梓枋 Grant

AS PHYSICS

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吴梓桢

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主编 吴梓桢

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走 读 部 ： 中关村教室 ：中关村东路 123 号都市网景 2 号楼 2103（地铁十号线知春里，十三号大钟寺，知春路，四号线人民大学站步行均可到达）

通州区教室 ：潞河名苑 1 号楼 4 单元 501 室

咨 询 电 话 ： 010-62142630 /62142632 或 15001212231(吴老师)

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公司简介

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2005 年以来，我们一直为“打造国内精品的 A-Level 私塾”而努力：

筹集 A—Level 教学资源——研究 A—Level 课程——亲自实践 A—Level 教学——聘用并培训 A—Level 教师——编写真正适合大陆学生的 A—Level 教学讲义和书籍。

我们萃取各校优秀外教的讲义/习题/练习册与从国外购的学习资料中优秀的部分，编了近 20 本大小的习题及讲义，这是国内第一批 **A-Level 教学资料：包括《**A-Level 教材注解》、**《A-Level 考试考点精讲》、《历年 CIE 高考真题分类汇编》、《A-Level 教科书经典题集粹》等等。**基于多年对 A-Level 课程的研究并结合公司的内部讲义、资料，我们形成了一套精辟的教学模式，对于有一定语言基础的学生，每门理论课只需上 8 至 10 次，每次 3 小时，就能学透国内**一整年的 A-Level 课程。**

多年来，我们接触了大量背景不同却持着同一个留学梦的孩子们，有很多国内 **A-Level 在读生来中心课外辅导；也有去英国读 A-Level 的孩子在出国前来提前预习；还有**英国 **A-Level 在读生利用圣诞节、复活节来中心进行 A-Level 高考的考前辅导；还有不少成绩较好的国内在读高中生利用寒暑假来中心学 A-Level 课程，3 至 4 个月的时间学完 AS/A2 并充分备考，也考入了英国理想的大学……**

为了能为更多的孩子圆留学梦，在培训辅导部稳步拓展的同时，北京梓桢国际教育又与**北京市私立树人·瑞贝学校**（成立于 1993 年）合作，开设了**全日制住宿教学部**与**全脱产/半脱产住宿教学部**，现已面向全国招生，旨在建立一个以培训准备赴英、美、加、澳等国家就读大学本科课程的高中学生为对象的国际教育考试优质培训基地，基本课程包括 A-Level 课程、SAT 课程、AP 课程及雅思、托福课程，国际高中采用国外高中教材，理论课同时采用中教汉英双语与外教全英语授课。

目录

Chapter 1--Physical Quantities & Units

(a) show an understanding that all physical quantities consist of a numerical magnitude and a unit

(b) recall the following SI base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)

- **Base unit**

1 Which row shows a base quantity with its correct S*I* unit? (10w)

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

(c) express derived units as products or quotients of the SI base units and use the named units listed in this syllabus as appropriate

- **Derived unit**

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. (08w)

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 $kgm^2 s^{-2} K^{-3}$

D $kgm^2 s^{-2} K^{-4}$

3 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. (09w)

What are the base units of the constant k ?

A $kgm^5 s^{-4}$ **B** $kgm^{-2} s^{-1}$ **C** kgm^{-3} **D** $kgm^{-4} s^2$

4 The table contains some quantities, together with their symbols and units.
Which expression has the units of energy? (09w)

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	$\mathrm{m^3}$

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

5 The SI unit for potential difference (the volt) is given, in base units, by (10s)

A $kgmA^{-1}s^{-3}$

B $m^2A^{-1}s^{-2}$

C kgm^2s^{-2}

D $kgm^2A^{-1}s^{-3}$

6 The product of pressure and volume has the same SI base units as (10s)
A energy.
B force.
C $\dfrac{force}{area}$
D $\dfrac{force}{length}$

7 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v, it experiences a drag force F given by F = kr v, where k is a constant.
What are the S*I* base units of k ?

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

8 The frictional force F on a sphere falling through a fluid is given by the formula (10w/12)

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

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

9 Which of the following correctly expresses the volt in terms of SI base units? (08s)

A AΩ

B WA^{-1}

C $kgm^2s^{-1}A^{-1}$

D $kgm^2s^{-3}A^{-1}$

10

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.

11

Stress has the same SI base units as

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

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

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

D energy.

(d) use SI base units to check the homogeneity of physical equations

12

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

Which equation must be **incorrect**?

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

13

A cylindrical tube rolling down a slope of inclination θ moves a distance L in time T. The equation relating these quantities is

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

Where a is the internal radius of the tube and P and Q are constants.

Which line gives the correct units for P and Q?

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

14

What is the unit of power in SI base units?

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

(f) u se the following prefixes and their symbols to indicate decimal sub-multiples or multiples of both base and derived units: pico (p), nano (n),micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)

- **prefix**

15 Five energies are listed. (08s)

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

16 Which statement, involving multiples and sub-multiples of the base unit metre (m), is correct? (09s)

A 1pm = 10^{-9} m

B 1nm = 10^{-6} m

C 1mm = 10^{6} μm

D 1km = 10^6 mm

17

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)?

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

18

What is the ratio $\frac{10^{-3}\ \text{THz}}{10^{3}\ \text{kHz}}$?

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

(g) make reasonable estimates of physical quantities included within the syllabus

- **Estimate**

19 What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m race that takes 10 s? (08s)

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

20

In making reasonable estimates of physical quantities, which statement is **not** correct?

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.

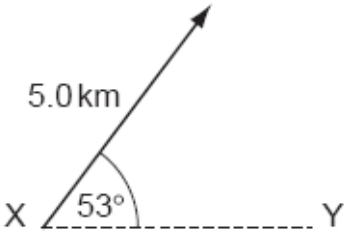
(j) distinguish between scalar and vector quantities and give examples of each

(k) add and subtract coplanar vectors

(l) represent a vector as two perpendicular components.

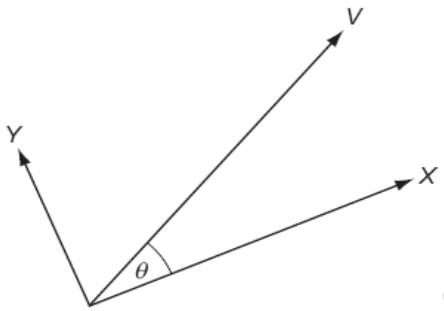
- **Vector and scalar**

21 What is the component of this displacement vector in the direction XY? (10w)



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

22 A vector quantity V is resolved into two perpendicular components X and Y. The angle between V and component X is θ.(10s)

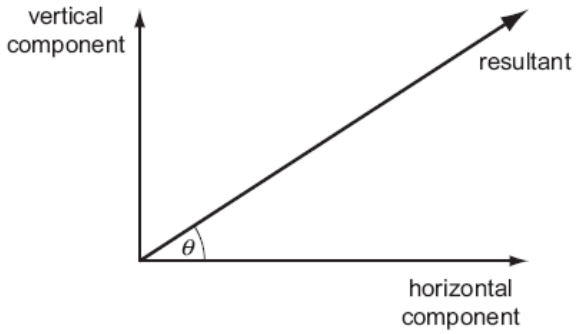


The angle between component X and the vector V is increased from 0 °to 90 °.
How do the magnitudes of X and Y change as the angle θ is increased in this way?

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

23 Forces of 3 N, 4 N and 5 N act at one point on an object. The angles at which the forces act can vary. (10s)
What is the value of the minimum resultant force of these forces?
A 0
B between 0 and 2N
C 2N
D between 2N and 4N

24 The diagram shows a resultant force and its horizontal and vertical components. (09s)



The horizontal component is 20.0 N and θ = 30°. What is the vertical component?

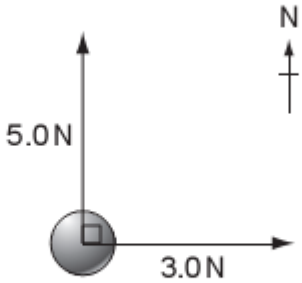
A 8.7N **B** 10.0N **C** 11.5N **D** 17.3N

25 The table shows the x-component and y-component of four force vectors. Which force vector has the largest magnitude? (08w)

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

26

A force of 5.0 N pushes a ball due north and another force of 3.0 N pushes it due east.

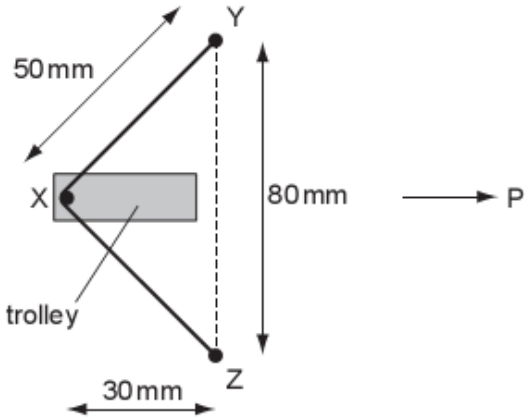


What is the magnitude of the net force acting on the ball?

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

27

The diagram shows two fixed pins, Y and Z. A length of elastic is stretched between Y and Z and around pin X, which is attached to a trolley.



X is at the centre of the elastic and the trolley is to be propelled in the direction P at right angles to YZ. The tension in the elastic is 4 N.

What is the force accelerating the trolley in the direction P when the trolley is released?

A 2.4 N **B** 3.2 N **C** 4.8 N **D** 6.4 N

28

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

29

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

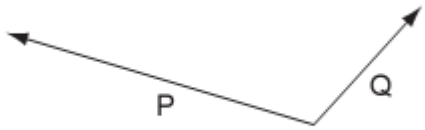
V : readings on a digital voltmeter

Which of these quantities are vectors?

A s, θ, q, V **B** s, q, V only **C** θ, V only **D** s only

30

Two possible displacements of an object are represented by the vectors P and Q.



Which vector best represents the resultant displacement (P – Q) of the object?

A

B

C

D

Chapter 1--Physical Quantities & Units（大题）

(a) show an understanding that all physical quantities consist of a numerical magnitude and a unit

(b) recall the following SI base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)

(c) express derived units as products or quotients of the SI base units and use the named units listed in this syllabus as appropriate

1 (a) Two of the SI base quantities and their units are mass(kg) and length (m). (09s/22/1)

Name three other SI base quantities and their units.

1. quantity.....unit.....

2. quantity.....unit.....

3. quantity.....unit.....

(b) The pressure ρ due to a liquid of density ρ is related to the depth h by the expression

$$p = \rho g h$$

where g is the acceleration of free fall.

Use this expression to determine the derived units of pressure. Explain your working.

2 (a) Two of the SI base quantities are mass and time. State three other SI base quantities. (10w/21/1)

1.

2.

3.

[3]

(b) A sphere of radius r is moving at speed v through air of density ρ. The resistive force F acting on the sphere is given by the expression

$$F = Br^2\rho v^k$$

where B and k are constants without units.

(i) State the SI base units of F, ρ and v.

F

ρ

v

[3]

(ii) Use base units to determine the value of k.

k = ... [2]

(f) u se the following prefixes and their symbols to indicate decimal sub-multiples or multiples of both base and derived units: pico (p), nano (n),micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)

3 A unit is often expressed with a prefix. For example, the gram may be written with the prefix 'kilo' as the kilogram. The prefix represents a power-of-ten. In this case, the power-of-ten is 10^3. (10s/21/1))

Complete Fig. 1.1 to show each prefix with its symbol and power-of-ten.

prefix	symbol	power-of-ten
kilo	k	10^3
nano	n	.....
centi	.....	10^{-2}
.....	M	10^6
.....	T	10^{12}

Fig. 1.1

[4]

(g) make reasonable estimates of physical quantities included within the syllabus

4 Make estimates of the following quantities. (10w/23/1)

(a) the thickness of a sheet of paper

thickness = ... mm [1]

(b) the time for sound to travel 100 m in air

time = ... s [1]

(c) the weight of 1000 cm^3 of water

weight = ... N [1]

5 Make reasonable estimates of the following quantities. (08s/1)

(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]

(j) distinguish between scalar and vector quantities and give examples of each

(k) add and subtract coplanar vectors

(l) represent a vector as two perpendicular components.

6 **(a) (i)** Distinguish between vector quantities and scalar quantities. (10w/22/1)

[2]

(ii) State whether each of the following is a vector quantity or a scalar quantity.

1. temperature

[1]

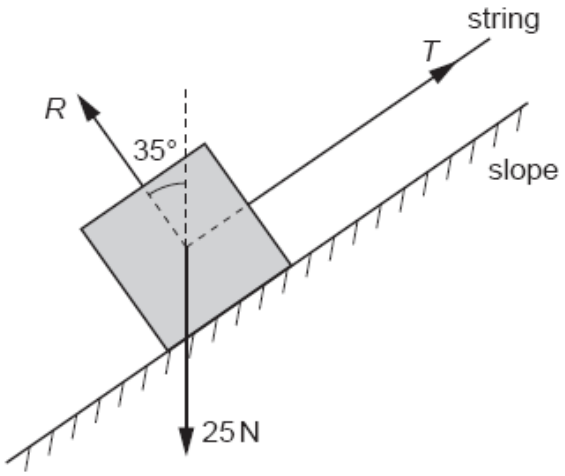
2. acceleration of free fall

[1]

3. electrical resistance

[1]

(b) A block of wood of weight 25 N is held stationary on a slope by means of a string, as shown in Fig. 1.1.



The tension in the string is T and the slope pushes on the block with a force R that is normal to the slope.

Either by scale drawing on Fig. 1.1 or by calculation, determine the tension T in the string.

T = ... N [3]

Chapter 2 -- Measurement Techniques

(a) use techniques for the measurement of length, volume, angle, mass, time, temperature and electrical quantities appropriate to the ranges of magnitude implied by the relevant parts of the syllabus. In particular, candidates should be able to:

- **measure lengths using a ruler, vernier scale and micrometer**
- **measure weight and hence mass using spring and lever balances**
- **measure an angle using a protractor**
- **measure time intervals using clocks, stopwatches and the calibrated time-base of a cathode-ray oscilloscope (c.r.o.)**
- **measure temperature using a thermometer as a sensor**
- **use ammeters and voltmeters with appropriate scales**
- **use a galvanometer in null methods**
- **use a cathode-ray oscilloscope (c.r.o.)**
- **use a calibrated Hall probe**

(b) use both analogue scales and digital displays

1 A micrometer screw gauge is used to measure the diameter of a copper wire. 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. (10s)

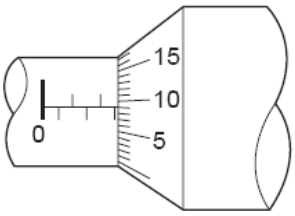


diagram 1

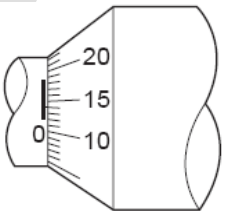
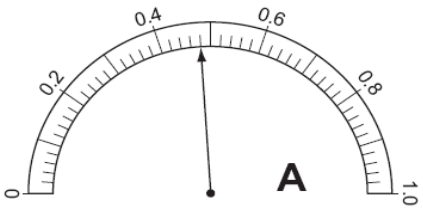


diagram 2

What is the diameter of the wire?

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

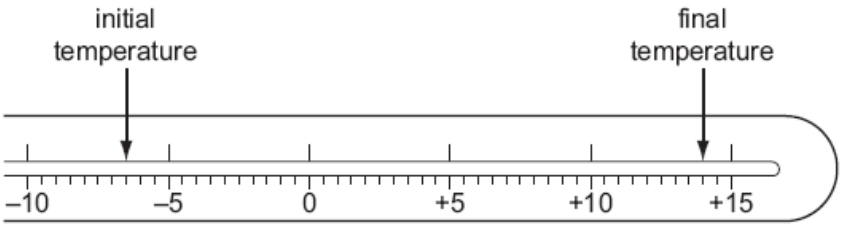
2 The diagrams show digital voltmeter and analogue ammeter readings from a circuit in which electrical heating is occurring. (09s)



What is the electrical power of the heater?

A 0.53 W **B** 0.58 W **C** 530 W **D** 580 W

3 The diagram shows the stem of a Celsius thermometer marked to show initial and final temperature values. (10s)



What is the temperature change expressed to an appropriate number of significant figures?

A 14 ℃ **B** 20.5 ℃ **C** 21 ℃ **D** 22.0 ℃

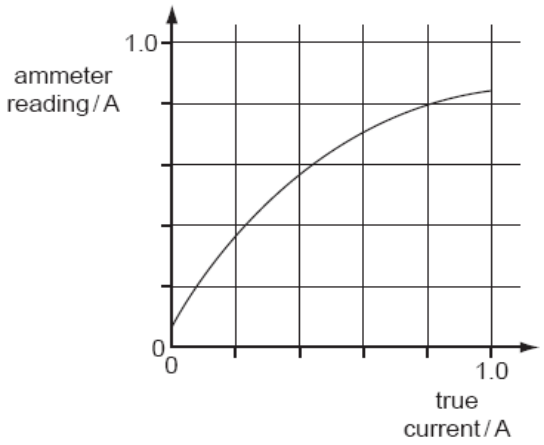
4 A metre rule is used to measure the length of a piece of wire. It is found to be 70 cm long to the nearest millimetre. (10w)

How should this result be recorded in a table of results?

A 0.7 m **B** 0.70 m **C** 0.700 m **D** 0.7000 m

(c) use calibration curves

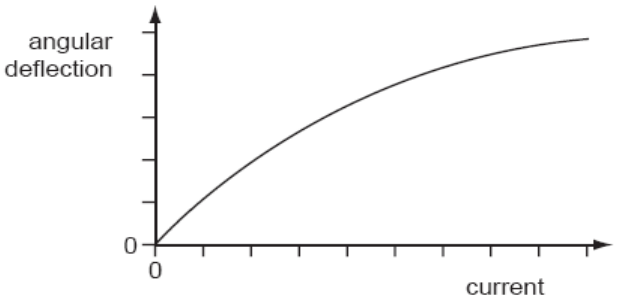
5 A calibration graph is produced for a faulty ammeter. (08w)



Which ammeter reading will be nearest to the correct value?

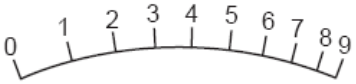
A 0.2 A **B** 0.4 A **C** 0.6 A **D** 0.8 A

6 The angular deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph. (10w)



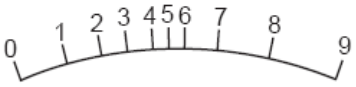
Which diagram could represent the appearance of the scale on this meter?

A



B

C



D

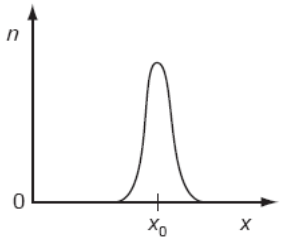
(d) show an understanding of the distinction between systematic errors (including zero errors) and random errors

(e) show an understanding of the distinction between precision and accuracy

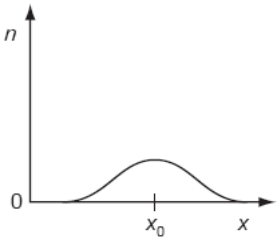
7 A fixed quantity x_0 is measured many times in an experiment that has experimental uncertainty. A graph is plotted to show the number n of times that a particular value x is obtained. (10w)

Which graph could be obtained if the measurement of x_0 has a large systematic error but a small random error?

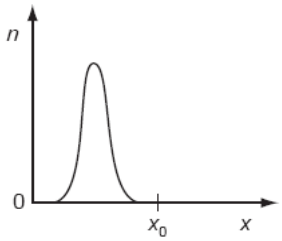
A



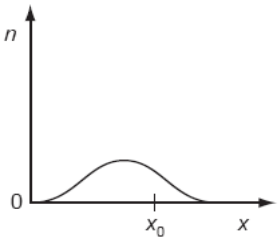
B



C



D



8 Four students each made a series of measurements of the acceleration of free fall g. The table shows the results obtained. (08s)

Which set of results could be described as precise but not accurate?

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

9

The speedometer in a car consists of a pointer which rotates. The pointer is situated several millimetres from a calibrated scale.

What could cause a random error in the driver's measurement of the car's speed?

A The car's speed is affected by the wind direction.

B The driver's eye is not always in the same position in relation to the pointer.

C The speedometer does not read zero when the car is at rest.

D The speedometer reads 10 % higher than the car's actual speed.

(f) assess the uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties (a rigorous statistical treatment is not required).

- **Uncertainty 的表示**

10 A student uses a digital ammeter to measure a current. The reading of the ammeter is found to fluctuate between 1.98 A and 2.02 A. (08w)

The manufacturer of the ammeter states that any reading has a systematic uncertainty of ±1 %.

Which value of current should be quoted by the student?

A (2.00 ±0.01) A

B (2.00 ±0.02) A

C (2.00 ±0.03) A

D (2.00 ±0.04) A

- **Uncertainty 的加减运算**

11 A quantity x is to be determined from the equation

$$x = P - Q.$$

P is measured as 1.27 ±0.02 m.

Q is measured as 0.83 ±0.01 m.

What is the percentage uncertainty in x to one significant figure?

A 0.4 % **B** 2 % **C** 3 % **D** 7 %

- **Uncertainty 的加减运算**

12 The resistance R of a resistor is determined by measuring the potential difference V across it and the current I in it. The value of R is then calculated using the equation (08s)

$$R = \frac{V}{I}$$

The values measured are V = 1.00 ±0.05 V and I = 0.50 ±0.01 A.

What is the percentage uncertainty in the value of R ?

A 2.5 % **B** 3.0 % **C** 7.0 % **D** 10.0 %

13 A student finds the density of a liquid by measuring its mass and its volume. The following is a summary of his measurements.(10s)

mass of empty beaker = (20 ±1) g

mass of beaker + liquid = (70 ±1) g

volume of liquid = (10.0 ±0.6) cm^3

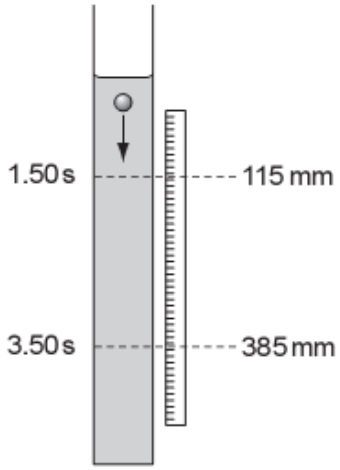
He correctly calculates the density of the liquid as 5.0gcm^{-3}.

What is the uncertainty in this value?

A 0.3 g cm^{-3} **B** 0.5 g cm^{-3} **C** 0.6 g cm^{-3} **D** 2.6 g cm^{-3}

12

The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.



There are two marks on the tube. The top mark is positioned at 115 ± 1 mm on the adjacent rule and the lower mark at 385 ± 1 mm. The ball passes the top mark at 1.50 ± 0.02 s and passes the lower mark at 3.50 ± 0.02 s.

The constant speed of the ball is calculated by $\frac{385-115}{3.50-1.50} = \frac{270}{2.00} = 135\,\text{mm s}^{-1}$.

Which expression calculates the fractional uncertainty in the value of this speed?

A $\frac{2}{270} + \frac{0.04}{2.00}$

B $\frac{2}{270} - \frac{0.04}{2.00}$

C $\frac{1}{270} \times \frac{0.02}{2.00}$

D $\frac{1}{270} \div \frac{0.02}{2.00}$

15

The uncertainty in the value of the momentum of a trolley passing between two points X and Y varies with the choice of measuring devices.

Measurements for the same trolley made by different instruments were recorded.

1 distance between X and Y using a metre rule with cm divisions = 0.55 m

2 distance between X and Y using a metre rule with mm divisions = 0.547 m

3 timings using a wristwatch measuring to the nearest 0.5 s at X = 0.0 s and at Y = 4.5 s

4 timings using light gates measuring to the nearest 0.1 s at X = 0.0 s and at Y = 4.3 s

5 mass of trolley using a balance measuring to the nearest g = 6.4×10^{-2} kg

6 mass of trolley using a balance measuring to the nearest 10 g = 6×10^{-2} kg

Which measurements, one for each quantity measured, lead to the least uncertainty in the value of the momentum of the trolley?

A 1, 3 and 6 **B** 1, 4 and 6 **C** 2, 3 and 6 **D** 2, 4 and 5

16

The Young modulus of the material of a wire is to be found. The Young modulus E is given by the equation below.

$$E = \frac{4Fl}{\pi d^2 x}$$

The wire is extended by a known force and the following measurements are made.

Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus?

	measurement	symbol	value
A	length of wire before force applied	l	2.043 ± 0.002 m
B	diameter of wire	d	0.54 ± 0.02 mm
C	force applied	F	19.62 ± 0.01 N
D	extension of wire with force applied	x	5.2 ± 0.2 mm

17

A micrometer is used to measure the diameters of two cylinders.

diameter of first cylinder = 12.78 ± 0.02 mm

diameter of second cylinder = 16.24 ± 0.03 mm

The difference in the diameters is calculated.

What is the uncertainty in this difference?

A ±0.01 mm **B** ±0.02 mm **C** ±0.03 mm **D** ±0.05 mm

Chapter 2 -- Measurement Techniques（大题）

(c) use calibration curves

1 The volume of fuel in the tank of a car is monitored using a meter as illustrated in Fig. 1.1. (09w/21/1)

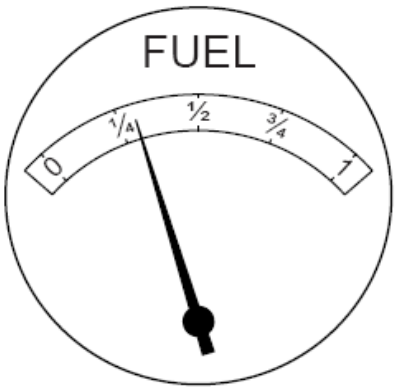


Fig. 1.1

The meter has an analogue scale. The meter reading for different volumes of fuel in the tank is shown in Fig. 1.2.

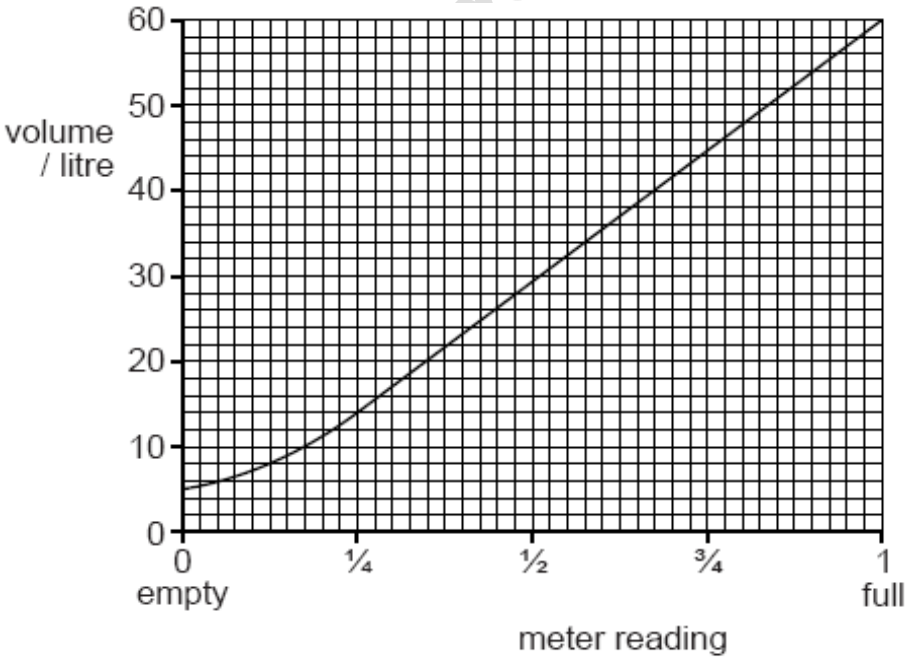


Fig. 1.2

The meter is calibrated in terms of the fraction of the tank that remains filled with fuel.

(a) The car uses 1.0 litre of fuel when travelling 14 km. The car starts a journey with a full tank of fuel.

(i) Calculate the volume of fuel remaining in the tank after a journey of 210 km.

volume = ... litres [2]

(ii) Use your answer to **(i)** and Fig. 1.2 to determine the change in the meter reading during the 210 km journey.

from full to ..... [1]

(b) There is a systematic error in the meter.

(i) State the feature of Fig. 1.2 that indicates that there is a systematic error.

[1]

(ii) Suggest why, for this meter, it is an advantage to have this systematic error.

[1]

(d) show an understanding of the distinction between systematic errors (including zero errors) and random errors

(e) show an understanding of the distinction between precision and accuracy

2 A metal wire has a cross-section of diameter approximately 0.8 mm. (10s/22/1)

(a) State what instrument should be used to measure the diameter of the wire.

[1]

(b) State how the instrument in **(a)** is

(i) checked so as to avoid a systematic error in the measurements,

[1]

(ii) used so as to reduce random errors.

[1]

3（S23-1）

(a) For each of the following, tick [✓] one box to indicate whether the experimental technique would reduce random error, systematic error or neither. The first row has been completed as an example.

	random error	systematic error	neither
keeping your eye in line with the scale and the liquid level for a single reading of a thermometer		✓	
averaging many readings of the time taken for a ball to roll down a slope			
using a linear scale on an ammeter			
correcting for a non-zero reading when a micrometer screw gauge is closed			

[2]

(b) The measurement of a particular time interval is repeated many times. The readings are found to vary. The results are shown in Fig. 1.1.

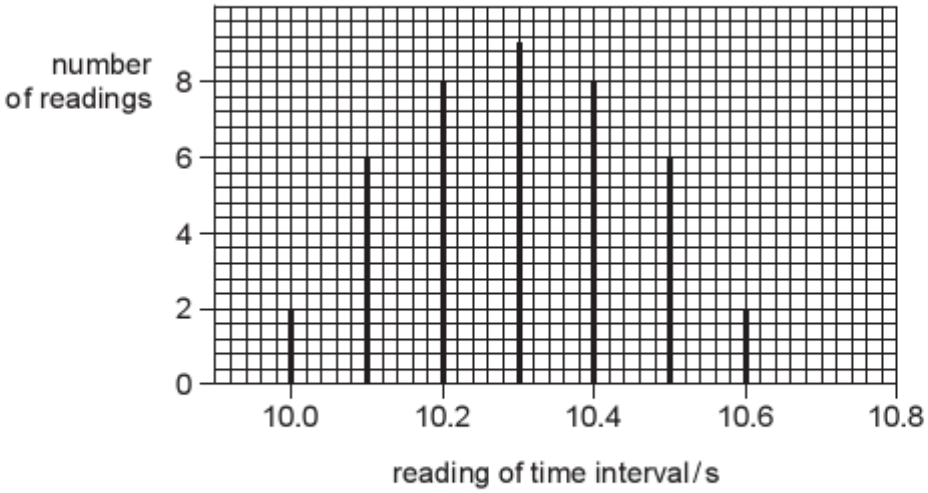


Fig. 1.1

The true value of the time interval is 10.1 s.

(i) State how the readings on Fig. 1.1 show the presence of

1. a systematic error,

.....

..... [1]

2. a random error.

.....

..... [1]

(ii) State the expected changes to Fig. 1.1 for experimental measurements that are

1. more accurate,

.....

..... [1]

2. more precise.

.....

..... [1]

(f) assess the uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties (a rigorous statistical treatment is not required).

4 A simple pendulum may be used to determine a value for the acceleration of free fall g. Measurements are made of the length L of the pendulum and the period T of oscillation. (09w/22/1)

The values obtained, with their uncertainties, are as shown.

T = (1.93 ± 0.03) s

L = (92 ± 1) cm

(a) Calculate the percentage uncertainty in the measurement of

(i) the period T,

uncertainty = ... % [1]

(ii) the length L.

uncertainty = ... % [1]

(b) The relationship between T, L and g is given by

$$g = \frac{4\pi^2 L}{T^2}$$

Using your answers in **(a)**, calculate the percentage uncertainty in the value of g.

uncertainty = ... % [1]

(c) The values of L and T are used to calculate a value of g as $9.751\ ms^{-2}$.

(i) By reference to the measurements of L and T, suggest why it would not be correct to quote the value of g as $9.751\ ms^{-2}$.

[1]

(ii) Use your answer in **(b)** to determine the absolute uncertainty in g.

Hence state the value of g, with its uncertainty, to an appropriate number of significant figures.

g = ... ± ..... ms^{-2} [2]

5 **(a)** State the most appropriate instrument, or instruments, for the measurement of the following. (09s/1)

(i) the diameter of a wire of diameter about 1 mm

..... [1]

(ii) the resistance of a filament lamp

..... [1]

(iii) the peak value of an alternating voltage

..... [1]

(b) The mass of a cube of aluminium is found to be 580 g with an uncertainty in the measurement of 10 g. Each side of the cube has a length of (6.0 ± 0.1) cm.

Calculate the density of aluminium with its uncertainty. Express your answer to an appropriate number of significant figures.

density = ... ± ..... g cm^{-3} [5]

6 A digital voltmeter with a three-digit display is used to measure the potential difference across a resistor. The manufacturers of the meter state that its accuracy is ±1% and ±1 digit. (10s/23/1)

The reading on the voltmeter is 2.05 V.

(a) For this reading, calculate, to the nearest digit,

(i) a change of 1% in the voltmeter reading,

change = ...V [1]

(ii) the maximum possible value of the potential difference across the resistor.

maximum value = ...V [1]

(b) The reading on the voltmeter has high precision. State and explain why the reading may not be accurate.

[2]

7（S21-1）

Measurements made for a sample of metal wire are shown in Fig. 1.1.

quantity	measurement	uncertainty
length	1750 mm	± 3 mm
diameter	0.38 mm	± 0.01 mm
resistance	7.5 Ω	± 0.2 Ω

Fig. 1.1

(a) State the appropriate instruments used to make each of these measurements.

(i) length

..... [1]

(ii) diameter

..... [1]

(iii) resistance

..... [1]

(b) **(i)** Show that the resistivity of the metal is calculated to be $4.86 \times 10^{-7}\ \Omega$m.

[2]

(ii) Calculate the uncertainty in the resistivity.

uncertainty = ± ..... Ωm [4]

(c) Use the answers in **(b)** to express the resistivity with its uncertainty to the appropriate number of significant figures.

resistivity = ... ± ..... Ωm [1]

Chapter 3 --Forces

(a) describe the forces on mass and charge in uniform gravitational and electric fields, as appropriate

(b) show an understanding of the origin of the upthrust acting on a body in a fluid

(c) show a qualitative understanding of frictional forces and viscous forces including air resistance (no treatment of the coefficients of friction and viscosity is required)

(e) show an understanding that the weight of a body may be taken as acting at a single point known as its centre of gravity

1 What is the centre of gravity of an object? (09w)

A the geometrical centre of the object

B the point about which the total torque is zero

C the point at which the weight of the object may be considered to act

D the point through which gravity acts

2 Which defines the weight of a body? (10w)

A the amount of matter in the body

B the force of gravity on the body

C the number of particles in the body

D the product of the body's volume and density

3 The gravitational field strength on the surface of planet P is one tenth of that on the surface of planet Q. (10w)

On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N.

What are the mass and weight of the same body on the surface of planet Q?

	mass on Q/kg	weight on Q/N
A	1.0	0.1
B	1.0	10
C	10	10
D	10	100

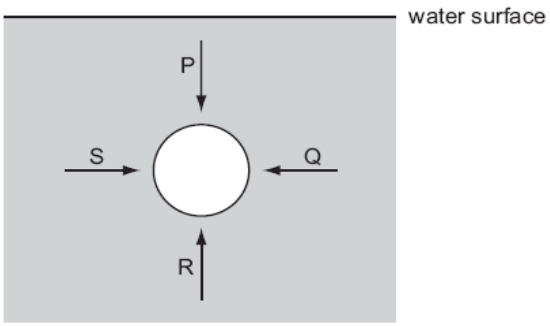
4 The acceleration of free fall on a planet P is $\frac{1}{6}$ of the acceleration of free fall on Earth. (08s)

The mass of a body on planet P is 30 kg.

What is its weight on planet P?

A 4.9N **B** 49N **C** 180N **D** 290N

5 The diagram represents a sphere under water. P, Q, R, and S are forces acting on the sphere, due to the pressure of the water.(09s)



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.
Which information about the magnitudes of the forces is correct?

A P < R ; S = Q **B** P > R ; S = Q
C P = R ; S = Q **D** P = R = S = Q

6 A ball is falling at terminal speed in still air. The forces acting on the ball are upthrust, viscous drag and weight. (08s)
What is the order of increasing magnitude of these three forces?

A upthrust → viscous drag → weight
B viscous drag → upthrust → weight
C viscous drag → weight → upthrust
D weight → upthrust → viscous drag

7

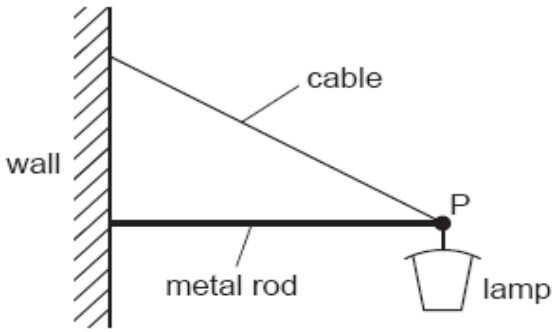
A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is $1.64\,m\,s^{-2}$.

What are the weight and the mass of the body when it is on the Moon?

	weight / N	mass / kg
A	9.85	1.00
B	9.85	6.00
C	58.9	1.00
D	58.9	6.00

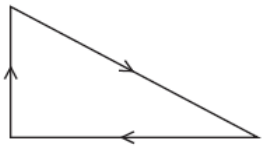
(d) use a vector triangle to represent forces in equilibrium

8 A street lamp is fixed to a wall by a metal rod and a cable. (10w)

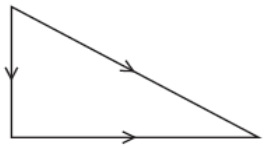


Which vector triangle represents the forces acting at point P?

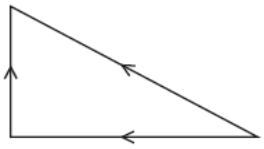
A



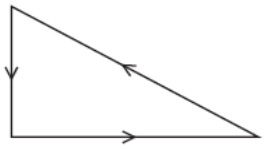
B



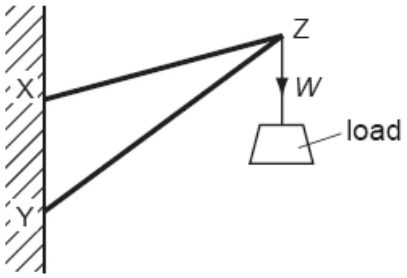
C



D

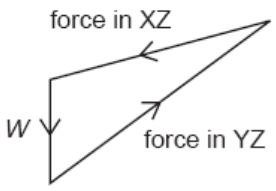


9 Two rigid rods, XZ and YZ, are fixed to a vertical wall at points X and Y.
A load of weight *W* is hung from point Z. (08s)
The load is not moving.

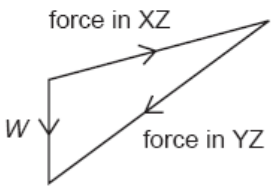


Which diagram shows the forces acting at point Z?

A



B



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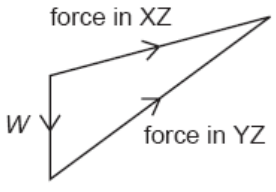
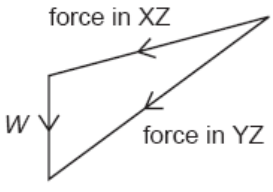


D



10 The diagrams show two ways of hanging the same picture. (09w)

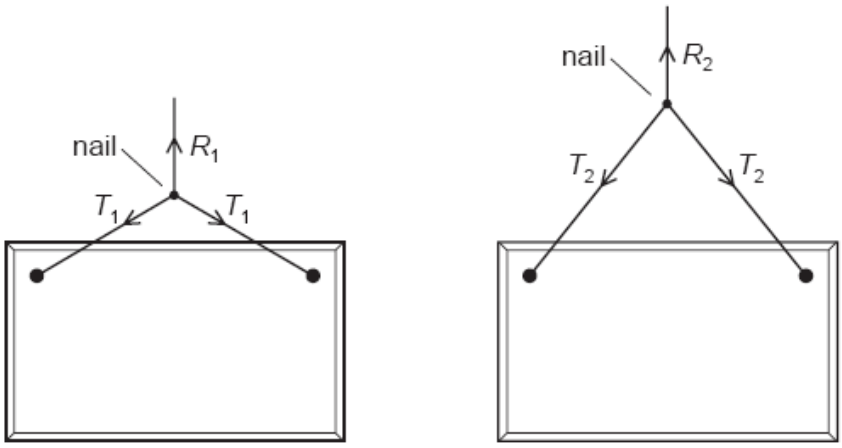


diagram 1 diagram 2

In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.

In diagram 1, the string loop is shorter than in diagram 2.

Which information about the magnitude of the forces is correct?

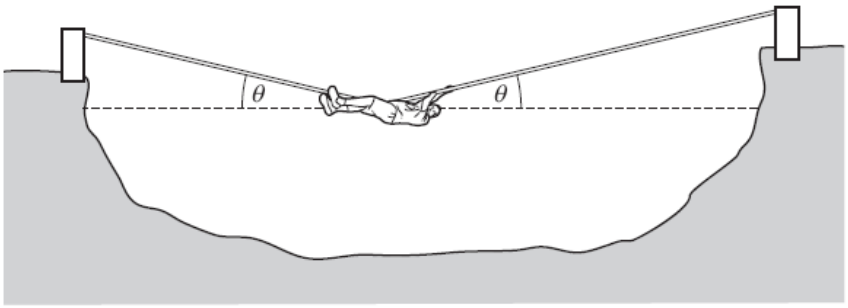
A $R_1 = R_2$ $T_1 = T_2$

B $R_1 = R_2$ $T_1 > T_2$

C $R_1 > R_2$ $T_1 < T_2$

D $R_1 < R_2$ $T_1 = T_2$

11 The diagram shows a rope bridge that a student makes on an adventure training course. The student has a weight W. (10w)



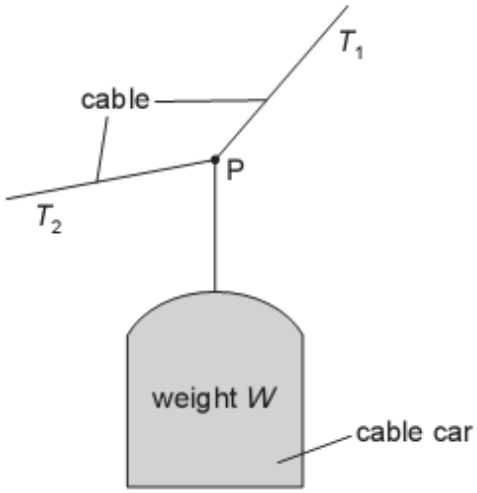
Which formula gives the tension T in the rope?

A $T = \frac{W}{2\cos\theta}$ **B** $T = \frac{W}{2\sin\theta}$ **C** $T = \frac{W}{\cos\theta}$ **D** $T = \frac{W}{\sin\theta}$

12

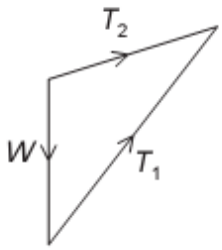
A cable car of weight *W* hangs in equilibrium from its cable at point P.

The cable has tensions T_1 and T_2 as shown.

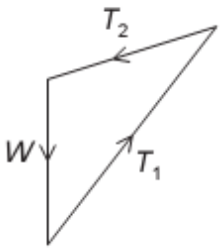


Which diagram correctly represents the forces acting at point P?

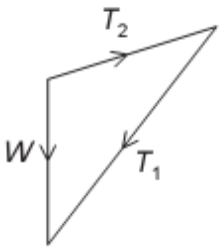
A



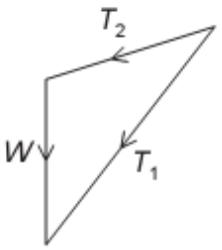
B



C

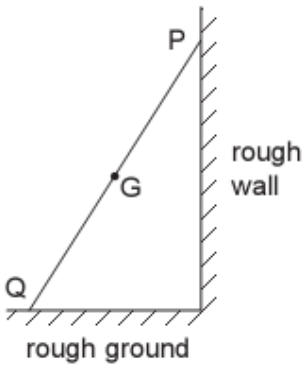


D



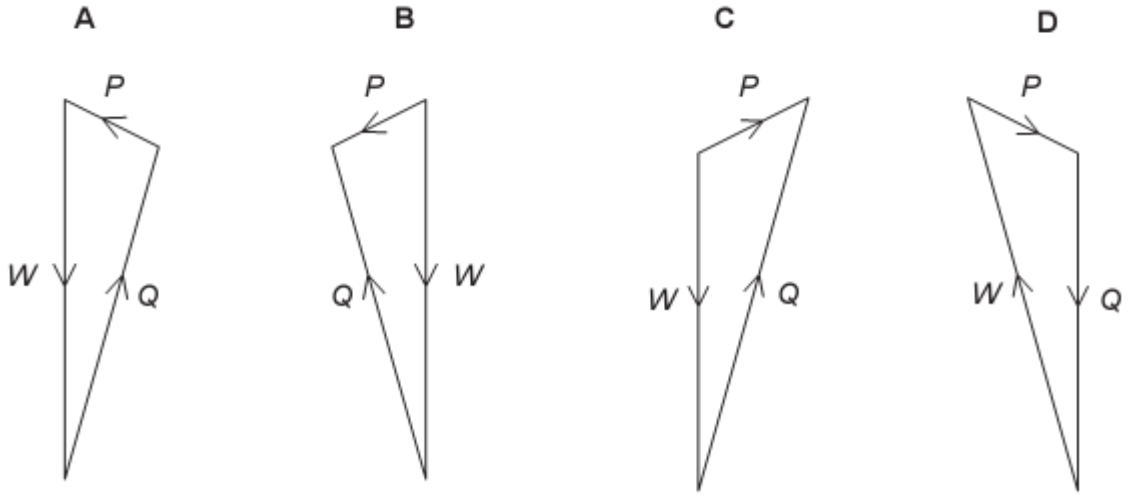
13

A ladder rests in equilibrium on rough ground against a rough wall.



Its weight *W* acts through the centre of gravity G. Forces also act on the ladder at P and at Q. These forces are *P* and *Q* respectively.

Which vector triangle represents the forces on the ladder?



(f) show an understanding that a couple is a pair of forces that tends to produce rotation only

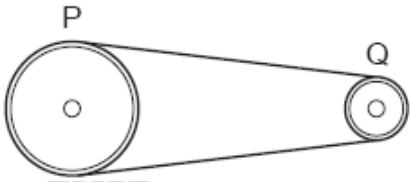
(g) define and apply the moment of a force and the torque of a couple

(h) show an understanding that, when there is no resultant force and no resultant torque, a system is in equilibrium

(i) apply the principle of moments.

- **Moments**

14 The diagram shows two pulley wheels connected by a belt. (09w)



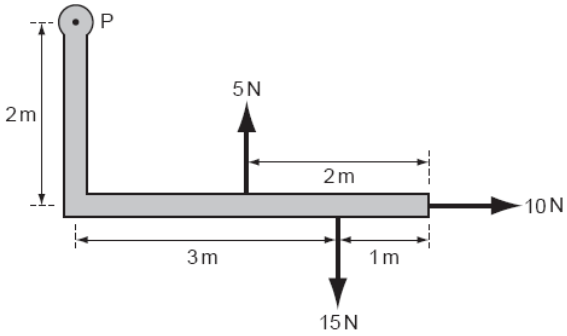
Wheel Q is driven by a motor and rotates clockwise at a constant rate. Wheel Q puts tension in the top portion of the belt, which in turn drives the wheel P. The lower portion of the belt is slack and has no tension. The weight of the belt and frictional forces are negligible.

The diameter of P is 150 mm. The diameter of Q is 100 mm. The torque applied to Q is 3.0 N m.

What is the tension in the belt and the torque on wheel P?

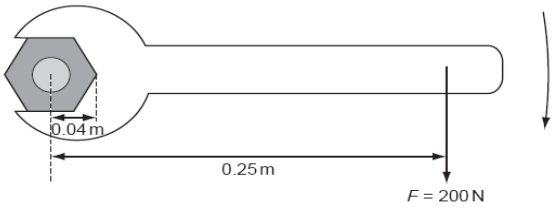
	tension in top of belt / N	torque on wheel P / N m
A	20	2.0
B	30	4.5
C	40	2.0
D	60	4.5

15 A rigid L-shaped lever arm is pivoted at point P. (10w)



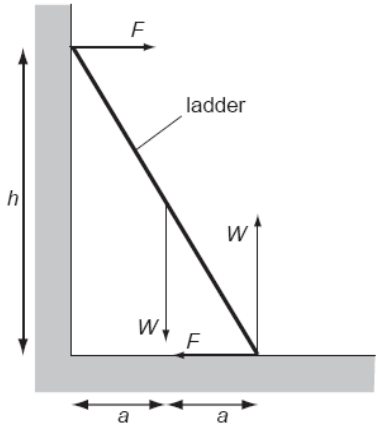
Three forces act on the lever arm, as shown in the diagram.
What is the magnitude of the resultant moment of these forces about point P?
A 15 N m **B** 20 N m **C** 35 N m **D** 75 N m

16 A spanner is used to tighten a nut as shown. (10w)



A force F is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.
What is the resistive torque, in an anticlockwise direction, preventing further tightening?
A 8 N m **B** 42 N m **C** 50 N m **D** 1250 N m

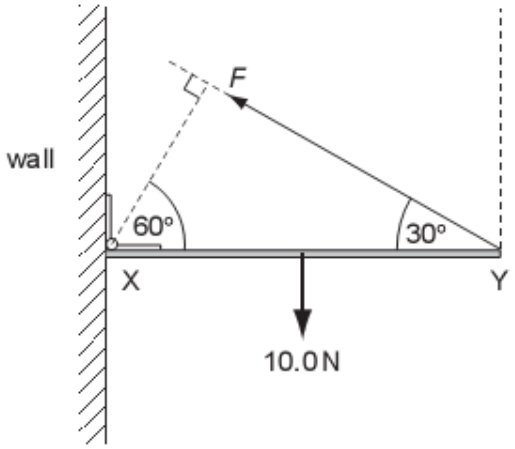
17 A uniform ladder rests against a vertical wall where there is negligible friction. The bottom of the ladder rests on rough ground where there is friction. The top of the ladder is at a height h above the ground and the foot of the ladder is at a distance 2a from the wall. (08s)
The diagram shows the forces which act on the ladder.



Which equation is formed by taking moments?
A W a + F h = 2W a
B F a + W a = F h
C W a + 2W a = F h
D W a – 2W a = 2F h

18

A uniform rod XY of weight 10.0 N is freely hinged to a wall at X. It is held horizontal by a force *F* acting from Y at an angle of 30° to the horizontal, as shown.

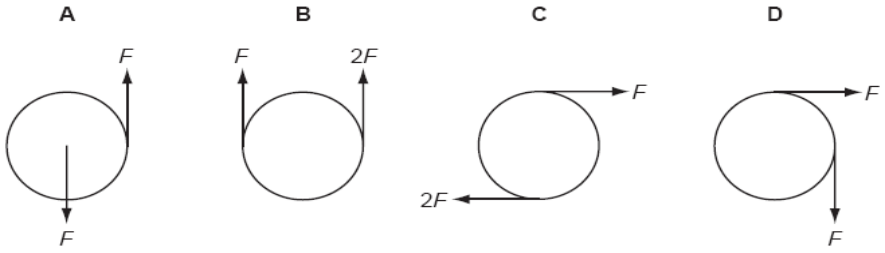


What is the value of *F*?

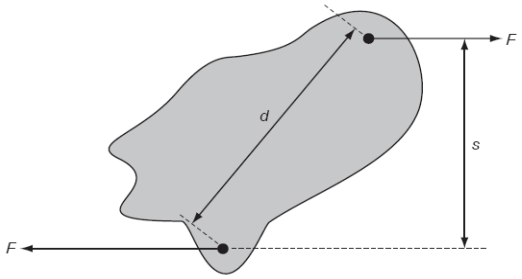
A 5.0 N **B** 8.7 N **C** 10.0 N **D** 20.0 N

- **Couple**

19 Which pair of forces acts as a couple on the circular object? (08w)



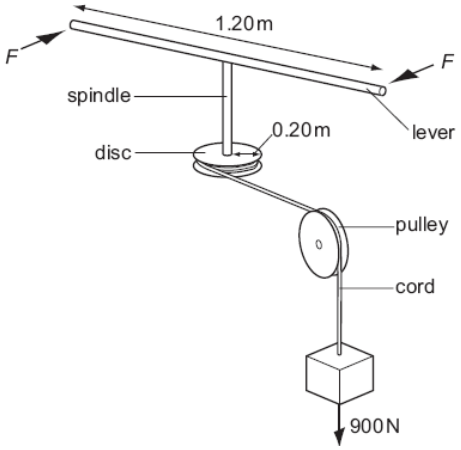
20 Two parallel forces, each of magnitude F, act on a body as shown. (10w)



What is the magnitude of the torque on the body produced by these forces?

A F d **B** F s **C** 2F d **D** 2F s

21 A spindle is attached at one end to the centre of a lever 1.20 m long and at its other end to the centre of a disc of radius 0.20 m. A cord is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



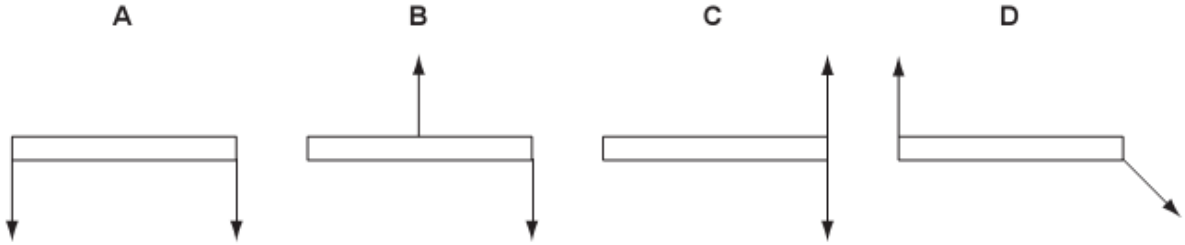
What is the minimum force F, applied to each end of the lever, that could lift the weight?

A 75 N **B** 150 N **C** 300 N **D** 950 N

22

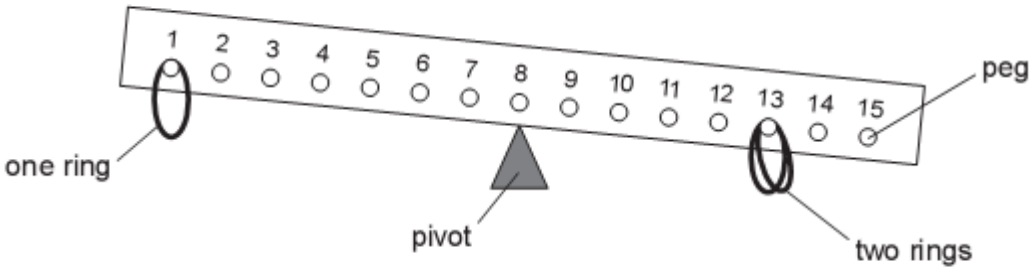
The diagrams all show a pair of equal forces acting on a metre rule.

Which diagram shows forces that provide a couple and zero resultant force?



23

The diagram shows a child's balancing game.



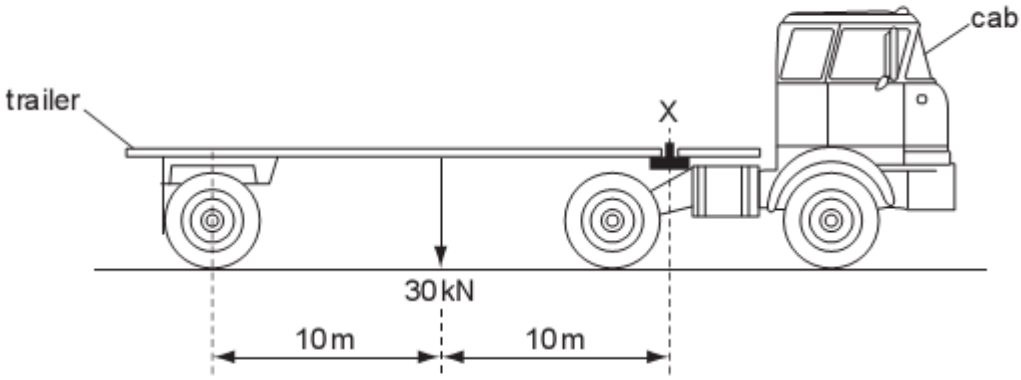
The wooden rod is uniform and all the rings are of equal mass. Two rings are hung on peg 13 and one on peg 1.

On which hook must a fourth ring be hung in order to balance the rod?

A 2 **B** 3 **C** 5 **D** 6

24

A trailer of weight 30 kN is hitched to a cab at X, as shown in the diagram.



What is the upward force exerted by the cab on the trailer at X?

A 3 kN **B** 15 kN **C** 30 kN **D** 60 kN

Chapter 3 –Forces（大题）

(h)show an understanding that, when there is no resultant force and no resultant torque, a system is in equilibrium

(d) use a vector triangle to represent forces in equilibrium

(i) apply the principle of moments.

1 (a) State the two conditions that must be satisfied for a body to be in equilibrium.
(10s/23/2)

1. .....

2. .....

[2]

(b) Three co-planar forces act on a body that is in equilibrium.

(i) Describe how to draw a vector triangle to represent these forces.

[3]

(ii) State how the triangle confirms that the forces are in equilibrium.

[1]

(c) A weight of 7.0 N hangs vertically by two strings AB and AC, as shown in Fig. 2.1.

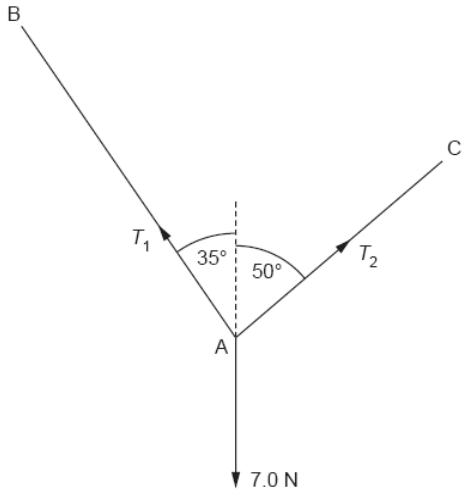


Fig. 2.1

For the weight to be in equilibrium, the tension in string AB is T_1 and in string AC it is T_2.

On Fig. 2.1, draw a vector triangle to determine the magnitudes of T_1 and T_2.

T_1 = ... N

T_2 = ... N[3]

(d) By reference to Fig. 2.1, suggest why the weight could not be supported with the strings AB and AC both horizontal.

.....

.....

....[2]

2（S23-2）

A climber is supported by a rope on a vertical wall, as shown in Fig. 2.1.

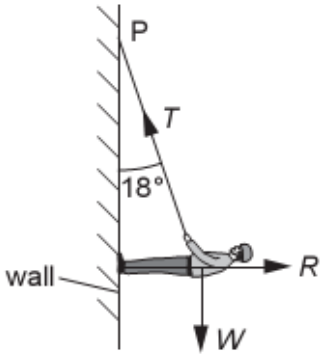


Fig. 2.1

The weight *W* of the climber is 520 N. The rope, of negligible weight, is attached to the climber and to a fixed point P where it makes an angle of 18° to the vertical. The reaction force *R* acts at right-angles to the wall.
The climber is in equilibrium.

(a) State the conditions necessary for the climber to be in equilibrium.

.....

.....

..... [2]

(b) Complete Fig. 2.2 by drawing a labelled vector triangle to represent the forces acting on the climber.

Fig. 2.2

(c) Resolve forces or use your vector triangle to calculate

(i) the tension T in the rope,

T = ... N [2]

(ii) the reaction force R.

R = ... N [1]

(d) The climber moves up the wall and the angle the rope makes with the vertical increases. Explain why the magnitude of the tension in the rope increases.

.....

.....

.....[1]

3（W23-1）

(a) Distinguish between scalars and vectors.

.....

.....[1]

(b) Underline **all** the vector quantities in the list below.

acceleration kinetic energy momentum power weight [2]

(c) A force of 7.5 N acts at 40° to the horizontal, as shown in Fig. 1.1.

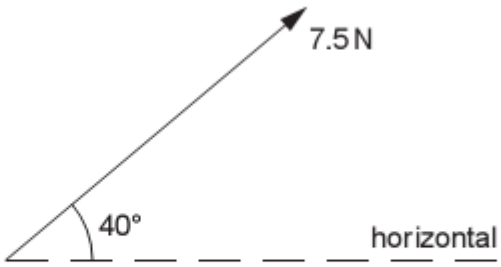


Fig. 1.1

Calculate the component of the force that acts

(i) horizontally,

horizontal component = ... N [1]

(ii) vertically.

vertical component = ... N [1]

(d) Two strings support a load of weight 7.5 N, as shown in Fig. 1.2.

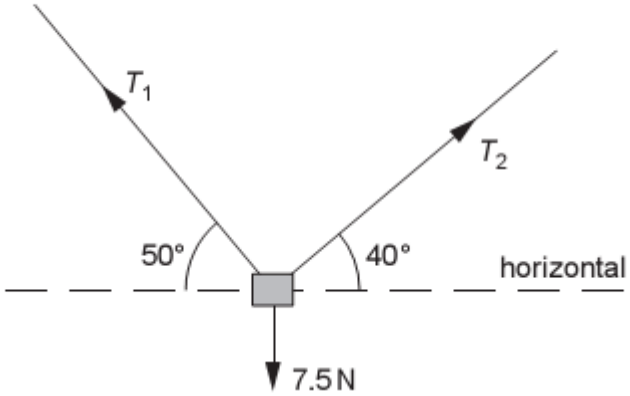


Fig. 1.2

One string has a tension T_1 and is at an angle 50° to the horizontal. The other string has a tension T_2 and is at an angle 40° to the horizontal. The object is in equilibrium. Determine the values of T_1 and T_2 by using a vector triangle or by resolving forces.

T_1 = ... N

T_2 = ... N

[4]

(h)show an understanding that, when there is no resultant force and no resultant torque, a system is in equilibrium

(i) apply the principle of moments.

4 (a) Distinguish between the moment of a force and the torque of a couple. (08w/3)

moment of a force

torque of a couple

[4]

(b) One type of weighing machine, known as a steelyard, is illustrated in Fig. 3.1

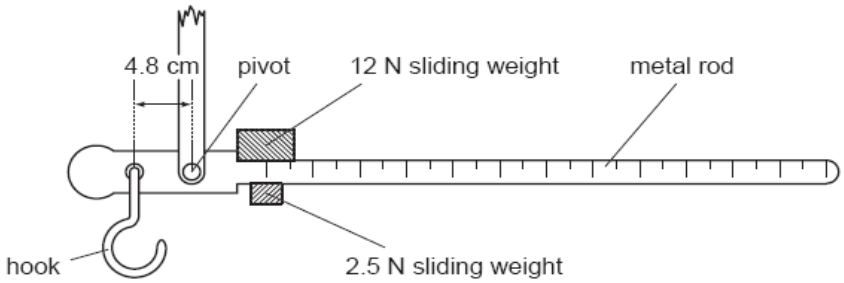


Fig. 3.1

The two sliding weights can be moved independently along the rod.

With no load on the hook and the sliding weights at the zero mark on the metal rod, the metal rod is horizontal. The hook is 4.8 cm from the pivot.

A sack of flour is suspended from the hook. In order to return the metal rod to the horizontal position, the 12 N sliding weight is moved 84 cm along the rod and the 2.5 N weight is moved 72 cm.

(i) Calculate the weight of the sack of flour.

weight = ……N [2]

(ii) Suggest why this steelyard would be imprecise when weighing objects with a weight of about 25 N.

[1]

5 **(a)** State what is meant by the centre of gravity of a body. (10w/22/3)

[2]

(b) A uniform rectangular sheet of card of weight W is suspended from a wooden rod. The card is held to one side, as shown in Fig. 3.1.

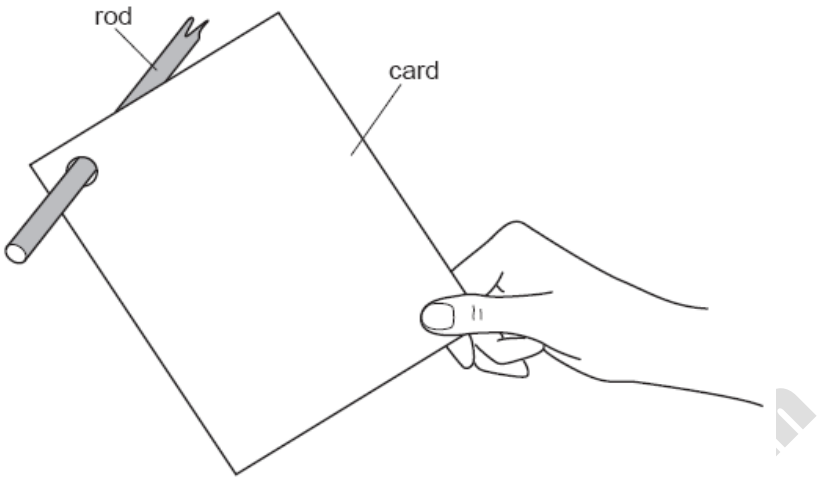


Fig. 3.1

On Fig. 3.1,

(i) mark, and label with the letter C, the position of the centre of gravity of the card,

[1]

(ii) mark with an arrow labelled W the weight of the card.

[1]

(c) The card in **(b)** is released. The card swings on the rod and eventually comes to rest.

(i) List the two forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1.

2.

[3]

(ii) By reference to the completed diagram of Fig. 3.1, state the position in which the card comes to rest.

Explain why the card comes to rest in this position.

[2]

6 **(a)** Define the torque of a couple. (09s/3)

[2]

(b) A torque wrench is a type of spanner for tightening a nut and bolt to a particular torque, as illustrated in Fig. 3.1.

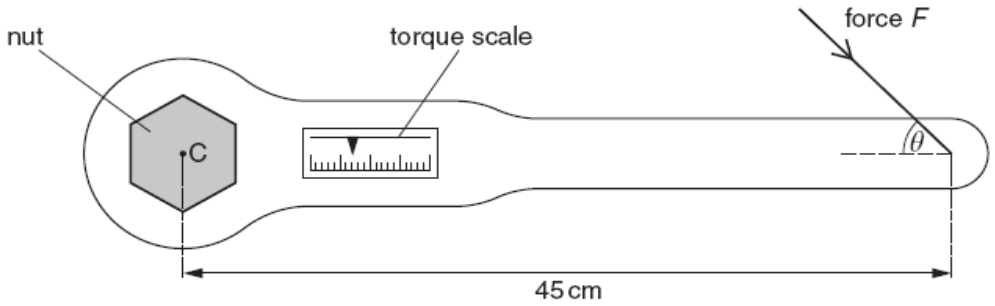


Fig. 3.1

The wrench is put on the nut and a force is applied to the handle. A scale indicates the torque applied.

The wheel nuts on a particular car must be tightened to a torque of

130 N m. This is achieved by applying a force F to the wrench at a distance of 45 cm from its centre of rotation C. This force F may be applied at any angle _ to the axis of the handle, as shown in Fig. 3.1.

For the minimum value of F to achieve this torque,

(i) state the magnitude of the angle _ that should be used,

θ = ... °[1]

(ii) calculate the magnitude of F.

F = ... N [2]

7（S21-3）

(a) Explain what is meant by *centre of gravity*.

.....

..... [2]

(b) Define *moment* of a force.

.....

..... [1]

(c) A student is being weighed. The student, of weight *W*, stands 0.30 m from end A of a uniform plank AB, as shown in Fig. 3.1.

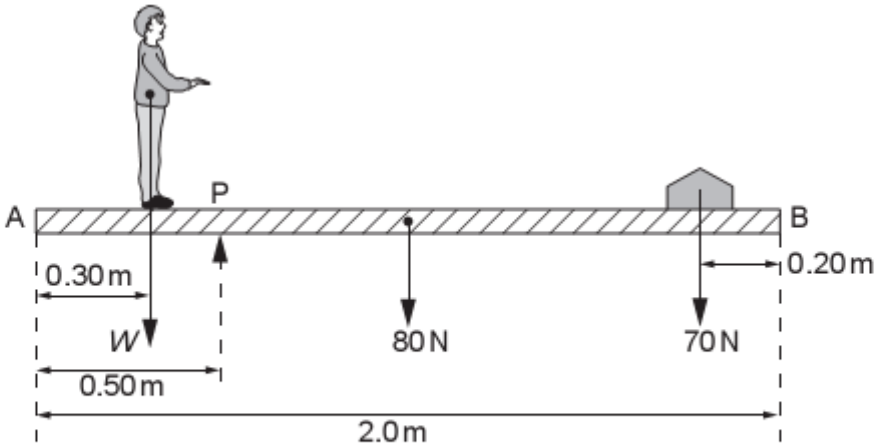


Fig. 3.1 (not to scale)

The plank has weight 80 N and length 2.0 m. A pivot P supports the plank and is 0.50 m from end A.
A weight of 70 N is moved to balance the weight of the student. The plank is in equilibrium when the weight is 0.20 m from end B.

(i) State the two conditions necessary for the plank to be in equilibrium.

1. .....

.....

2. .....

.....
[2]

(ii) Determine the weight W of the student.

W = ... N [3]

(iii) If only the 70 N weight is moved, there is a maximum weight of student that can be determined using the arrangement shown in Fig. 3.1. State and explain **one** change that can be made to increase this maximum weight.

.....

.....

..... [2]

8（W21-2）

(a) Define the *torque* of a couple.

.....

..... [2]

(b) A uniform rod of length 1.5 m and weight 2.4 N is shown in Fig. 2.1.

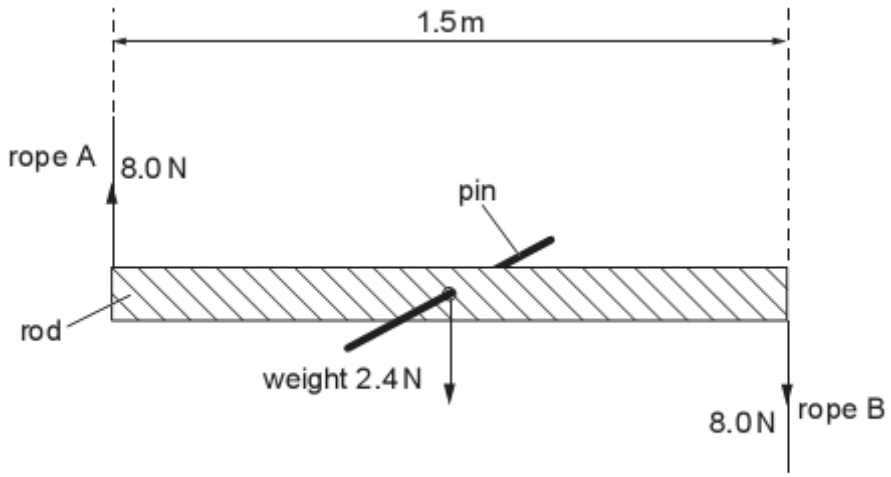


Fig. 2.1

The rod is supported on a pin passing through a hole in its centre. Ropes A and B provide equal and opposite forces of 8.0 N.

(i) Calculate the torque on the rod produced by ropes A and B.

torque = ... N m [1]

(ii) Discuss, briefly, whether the rod is in equilibrium.

.....

.....

.....

..... [2]

(c) The rod in **(b)** is removed from the pin and supported by ropes A and B, as shown in Fig. 2.2.

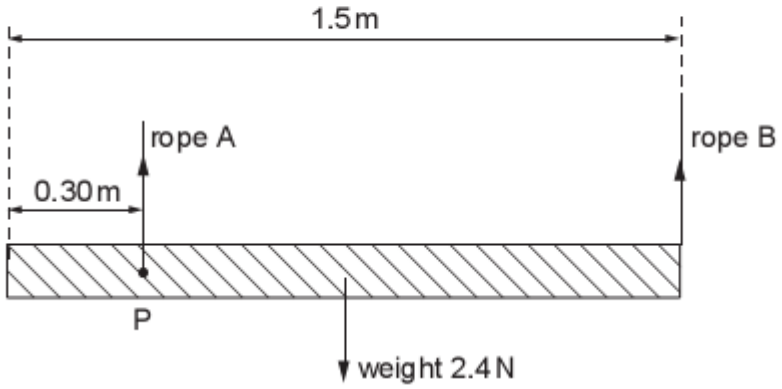


Fig. 2.2

Rope A is now at point P 0.30 m from one end of the rod and rope B is at the other end.

(i) Calculate the tension in rope B.

tension in B = ... N [2]

(ii) Calculate the tension in rope A.

tension in A = ... N [1]