AS

LEVEL

PHYSICS QUESTIONS

FOR CCEA AS LEVEL

COLOURPOINT EDUCATIONAL

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Rewarding Learning

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Note: it is the responsibility of teachers and lecturers to carry out an appropriate risk assessment when planning any practical activity. Where it is appropriate, they should consider reference to CLEAPPS guidance.

Contents

Unit 1.1 (AS 1)
Physical quantities

1. Express the following physical quantities in base units:
   (a) Gravitational potential energy
   (b) Density
   (c) Pressure (Pressure is the force acting per unit area)
   (d) Weight
   (e) Impulse (Impulse is the product of force and time)

2. (a) Express electrical resistance in base units (the volt is defined as joule per coulomb and the coulomb is defined as current multiplied by time).
   (b) The temperature rise Δθ when an object is heated is given by the equation

$$\Delta\theta = \frac{Q}{mc}$$

   where Q is the quantity of heat energy supplied, m is the mass of the object in kg and c is a constant known as the specific heat capacity. Derive the base units of c.

3. The motion of a vibrating object is known as simple harmonic motion. The acceleration a of the object is given by the equation

$$a = (2\pi f)^2 x$$

   where x is distance from a fixed point and f is the frequency of vibration.
   Show that the right hand side of the equation has the units of acceleration.

4. The strength of a material is measured by a term known as Young's modulus, E. Young's modulus is calculated by the equation:

$$E = \frac{\text{stress}}{\text{strain}}.$$

   Stress is defined as force per unit area and strain is the ratio of the extension of a material to its original length. Determine the base units of Young's modulus.

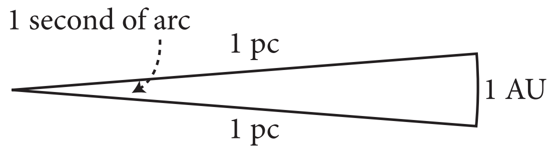
5. The radius of a proton is 0.9 fm and its mass is 1.67×10^{-27} kg. Calculate the density, in kg m^{-3}, of the nuclear material that makes up the proton.

6. The energy released in nuclear explosions is often given in terms of thousands of tons of a conventional explosive known as TNT (1 kT = 1000 tons of TNT). The energy release of 1 kT is approximately 4.2 TJ. In 1961 the Soviet Union detonated a nuclear device with an energy release of 50 MT. Calculate the energy release of this device in J.

7. Some countries still use a system based on the inch, pound and second.
   (a) A *thou* is $\frac{1}{1000}$ of an inch. One inch is equal to 2.54 cm.
   Calculate the number of microns (μm) in 1 *thou*.

(b) The *poundal* is the unit of force when the pound (lb) is the unit of mass. A one pound mass will accelerate at one foot per second squared when pushed by a one poundal force. Calculate the number of newtons in one poundal. 1 lb = 16 ounces (oz). 1 kg = 2 lb 3.274 oz. 1 foot = 12 inches.

8. Astronomical distances are so large that other units of measuring distance are used. 1 *astronomical unit* (AU) is equal to the average distance between the Earth and the Sun. 1 AU = 1.496×10^8 km. A *parsec* (pc) is the distance at which 1 AU will subtend an angle of 1 second of arc (see diagram).



1 complete circle = 360° or 2π radians (symbol rad).
1° = 60 minutes of arc, written as 60'.
1 minute of arc (1') = 60 seconds of arc, written as 60".

A *light year* (ly) is the distance light travels in one year. The speed of light is 3×10^8 m s^{-1}.
Calculate the number of light years equivalent to 1 pc.

9. In high energy physics the probability of collisions between particles is measured in units known as *barns* (symbol b). Barns are measured in units of area. 1 b = 100 fm^2.
(a) Give 1 b in m^2.
(b) The probability of an alpha particle being scattered by a nucleus of a gold atom at a certain angle has been calculated to be 100 b. Treating the gold nucleus as a circular target for the alpha particle, calculate its radius based on this information.

10. In the SI system of units mass (M), length (L) and time (T) were chosen as base physical quantities. Imagine that instead force (F), acceleration (A) and time (T) had been chosen as the base physical quantities. What would be the base units of energy in this case?

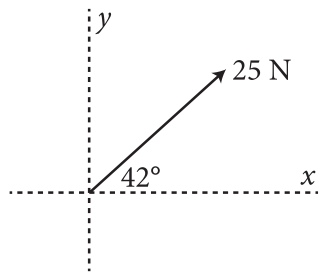
11. A *nautical mile* is defined the distance around the equator equal to 1 minute of arc (1'). The equatorial radius of the Earth is 6378 km. A *knot* is defined as a speed of one nautical mile per hour. 1° = 60 minutes of arc, written as 60'.
(a) What is 1 nautical mile in km?
(b) Convert 15 knots to m s^{-1}.

12. The wavelength of light is sometimes given in units known as *angstroms* (symbol Å).
(a) A green line in the spectrum of mercury has wavelength of 546.047 nm or 5460.47 Å. Express 1 Å in m.
(b) Red light has a wavelength of 630 nm. What is this wavelength in angstroms?

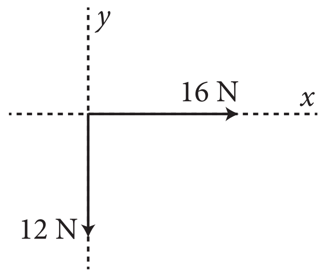
Unit 1.2 (AS 1)

Scalars and vectors

1. (a) Distinguish between scalar and vector quantities.
   (b) Give three examples of each type of quantity, stating the SI unit in which each is measured.
   (c) The diagram shows a force of 25 N acting at 42° to the *x*-direction. Calculate its components in the *x* and *y* directions.

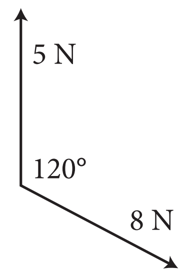


2. Two forces of 12 N and 16 N act at right angles to each other and in the directions shown in the diagram. Calculate the resultant of these two vectors and the angle it makes with the *x*-direction.

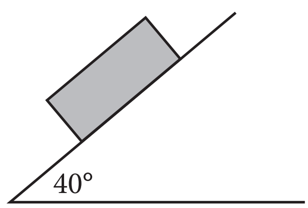


3. (a) An aircraft flies due north for 400 km then due east for 300 km. Calculate the displacement of the aircraft from its starting position. Illustrate your answer with an appropriate vector diagram.
   (b) Raindrops fall vertically with a speed of 4 m s^{-1} in still air. Calculate the angle they make with the vertical when the wind is blowing horizontally at 6 m s^{-1}. Illustrate your answer with an appropriate vector diagram.

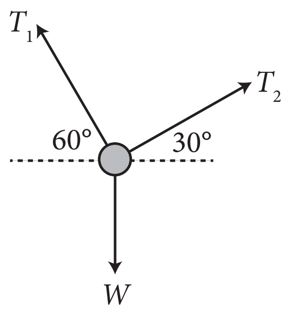
4. The diagram shows two forces of 5 N and 8 N acting at 120° to each other. Calculate the resultant of these two forces and state its direction relative to the 5 N force. Illustrate your answer with an appropriate vector diagram.



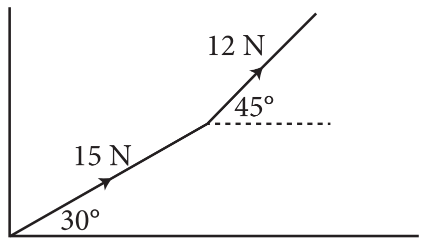
5. The diagram shows a block resting on a slope. Copy the diagram. Mark on your copy the weight of the block. The block weighs 15 N. Calculate the component of the weight at right angles to the slope and the component of the weight along the slope. Mark these components and their values on your diagram.



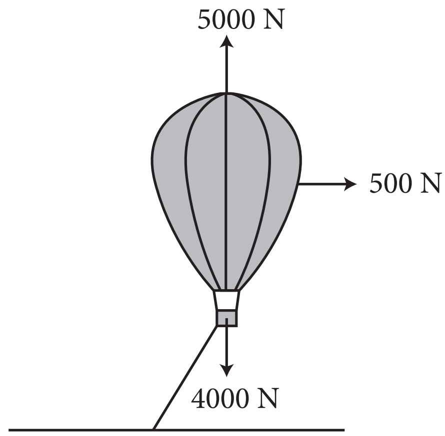
6. An object of weight W is suspended by two cables and is in equilibrium, as shown in the diagram. What is the ratio of the tensions T_1:T_2 in the cables?



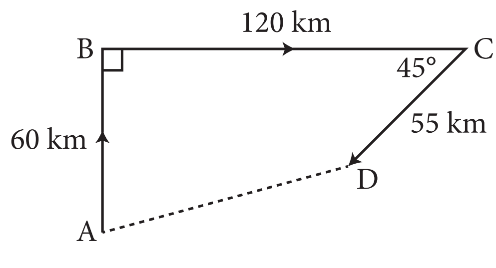
7. Find the resultant of the two forces shown in the diagram.



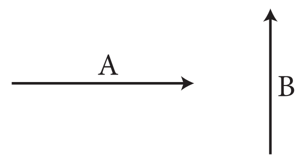
8. A hot air balloon is tethered as shown in the diagram. The balloon weighs 4000 N and the upward force on the balloon is 5000 N. The wind blowing from the left exerts a force of 500 N on the balloon. The balloon is in equilibrium. Calculate the tension in the cable.



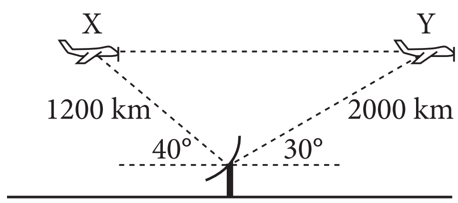
9. An aircraft makes the journey shown in the diagram. It takes off at A and finally arrives at D. Calculate its final displacement from A.



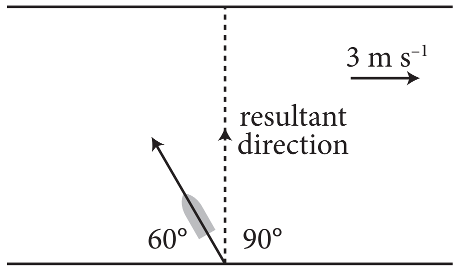
10. Vector A has a magnitude of 5 and vector B has a magnitude of 4. Their directions are at right angles to each other as shown in the diagram. In each case below draw a diagram to show the resultant vector and mark the angle the resultant makes with one of the other vectors.
   (a) A +B
   (b) A – B
   (c) 2A – 3B
   (d) –3A + 2B



11. An aircraft is initially detected on radar at a distance of 1200 m, 40° above the horizontal, as shown in the diagram. The monitoring is stopped when the aircraft is 2000 m from the radar station. Calculate the displacement XY of the aircraft.

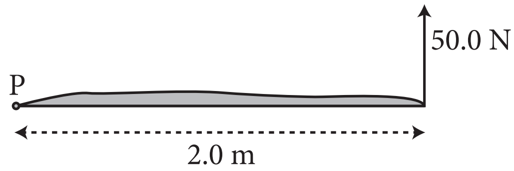


12. A motor boat sets off to cross a river. It steers at 60° to the bank as shown. The river has a current of speed 3 m s^{-1}. At what speed should it move so that the resultant of the two speeds is in the direction shown?

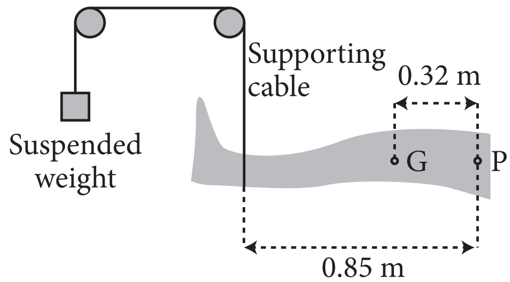


Unit 1.3 (AS 1)
Principle of moments

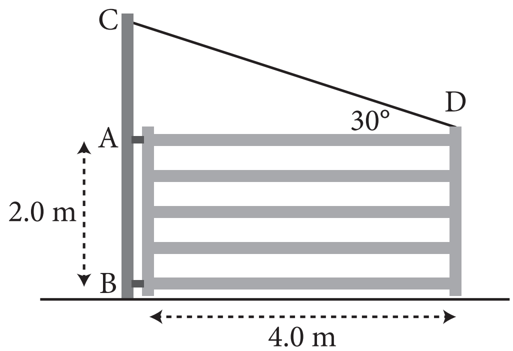
1. A non-uniform rod of mass 12.0 kg and length 2.00 m is pivoted at a point P at one end of the rod. The rod is held horizontally by an upward form of 50.0 N as shown in the diagram. Calculate the position of the centre of gravity. Give your answer as the distance the centre of gravity is from the point P.



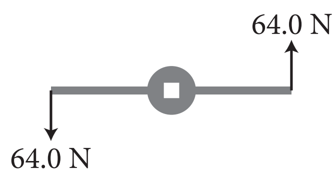
2. A patient has a leg in plaster which is supported by a sling system as shown in the diagram. The mass of the patient's leg and plaster cast is 14 kg. Calculate the suspended weight needed to hold the patient's leg in the horizontal. The leg pivots about the point P, and the centre of gravity of the leg and plaster is at point G.



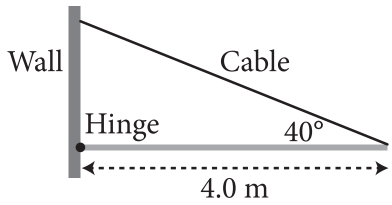
3. (a) Explain what is meant by the moment of a force about a point.
   (b) The diagram shows a gate with hinges at A and B. A steel wire CD helps support the gate. The gate weighs 500 N. The centre of gravity of the gate is at its geometrical centre. The horizontal component of the force exerted at hinge A is zero.
   (i) Calculate the distance AC.
   (ii) Calculate the tension in the wire CD.
   (iii) Calculate the magnitude and direction of the horizontal component of the force exerted on the gate by hinge B.
   (iv) Calculate the total vertical force exerted by hinges A and B.



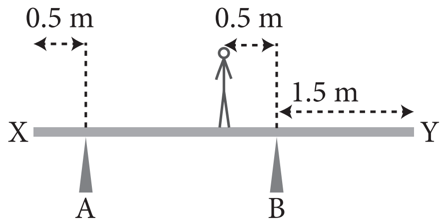
4. A double-handled wrench is used open a valve. The moment needed to do this is 22.4 N m. This is achieved by applying two equal and opposite forces of 64 N as shown in the diagram. Calculate the distance between the two forces.



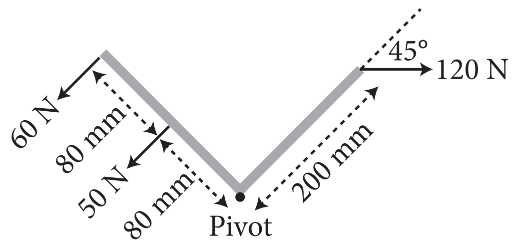
5. A uniform beam is 4.0 m long and weighs 500 N. It is hinged at one end and a cable is attached at the other end. The beam is in equilibrium.
   (a) Calculate the tension in the cable.
   (b) Calculate the resultant force at the hinge and give its direction.



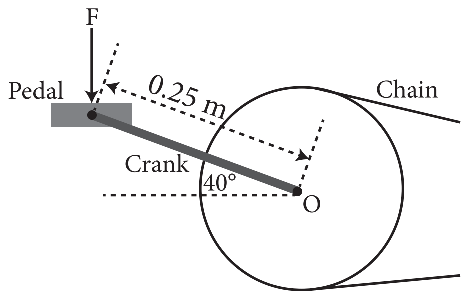
6. A painter stands on a uniform plank of length 4 m supported at two places as shown. The painter has a mass of 80 kg and the plank weighs 400 N.
   (a) Calculate the reaction (upward) forces at the supports at points A and B.
   (b) The painter moves towards the end Y. How far from end Y can the painter stand before the plank starts to tilt?



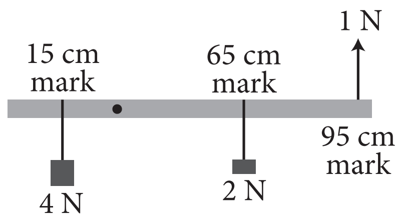
7. The diagram shows a L-shaped lever.
   (a) Calculate the resultant moment.
   (b) By how much must the 50 N force change to have the lever in equilibrium?



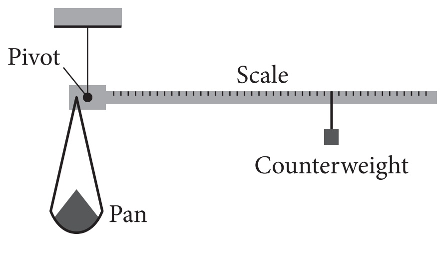
8. The diagram shows the force acting on the pedal of a bicycle. The moment of the force about the centre O is 50 N m.
   (a) Calculate the force required to produce this moment.
   (b) Explain the advantage of moving the pedal so that the force is applied at right angles to the crank. Support your answer with an appropriate calculation.



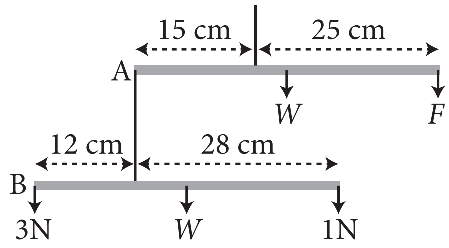
9. A metre rule is pivoted at the 30 cm mark as shown in the diagram. Weighs and forces act at the positions shown. If the metre rule is in equilibrium, calculate its weight.



10. A *steelyard* was used for many centuries to measure weights of salt or flour. The counterweight is moved along the arm until the steelyard is balanced. The weight of the salt or flour can then be read off the scale. The distance between the pivot and the pan holding the salt or flour is fixed at 1 cm. In a particular version the counterweight has a mass of 10 g and the separation of marks on the long arm 2 cm. Calculate the smallest difference in mass that this steelyard can measure.



11. The diagram shows a mobile made of two identical strips each of length 40 cm and weight W.
    (a) Strip B is in equilibrium. Calculate its weight W.
    (b) Strip A is also in equilibrium. Calculate the force F.



12. A metre rule of weight 3 N is pivoted at the 60 cm mark. A weight W is placed 30 cm from the pivot and the metre rule is balanced when a 6 N weight is placed 25 cm from the pivot.

    (a) Calculate the value of the weight W.

    When the weight W is placed in water the 6 N weight has to be moved to 20 cm from the pivot to have the metre rule balanced.

    (b) Calculate the upthrust on the weight W due to the water.