10. A particle of mass, 2.5×10^{-6}kg revolving around the earth has a radial acceleration of $4 \times 10^{3} m/s^{2}$. What is the centripetal force of the particle ? [SSCE, Nov., 1990]

11. A stone tied to a string is made to revolve in a horizontal circle of radius 4m with another speed for 2 rad/s. With what tangential velocity will the stone be off the circle if the string cuts ? [SSCE, Nov., 1989]

12. A body moves along a circular path with uniform angular speed of $0.6 rads^{-1}$ and at a constant speed of 3.0mls. Calculate the acceleration of the body towards the centre of the circle. [SSCE, June 1993]

13. A body weighing 108N moves with speed of $5ms^{-1}$ in a horizontal circular path of radius 5m. Calculate the magnitude of the centripetal force acting on the body. ($g=10m/s^{2}$) [WASSCE, June 1999]

14. What is the angular velocity of an object in a horizontal circular path of radius 1.5m with a constant speed of $12ms^{-1}$? [NECO, 2001]

15. Explain the following: (i) Friction
(ii) limiting friction (iii) static friction
(iv) dynamic friction.

16(a) Define friction. (b) Differentiate between static and dynamic friction.

17(a) What is friction? (b) Define the relationship between angle of friction and co-efficient of friction.

18. A block of mass, 1kg is placed on an incline plane at an angle of 60^{o} to the horizontal. Calculate: (i) The force that will make it to slide down the plane (ii) Coefficient of static friction (iii) frictional force [$g = 10m/s^{2}$]

19. An object of mass, 10kg is placed on an incline plane at 30^{o} to the horizontal.
Calculate (i) the reaction between two surfaces (ii) Coefficient of static friction. [$g = 10m/s^{2}$]

20. A mass of 10kg is placed on a horizontal table with a coefficient of friction of 0.5. If the mass is static, determine: (i) weight of the object against the horizontal table (ii) the limiting frictional force.

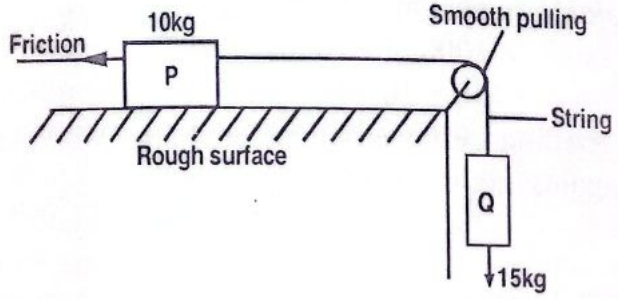
21. A body just rest in equilibrium on a slope inclined at θ to the horizontal surface,

where $\sin\theta = \frac{4}{15}$, find μ

22. If the coefficient of friction is 0.5 and the reaction is 60N. Calculate the limiting frictional force required to prevent an object from moving. [g = 10m/s^2]

23. (a) State two (i) laws of solid fricti (ii) advantages of friction (iii) disadvantages of friction (iv) Methods of reducing friction

(b)



Two bodies, p and Q of masses, 10kg and 15kg respectively are connected by a light in extensible string as shown in the diagram above. P is placed on a tough surface of coefficient of friction, 0.5. If the acceleration due to gravity P is 10m/s^2, calculate the magnitude of the (i) normal reaction on P (ii) Frictional force between P and the surface (iii) tension in the string (iv) Force which causes P and Q to accelerate (v) Common acceleration of P and Q. [SSCE Nov., 1998]

24. A force of 20N applied parallel to the surface of a horizontal table is just sufficient to make a block of mass, 4kg move on the table, calculate the coefficient of friction between the block and the table. g=[10m/s^2] [SSCE, June 1992]

25. A 5kg mass on a horizontal platform accelerated at the rate of 0.1m/s^2 when a horizontal force of 10N is applied to it. Calculate the coefficent of friction between it and the platform [g=10mls^2] [SSCE, June 1998]

26. A wooden block of mass, 1.6kg rests on a rough horizontal surface. If the surface is 8N, calculate the coefficient of friction. [g=10m/s^2] [WASSCE June, 2000]

27. A block weighing 15N rests on a flat surface and a horizontal force of 3N is exerted on it, determine the frictional force on the block. [WASSCE, June 2001]

28. What is the coefficient of static friction between a load of mass, 2kg and a horizontal surface, if the limiting frictional force is 10N? (g=10m/s^2) [NECO, 2000]

29. (a) State the laws of solid friction.
(b)(i) Describe an experiment to determine the coefficient of static friction between two solid surfaces. (ii) State one precaution that should be taken to ensure an accurate result. (c) State two: (i) disadvantages of friction
(ii) methods of reducing friction [NECO, 2002].

30. A ball-bearing is placed on a smooth plane inclined at 30° to the horizontal. Show by a sketch, the forces acting on the ball-bearing.(b) What is its acceleration as it rolls down the plane? (g = 10m/g^2) [NECO, 2002]

31. (a) Distinguish between static and dynamic friction. (b) An object of mass 8kg rests on a wooden plane inclined at 35° to the horizontal. It is found that the least force parallel to the plane which causes the object to slide up the plane is 105N. What is the coefficient of sliding friction between the object and wood? (Take the value of g to be 10 m s^{-2}).

32 .(a) Provide three examples of natural bodies undergoing circular motion. (b) An object of mass 5kg is whirled round a vertical circle of radius 1.5m with a constant velocity of 4ms^{-1}. At what point along the circular path will the string experience maximum tension? Determine the value of this tension (g = 10ms^{-2}).

33 (a) Distinguish between contact force and force field. (b) A block of mass 12kg rests on a horizontal floor, coefficient of friction 0.35. Determine the minimum force required to move the block when pulling at an angle of 30° to the horizontal (g = 10ms^{-2}).

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Revision exercise

1. Name the three fundamental quantities in science and their respective units.
2. Name the instruments that can be used to measure the following:

(i) the length or thickness of solid bodies
(ii) time
(iii) weight of an object
(iv) length
(v) distance of solid objects
(vi) mass of an object
(vii) temperature
(viii) specific heat capacity.

3. Distinguish between mass and weight.
4. What do you understand by:

(i) fundamental units
(ii) fundamental quantities
(iii) derived quantities?

5(i) Name five fundamental quantities and their respective or associated fundamental units.

(ii) Mention seven derived quantities and show how their respective units are obtained or formed.

6. Define dimension.
7. Using the method of dimension, derive an expression for the velocity of sound waves (v) through a medium. Assume that the velocity depends on: (i) modulus of elasticity E of the medium

(ii) the density of the medium ρ Take the constant $K = I$.

uneven expansion. The glass near the water expands more than the one outside and since glass is a bad conductor, the stress causes the glass to crack.

2. In hot countries, you can hear cracking noise if you are under a galvanized iron sheet. Because of high intensity of heat, the iron expands and in the evening, another crack is heard, which shows contraction.

3. To allow for expansion, gaps are left between rail sections on a railway line. The ends are held in line with fish plate, which are strips of metal blotted to the end of the rail by slotted holes.

4. If the handle (i.e, an insulator) of a bi-metallic strip is held and the metal part is heated to a very high temperature, we notice that the metal bends inward with brass outside and iron inside because brass has higher co-efficient of expansion compared to iron. When the flame is removed and the metal is allowed to cool, they regain their original shape and size.

The bi-metallic strip is an instrument which is made up of two metals, e.g. iron and steel, iron and brass of different linear expansion. It has a wide application. For example, a bi-metallic strip is used in thermostat.

A thermostat is a device which is made of bi-metallic strip to maintain the temperature of an electrical system, e.g iron, water bath, oven, etc. Thus, the bi-metallic strip is used to regulate temperature.

Revision exercise

1. What is thermal expansion?
2. State and describe three experiments demonstrating expansion in solid.
3. What is linear expansivity of a solid?
4. Highlight three effects of expansion and their application.
5. If the linear expansivity of a copper rod is 0.000017/k, calculate the expansion of 10m of copper rod when heated from 10°C to 80°C
6. A cube with side 100cm at 0°C is heated to 100°C. If the side becomes 101cm long, find: (i) the linear expansivity (ii) cubic expansivity
7(i) What is meant by anomalous expansion of water? (ii) Explain the statement "the linear expansivity of a copper rod is 0.000017/k.
8. A brass and iron which are compounded are straighten at room temperature. Draw how the compounded strip would be after it is heated.
9. Distinguish between real and apparent cubic expansivity of a liquid.
10. What is (i) real cubic expansivity (ii) apparent cubic expansivity?
11(a). What is meant by the statement, "the linear expansivity of a solid is $1.0 \times 10^{-5} k^{-1}$? (SSCE June, 1989)

(b)(i) Describe an experiment to determine the linear expansivity of steel rod. (ii) Steel bars, each of length 3m at 28°C are to be used for constructing a rail line. If the linear expansivity of steel is $1.0 \times 10^{-5} k^{-1}$, calculate the safety gap that must be left between successive bars if the highest temperature expected is 40°C?

(c) State three advantages and two disadvantages of thermal expansion of solids. (SSCE Nov., 1989)

12(a). Define the apparent cubic expansivity of a liquid. (b)(i) Describe, with the aid of a labelled diagram, an experiment to determine the apparent cubic expansivity of a liquid. (ii) State two precautions that should be taken to ensure accurate results. (c) A density glass bottle contains 44.25g of a liquid at 0°C and 42.02g at 50°C, calculate the real cubic expansivity of the liquid (linear expansivity of glass = $1.0 \times 10^{-5} k^{-1}$) (SSCE June, 1996)

13. An iron rod of length 30cm is heated through 50 kelvin. Calculate its increase in length. (linear expansivity of iron = $1.2 \times 10^{-5} k^{-1}$) (WASSCE June, 2000)
14. A wire, 20m long, is heated from a temperature of 5°C to 55°C. If the change in length is 0.020m, calculate the linear expansivity of the wire. [SSCE, Aug, 1991]
15. A brass rod is 2m long at a certain temperature. Calculate the linear expansion of the rod for a

temperature change of 100K [take the linear expansivity of brass as $1.8 \times 10^{-5} K^{-1}$] [SSCE, June, '95]

16. The temperature of glass vessel containing $100 cm^3$ of mercury is raised from 10^0C to 100^0C. Calculate the apparent cubic expansion of the mercury. (real cubic expansivity of mercury $= 1.82 \times 10^{-4} K^{-1}$ and cubic expansivity of mercury $= 2.4 \times 10^{-5} K^{-1}$) [SS CE, June, '95]

17. The linear expansivity of a metal, P, is twice that of another metal Q. When these metals are heated through the same temperature change, their increase in length is the same. Calculate the ratio of the original length of P to that of Q ? [SSCE, June, 1996]

18. A solid metal cube of side 10cm is heated from 10^0C to 60^0C. If the linear expansivity of the metal is $1.2 \times 10^{-5} K^{-1}$, calculate the increase in the volume. [SSCE, June, 1993]

19. A metal rod of length 40.0cm at 20^0C is heated through a temperature of 45^0C. If the new length of the rod is 40.05cm, calculate its linear expansivity. [SSCE, June, 1994]

20. A solid material of volume, $100 cm^3$ is hea through a temperature difference of 40 Calculate the increase in the volume of the mater if its linear expansivity is $2.0 \times 10^{-6} K^{-1}$ [SSCE, Ju 1997]

21. An iron rod of length 50m and at a temperatur of 60^0C is heated to 70^0C. Calculate its new lengt [linear expansivity of iron $= 1.2 \times 10^{-5} K$ [WASSCE, June, 1999]

22. The cubic expansivity of mercury is $1.8 \times 10^{-4} K^{-1}$ and the linear expansivity of glass is $8 \times 10^{-6} K^{-1}$. Calculate the apparent expansivity of mercury in a glass container. [WASSCE, June, 2000]

23. A brass of cube of side 10cm is heated through 30^0C. If the linear expansivity of brass is $2.0 \times 10^{-5} K^{-1}$, what is the increase in its volume? [NECO. 2002]

24. The length of a side of a metallic cube at 20^0C is 5.0cm. Given that the linear expansivity of the metal is $4.0 \times 10^{-5} K^{-1}$, find the volume of the cube at 120^0C [NECO, 2000]