1**

Which pair includes a vector quantity and a scalar quantity?

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

***6 June 06 P1 Q3**

The following physical quantities can be either positive or negative.

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

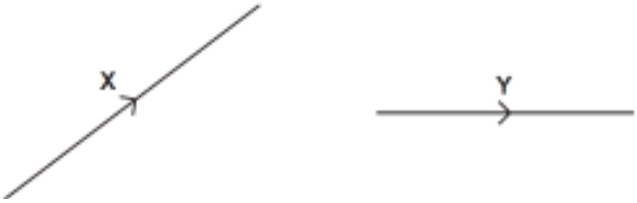
B s, q, V

C θ, V

D s only

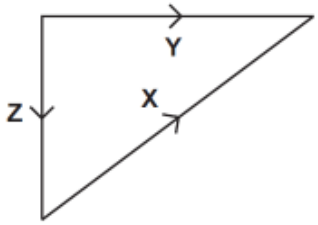
***7 Nov 07 P1 Q3**

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

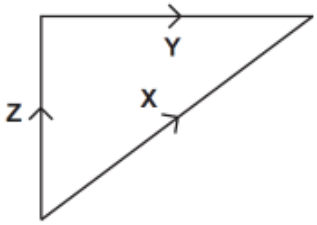


In which vector triangle does the vector **Z** show the magnitude and direction of vector **X**–**Y**?

A



B



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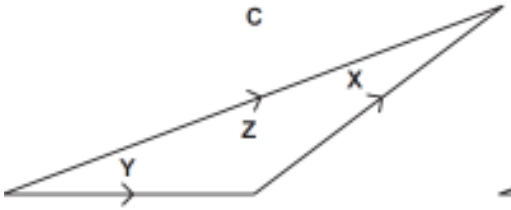
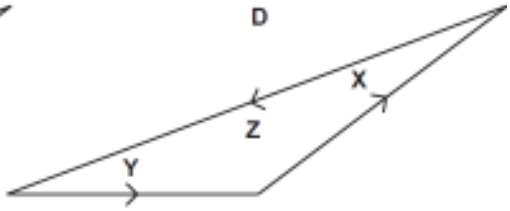


D



***8 Nov 08 P1 Q3**

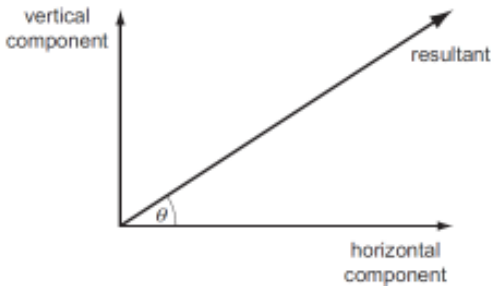
3 The table shows the *x*-component and *y*-component of four force vectors.

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

**9 June 09 P1 Q2

2 The diagram shows a resultant force and its horizontal and vertical components.



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

Section B

1 June 04 P2 Q1

(a) State the difference between a scalar quantity and a vector quantity.

scalar: .....

.....

vector: .....

..... [2]

(b) Two forces of magnitude 6.0 N and 8.0 N act at a point P. Both forces act away from point P and the angle between them is 40°.
Fig. 1.1 shows two lines at an angle of 40° to one another.

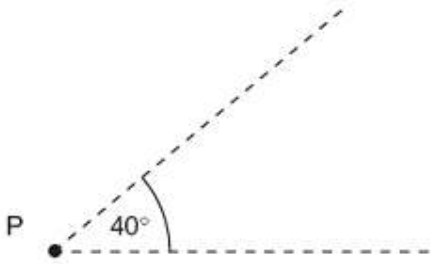


Fig. 1.1

On Fig. 1.1, draw a vector diagram to determine the magnitude of the resultant of the two forces.

magnitude of resultant = ... N [4]

2. A particle which is moving due east at 4.0 ms^{-1} changes directionj and starts to move due south at 3.0 ms^{-1}. Find the change in velocity

Physical Quantities and Units

Section A (MCQ)

***1 June 02 P1** B
*** 2 June 02 P1 A** check unit on the left and the right side of the equation
***3 Nov 02 P1 C** check in your Casio 570 MS calculator
***4 June 03 P1 B**
***5 June 03 P1 B** use W = F.s = ma.s
***6 Nov 03 P1 C**
****7 Nov 03 P1 Q3 A** Momentum p = mv. Hence $p^2/m = mv^2$. Kinetic energy = ½ mv^2
***8 June 04 P1** Q2 A use work W = F.s
***9 June 04 P1 A** check in your Casio 570 MS calculator
***10 June 04 P1 B**
***11 Nov 04 P1 C** check in your Casio 570 MS calculator
***12 Nov 04 P1 Q2 D**
***13 Nov 04 P1 D** [energy]= [work] = [F.s] = [ma.s] = kg ms^{-2}m; [Area] = m^2 ; [time] = s
***14**. **June 05 P1** C check in your Casio 570 MS calculator
***15 June 05 P1 Q2** C [F] = [ma] = kg ms^{-2}. [rv] = m. ms^{-1} = m^2 s^{-1}
[k] = kg ms^{-2} /(m^2 s^{-1})
****16 June 05 P1 B** Olympic time = 10 s. Hence v = 10 ms^{-1}
***17. Nov 05 P1 B**
***18. Nov 05 P1** C
***19 Nov 05 P1 Q3** D Potential difference V = W/Q . W = F.s = ma.s and Q = It.
[W] =kg ms^{-2}. m and [Q] = As. Hence [V] = kg m^2 s^{-2} / As
****20 June 06 P1 Q2 D** Wavelength of light λ = 400 nm to 700 nm
***21 Nov 06 P1** D check in your Casio 570 MS calculator
***22 Nov 06 P1 Q2 B** Energy is equivalent to work done. W = F.s = F(vt)
****23 Nov 06 P1 Q3 A** For A: E = F/q, [E] = kg ms^{-2} /C = kg m s^{-2} C^{-1}
***24 June 07 P1 Q1 C**
***25 June 07 P1 Q2 D** 1μm = 10^{-6}m, 1Gm =10^9 m
***26 June 07 P1 Q2 A** LHS: [v] = ms^{-1}, RHS: [$\sqrt{g\lambda}$] =
***27 Nov 07 P1 Q1 B**
****28 Nov 07 P1 Q1 A**
***29 June 08 P1 Q1 C**
****30 June 08 P1 Q2 D** V = W / Q = F.s / (It) = kg m s^{-2} m / (As)
****31 June 08 P1 Q3 C** estimated mass of athlete = 80 kg. Velocity = 100 / 10 = 10 ms^{-1}. Substitute into the formula E_k = ½ mv^2
****32 Nov 08 P1 Q1 C** Speed of light c = 3.0 x 10^8 ms^{-1}. Distance travelled in 1 second = 3.0 x 10^8 m. Number of wavelength = 3.0 x 10^8 m / 600 x 10^{-9} =
****33 Nov 08 P1 Q2 B** c = Q / (mθ) = W/(mθ) = (Fs) / (mθ) = (mas)/ (mθ), Hence unit for c = (kg ms^{-2}m) / (kgK) = $m^2s^{-2}K^{-1}$. Hence unit for b = $m^2s^{-2}K$
***34 June 09 P1 Q1 D**

Section B (Structure Questions) Physical quantities and units

1. June 02 P2 Q1 (a) 200 g (b) 1 kW-hour = 1000 W x 1h = 1000 W x 1x60x60 s =
(c) 7×10^{-7} m (d) use p = hρg to calculate

2 Nov 02 Paper 2 Q1

1	**(a)**	**(i)**	mass / volume …(ratio must be clear).....	B1	
		(ii)	$kg\ m^{-3}$ OR kg / m^3	B1	[2]
	(b)		v has unit of $m\ s^{-1}$	B1	
			p / ρ has unit of $kg\ m^{-1}\ s^{-2}$ / $kg\ m^{-3}$ (no e.c.f. from (a))	M1	
			$\sqrt{(p / \rho)}$ has unit of $m\ s^{-1}$	A1	
			LHS = RHS so γ has no unit	A0	[3]

3 June 03 Paper 2 Q1

$kg\ m^{-3}$, frequency, NC^{-1} or Vm^{-1}, momentum

4 June 05 P2 Q1

1	**(a)**	allow 100 $m\ s^{-1} \rightarrow$ 900 $m\ s^{-1}$	B1	**[1]**
	(b)	allow 0.5 $kg\ m^{-3} \rightarrow$ 1.5 $kg\ m^{-3}$	B1	**[1]**
	(c)	allow 5 g → 50 g	B1	**[1]**
	(d)	allow $2 \times 10^3\ cm^3 \rightarrow 9 \times 10^3\ cm^3$	B1	**[1]**

5 Nov 05 P2 Q1

(a) (i) pressure = force per uni area, and the force act normally to the area.
(ii) $[p] = [F/A] = [ma/A] = kg\ ms^{-2} / m^2 = kg\ m^{-1}\ s^{-2}$
(b) LHS. $[p] = kg\ m^{-1}\ s^{-2}$
RHS, $[\rho gh] = [m/V][g][h] = kg\ m^{-3} . m\ s^{-2} . m =$

6. June 06 P2 Q1 F = ma, $[F] = [ma] = kg\ ms^{-2}$
(b) F = crv; c = F/rv; $[c] = [F] / [rv] = kg\ ms^{-2} / (m . ms^{-1}) =$

7 June 08 P2 Q1

1	**(a)**	allow anything in range 20 Hz → 20 kHz	B1	[1]
	(b)	allow anything in range 10 nm → 400 nm	B1	[1]
	(c)	allow anything in range 10 g → 100 g	B1	[1]
	(d)	allow anything in range 0.1 $kg\ m^{-3} \rightarrow$ 10 $kg\ m^{-3}$	B1	[1]

8 Nov 08 P2 Q1

1 (a) (i) Q = It (allow any subject for the equation) B1 [1]

(ii) I B1

t B1 [2]

(allow 1 mark only if all three quoted)

(b) (i) base unit of I is A

base unit of n is m^{-3} (not $/m^{-3}$)

base unit of S is m^2

base unit of q is A s (not C)

base unit of v is m s^{-1}

(–1 for each error or omission) B3 [3]

(ii) $A = m^{-3} m^2 A s (m s^{-1})^k$ M1

e.g. for m: $0 = –3 + 2 + k$

$k = 1$ A1 [2]

Scalar and Vector quantities.

Section A

*1. **June 02 P1** B convert to X = Y + Z

***2. Nov 02 P1 C** resolve T vertically and horizontally

****3. June 03 P1 B** Use parallelogram method

***4. Nov 03 P1 C** Use Pythagoras theorem

***5. June 06 P1** B

***6. June 06 P1** D

***7 Nov 07 P1 Q3** B

***8 Nov 08 P1 Q3** A

****9 June 09 P1 Q2** C Let resultant force = F. Hence F cos 30 = 20. F = 23.1. Vertical component = 23.1 sin 30^o = 11.5 N

Section B

1. **June 04 P2 Q1** scalar: quantity that has only magnitude but no direction.

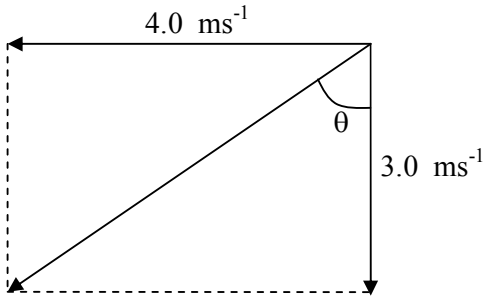
Vector: quantity that has both magnitude and direction.

(b) Use parallelogram method and draw accurately to scale.

2 Change in velocity = final velocity – initial velocity

$= V_S - V_E$

$= V_S + (-V_E)$



Magnitude of velocity = 5.0 ms^{-1}

$\tan \theta = 4/3$. Hence $\theta = 53.1^o$

Velocity change = 5 ms^{-1} in the direction South 53.1^o West.