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WHAT YOU NEED TO KNOW ABOUT APPROXIMATIONS

Approximations are very significant in uniben physics and chemistry exams because if you approximate wrongly you will get a wrong answer but in this material I will Teach you how to approximately correctly. Note that you approximate A number only when the decimal number is in the range of **0-2** and when the decimal number is in the range of **7-9**, you don't approximate when the decimal number is in the range of **3-6** or else u get a wrong number which will be either bigger or lesser than answers in the options instead write your figures and solve like that. I will Explain what I mean in details .for instance you are solving and you Get a number like **2.1112** If you must approximate you get **2.1 or 2.11** because decimal range is **0-2**,if you get a number **3.7 or 3.79 or 3.668** you can approximate to **4,3.8 and 3.67** respectively because the decimal numbers you approximated ranges from 7-9 .but note when u have a number **2.555,2.554,2.556 or 2.443 or 2.553** you don't approximate instead solve with the figures the Way you see it in the calculator because the decimal number ranges from 3-6.This aspect is very important when solving questions else you get a number slightly different from the ones in the options please take note. More examples, if you get a number **2.2275,7.1284,6.394,2.3844,3.293,** you get **2.23,7.13,6.4,2.4,3.3,** respectively .it doesn't matter where the decimal number is as far as it follows the rules. also if u get **2.335,2.445,2.333333,2.66666,2.43434**, do not approximate solve with it the way you see it. **TAKE NOTE!!!!!!!!!!!**

(let's begin see page 19 for the theory questions and answers but let's deal with the calculation aspect first)

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MEASUREMENTS AND UNITS (CHAPTER 1)

Fundamental quantities are quantites that do not depend on other quantities e.g. mass(kg), length(m), time(s), temperature(k), electric current(ampere A), amount of substance(mol) luminous intensity (candela 'Cd').

Derived quantities; are quantities derived from other quantities e.g. speed(m/s), acceleration (m/s^2) ,density (kgm^{-3}), moment (Nm), pressure (Nm^{-2}), torque e.t.c.

Dimension: getting dimension is very easy, in exam you might be asked to find the dimension of an uncommon formular, note that the **dimension for mass is L, distance is L, time is T, current is I,** in getting dimension you need to know the formular first

ex. 1; Find the dimension of velocity.

SOLUTION

v=$\frac{distance}{time}$=$\frac{L}{T}$=LT^{-1}.

ex. 2; what is the dimension for acceleration

SOLUTION

a=$\frac{velocity}{time}$=$\frac{LT^{-1}}{T}$=LT^{-2}.

Ex. 3; what is the dimension for pressure?

SOLUTION

P=$\frac{force}{area}$=$\frac{ma}{lxb}$=$\frac{MLT^{-2}}{LXL}$=$ML^{-1}T^{-2}$. Dimension of l and b are ''L''. Hence simply knowing the basic acceleration like velocity(LT^{-1}) ,acceleration (LT^{-2}), pressure ($ML^{-1}T^{-2}$), volume (L^3). you can easily get other higher dimension easily ,other examples of dimension are moment (ML^2T^{-2}), impulse (MLT^{-1}), momentum (MLT^{-1}), elastic modulus ($ML^{-1}T^{-2}$), you can try deriving them using their formulars.

application of dimension; It is useful in in checking if an equation which has been derived is dimensionally correct, note that for an equation to be dimensionally correct co-efficient of dimension must be the same

ex. 4; if x refers to a distance u and v are velocities , a is acceleration and t is time , which of the following is dimensionally correct. (a) x=$ut + at^3$ (b) v^2=u^2 +2ax

SOLUTION

x=$ut + at^3$,L=$\frac{L}{T}xT + \frac{L}{T^2}xT^3$, L=L + LT, It is incorrect because the co-efficient are not the same, take a look at L, we have L^3 and T^1, The co-efficient are not the same , hence is no correct.

(b) v^2=u^2 +2ax ,force MLT^{-2}, $\frac{L^2}{T^2}$=$\frac{L^2}{T^2}$ + $\frac{L^2}{T^2}$,is correct because co-efficient of dimensions is the same. Note that numbers are dimension e.g. they don't appear in dimensionless.

SOLUTION OF EXERCISE 1

1.1 You are told that the volume of a sphere is given by V=$\frac{\pi d^3}{4}$, where V is the volume and d is the diameter of a sphere. Is this equation dimensionally correct?

SOLUTION

volume= m^3(L^3) , dimension of diameter ''d''=m (L^3) ,from V=$\frac{\pi L^3}{4}$, L^3=$\frac{\pi L^3}{4}$=L^3 , L^3=L^3. note that numbers and symbols do not appear in dimension. It is dimensionally correct.

1.2 If x=$\frac{gt^2}{2}$, where x is length and t is time, is it dimensionally correct, what are the S.I unit of the constant g?

SOLUTION

x=$\frac{gt^2}{2}$, x= length (L) , g=gravity (m/s^2), (LT^{-2}), L=$\frac{LT^{-2}xT^2}{2}$, L=L. Hence it is dimensionally.

1.3. show that the equation x=$x_0 + vt$, where v is velocity and x and x^0 are length is dimensionally correct.

SOLUTION

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$x=x^0+vt$, x=distance (L) , x^o=distance(L) , v=velocity (LT^{-1}), t=time (T) ,L=L + $LT^{-1}xT$, L=L + L. It is dimensionally correct.

1.4. One student using unit analysis, says that the equation V=$\sqrt{2ax}$ is dimensionally correct. Another says it is not with whom do you agree?

SOLUTION

V=$\sqrt{2ax}$, a=acceleration=LT^{-2} ,

LT^{-1}=$\sqrt{LT^{-2}xL}$, $\frac{L}{T}$=$\sqrt{\frac{L^2}{T^2}}$, $\frac{L}{T}$=$\frac{L}{T}$. Hence it is dimensionally correct.

1.5. A car travels at a constant speed of 15m/s . how many miles does it travel in 1h?

SOLUTION

Converting 15m/s to miles/hr, 15x$\frac{1}{1609}$$x3600$ =33.56m/s.

1.6. Which one of the following has the same dimension as time? (a) $\frac{x}{a}$ (b) $\sqrt{\frac{2x}{a}}$

(c) $\sqrt{\frac{v}{x}}$ (d) vx (e) xa

SOLUTION

T= $\sqrt{\frac{2x}{a}}$, T=$\sqrt{\frac{2L}{LT^{-2}}}$=$\sqrt{2T^2}$, T=T, Therefore the answer is B

1.7 The area of a room floor is 25ft^2. How many m^2 are there in the floor?

SOLUTION

Note that 3.28feet= 1m, 3.28^2=m^2, hence 10.7584=m^2. 10.758 → m^2

25 → x, x=$\frac{25}{10.7584}$=2.324m^2.

1.8. What is the dimension of co-efficient of friction and viscosity ?

SOLUTION

Co-efficient of friction is given by μ=$\frac{F}{R}$=$\frac{mg\sin\theta}{mg\cos\theta}$ =tan ϴ. It is dimensionless because symbols do not appear in dimension.

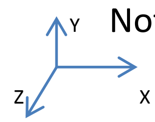
VECTORS (CHAPTER 2)

Vectors are physical quantities that have magnitude size and direction. Examples are displacement , velocity , acceleration, force , impulse, moment, field intensities (e.g. magnetic field , electric field, gravitational field) , weight , momentum , friction , torque, tension , upthrust , you can use the ''SHORTCUT'' **[DAVIM TUT FOR FORM FILL MANAGEMENT WORK]** to remember all vector quantities easily where d=displacement a=acceleration, v=velocity , i= impulse, m=moment , t=tension , u=upthrust, t=torque , f=force , f=field intensities , f=friction , m=momentum , w=weight any other quantity that isn't in ''davim tut for form fill management'' .

scalar quantities: Scalar quantities are physical quantities which have only magnitude but no direction e.g. distance, speed, mass, time, length, volume, e.t.c.

Resultant of a vector is given by

|R|=$\sqrt{R_x{}^2+R_y{}^2+R_z{}^2}$, R_x=resultant vector along x-axis , R_y= resultant vector along x-axis , R_z= resultant vector along x-axis.



Note that magnitude can also be |R|=$\sqrt{R_x{}^2+R_y{}^2}$. The direction is given by ϴ=$\tan^{-1}\frac{R_y}{R_x}$

RESOLVING VECTORS

The best and common method of resolving vectors is the vectorial or component or component method.

(i) Vectors in the same direction are added together. e.g. all vectors moving in x-axis are added together . (you will understand better when we solve exercises)

(ii) Always add vector in same direction together

(iii) After adding vectors in each direction you the resultant

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you find the resultant
(iv) Note that when resolving vectors , vectors in the x-axis (R_x) are resolved using ''cos ϴ'' i.e. R_x=cos ϴ and for R_x=sin ϴ . Please take note , these two formulars are very crucial. This is very crucial according to trigonometry ''ACTS'' to be specific4th quadrant
2nd quadrant 180^0 S | A 90^0 1st quadrant
3rd quadrant 270^0 T | C 360^0 4th quadrant
A=all is positive , C= cos is positive , T=tan is positive , S=sine is positive

SOLUTION TO EXERCISE 2

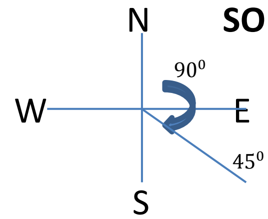
2.1 A particle has velocities 1m/s , 2m/s, $3\sqrt{3}$m/s, and 4m/s inclined at an angle of 0^0, 60^0, 150^0 and 300^0 respectively to the x-axis. Find the resultant velocity in magnitude and direction

SOLUTION

velocities=1m/s , 2m/s, $3\sqrt{3}$m/s, and 4m/s , angles= 0^0, 60^0, 150^0 and 300^0
Note that we resolve the vectors in both x-axis and y-axis and find resultant hence from R_x=$1\cos 0^0$+ $2\cos 60^0$ + $3\sqrt{3}\cos 150^0$ + $4\cos 300^0$= -0.5. , for R_y=$1\sin 0^0$ + $\sin 60^0$ +$\sin 150^0$ + $\sin 300^0$=$\frac{\sqrt{3}}{2}$=0.866 . from |R|=$\sqrt{{R_x}^2+{R_y}^2}$=|R|=$\sqrt{0.5^2+0.866^2}$= 1N.
When calculating resultant you ignore any minus sign because $(-)^2$= $+$. No need of putting it because we already know it will give us '+' direction using ϴ=$\tan^{-1}\frac{R_y}{R_x}$=$\frac{0.866}{-0.5}$
ϴ= -60^0. Checking the hint on trigonometry tan is only negative in 2nd quadrant and 4th quadrant hence we add 180^0 to -60^0, because it's a negative answer
ϴ= 180^0 + (-60^0) = 120^0.

2.2 A boar sails 3km east , then 5km west south east, then a further distance in an unknown direction. If his final position is 8km directly east of the starting point determine the magnitude and direction of the third leg of the journey

SOLUTION



According to the cardinal point it moved 3km east at 90^0, it moved again from east to south east (45^0 extension) . hence 90^0+45^0=135^0. Hence let the unknown further distance k resolving x and y axis, we take R_x and R_y as 8m hence R_x= 8km and R_y= 8km.
8=$3\cos 90^0$+ $5\cos 135^0$ + Bcos ϴ ,
Bcos ϴ= 8 $-$ $(3\cos 90^0$+ $5\cos 135^0)$
Bcos ϴ = 3.5355 -------- (1)
8=$3\sin 90^0$ + $5\sin 135^0$ +Bsin ϴ
Bcos ϴ= 8 – $(3\sin 90^0$ + $5\sin 135^0)$
Bcos ϴ= 1.4645---------- (2) . The magnitude of (1) and (2) will give us B. from
|R|=$\sqrt{{R_x}^2+{R_y}^2}$
|R|=$\sqrt{3.5355^2+1.4645^2}$= 3.83km. The direction is given by ϴ=$\tan^{-1}\frac{R_y}{R_x}$=$\frac{3.5355}{1.4645}$=67.5^0

2.3. Determine the magnitude of the resultant of two displacement A and B where A=($5i$-2k)m , B=$(-3i+4j+6k)$m

SOLUTION

Whe are simply add up the two vectors and find the resultant , A + B = ($5i$-2k) + $(-3i+4j+6k)$ = $2i+4j+4k$
from |R|=$\sqrt{{R_x}^2+{R_y}^2+{R_z}^2}$
|R|=$\sqrt{2^2+4^2+4^2}$= $\sqrt{36}$ = 6.

2.5. A lady drove her car northwest for a distance of 10km , then east for 40km a then south or 60km calculate the overall displacement of the car from the starting point.

SOLUTION

I need you to study the cardinal point

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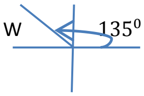
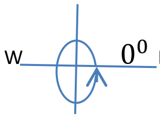
carefully and know how I got the values from



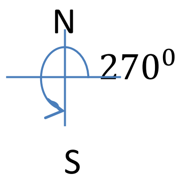
from 10km northwest

northwest = 135^0 from 10km

East of 40km at 0^0 east=0^0



60 km south = 270^0 given by the diagram



R_x= 10cos 135^0+2cos 0^0 + 60cos 270^0= 32.93.

R_y=10sin 135^0 + 4sin 0^0 + R_y=1sin 270^0= -52.93 .

|R|= $\sqrt{{R_x}^2 + {R_y}^2}$=$\sqrt{32.93^2 + 52.93^2}$=62.3km

ϴ=$\tan^{-1}\frac{R_y}{R_x}$=$\frac{-52.93}{32.93}$= -58.1^0.

2.6 A particle of mass 10,000g is acted upon by forces of 2N, $4\sqrt{2}$N , 6N and 8N inclines at angles of 30^0, 45^0, 60^0 and 120^0 respectively to a given direction. The magnitude of the resultant force and the acceleration are?

SOLUTION

We were given 2N, $4\sqrt{2}$N, 6N and 8N and for angle 30^0 , 45^0 , 60^0 , 120^0 , hence R_x=2cos 30^0+ $4\sqrt{2}$ cos 45^0 + 6cos 60^0 + 8cos 120^0 = 4.73. R_y=2sin 30^0 + $4\sqrt{2}$ sin 45^0 + 6sin 60^0 + sin 120^0 = 17.12N.

|R|= $\sqrt{{R_x}^2 + {R_y}^2}$=$\sqrt{4.73^2 + 17.12^2}$=17.77N.

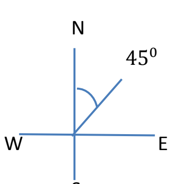
Note that from f = ma , m= 10,000g to kg=10kg

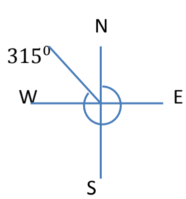
a = $\frac{f}{m}$=$\frac{17.77}{10}$ = 1.777m/s^2.

2.7 A particle is subjected to two displacement as follows 30m to the northwest and 40m to the northwest. What must be the third displacement the particle is to end if the particle is to end up at the starting point?

SOLUTION

30m northeast=45^0 , northwest = 315^0 , note that if it moves





to starting point it goes back to north where it started , hence R_x= 30cos 45^0+ 40cos 315^0 R_x= 49.4975. R_y=30sin 45^0 + 4sin 315^0

R_y= -7.071. |R|= $\sqrt{{R_x}^2 + {R_y}^2}$

|R|=$\sqrt{49.4975^2 + 7.071^2}$ = 49.99 = 50.

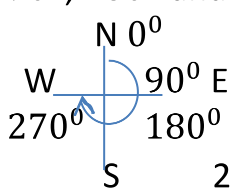
ϴ=$\tan^{-1}\frac{R_y}{R_x}$=$\frac{-7.071}{49.4975}$ = -8.1^0 . in acts tan is negative in first quadrant hence,

ϴ = $90^0 + (-8.1) = 81.9^0$.

2.8 Four forces 8N, 6N , 2N, and 4N act at a point O in the directions north, east, south and west respectively , find the magnitude of their resultant

SOLUTION

We were given 8N, 6N, 2N and 4N moving from north, east, south, west .we have 0^0, 90^0, 180^0 and 270^0 . R_x= 8cos 0^0+



6cos 90^0+ 2cos 180^0 + 4cos 270^0 = 6.

R_y=8sin 0^0 + 6sin 90^0 + 2sin 180^0 + 4sin 270^0 = 2N

|R|= $\sqrt{{R_x}^2 + {R_y}^2}$ =$\sqrt{6^2 + 2^2}$ = 6.32N.

2.9 Referring to question 2.8 . find the direction of the resultant force.

SOLUTION

from ϴ=$\tan^{-1}\frac{R_y}{R_x}$=$\frac{2}{6}$= -18.4^0 .

MECHANICS (CHAPTER 3)

speed or velocity is given by V = $\frac{distance}{time}$ = $\frac{s}{t}$

acceleration is given by $A = \frac{v}{t}\frac{v-u}{t}$, u−v is the change in velocity . Average velocity is given by $V = \frac{u+v}{2}$, u= initial velocity , v=final velocity , (this average velocity is for uniformly accelerated motion note that a body is said to be uniformly accelerated if the rate of change of velocity with time is constant), the average velocity for non-uniformly accelerated motion is given by

$V_{av} = \frac{total\ distance\ covered}{total\ time}$

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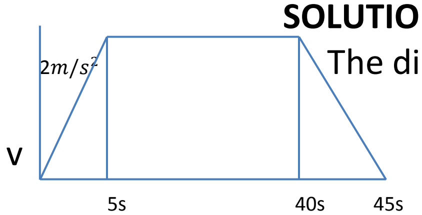
EQUATIONS OF MOTION: equations of motion are given by $v^2 = u^2 + 2as$, $v = ut + at$, $s = ut + \frac{1}{2}at^2$. The distance covered by a rectangle , trapezium or triangle is the area of the shape . Areas of this shapes or rather distance are; for trapezium $S = \frac{1}{2}(a+b)h$, a= distance of the shape under v-t graph , b= base , h= height . for triangle $S = \frac{1}{2}bh$. **Note that for freely falling objects under the influence of gravity** are given by; $v = u \pm gt$, $S = ut \pm \frac{1}{2}gt^2$ $v^2 = u^2 \pm 2gs$, $s - s_0 = ut \pm \frac{1}{2}gt^2$, where x_0= initial distance , x = final distance .The derivative $\frac{dy}{dx}$ of distance or displacement gives speed (velocity) . The derivative of velocity $\frac{dy}{dx}$ give acceleration . To differentiate you multiply bt the power of 'x' and minus 1 from the power i.e. $y=t^n$, $\frac{dx}{dt}=nt^{n-1}$. **Note when a body start from rest u= 0 but when it comes to rest v= 0** . Note that in motion influenced by gravity "$-$" is an upward motion while "$+$" is a downward motion. **Note also that for upward motion v= 0 an for downward motion u= 0 .** Note that negative sign in acceleration means retardation.

SOLUTION TO EXERCISE 4

3.1. A car starts from rests , accelerate at $2m/s^2$, for 15sec, it then continues at a steady speed for further 25sec and decelerates to rest in 5sec find (a) The distance travelled in m (b) The maximum velocity (c) The average velocity (d) The time taken to cover two-third of the distance.

SOLUTION

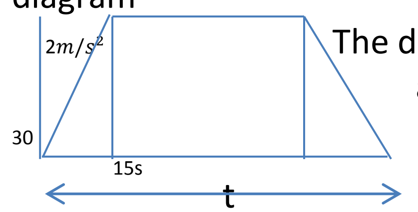


The diagram of movement is a trapezium hence the distance will be given from $S = \frac{1}{2}(a+b)h$, a= 40$-$15 = 25. b= 45. This is a velocity-time graph , the height of the shape is the velocity which we to find using

v= at=2x15= 30secs. $S = \frac{1}{2}(25+45)30$

S= 1050m. **(b)** The maximum velocity is also 30m/s. **(c)** This is a non-uniformly accelerated motion , the total time = 45s using $V_{av} = \frac{total\ distance\ covered}{total\ time} = \frac{1050}{45}$=23.33s

(d) $\frac{2}{3}$ of distance , $\frac{2}{3}$ x 1050 = 700m. we then find the time it takes to cover 700m from diagram



The diagram of a= t$-$15 , b= t h=30m/s,

$S = \frac{1}{2}(t - 15 + t)30$, 1400= $(2t - 15)30$, t= 30.84secs. to 2 significant figures it is approximately 30.00sec.

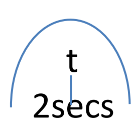
3.2. The displacement of a body in positive x-direction is given x = $3t^3 + 2t^2 + 4t + 5$. Find the velocity and acceleration of the body after 5sec.

SOLUTION

x = $3t^3 + 2t^2 + 4t + 5$, we differentiate once for velocity and twice for acceleration t= 5s. $\frac{dx}{dt}=9t^2 + 4t + 4$ substituting 5 for t . $\frac{dx}{dt}=9(5)^2 + 4(5) + 4$ = 249m/s. this is for velocity to get acceleration we differentiate again $\frac{d^2y}{dx^2}$ = 18t + 4 = 18(5) + 4 =- 94m/s^2

3.3. A ball thrown vertically upward returns to the thrower 4.0seconds later. Determine the speed with which it was thrown (g= 10m/s^2

SOLUTION



note that the total time of flight is 4 sec that is for it to move back to the thrower but time= 2sec. note that time

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is half of the total time of flight i.e (T=2t) from v=$u - gt$ '—' was used because It was an upward motion. Also v= 0 . hence

0= u − 10x2, u= 20m/s.

3.4. A train approaching a terminus does two successive 200m in 10seconds and 15seconds respectively . Assuming the retardation to be uniform . Find total distance the train runs before coming to stop.

SOLUTION

Doing two successive means it moved 200m twice , therefore it did 200m in 10sec and 400m in 10 + 15=25secs. Using s = ut+$\frac{1}{2}at^2$

200= $10u$+$\frac{1}{2}a10^2$, 200= 20u + 100a----(1)

400= $25u$+$\frac{1}{2}a25^2$, 800= 50u + 625a----(2)

solving simultaneously ,(HINT; you can use calculator to solve simultaneous equations see page 34 on hint on calculators) .a= -0.533m/s^2 u= 22.67m/s , v= 0 , (body comes to rest) total distance from $v^2 = u^2 + 2as$,

0=$22.67^2 + 2s$x—0.53 , 0= 22.67^2 —2x0.53xs

s= $\frac{22.6^2}{2x0.533}$ = 482m .

3.6. In a movie the FBI is investigating an assassination attempt on the life of the president. The settings is a parade in new york and an amateur photographer has made a videotape of the passing motorcade . A careful examination of the tape shows in the background a falling object that turns out to be a pair of binoculars used by the would-be assassin . From the tape the FBI is able to determine that the binoculars fell the last 12m before hitting the ground in 0.38s, it is important for them to know the height and hence the building floor from which the binoculars were dropped . Can this be determined from the given info? If so, from what height were the binoculars dropped (g = 9.8m/s^2).

SOLUTION

s_0= 12m , s= ? , it was dropped hence u= 0 , from S =$ut + \frac{1}{2}gt^2$, S =$0t + \frac{1}{2}10xt^2$

S= 4.9t^2 -------(1) ,it fell the last 12m in 0.38s , s −12= $0xt + \frac{1}{2}x10x(t - 0.38)^2$

s −12= $4.9(t - 0.38)^2$,

s—12=4.9t^2 —3.724t + 0.71 ,

s= 4.9t^2 —3.724t + 12.71 ---(2) , equating (1) and (2) , 4.9t^2= 4.9t^2 —3.724t + 12.71

4.9t^2 − 4.9t^2 =—3.724t + 12.71

3.724t = 12.71 , t= $\frac{12.71}{3.724}$ = 3.413sec.

3.7. Two runners approaching each other on a straight track have constant speeds +4.5m/s^2 and - 3.50m/s^2 respectively , when they are 100m apart. How long will it take for the runners to meet and at what position will this occur if they maintain these speeds?

SOLUTION

Note that they are running in opposite direction to each other hence from question

-3.5m/s → ← 4.5m/s

100—x x

from v= $\frac{d}{t}$, hence t= $\frac{d}{v}$,d_1= x , d_2= 100—x

$\frac{d_1}{v_1} = \frac{d_2}{v_2}$, $\frac{x}{4.5} = \frac{100-x}{3.5}$, 3.5x = 4.5(100—x)

3.5x = 450—4.5x , 8x = 450 , x= $\frac{450}{8}$= 56.25m.

3.10. If the speed of a truck is reduced from 26.7m/s to 6.7m/s within a distance of 800m . find (a) how long were the breaks applied ? (b) How much longer will it take before coming to rest ?

SOLUTION

u= 26.7m/s , v= 6.7m/s , s= 800m from S= $\frac{(v+u)t}{2}$, t= $\frac{800x2}{(26.7+6.7)}$ = 48sec. **(b)** , we need to find the deceleration (negative acceleration) from $v^2 = u^2 + 2as$,

$6.7^2 - 26.7^2 = 2xax800$, a= $\frac{-668}{2x800}$

a= −0.4175m/s^2. (negative sign must show when calculating deceleration but not

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before calculation). V=0, because body comes to rest. From v= u + at , 0= 26.7 − 0.4175t , t= $\frac{26.7}{0.4175}$ = 16sec.

for a body coming to rest , a= ? s= 800m

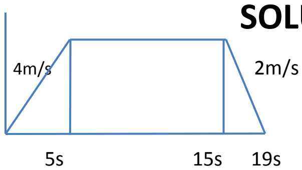
3.11. What is the effective take off velocity of a ball that bounces to a maximum height of 4m (g = $10m/s^2$)

SOLUTION

Note that at maximum height v= 0 ,the ball is opposing gravity because the ball accelerate upward (-g) . u= ? s= 4m ,using $v^2 = u^2 - 2gs$ $0 = u^2 - 22x10x4$, u= $\sqrt{80}$ = $8.94m/s^2$.

3.12. A starts from rest and accelerates for $4m/s^2$ for 5s, then maintains that velocity for 10sec and then decelerates at the rate $2m/s^2$ for 4s. What is the final speed of the car?

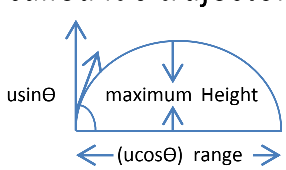
SOLUTION



. Note from 0 to 4m/s is accelerating and from ,the final velocity is the difference in velocities of the accelerating and decelerating body v_1= 4x5 = 20m/s. v_2= 2x4 = 8m/s, hence 20—8 = 14m/s.

PROJECTILE MOTION

A projectile is a body launched into the air, which moves under gravity in a parabolic path called it's trajectory



Time to reach maximum height is given by $t = \frac{u \sin \Theta}{g}$. Total time of flight is twice the time to reach maximum height i.e. $T = 2t = \frac{2u \sin \Theta}{g}$, maximum height is given by $H_{max} = \frac{u^2 sin^2 \Theta}{2g}$, **note that $sin^2\Theta$ is same as $(sin\Theta)^2$** , Range is given by $R = \frac{u^2 \sin 2\Theta}{g}$, where u= initial velocity of projection , g= gravity , Θ= angle of projection. Note that a projectile makes a vertical motion (v_x) with constant acceleration and the horizontal motion is with constant velocity (v_y) **Maximum range at any velocity is obtained at 45^0 angle of projection .** and is given by $R_{max} = \frac{u^2}{g}$, horizontal component of a projectile is given by $V_x = u \cos \Theta$, vertical component of projectile is given by $V_y = u \sin \Theta - gt$, the instantaneous velocity or final velocity is given by $V = \sqrt{V_y{}^2 + V_x{}^2}$, the direction is given by $\Theta = \tan^{-1} \frac{V_y}{V_x}$ parabolic equation is given by $Y = x \tan \Theta - \frac{gx^2(1+tan^2\Theta)}{2u^2}$ where y= horizontal axis x= vertical axis Θ= angle of projection , u= initial velocity.

, range is also given by R= $u_x t$ where t = time and u_x= initial velocity , **Note that sin 2Θ is same as (2 sin Θ cos Θ).**

RELATIVE VELOCITY : Two dimensional relative velocity between two bodies moving along non – parallel lines it is given by $V = \sqrt{V_y{}^2 + V_x{}^2}$, the direction is given by $\Theta = \tan^{-1} \frac{V_y}{V_x}$ .For one dimensional relative velocity **(i)** When they move in opposite directions their relative velocity is sum of their velocities $V_A + V_B$ **(ii)** When they move in the same direction their velocities is the difference in their velocities $V_A - V_B$ **(iii)** If the velocity of a body 'A' with respect to another body 'B' is $V_{AB} = V_A - V_B$, then The velocity of 'B' with respect to 'A' is $V_{AB} = -(V_A - V_B)$

EXAMPLE 1: A cyclist A rides with a velocity of 4m/s , ahead of another 'B' which chases after him with a velocity 3m/s . Determine the (i) relative velocity of A to B (ii) relative velocity of B to A

SOLUTION

It moves in the same direction and it's a one

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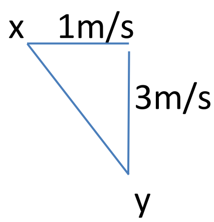
dimensional relative velocity hence $V_{AB} = V_A - V_B$=4−3= 1m/s. (ii) B relative to A using V_{AB} = $-(V_A - V_B)$= −(4−3)= −1m/s.

EXAMPLE 2: An athlete walks 3m/s due south of a golf hole while his coach walks at 1m/s due west of it , determine the relative velocity of the athlete with respect to his coach and it's direction.

SOLUTION



from $V = \sqrt{{V_y}^2 + {V_x}^2}$

$V = \sqrt{3^2 + 1^2}$ = 3.16m/s

the direction is given by

Ө= $\tan^{-1}\frac{V_y}{V_x} = \tan^{-1}\frac{3}{1} = 71.5^0$.

SOLUTION TO EXERCISE 4

4.1. A ball shot at an angle of 60^0 to the ground strikes a building 23m away at a point 16m high . Find the magnitude and direction of the final velocity of the ball as it strikes the wall.

SOLUTION

We are to find final velocity using

$V = \sqrt{{V_y}^2 + {V_x}^2}$, but we need to find 'u' using

Y= $x \tan Ө - \frac{gx^2(1+tan^2Ө)}{2u^2}$, x= 23m , Ө= 60^0 , u= ? , y= 16m, g= gravity -10m/s.

$16 = 23\tan 60^0 - \frac{10(23)^2(1+tan^2 60^0)^2}{2u^2}$

$16 = 39.837 - \frac{5290(1+tan^2 60^0)^2}{2u^2}$

$16 = 39.837 - \frac{5290(1+tan^2 60^0)^2}{2u^2}$

$16 = 39.837 - \frac{21160}{2u^2}$, $16 + \frac{21160}{2u^2} = 39.87$

$\frac{32u^2+21160}{2u^2} = 39.87$, $32u^2 + 21160 = 79.74^2$

$47.74u^2 = 21160$, u= $\sqrt{\frac{21160}{47.74}}$= 21.053m/s.

from $V_x = u\cos Ө$ because we are dealing with initial velocity hence we use $\boldsymbol{u_x}$ in place of v_x) $U_x = u\cos Ө = 21.053x\cos 60^0$

u_x= 10.5265m/s . using R=$u_x t$, t= $\frac{R}{u_x}$= $\frac{23}{10.5265}$= 2.185secs

$V_y = u\sin Ө - gt$= $21.053\sin 60^0 - 10x2.185$

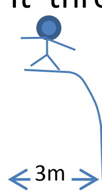
V_y= −3.6m/s. from $V = \sqrt{{V_y}^2 + {V_x}^2}$

$V = \sqrt{3.6^2 + 10.5265^2}$ = 11.12m/s. the direction is from Ө= $\tan^{-1}\frac{V_y}{V_x}$=$\tan^{-1}\frac{-3.6}{10.5265}$ = 18.88^0

4.2. A boy throws himself from the top of a diving board with a horizontal velocity of 4m/s if he land in the pool 3m from the point vertically below his point of projection how high is the diving board

SOLUTION

It threw himself from rest hence U= 0



R= 3m , U_x= 4m/s , from R= $U_x t$,

t= $\frac{R}{U_x} = \frac{3}{4}$= 0.75secs. we look for height using S =$ut + \frac{1}{2}gt^2$, (we used positive(+) in formular because it is not acting against gravity, it is coming down)

S = 0xt+$\frac{1}{2}$x9.8x0.75^2 = 2.756 = 2.76m

4.3. What is the least velocity of projection required to obtain a horizontal range of 100m and what will be the time of flight (g= 10m/s)

SOLUTION

The least velocity of projection is the maximum range R_{max} = 100m ,g= 10m/s , U=? using $R_{max} = \frac{u^2}{g}$, U= $\sqrt{R_{max}\ x\ g}$= $\sqrt{100x10}$ U= 31.6m/s. at maximum range Ө= 45^0 .we find time of flight using T = $\frac{2u\sin Ө}{g}$ T = $\frac{2x31.6x\sin 45}{10}$ = 4.47secs

4.4. Particle is fired of the cliff of 49m high, with a speed of 14m/s at an angle 45^0 to the horizontal . Find the maximum height reached and the point where the particle enters the sea.

SOLUTON

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Note that when particle enters the sea , it has a maximum height of (HEIGHT OF CLIFF AND HEIGHT(DEPTH) OF SEA) ,hence you can use this formular $H_{max} = \frac{u^2 sin^2 Ө}{2g}$ + H

for questions like this, where H= height of clif = 49m , u = 14m/s , g = $9.8m/s^2$ Ө = 45^0

$H_{max} = \frac{14^2 x (\sin 45^0)^2}{2x9.8}$ + 49 = 54m.

4.5. If a man on a train turns and walk 5km/h in the direction opposite that of the train moving at 20km/h . find the velocity of the man relative to a boy stand by the road

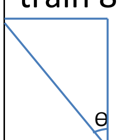
SOLUTION

we are not asked to find the relative velocity of the man to the train but of a man to a boy standing on the road , THE MAN IS MOVING IN THE SAME DIRECTION WITH THE BOY hence for this reason we minus using rule **(ii)** of one dimensional relative velocity we minus man= 5km/h , train = 20km/h. 20−5= 15km/h

4.6. A car travelling at 80km/h on a level road raining day. The trucks of the rain drops on a side window make an angle 30^0 with the vertical. Neglecting the wind velocity , determine the velocity of the rain drops

SOLUTION

train 80km . where ''k'' is the raindrop From



SOH-CAH-TOA Ө = 30^0 tan Ө = $\frac{opp}{adj}$

k $\tan 30^0 = \frac{80}{v}$,V= $\frac{80}{\tan 30^0}$ = 138.6km/h

4.8. If a particle is projected with speed 30m/s at an angle $\tan^{-1} 2$, find the greatest height and the corresponding horizontal distance . Find also the time of flight .

4.9. When a stone is projected, it's horizontal range is 24m and greatest height 6m. Find it's velocity of projection

SOLUTION

H$_{max}$ = $\frac{u^2 sin^2 Ө}{2g}$, Ө = $\tan^{-1} 2$ = 63.435.

U= 30m/s , H$_{max}$ = $\frac{30^2 (\sin 63.435)^2}{2x9.8}$ = 36.735m

4.10. During a football match, the ball kicked at 45^0 angle of elevation went just over the goal post , height 2.4m. assuming the goal post height is the greatest, calculate (a) speed at which the ball was projected (b) the time taken to reach the greatest height (c) the horizontal distance between the point of kick and foot of the goal post bar (neglect the thickness of the bar)

SOLUTION

because the goal post height is greatest We are to find the initial speed or velocity u= ?

H_{max} = 2.4m , Ө = 45^0 , H$_{max}$ = $\frac{u^2 sin^2 Ө}{2g}$

U= $\sqrt{\frac{2gH_{max}}{\sin^2 Ө}} = \sqrt{\frac{2x9.8x2.4}{(\sin 45^0)^2}}$ = 9.6995m/s

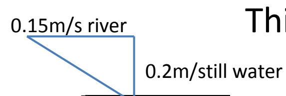
(b) t= $\frac{u \sin Ө}{g}$ = t= $\frac{9.6995x (\sin 45)^2}{9.8}$ = 0.495secs

(c) the horizontal distance is the range

R= $\frac{u^2 \sin 2Ө}{g}$ = R= $\frac{9.6995^2 \sin(2x45^0)}{9.8}$ = 9.6m

4.11. A swimmer swims north across a river that flows at 0.20m/s from west to east . If the speed of the swimmer is 0.15m/s relative to still water, what is the swimmer's velocity relative to the river bank?

SOLUTION



This is a two dimensional relative velocity question

$V = \sqrt{{V_y}^2 + {V_x}^2} = \sqrt{0.15^2 + 0.2^2}$ = 0.25m/s. .

the direction is from Ө= $\tan^{-1} \frac{V_y}{V_x}$

Ө = $\tan^{-1} \frac{0.2}{0.15}$ = 36.87^0 = 37^0 .

4.12 A ball is thrown horizontally , with a sped of 15m/s from the top of a 6.0m tall hill. How far from the point on the ground directly below the launch point does the ball strike the ground

SOLUTION

We are to find the range from R= $U_x t$

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but we look for time first , Before the ball was at rest hence U= 0 , using S $=ut+\frac{1}{2}gt^2$,

6= $0xt+\frac{1}{2}9.8t^2$, t= $\sqrt{\frac{2x6}{9.8}}$ = 1.1secs. ,

U_x=15m/s , R= 15X1.1 = 16.5m = 17m

4.13. A person riding in th =e back of a pick up truck travelling at 70km/h on a straight , level road throws a ball with a speed of 15km/h relative to the truck in a direction opposite its motion. What is the velocity of the ball (a) relative to a stationary observer by the side of the road (b) relative to the driver of a car moving in the same direction as the truck at speed of 90km/h

SOLUTION

(a) Relative to a stationary observer (in same direction hence we subtract) truck = 70km/h ball= 15km/h ,V = 70—15 = 55km/h.

(b) Note that the ball and the car (which is moving in the same direction as the truck) are moving opposite each other , hence we add car= 90km/h , V= 90+15= 105km/h.

FORCE AND NEWTON'S LAW (CHAPTER – 5)

momentum is given by P = MV , m= mass , v= velocity . Impulse is given by I = FXT , f=force , t= time , force is given by F = $\frac{m(v-u)}{t}$, v= final velocity , u= initial velocity . Upward acceleration of a lift is given by R = m(g + a) Downward acceleration of lift is given by R= m(g – a) , True weight is given by W= mg .

ACCELERATION OF CONNECTED PARTICLES ARE GIVEN BELOW . Acceleration of two smooth pulleys are given by a= $\left(\frac{m_2-m_1}{m_2+m_1}\right)g$.

m_2, m_1 are masses of pulleys. The tension in The string is given by T= $\left(\frac{2m_1m_2}{m_2+m_1}\right)g$

Net force of the pulley system is given by Netforce= 2T . acceleration in air- track glider is given by a = $\left(\frac{m_2}{m_2+m_1}\right)g$, Tension in the string is

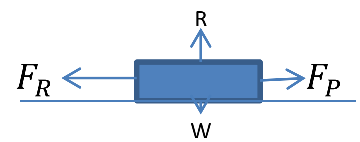
glider is given by T= $\left(\frac{m_1m_2}{m_2+m_1}\right)g$, force is given by F = 1.414T , where T=tension , Acceleration on a frictionless surface plane is given by a = $\left(\frac{m_2-m_1 \sin\theta}{m_1+m_2}\right)g$ .Two bocks resting on an inclined plane connected by a light string , the acceleration is given by

a= $\left(\frac{m_2 \sin\theta_2-m_1 \sin\theta_1}{m_1+m_2}\right)g$

FRICTIONAL FORCE: frictional force when object is accelerating is given $F_R=F_P-ma$

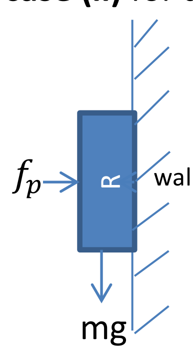
f_p = applied force ,m= mass ,a= acceleration When object is not moving the weight or normal reaction is given by R=W= mg , note that normal reaction(R) and weight (W) are equivalent to each other

case (i)



When object is on a horizontal plane , the applied force is what cause the object to move , the force need to be greater than the frictional force for the object to move. Friction on a horizontal surface is given by F_R=μmg , μ = co-efficient of friction.

case (ii) for a vertical surface i.e



let's assume that a block is held vertically on a wall , the applied force 'f_p' is what keeps the object on the wall , the friction on the vertical surface is given by μ= $\frac{mg}{R}$, R= normal reaction . Take note of the two cases.

SOLUTION TO EXERCISE 5

5.1. A box of books of mass 2.0kg is sliding across a level floor and its retardation is measured to be $4m/s^2$. Calculate the co-efficient of kinectic friction . $(10m/s^2)$

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SOLUTION

m=0.2kg, a= $4m/s^2$, g= $10m/s^2$We find 'µ' using f_r = ma , µmg= ma , µ= $\frac{ma}{mg}$= $\frac{a}{g}$= $\frac{4}{10}$= 0.4

5.2. A body hangs from a spring balance supported from the roof of an elevator . If the elevator has an upward acceleration of $3m/s^2$ and the balance reads 50N, what is the true weight of the body? ($10m/s^2$)

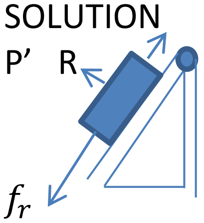
SOLUTION

R= 50N (normal reaction is same as tension in the cord T) g= $10m/s^2$, a= $3m/s^2$, we are to find the true weight from (w= mg) but we look for mass first from R= m(g + a)

m = $\frac{R}{(g+a)}$ = $\frac{50}{10+3}$ = 3.846N

5.3. A 15kg block rest on the surface of a smooth plane inclined at an angle 30^0 to the horizontal . A light inextensible string passing over a small , smooth pulley at the top of the plane connects the block to another 13kg block hanging freely . Find the acceleration of the resulting motion and the tension in the string . ($10m/s^2$)

SOLUTION



According to the question and this diagram you can see that it is a frictionless plane. m_1= 15kg m_2= 13kg ,

a= ? , hence using a = $\frac{(13-15\sin 30^0)x9.8}{13+15}$

a= $1.925m/s^2$.

5.5. A 0.84kg glider on a level air truck is joined by string to two hanging masses. m_1 = 4.85kg and m_2 = 3.62kg the string have negligible mass and pass over light , frictionless pulley . (a) find the acceleration of the masses (b) the tension in the strings

SOLUTION

For question like this that has three masses you use a= $\left(\frac{m_1-m_2}{m_1+m_2+m_3}\right) g$, Note that this is a frictionless pulley system question m_1 = 4.85kg , m_2= 3.62kg m_3 = 0.84kg g= m/s^2

a= $\left(\frac{4.85-3.62}{4.85+3.62+0.84}\right) x9.8$ = $1.3m/s^2$.

(b) in each string we use T= m_2(g + a) and T= m_1(g − a) . T= 3.62(9.8 + 1.3) = 40.2N

T= 4.85(9.8 − 1.3) = 41.2N

5.7. Two particles of masses 6kg and 14kg are connected by the light string passing over a smooth pulley ; what is the tension in the string?

SOLUTION

m_1 = 6kg , m_2= 14kg , T= $\left(\frac{2m_1m_2}{m_2+m_1}\right) g$

T = $\left(\frac{2x6x14}{6+14}\right)$9.8 = 82.32N. **Note that while solving if you are not given ''g'' always use 9.8m/s^2 except when specified in the question else you get a wrong answer.**

5.11. If an air truck glider of mass 2kg is connected to a mass of 5kg with a spring over a frictionless, massless pulley. What is the force on the pulley

SOLUTION

m_1 = 2kg , m_2= 5kg , g= $10m/s^2$It is an air glider hence T= $\left(\frac{m_1m_2}{m_2+m_1}\right) g$= $\left(\frac{2x5}{2+5}\right)$10= 14.3N.

force on air-track glider using F=1.414T

F= 1.414X14.3 = 20.2N.

5.12. Two particles of masses 7kg and 9kg are connected by a light inextensible string passing over a smooth fixed pulley. What is the force on the pulley? (9.8m/s^2)

SOLUTION

This is a pulley hence m_1 = 7kg , m_2= 9kg , g= $9.8m/s^2$,It is an air glider hence

T=$\left(\frac{2m_1m_2}{m_2+m_1}\right) g$= $\left(\frac{2x7x9}{7+9}\right)$ x9.8= 77.175N.

force on pulley using F=2T = 2x77.175

F = 154.35N.

5.14. Two blocks connected are connected by a cord on a horizontal surface . A force F pulls on the blocks as shown In the figure below

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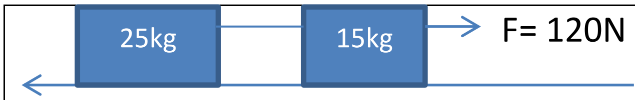

SOLUTION

f_p = 120N , m= 25 + 15= 40kg , a= ? , μ= 0.2
g= 9.8m/s^2 from $F_R = F_P - ma$, a= $\frac{f_p-\mu mg}{m}$
a= $\frac{120-0.2x40x9.8}{40}$ = 1.04m/s^2 .

5.13.A disk of moment of inertia 2x10^{-2}kgm^2 Is rotating freely about an axis through it's centre at 20rad/s . Calculate the new angular velocity if some wax of candle 0.05kg is dropped gently on the disc 0.1m from the axis

SOLUTION

If some wax is dropped into the disk , **the new moment of inertia = moment of inertia of disk + that of wax** .inertia of disk = $2.0x10^{-2}$kgm^2 ,m= 0.05kg, r= 0.1m, moment of inertia of wax = mr^2 = 0.05x0.1^2
= 5x10^{-4}kgm^2 . new moment of inertia = $2.0x10^{-2}$ + 5x10^{-4} = $2.05x10^{-2}$kgm^2

5.15. If an air-track glider of mass 5kg is connected to a mass of 2kg with a string over a frictionless and massless pulley . Calculate the acceleration of the glider ($10m/s^2$)

SOLUTION

m_1= 5kg m_2= 2kg , g= $10m/s^2$,
a= ? a = $\left(\frac{m_2}{m_2+m_1}\right) g$ = $\left(\frac{2}{5+2}\right) x10$ = 2.86m/s^2

5.16.Two blocks at rest on inclined frictionless plane connected by light string passed through a pulley . find the acceleration of the system if the first mass is 5kg at an angle of 30^0 and the second mass is 8kg at an angle of 60^0 ($10m/s^2$)

SOLUTION

This is a question of two blocks resting on an inclined plane m_1= 5kg m_2= 8kg , g= $10m/s^2$, Θ_1 = 30^0 , Θ_2 = 60^0 a= $\left(\frac{m_2 \sin\Theta_2 - m_1 \sin\Theta_1}{m_1+m_2}\right) g$
a= $\left(\frac{8x \sin 60^0 - 5x \sin 30^0}{8+5}\right) g$ = 3.41m/s^2 .

CIRCULAR MOTION AND GRAVITATION (CHAPTER 6)

gravitational force of two bodies of masses $m_1$and m_2 is given by $F_g = \frac{Gm_1m_2}{r^2}$, orbital speed is given by V= $\sqrt{\frac{Gm_e}{r}} = \sqrt{\frac{Gm_e}{R_e+h}}$, where r= radius of earth (R_e= 6.4x10^6 ,it's a constant) , G= gravitation constant (6.67x10^{-11} ,it's a constant) , M_e = mass of earth (6x10^{24} ,it's a constant) , h= height .When object is above the earth surface , the magnitude of gravitational force is given by $F_g = \sqrt{\frac{Gmm_e}{(R_e+h)^2}}$, where m= mass . Centripetal acceleration is given by $a_c = \frac{v^2}{r}$, it is also given by $a_c = w^2r$ and a_c =vw , where v= velocity , r= radius , w = angular velocity . acceleration is also given by a = w^2x , x= displacement , centripetal force is given by $F_c = \frac{mv^2}{R}$ and $F_c = mw^2r$, m= mass , period of satellite is given by T = 2π$\sqrt{\frac{r^3}{GM_e}}$ period of satellite is also given by T = 2π$\sqrt{\frac{(R_e+h)^3}{GM_e}}$, period of circular motion is given by T= $\frac{2\pi R}{V}$, v= velocity , escape velocity is given by V=$\sqrt{2gr}$. **Note that r = $R_e + h$**
Tension in string for a body moving horizontally in a circle path is given by T=$\frac{mg}{\cos\Theta}$

SOLUTION EXERCISE 6

6.1. Calculate the force necessary to keep a particle of mass 0.2kg moving in a horizontal circle of radius 0.5m with period of 0,5s . What is the direction of the force?

SOLUTION

m= 0.2kg , T= 0.5s, r= 0.5m , we are to find the centripetal force which keeps the body moving in a circular path but we find 'v' first

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using T= $\frac{2\pi r}{v}$, v= $\frac{2\pi r}{T}$ = $\frac{2x3.142x0.5}{0.5}$ = 6.284m/s.
using F_c = $\frac{mv^2}{R}$ = $\frac{0.2x6.284^2}{0.5}$ = 15.805N=15.81N

6.2. A body of mass 0.2kg is whirled round in a horizontal circle by a string inclined by a string inclined 30^0 to the vertical calculate (i) tension in the string (ii) speed of thr body in the circle

SOLUTION

we are to find the Tension in string for a body moving horizontally in a circle path , m= 0.2kg, ϴ = 30^0 , g= $9.8m/s^2$ using T= $\frac{mg}{\cos\theta}$
T= $\frac{0.2x9.8}{\cos 30^0}$ = 2.263N= 2.26N

6.4. A pebble of mass , m is attached to one end of a high inelastic string of length , L. The other end of the string is fixed. The string is initially held taut to the horizontal and the pebble is then released . Find the values of the following quantities when the string reached the vertical position (i) The kinectic energy of the pebble (ii) The velocity of the pebble

SOLUTION

K.E= mgh , $\frac{1}{2}mv^2$, since h=l , K.E = mgl ,
, $\frac{1}{2}mv^2$ = mgl , v^2= 2gl . **(ii)** v=$\sqrt{2gl}$ m/s.

6.6. A satellite is to be put into orbit 500km above the earth's surface. If its vertical velocity after launching is 4000m/s. Calculate the magnitude and direction of the impulse required to put the satellite directly , into orbit , if it's mass is 50kg . Assume g= $10m/s^2$, radius of earth R= 6,400km,
hint: at the parking orbit height , the vertical momentum is P_y= MU_y , horizontal momentum is given by P_x= MU_x where
U_x =$\sqrt{\frac{gR^2}{r}}$, tan ϴ= $\frac{P_y}{P_x}$

SOLUTION

Impulse= FXT , (impulse)ft=mu . where 'u' is its initial velocity u=4000m/s , m= 50kg, P_y (which is impulse)= MU_y , where U_y= initial velocity .impulse= 50x4000= $2.0x10^5 kgms^{-1}$
h=500x10^3=$5x10^5$m . **r =** $R_e + h$
r=6.4x10^6+5x10^5 = 6.9x10^6m . g= $10m/s^2$
U_x =$\sqrt{\frac{gR^2}{r}}$ U_x=$\sqrt{\frac{10x(6.4x10^6)^2}{6.9x10^6}}$ = 7704.7m/s.
P_x = MU_x = 50x7704.7 = 385235kgms^{-1}
direction tan ϴ =$\frac{P_y}{P_x}$, ϴ= $\tan^{-1}\frac{2x10^5}{385235}$
ϴ = 27.4367^0 .

6.7. If a body of mass 0.5kg is whirled in a horizontal circle at the rate of 1000 revolution per minute . Determine the angular velocity

SOLUTION

no of revolution = 1000rev/min to convert to Hz , t= 1min= 60sec, from f= $\frac{n}{t}$ = $\frac{1000}{60}$
f= 16.6666667Hz. from w=2πf=
2x3.142x16.6666667= 104.7333335rad/s.

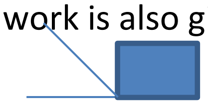
6.8.(ii) A communication satellite in the orbit is located at a height of 32000km above the earth surface . What is the (a) speed of the satellite in it (b) period of revolution of satellite.

SOLUTION

(a). h= 32000km(to m)= 3.2x10^7m .
R_e= 6.4x10^6 , G= 6.67x10^{-11} , M_e= 6x10^{24}
V = $\sqrt{\frac{Gm_e}{R_e+h}}$ = $\sqrt{\frac{6.67x10^{-11}x6x10^{24}}{6.4x10^6+3.2x10^7}}$ = 3228.3m/s.
(ii) T = 2π $\sqrt{\frac{(R_e+h)^3}{GM_e}}$
T= 2x3.142$\sqrt{\frac{(6.4x10^6+3.2x10^7)^3}{(6.67x10^{-11}x6x10^{24})}}$= 74747.1sec.

WORK , ENERGY AND POWER (CHAPTER-7

work is given by W=fxd , f=force , d= distance
work is also given by W=fxdcos ϴ from



when an object is being dragged or pulled on a horizontal floor or ground . Hook's law

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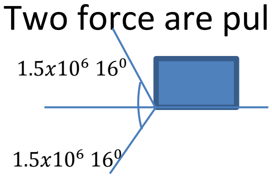
(extension) is given by F=kx , x= displacement or extension , k= force constant . power is given by $P= \frac{fxd}{time}$, t= time , Power is also given by P= FV , WHERE v= velocity f=force , work done in spring is given by $W=\frac{1}{2}kx^2$, x=displacement , k= force constant , it is also conservative energy of (K.E and P.E) by E= K.E + mgh . Relationship between work done and kinectic energy is given by $fxd = \frac{1}{2}mv^2$. Relationship between work done and potential energy (P.E) is given by fxd = mgh

SOLUTION TO EXERCISE 7

7.1. Two tugboats pull a disabled supertanker . Each tug exerts a constant force of 1.50x 10^6N, one 16^0 north of west and other 16^0 south of west , as they pull the tanker 0.65km toward the west . What is the total work they do on the supertanker?

SOLUTION

Two force are pulling the super tanker at 16^0 with the same force hence the total force will be Fcos Θ +Fcos Θ=2Fcos Θ



d= 650m , f= 1.5x10^6 .workdone = 2Fcos Θd
W.D= 2X1.5x10^6Xcos 16^0X650 = 1.87X10^9J

7.2. To compress a spring 4cm from it's unstretched length , 12.0J of work must be done. How much work must be done to stretch the same spring 3cm from it's unstretched length?

SOLUTION

The said spring hence x= 4cm (to m)= 0.04m. w= 12J , to find the work done if same string is stretched 3cm , we find 'k' . $W=\frac{1}{2}kx^2$, $k= \frac{w2}{x^2} = \frac{12x2}{0.04^2}$ = 15000N . x_2 = 3cm(to m)= 0.03m , $W=\frac{1}{2}kx^2 = \frac{1}{2}15000x0.03^2$ = 6.75J.

7.3. A woman weighing 600N steps on a bathroom scale containing a stiff spring. In equilibrium the spring is compress at 1.0cm under her weight . Find the force constant of the spring and the total work done on it during the compression.

SOLUTION

f= 600N ,x= 1cm= 0.0m , we find 'k' first , from f= kx , $k= \frac{f}{x} = \frac{600}{0.01}$ = 60, 000N/m , from $W=\frac{1}{2}kx^2 = \frac{1}{2}60000x0.01^2$ = 3J.

7.4. A Chicago marathon runner with mass 50kg runs up the stairs to the top of a 443m tall tower. In order to lift herself to the top 15.0 minutes , what must be her average power output in watts? In horse power

SOLUTION

because she need energy to lift herself , the energy is a potential energy , m= 50kg , g= $10m/s^2$, P.E = mgh power = $\frac{mgh}{time}$

power =$\frac{50x9.8x443}{900}$ = 241watts.

1 horse power → 746watts
x → 241watts. cross multiply

$x= \frac{241}{746}$ = 0.323hp .

7.5. A motorcycle is $\frac{1}{28900}$ times the mass of the truck . How much faster than a speeding truck must it moves to have the same kinectic energy

SOLUTION

m_c = mass o motorcycle , m_t = mass of truck

$m_c = \frac{1}{28900}xm_t = \frac{m_t}{28900}$. K.E = $\frac{1}{2}m_t{v_t}^2$,
K.E = $\frac{1}{2}m_c{v_c}^2$, $\frac{1}{2}m_t{v_t}^2 = \frac{1}{2}m_c{v_c}^2$

$\frac{1}{2}m_t{v_t}^2 = \frac{1}{2}x\frac{1}{28900}x{v_c}^2$,we are looking for the number of times v_c is faster than v_t hence , cancelling terms ${v_t}^2 = \frac{2xm_txv_c^2}{2x28900xm_t}$

$v_t = \sqrt{\frac{{v_c}^2}{28900}} = \frac{v_c}{170}$, v_c =170v_t . hence 170 times faster.

7.6. A man throws a ball that leaves his hand at a speed of 32.0m/s. the mass of the ball is 0.25kg . Ignore air resistance . How much

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work has the man done on the ball in throwing it?

SOLUTION

m = 0.25kg , v = 32m/s because it is moving using kinectic energy , we use W=$\frac{1}{2}mv^2$

W = $\frac{1}{2}0.25x32^2$ = 128J.

7.7. A baseball of mass 0.145kg is thrown straight up in the air , giving it an initial upward velocity of magnitude 20.0m/s. Use conservation of energy to find how high it goes.Ignoring air resistance.

SOLUTION

m= 0.145kg , v= 20m/s , in conservation of energy we have K.E and P.E because hence P.E = K.E , mgh= $\frac{1}{2}mv^2$, h= ? . h = $\frac{mv^2}{2mg}$

h = $\frac{0.145x20^2}{2x0.145x9.8}$ = 20.41m .

7.8. A 1000kg weather satellite was placed into a circular orbit 300km above the earth's surface . What speed must it have? (Take R_e= 6380km and M_e= $5.97x10^{24}$kg.

SOLUTION

R_e= 6380km= 6.38x10^6m , M_e= $5.97x10^{24}$kg h=300km= 3x10^5m. G= 6.67X10^{-11} from

v= $\sqrt{\frac{Gm_e}{R_e+h}}$ = $\sqrt{\frac{6.67x10^{-11}x5.97x10^{24}}{6.38x10^6+3x10^5}}$ = 7720.79m/s

7.9. A block of mass 0.5kg is forced against a horizontal spring of negligible mass, compressing the spring a distance of 0.2m . when released , the block moves on a horizontal table for 1.00 m

SOLUTION

F_r = µmg, because it was a spring an has a distance hence µmg= $\frac{1}{2}kx^2$, noting that f_r is also a force . m= 0.5kg , k= 100N/m , x= 0.2m g= $9.8m/s^2$, d= 1m . µ = $\frac{kx^2}{2mg}$ = = $\frac{100x0.2^2}{2x0.5.9.8}$

µ = 0.41 . (kinectic friction has no unit)

MOMENTUM

(CHAPTER 8)

Force is given by F= $\frac{mv}{t}$ = $\frac{m(v-u)}{t}$,

momentum is given by P= mv ,

ELASTIC COLLISION: Two bodies in a elastic collision bounce off after collision with their individual final speed given by

$m_1u_1 + m_2u_2$= $m_1v_1 + m_2v_2$,

m_1 and m_2=are masses of body , u_1 and u_2= are initial velocities , m_1 and $m_2$are masses of body , v_1 and v_2= final velocities

INELASTIC COLLISION: The bodies stick together after collision and move off with a common velocity is given by

$m_1u_1 + m_2u_2$ = $(m_1 + m_2)v$,

The ratio of the initial kinectic energy to the final kinectic energy is given by

$\frac{k_f}{k_i}$ = $\frac{m_1}{m_1+m_2}$, k_i k_f are initial and final kinectic energy of body respectively .Note **momentum before collision = momentum after collision** . K.E of two masses is given by K.E = $\frac{1}{2}(m_1 + m_2)v^{\ 2}$. note also the formuar $\frac{1}{2}m_1{v_1}^2$ = $\frac{1}{2}m_2{v_2}^2$, acceleration is given by a= $\frac{f}{m}$, m= mass , f= force , co – efficient at elastic collision of restitution is given by e = $\frac{v_2-v_1}{u_1-u_2}$,at elastic e= 1

SOLUTION TO EXERCISE 8

8.1. High – speed photography reveals that when a bat strikes a baseball , a typical collision time is about 0.25seconds, if a speed of 35m/s is imparted to a ball of mass 0.325kg , what average force is exerted by the bat ?

SOLUTION

m = 0.325kg , v = 35m/s , t = 0.25sec from

f = $\frac{mv}{t}$ = $\frac{0.325x35}{0.25}$ = 45.5N.

8.2.A football of mass 90kg running back and moving with a speed of 5m/s , is tackled he-ad on by a line backer of mass 120kg running.

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4m/s . They stick together . How fast are they moving just after the collision

SOLUTION

Note the word 'stick together' hence it is an inelastic collision , it was stated that one was running back, meaning they were running in opposite direction , hence we use (−) sign to calculate , we find v = ? (the velocity after collision) . m_1= 90kg , m_2= 120kg

u_1= 5m/s , u_2= 4m/s using

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

, $90x5 - 120x4 = (90 + 120)v$,

$v = \frac{450-480}{210}$ = −0.14m/s.

8.3. A 2kg block of ice is moving on a frictionless horizontal surface. At t= 0, the block is moving to the right with a velocity of magnitude 3.00m/s. Calculate the velocity of the block (magnitude and direction) after a force of 5N directed to the right has been applied for 4 seconds.

SOLUTION

f = 5N , t = 4sec , m = 2kg , u = 3m/s , v= ?

from ft = m(v −u) ,v= $\frac{ft+mu}{m} = \frac{5x4+2x3}{2}$ = 13m/s

8.4. An 18kg fish moving horizontally to the right at 3.2m/s swallows a 2kg fish that is swimming to the left at 7.4m/s . What is the speed of the large fish immediately after it's lunch if the forces exerted on the fishes by the water can be neglected?

SOLUTION

You have to pay attention carefully it was stated that a fish swallows another and moves , therefore they 'stick together' . (inelastic collision) . m_1= 18kg , m_2= 2kg

u_1= 3.2m/s , u_2= −7.4m/s (we used '−' because it moves left in the negative direction using $m_1u_1 + m_2u_2 = (m_1 + m_2)v$

, $18x3.2 + 2x(-7.4) = (18 + 2)v$,

42.8 = 20v , v = 2.14m/s.

8.5. A 0.3kg glider is moving to the right on a horizontal , frictionless air track with a speed of 0.8m/s . It makes a head on collision with a 0.2kg glider that is moving to the left with a speed of 2.2m/s. Find the final velocity (magnitude and direction) of each glider if the collision is elastic.

SOLUTION

It was stated that they moved in opposite direction after collision , (it is an elastic collision) m_1= 0.3kg , m_2= 0.2kg

u_1= 0.8m/s , u_2= −2.2m/s (it moved left in the negative direction '−') using

v_1 *and* v_2= ? using

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$0.3x0.8 + 0.2x(-2.2) = 0.3v_1 + 0.2v_2$

$-0.2 = 0.3v_1 + 0.2v_2$ ----------- > (1) also

using e = $\frac{v_2-v_1}{u_1-u_2}$, e= 1 , 1 = $\frac{v_2-v_1}{0.8-(2.2)} = \frac{v_2-v_1}{3}$

3 = $-v_1 + v_2$ ----- > (2) solving equation 1 & 2 simultaneously (check page 34 to see how to solve simultaneous equations with calculator) we have v_1= −1.6m/s (The negative sign indicates left) . v_2= +1.4m/s (positive sign indicates right)

8.7.A rocket in deep outer space turns on it's engine and ejects 1 percent (1%) of its mass per second with an ejection velocity of 2200m/s . What is the initial acceleration of the rocket?

SOLUTION

8.7. The m = 1kg , the mass per second is $\frac{m}{t} = \frac{1}{100}$ = 0.01kg/s. v = 2200m/s ,using

f = $\frac{mv}{t}$ = 0.01x2200 = 22N. from f = ma , a = $\frac{f}{m}$

a= $\frac{22}{1}$ = $22m/s^2$.

8.8. A rocket is fired in deep space, where gravity is negligible . If the rocket has an initial mass of 7000kg and ejects a gas at a relative velocity of magnitude 2000m/s , how much gas must it eject in the first second to have an initial acceleration of $25m/s^2$?

SOLUTION

We are to find the mass of the ejected gas

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per time i.e. $\frac{m}{t}$ = ? , mass of rocket = 7000kg
a = $25m/s^2$, t = 1sec (from per second)
v = 2000m/s , using f = ma = 7000x25 = 175000N . using f = $\frac{mv}{t}$, $\frac{m}{t}$ = $\frac{f}{v}$ = $\frac{175000}{2000}$,
$\frac{m}{t}$ = 87.5kg.

8.9. A truck moving with a velocity of 10m/s to the right hits a bicycle also moving to the right with a velocity of 6m/s . After the collision , the truck and the bicycle move to the right with a velocity of 6m/s and 5.5m/s respectively . What is the co – efficient of restitution of the collision?

SOLUTION

u_1= 10m/s , u_2= 6m/s ,v_1= 6m/s , v_2= 5.5m/s
e = ? (it is an inelastic collision) using
e = $\frac{v_2-v_1}{u_1-u_2}$ = $\frac{6-5.5}{10-6}$ = 0.125

8.10. (a) What is the magnitude of the momentum of a 10000kg truck whose speed is 15m/s? (b) What speed must a 5000kg truck attain in order to have: (i) The same momentum? (ii) The same kinectic energy

SOLUTION

m = 10,000kg , v = 15m/s using P = mv
P = 10000x15 = 1.5x10^5kgm/s. (b) i. v = ? , m = 5000kg , V = $\frac{1.5x10^5}{5000}$ = 30m/s.

8.11. A 3.0x10^3kg shuttle craft containing 50kg of fuel is located in deep space where the force of gravity can be neglected . If the fuel is consumed at a constant rate of 5kg/s with a constant exhaust velocity of 150m/s. What is ? (a) The thrust exerted on the shuttle craft and (b) The initial acceleration of the shuttle craft . **SOLUTION**

(a) m of shuttle craft = $3x10^3$kg , m of fuel = 50kg . The thrust is the force exerted on the shuttle m = $3x10^3 + 50$ = 3050kg. $\frac{m}{t}$ = 5kg/s.
v = 150m/s , using f = $\frac{mv}{t}$ = 5x150 = 750N **. (b)** from f = ma , a= $\frac{f}{m}$ = $\frac{750}{3050}$ = 0.246m/s^2

8.12. A single stage stationary in free space has a total mass of 4x10^5kg of which 3.4x10^5kg is fuel. If the velocity of the exhaust gases relative to the rocket is at 2km/s when the rocket engine is fired , what is the final velocity of the rocket at burnout?

SOLUTION

Final velocity of rocket burnout is given by
V= $v_e$ln$\frac{m_i}{m_f}$. where v_e = velocity of exhaust ,
m_i = initial mass , m_f = final mass , v_e = 2m/s , V = 2ln $\frac{4x10^5}{3.4x10^5}$ = 0.325m/s.
m_i = 4x10^5kg , m_f = 3.4x10^5kg ,

8.13. A 1kg ball with a spee 4.5m/s strikes a 2kg stationary ball. (a) What are the speeds of the balls after the collision? (b) What percentage of the initial kinectic energy do they have after the collision (c) What is the total momentum after the collision?

SOLUTION

(inelastic collision) . m_1= 1kg , m_2= 2kg
u_1= 4.5m/s , u_2= 0 (art rest) using
$m_1u_1 + m_2u_2 = (m_1 + m_2)v$
, $1x4.5 + 2x0 = (1 + 2)v$, $v = \frac{4.5}{3}$ = 1.5m/s.
(b) using $\frac{k_f}{k_i}$ = $\frac{m_1}{m_1+m_2}$ = $\frac{1}{2+1}$ = $\frac{1}{3}$, in % , $\frac{1}{3}x100$ = 33.33 % . (c) from P = mv , we have two masses , hence P = $(m_1 + m_2)v$
P = $(1 + 3)x1.5$ = 4.5kgm/s. (we used the total momentum after collision velocity as stated)

8.14. A rubber with a speed of 5.0m/s collides head on elastically with an identical ball at rest. Find the velocity of each object after the collision?

SOLUTION

u_1= 5m/s , u_2= 0 (because it at rest) using v_1 *and* v_2= ? m_1& m_2 = m .using
$m_1u_1 + m_2u_2$= $m_1v_1 + m_2v_2$. Note that this is an elastic collision because it was not

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stated that they moved together.

$mx5 + mx0 = mv_1 + mv_2$, m5 = m $(v_1 + v_2)$

5 = $v_1 + v_2$ ----------- > (1) also

using e = $\frac{v_2 - v_1}{u_1 - u_2}$, e= 1 , 1 = $\frac{v_2 - v_1}{5-0}$ = $\frac{v_2 - v_1}{5}$

5 = $-v_1 + v_2$ ----- > (2) solving equation 1 & 2 simultaneously (check page 00 to see how to solve simultaneous equations with calculator) we have v_1= 0 & v_2= 5m/s.

8.15. Two balls with masses of 2kg and 6kg travelled toward each other at speeds of 12m/s and 4m/s respectively. If the balls have a head-on inelastic collision and the 2kg ball recoil with speed of 8m/s , how much K.E is lost in the collision ?

SOLUTION

K.E lost = K.E of inelastic collision − K.E of elastic collision , . m_1= 2kg , m_2= 6kg

u_1= 12m/s , u_2= 4m/s . (it was not stated if ball was elastic or inelastic hence to find the K.E we assume it as elastic & solve and assume it as inelastic) , for inelastic

K.E = $\frac{1}{2}(m_1 + m_2)v^2 = \frac{1}{2}(2+6)8^2$ = 256J

K.E for elastic v_1= 8m/s . we look for v_2 = ?

$2x12 + 4x6 = 2x8 + 6v_2$, v_2 = 5.333m/s .

K.E = $\frac{1}{2}m_1{v_1}^2 + \frac{1}{2}m_2{v_2}^2 = \frac{1}{2}2x8^2 + \frac{1}{2}6x5.333^2$ = 149.3J.

K.E loss = 256 −149.3 = 106.7 = 1.1X10^2J

ROTATIONAL MOTION (CHAPTER 9)

Angle of rotation in a circular path is given by $\Theta = \frac{s}{r}$, s = arc length , r = radius , angular velocity is given by $W = \frac{\theta}{t}$, t = time , Note that 1^0 = 0.01745rad . Angular velocity is also given by W = 2πf & $W = \frac{2\pi}{T}$, where f = frequency & T = period , angular acceleration is given by $\alpha = \frac{\Delta w}{t} = \frac{w_f - w_i}{t}$. w_f & w_i = final and initial angular velocity. T = time.

Total linear acceleration is given by $T_{La} = \sqrt{at^2 + ac^2}$ where a_t = Tangential acceleration given by a_t = αR , where R = radius , a_c = centripetal acceleration given by $a_c = \frac{V^2}{R}$ Torque is given by $\boldsymbol{\tau} = I\alpha$, where I = moment of inertia , α = angular acceleration , moment of the inertia of a body is given by $I = MR^2$. moment of inertia of solid disk or circular disk is given by $I = \frac{1}{2}MR^2$, I for a cylindrical hoop is given by $I = MR^2$, moment of inertia for solid sphere is given by $I = \frac{2}{5}MR^2$, moment of inertia for through one end and perpendicular to the rod is given by $I = \frac{1}{3}ML^3$, l = length , m = mass . moment of inertia of a uniform rod passing through the centre is given by $I = \frac{1}{12}ML^2$, moment of inertia in radius of gyration is given by $I = MK^2$, K= radius of gyration. Rotational kinectic energy is given by K.E = $\frac{1}{2}IW^2$, I = moment of inertia , w = angular velocity . Note that 1rev/min = 0.1047rad/s . For thin – hallow spherical shell moment of inertia is given by $I = \frac{2}{3}MR^2$. Angular velocity is given by $W = \frac{v}{R}$, v = velocity , r = radius , rotational power is given by $P = \frac{w}{t}$, note also this formular $I_1W_1 = I_2W_2$, I_1 & I_2 = initial and final inertia , W_1 & W_2 = initial and final angular velocity . Inertia for a bowling ball is given by $I = \frac{1}{2}MR^2$ Also note this formulas ${W_f}^2 = {W_i}^2 + 2\alpha\Theta$, $W_f = W_i + \alpha t$, $\Theta = W_i t + \frac{1}{2}\alpha t^2$, these three equations are equivalent to the equations of motion. Note also that Θ = 2πn Ratio of the earth orbital speed to it's rotational angular momentum is given by

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$\frac{L_0}{L_S} = \left(R_e - \frac{2}{5}R_e\right)$, where R_e = 6.4x10^6

SOLUTION TO EXERCISE 9

9.1. The moment of inertia of a thin cylindrical hoop is given as $I = MR^2$. Calculate its radius of gyration.

SOLUTION

It was a cylindrical hoop , hence $I = MR^2$
I = MK^2 , equating formulars MR^2 = MK^2 taking the square – root of both sides **R = K OR K = R**

9.3. The power on a medical centrifuge rotating at 120000rpm is cut off. If the magnitude of the maximum deceleration of the centrifuge is 50rad/s^2 . how many revolutions does it rotates before coming to rest ?

SOLUTION

n= 12000Rpm (to convert revolution per min to sec , divide by t = 60secs , f = $\frac{n}{t}$ = $\frac{12000}{60}$ = 200rev/s(Hz) . , we find W_i using W= 2πf
W = 2X3.142X200 = 1256.8rad/s. body came to rest W_f = 0 , α = $-50rad/s^2$. (we used '—' sign because it's a deceleration) we then look for ϴ using ${W_f}^2 = {W_i}^2 + 2αϴ$,because .
0 = 1256.8^2 −2x50xϴ , $\frac{1256.8^2}{2x50}$ = 15795.46 ^{0} , also using ϴ = 2πn , n = $\frac{ϴ}{2\pi}$ = $\frac{15795.46}{2x3.142}$
n = 2.5x10^3 revolutions.

9.5. The tangential speed of a particle on a rotating wheel is 3.0m/s . If the particle is 0.20m from the axis of rotation , how long will it take for the particle to go through one revolution ?

SOLUTION

v = 3m/s , r = 0.2m , we look for 'w' first , from w = $\frac{v}{r}$ = $\frac{3}{0.2}$ = 15rad/s. then from W = $\frac{2\pi}{T}$
T = $\frac{2\pi}{W}$ = $\frac{2x3.142}{15}$ = 0.42sec.

9.6. A fixed 0.15kg solid disk pulley with a radius if 0.075m is acted on by a net torque of 6.4m.N , what is the angular acceleration of the pulley?

SOLUTION

m = 0.15kg , R = 0.075m . Inertia 'I' of solid disk is by $I = \frac{1}{2}MR^2$ = by $I = \frac{1}{2}0.15x0.075^2$
I = 4.2x$10^{-4}kgm^2$ **τ** = 6.4mN. we find 'α' using **τ** = Iα , $α = \frac{\tau}{I} = \frac{6.4}{4.2x10^{-4}}$
$α = 15238rad/s^2 = 1.5238x10^4 rad/s^2$

9.9. A disk of moment of inertia 2x10^{-2}kgm^2
is rotating freely about an axis through its centre at 20rad/s . Calculate the new angular velocity if some wax of candle 0.05kg is dropped gently on the disc 0.1m from the axis

SOLUTION

m = 0.05kg , r = 0.1m , inertia of disk = 2x$10^{-2}kgm^2$, Moment of ineria of wax = MR^2 = 0.05x 0.1^2 = 5x$10^{-4}kgm^2$
new moment of inertia = inertia of wax + inertia of disk . hence new moment of
I = 2x10^{-2} + 5x10^{-4} = 0.0205kgm^2 , using
$I_1W_1 = I_2W_2$,W_2 = $\frac{I_1W_1}{I_2}$ = $\frac{2x10^{-2}x20}{0.0205}$= 19.5rad/s

9.10. Compute the ratio of the earth's orbital angular momentum and its rotational angular momentum. Are these momenta in the same direction?

SOLUTION

using $\frac{L_0}{L_S} = \left(R_e - \frac{2}{5}R_e\right)$, where R_e = 6.4x10^6
$\frac{L_0}{L_S} = \left(6.4x10^6 - \frac{2}{5}x6.4x10^6\right)$ = 3.8x10^6 .

9.11. Calculate the radius of gyration of a sphere of mass 45kg and radius 3m when it rotates about a diemeter.

SOLUTION

m = 45kg , r = 3m , Inertia of sphere = $\frac{2}{5}MR^2$
$I = \frac{2}{5}x45x3^2$ =162kgm^2 . , we find 'k' using
I = MK^2 , K = $\sqrt{\frac{I}{M}}$ = $\sqrt{\frac{162}{45}}$ = 1.9m.

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TEMPERATURE AND THERMOMETER (CHAPTER 10)

Fundamental intervals is the interval between the two fixed point of a temperature , Resistance thermometer formular is given by

INTERVALS	FUNDAMENTAL INTERVALS
(i) Celsius: higher point → 100^0C lower point →100^0C	(i) 100^0
(ii) Fehrenheit : higher point → 212^0C lower point → 32^0C	(ii) 180^0
(iii) Kelvin scale : higher point→ 373.16^0K lower point → 273.16^0K	(iii) 100^0
(iii) Rankin scale : higher point→ 672^0R lower point → 49.2^0R	(iv) 180^0

Resistance thermometer formular is given by $R_t = R_0(1 + \alpha t + \beta t^2)$, Where α & β are constant s of platinum wire

R_t = Resistance at steam temperature (t) ,

R_0 = resistance at ice point , resistance thermometer formular is given by

$\frac{T}{100} = \frac{R_t - R_0}{R_{100} - R_0}$ & $R_t = R_0 \,(1 + \alpha t + \beta t^2)$ This means t = 100^0C . hence $R_{100} = R_0 \,(1 + 100\alpha + 10000\beta)$, also if we have R_{60} for instance we will have,

$R_{60} = R_0 \,(1 + 60\alpha + 3600\beta)$

(take not while solving). Liquid in glass thermometer formula is given by $\frac{\Theta}{100} = \frac{V_\Theta - V_0}{V_{100} - V_0}$

$V_\Theta = V_0 \,(1 + \alpha\Theta + \beta\Theta^2)$,

$V_\Theta = V_0 \,(1 + 100\alpha + \beta 100^2)$, (like theformer) . you will understand better when you go through the exercises. . Temperature at triple point is given by $T = \frac{X_t}{X_{tr}} x273.16$, X_t = unkown temperature . X_{tr} = thermometric property to convert Celsius to Fahrenheit or Fahrenheit or Celsius is given by $\frac{C}{5} = \frac{F-32}{9}$, to convert from Celsius to rankie or rankie to Celsius use $\frac{C}{100} = \frac{R-400R}{180}$, To convert from Fahrenheit to kelvin or kelvin to fahrenheit. Use $\frac{F-32}{9} = \frac{K-273}{5}$

SOLUTION TO EXERCISE 10

10.1. A platinium wire has resistance of 2.56, 3.62 and 3.15ohms respecticely at 0^0C , 100^0C and 55^0C respectively . Calculate the difference between 55^0C and the corresponding platinum temperature.

SOLUTION

Note that we have three temperature ,note that we also have 3 ohms carrying 3 temperatures which will be R_0 (0^0C), R_{55}(55^0C and R_{100} (100^0C) from question hence R_0 = 2.56Ω, R_{55} = 3.15Ω and R_{100} = 3.62Ω , notice that the ohms were distributed according to the increase in temperature , we are to find the difference in temperature but we find 'T' first using $\frac{T}{100} = \frac{R_t - R_0}{R_{100} - R_0}$

$T = \left(\frac{R_{55} - R_0}{R_{100} - R_0}\right) x100 = \left(\frac{3.15 - 2.56}{3.62 - 2.56}\right) x100$

T = 55.66^0C . Now we had 55^0C before , the difference = $55.66^0 - 55^0 = 0.66^0$C .

10.2. The resistance of a platinum wire at 0^0C , 100^0C and 444.6^0C is found to be 5.5, 7.5 and 14.5 ohms respectively . The resistance of a wire at a temperature t^0C is given by the equation $R_{100} = R_0 \,(1 + \alpha t + \beta t^2)$. Find the values of α and β.

SOLUTION

This is quite similar to 10.1 in terms of the way we distributed ohms among each

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temperature , we have three temperatures 0^0C , 100^0C and 444.6^0C , also we have three ohms 5.5Ω, 7.5Ω and 14.5Ω and hence we have 3 ohms R_0 (0^0C), R_{100}(100^0C) and $R_{444.6}$ (444.6^0C) , R_0 = 5.5Ω, R_{100} = 7.5Ω and $R_{444.6}$ = 14.5Ω , notice that ohms were distributed according in increase in temperature. we find α & β by forming two sulmultaneous equations using $R_t = R_0 (1 + \alpha t + \beta t^2)$,7.5 = $5.5(1 + 100\alpha + \beta 100^2)$

7.5 = $5.5 + 550\alpha + 55000\beta$,

2 = $550\alpha + 55000\beta$ -------------(1) also

$R_{444.6} = R_0 (1 + \alpha t + \beta t^2)$,14.5= $5.5(1 + 444.6\alpha + \beta 444.6^2)$,

14.5 = 5.5+2445.3 + 1087180.4β

9= $2445.3\alpha + 1087180.4\beta$ --------(2)

solving 1 & 2 sulmultaneously (use a calculator to solve the sulmultaneous equation check page 34)

α=3.623547x$10^{-3}C^{-1}$ & β = 1.28X$10^{-7}C^{-1}$.

10.3. Which of the following is the closest to 15^0C ?

SOLUTION

C^0= 15^0C , This is a conversion of C to F using $\frac{C}{5} = \frac{F-32}{9}$, $\frac{15^0}{5} = \frac{F-32}{9}$, F = $\frac{15x9}{5} + 32$

F = $59^0 F$. We are to find the closest **answer hence D is the answer $50^0 F$**

10.4. A person running a fever has a body temperature of 39.4^0C . what is this temperature on the Fahrenheit scale?

SOLUTION

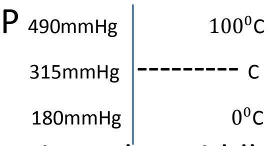
Similar to 10.3 , C = 39.4^0C , from $\frac{C}{5} = \frac{F-32}{9}$

$\frac{15^0}{5} = \frac{F-32}{9}$, F = $\frac{39.4x9}{5} + 32 = 102.92 = 103^0 F$

10.5. A constant volume gas thermometer registers 180mmHg at 0^0C and 490mmHg at 100^0C . Find the temperature when the pressure is 315mmHg.

SOLUTION

When you are given to convert a temperature to an unknown temperature or to pressure or to any other conversion , they is another formular you can use but you must know the ice & steam point by drawing a quick sketch e.g.P



You minus the middle & upper fixepoin from the lower fixed

You minus the middle & upper fixed point

$\frac{315-180}{490-180} = \frac{c-0}{100-0}$, $\frac{27}{62} = \frac{c}{100}$, c = $\frac{27x100}{62}$ = 43.55 ^{0}C. Note that you can use this method to do all conversions including ^{0}C , ^{0}F , ^{0}K

10.6. At what temperature will the Celsius scale read twice the Fahrenheit scale.

SOLUTION

C = 2F , hence from using $\frac{C}{5} = \frac{F-32}{9}$,

$\frac{2F}{5} = \frac{F-32}{9}$, 18F = 5F —32 , 13F = —32

F = $\frac{-32}{13}$ = $-2.46\ ^0F$

10.7. Convert 3^0 rise in Celsius temperature scale to Fahrenheit scale.

SOLUTION

C = 3^0C , using $\frac{C}{5} = \frac{F-32}{9}$, $\frac{3}{5} = \frac{F-32}{9}$,

F = $\frac{3x9}{5} + 32$ = $37.4^0 F$.

10.9. convert (a) 50^0F (b) 36^0R to degree Celsius ^{0}C .

SOLUTION

F = 50^0F , using $\frac{C}{5} = \frac{F-32}{9}$, $\frac{C}{5} = \frac{50-32}{9}$,

F = $\frac{50-32}{9} x5$ = $10^0 C$.

10.10. The resistance of a certain platinum thermometer is 65.5Ω at 0^0C and 98Ω at 100^0C . If the resistance is 86.8Ω when placed in hot water , find the temperature of hot water.

SOLUTION

Same as 10.1 , R_0 (0^0C), R_{100}(100^0C) and R_t (Θ^0C) from question hence

R_0 = 65.5Ω, R_Θ = 86.8Ω and R_{100} = 3.62Ω

$\frac{C}{100} = \frac{R_t - R_0}{R_{100} - R_0}$, C = $\left(\frac{R_t - R_0}{R_{100} - R_0}\right) x100$ = $\left(\frac{86.8-65.5}{98-65.5}\right) x100$, T = 65.54^0C .

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WORK DONE BY SYSTEM OF EXPANDING GAS AND CALORIMENTRY (CHAPTER 11)

Power is given by $P = \frac{Energy}{time}$, Quantity of heat is given by Q = MCΔT , Specific heat capacity , mass = mass , ΔT = Change in temperature , latent heat is given by $L = \frac{Q}{M}$ (J/kg) . Workdone is given by $W = P(V_2 - V_1)$, P = power , V_2 & V_1 = volume of gases . Note that HEAT GAIN = HEAT LOSS , MCΔT = MCΔT , Note that change in temperature for heat gain = heat loss . $T_3 - T_1 = T_2 - T_3$, hence , T_1, T_2, T_3 = temperatures in body

$MC(T_3 - T_1) = MC(T_2 - T_3)$ where it involves latent heat of fusion

$ML_f + M_{ice}C_{ice}\Delta T = M_C C_C \Delta T + M_w C_w \Delta T$

C_C = specific heat capacity of calorimeter .
C_C = specific heat capacity of ice
C_C = specific heat capacity of water
L_f = latent heat of fusion
note also **1CAL(CALORIES) = 4.186J**
1KCAL = 4186J OR 4.2KJ (KILOJOULES)
1BTU(BRISTISH THERMAL UNIT) = 252CAL
1 CAL = 0.004BTU , where it involves latent heat of vaporization

$ML_F + M_{ice}C_{ice}\Delta T = M_C C_C \Delta T + M_w C_w \Delta T$

L_f = latent heat of fusion.

SOLUTION TO EXERCISE 11

11.1. How much heat energy is needed to change 10kg of ice at -20^0C to steam at 120^0C , Take C_{ice} = 2100J/kg ^{0}C , C_w = 4186J/kg ^{0}C , C_{ice} = 2010J/kg ^{0}C
L_f = 3.33X10^{5}J/kg , L_f = 22.26X10^{5}J/kg

SOLUTION

To find 'Q' wr need to all up al quantities that caused the heat change Q = $M_{ice}C_{ice}\Delta T + M_{ice}L_f + M_w C_w \Delta T + M_s C_s \Delta T$
M_{ice} = 10kg , we only have one mass, M_w = 10kg , always note that heat gain = heat loss we are only dealing with one side in this question ''heat gain'' C_{ice} = 2100J/kg ^{0}C , C_w = 4186J/kg ^{0}C , C_{ice} = 2010J/kg ^{0}C
L_f = 3.33X10^{5}J/kg , L_f = 22.26X10^{5}J/kg
Q = 10X200(0−(−20) + 10X3.33X10^5 + 10X4186X(100−0) + 10X22.226X10^5 + 10X2010X(120−100) = 3.1X10^{7}J .

11.2. A 2kg steel block is originally at 10^0C.

11.3. a heater supplies 240 Btu of energy what is this in joules?

SOLUTION

1 Btu ------------- 252cal
240Btu ------------x
x = 240x252 = 60480cal.

11.4. A student heats a thanks giving dinner that totaled 2800Kcal . He wants to use up all that energy by lifting a 20kg mass a distance of 1.0m (a) How many times must he lift the mass ?

SOLUTION

(a) It takes potential energy to lift up the mass , hence energy = mgh , m = 20kg , h = 1m , g = $9.8m/s^2$, energy = 20x1x9.8 = 196J. note that we need to find how many joules are in 2800kcal hence,
2800kcal = 2800000cal (K = 1000)
1cal---------------- 4.186J
2800000 -----------X
X = 2800000X4.186 = 11720800J.
HENCE $\frac{11720800}{196}$ = 59600 TIMES .
(approximately 60, 000 times , we needed to find how many 196J are in 11720800joules.

11.5. A 0.250kg cut at 20^0C is filled with 0.250kg of boiling coffee . The cup and the coffee came to theme equilibrium at 80^0C. If no heat is lost , what is the specific heat of the cup material? [hint : consider the coffee to be essentially boiling water].

SOLUTION

Heat gain = Heat loss , M_{ice}= 0.250kg , if we consider the coffee to be boiling water, the

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coffee = 4200J/kg ^{0}C. (always use this for water when 'C' is not given) . M_{coffee} = 0.250kg , we are to find the 'c' of the cup, using T_1 = 20^0C , T_2 = 100^0C (boiling water 'T' is 100^0C because we were told to consider the coffee as boiling water . T_3 = 80^0C . (The final temperature using
$M_{coffee}C_{Coffee}(T_3 - T_1)$ =$M_{ice}C_{ice}$ $(T_2 - T_3)$
0.25xC_{Coffee}x(80−20) = 0.25x4200x(100−80)
15C_{Coffee} = 21000 , C_{Coffee} = 1400Jkg ^{0}C .

11.6. A gas is expanding against a constant pressure of 1atm from 10 to 16 litres , what is the work done by the gas [take 1 lit.atm = 101.33J] .

SOLUTION

p = 1atm , V_1 = 10litres , V_2= 16litres .
W = $P(V_2 - V_1)$ = 1x$(16 - 10)$ = 6lit.atm.
1 lit.atm -------------- 101.33
6 lit.atm -------------- x
xx1 = 6x101.33 = 607.98joules .

11.7. A water fall is 500m high . If the water retains 65 per cent of the heat generated at the end of the fall, calculate the change in temperature due to the fall. (specific heat capacity of water = 4200J/Kgk).

SOLUTION

h = 500m , c = 4200J/kgk , g = $9.8m/s^2$, note that it was heat energy , it transferred to potential energy at end of fall
Heat energy = Potential energy ,
mcΔt = mgh , Δt = $\frac{mgh}{mc}$ = $\frac{gh}{c}$ = $\frac{9.8X500}{4200}$
ΔT = 1.1666666667 ^{0}C = 1.2 ^{0}C .

11.8. An electric heater of 60w is used to heat a metal block of mass 20kg for 5 minutes . Calculate the specific heat capacity or metal block if the rise in temperature is 20^0C

SOLUTION

p= 60W , t= 5minx60 = 300sec. m= 20kg , c = ? , they said the temperature , hence they gave us the change in temperature ''ΔT'' = 20^0C , from pt = mcΔt ,
C = $\frac{pt}{m\Delta t}$ = $\frac{60x300}{20x20}$ = 45J/kg.k

11.9. A 60g of water at 90^0C is poured into a calorimeter containing 20g of water at 30^0C The temperature of the mixture will be.

SOLUTION

T_1 = 20^0C , T_2 = 100^0C , T_3 = 80^0C
$M\,C\,(T_3 - T_1)$ =$M\,C\,(T_2 - T_3)$
0.06xCx$(T_3 - 90)$ =0.02xCx$(30 - T_3)$
0.06$T_3 - 5.4$ = 0.6 $-T_3$, T_3 = 75^0C .

THERMAL PROPERTIES OF MATTER (CHAPTER 12)

Linear expansivity is given by α = $\frac{\Delta x}{x_1\Delta\Theta}$ = $\frac{x_2-x_1}{x_1(\Theta_2-\Theta_1)}$, Δx = increase in length $(x_2 - x_1)$, x_1 = length of first object , ΔΘ = change in temperature $(\Theta_2 - \Theta_1)$. Area expansivity is given by β = = $\frac{\Delta A}{A_1\Delta\Theta}$ = $\frac{A_2-A_1}{A_1(\Theta_2-\Theta_1)}$, Area expansivity is also given by β = 2α , cubical volume is given by $\gamma = 3\alpha$, Apparent expansion is given by
γ_{app} = $\frac{apparent\ increase\ in\ volume}{original\ volumextemperature\ rise}$
γ_{app} = $\frac{V_{app}}{V_{original}x\Delta\Theta}$, density relationship between density & temperature is given by P_1 = P_2 $(1 + \gamma\Delta\Theta)$ where P_1 & P_2= are densities γ = cubical or volume expansivity , young modulus is given by E = $\frac{F/A}{e/x_0}$ = $\frac{F}{A}x\frac{x_0}{e}$, real expansion = $\gamma_{app} + \gamma$
γ_{app} = apparent expansion , γ = cubical expansion(volume expansion) Note that stress = $\frac{F}{A}$ & strain = $\frac{e}{x_0}$, relationship between volume & temperature is given by V_2 = V_1 $(1 + \gamma\Delta\Theta)$, Force due to expansion is given by **F = EAαΔΘ** , E = young modulus , A = area , α = linear expansivity . ΔΘ = change in temperature .Note that γ = 3α

SOLUTION TO EXERCISE 12

12.1. The density of iron at 30^0C is 4.8g/cm^3 What is the density at 80^0C if the linear

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expansivity of iron is 1.2x10^{-5}/K

SOLUTION

P_1= 4.8g/cm^3, P_2=?, Θ_1 = 30^0C , Θ_2 = 80^0C
α = 1.2x10^{-5}/K , γ = 3α.note tha t we are to find the 2nd density

using $P_1 = P_2\ (1+\gamma\Delta\Theta)$, $P_2 = \frac{P_1}{(1+3\alpha\Delta\Theta)}$

$P_2 = \frac{4.8}{1+3x1.2x10^{-5}(80-30)}$ = 4.79g/cm^3

12.2. (b) A dteel rod of length 2000cm and uniform cross-sectional area 3x$10^3 cm^2$ at 28^0C is heated to 45^0C . Find the change in length and the force due to the expansion exerted 1.2x10^{-5}/K d by the rod take: (linear expansivity of steel , young modulus of steel = 2.0x10^7N/cm^2 .

SOLUTION

We are to find 'Δx' , x_1 = 2000cm , Θ_1 = 28^0C
Θ_2 = 45^0C , from α = $\frac{\Delta x}{x_1(\Theta_2-\Theta_1)}$,
$\Delta x = \alpha x_1(\Theta_2-\Theta_1) =$
$1.2x10^{-5}x2000x(45-28) = 0.41$cm.
from F = EAαΔΘ , E = 2.0x10^7/K ,
A =3x$10^3 cm^2$, . F = 2.0x10^7X3x10^3X
1.2x10^{-5}X$(45-28)$ = 1.224X10^7N.

12.3. A wire of length 5m and uniform circular cross-sectional of radius 1.4mm was extended by 2mm by tension of 110N . Calculate the average strain per unit volume hint:strain average per unit volume= $\frac{1}{2}\left(\frac{F}{A}x\frac{e}{x_0}\right)$

SOLUTION

F =110N , x_0= 5m , radius = 1.4x10^{-3}m (to m)
e = 2x10^{-3}m , it's a circular wire , hence
A= πr^2 = 3.142x$(1.4x10^{-3})^2$ = 6.16x$10^{-6}m^2$
from question using AV= $\frac{1}{2}\left(\frac{F}{A}x\frac{e}{x_0}\right)$
AV = $\frac{1}{2}\left(\frac{110}{6.16x10^{-6}}x\frac{2x10^{-3}}{5}\right)$ = 3571.43J= 3.52KJ

12.4. What is the increase in length of a steel bar that is 1000cm long at 10^0C when its temperature rises to 60^0C. [for steel, α = 1.2x$10^{-5}\ {}^0C^{-1}$]

SOLUTION

We are to find 'Δx' , x_1 = 1000cm , Θ_1 =10^0C
Θ_2 = 60^0C , from α = $\frac{\Delta x}{x_1(\Theta_2-\Theta_1)}$,
$\Delta x = \alpha x_1(\Theta_2-\Theta_1)$ = 1.2x$10^{-5}1000x(60-10)$ = 0.6cm.

12.5. Referring to question (4) above , how much force is associated with the expansion of the steel bar if it's cross-sectional area is 100$cm^2$and young's modulus=2.0x10^7N/cm^2

SOLUTION

F = EAαΔΘ , E = 2.0x10^7/K ,
A =100cm^2 , . F = 2.0x10^7X100X
1.2x10^{-5}X$(60-10)$= 1.2X10^6N.

12.6. If the length of a cylindrical solid metal is Lcm at 30^0C and the linear expansivity is α , then the ratio of the new volume to the initial volume at 70^0C is.

SOLUTION

we are to find the ratio of V_1 to V_2, Θ_1 = 30^0C , Θ_1 = 70^0C , α = 1.2x10^{-5}/K ,
$V_2 = V_1\ (1+\gamma\Delta\Theta)$, $\frac{V_2}{V_1} = (1+3\alpha\Delta\Theta)$
, $\frac{V_2}{V_1}$ = 1+3α(70−30) = 1 +120α.

12.7. Everything about water expansion has been explained in the theoretical chapter

KINECTIC THEORY AND THERMODYNAMICS (CHAPTER 13)

Mayer's formula is given by R = $C_p - C_v$, C_p = amount of specific heat capacity when pressure is constant , C_v = amount of specific heat capacity when volume is constant , heat removed in a system is given by dQ = dW + dU , dU = internal energy , dw = work done on a system .**FOR ISOTHERMAL PROCESS dQ = dw** , **FOR ADIABATIC PROCESS du = −dw , FOR ISOBARIC PROCESS dQ = dU** .The internal energy of an isothermal process is zero when dU = 0 , Work done in an isometric process is

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zero dW = 0 , for adiabatic system dQ = 0 , in adiabatic process T_1V_1 = constant , T = temperature , v = volume , note that T_1V_1 = T_2V_2 , carnot efficiency is given by $\cap_c$ =1$-\frac{T_1}{T_2}$, Thermal efficiency is given by by $\cap_{th}$ = $\cap_{re}\cap_c$, $\cap_{re}$ = relative efficiency . ratio of two root mean squared is given by $\frac{V_{rms\,2}}{V_{rms\,1}} = \sqrt{\frac{T_1}{T_2}}$, root mean – squared speed is given by $V_{rms} = \sqrt{\frac{3RT}{M}}$. m = mass , R = 0.0821 T = Temperature , root –mean squared can also be given by $V_{rms} = \sqrt{\frac{3KT}{M}}$ & $V_{rms} = \sqrt{\frac{3P}{e}}$
k = botmann constant (given by 1.38x10^{23})
e = density .

PAST QUESTION 2013/2014 (Q 31)

What is the average (RMS) speed of a helium atom (He) in a helium ballon at room temperature (take the mass of the helium to be 6.6x10^{-27}kg .

SOLUTION

k = 1.38x10^{23} , T = room temperature = 20^0C.
T = 20 + 273 = 293^0K. m = 6.6x10^{-27}kg
using $V_{rms} = \sqrt{\frac{3KT}{M}} = \sqrt{\frac{3x1.38x10^{-23}}{6.6x10^{-27}}}$
V_{rms} = 1355.7m/s = 1.3557km/s
Note that for MONOATOMIC GAS the total internal energy is U = $\frac{3}{2}nRT$, n = no of moles , for diatomic gas total internal energy U = $\frac{5}{2}nRT$, polyatomic gas internal energy is U = $\frac{6}{2}nRT$, The formula for heat engine is given by $\frac{W}{Q_H} = \frac{T_H-T_C}{T_H}$, W = work done , Q_H = Heat absorbed from the reservoir , T_H = Temperature of reservoir(hot) , T_C = Temperature of silk(cold) .

PAST QUESTIONS 2014/2015 (Q 14)

A reversible engine takes in heat from a reservoir of heat at 527^0C and gives out heat to the silk at 127^0C . How many calories per second must it take from the reservoir in order to produce useful work at the rate of 750watts

SOLUTION

Q_H = ? , p= 750watts , t = 1sec,
Work done =pt = 750x1 = 750J , T_H = 800
T_C = 400 , using $\frac{W}{Q_H} = \frac{T_H-T_C}{T_H}$, $Q_H = \frac{WT_H}{T_H-T_C}$
$Q_H = \frac{750x800}{800-400}$ = 1500J .
1cal --------- > 4.186J
Xcal ---------- > 1500J, $x = \frac{1500}{4.186}$ = 358.34cal.
t = 1sec,per sec will be $\frac{358.34}{1}$ = 358.34cal/sec

HEAT TRANSFER (CHAPTER 14)

An extensive explanation of theoretical aspect of heat transfer , conduction, convection , convection e.t.c. has been done in chapter 16. Heat flux is given by H = KA. $\frac{T_H-T_C}{L}$, K = thermal conductivity , A = area , Temperature gradient = $\frac{T_H-T_C}{L}$

EXAMPLE 1.

If 1.2x10^6J of heat energy is given off in 1sec from a vessel maintained at a temperature gradient of 30km^{-1} , The surface aea of the vessel is? (Thermal conductivity of the vessel = 400W$m^{-1}k^{-1}$.

SOLUTION

H = 1.2x10^6J , $\frac{T_H-T_C}{L}$ = 30km^{-1} , K= 400W$m^{-1}k^{-1}$, A= ? using H = KA. $\frac{T_H-T_C}{L}$
1.2x10^6 = 400XAX30 , A = $\frac{1.2X10^6}{400x300}$ = 100m^2.
Radiant flux is the rate of emission of radiant heat per unit time , it is given by Stephan – boltzmann's law, The heat flux is given by H = $\sigma A\mathcal{E}T^4$, $\sigma =$ Stephan –boltzmann's constant , A = area , $\mathcal{E}$ = emissivity , T = temperature .

EXAMPLE 2

The temperature of a tungsten filament bulb

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200^0C , and it's emissivity is 0.47 , find the surface area of the bulb of power 80W , (Take Stephan –boltzmann's constant = 5.67x10^{-8}W/m^2k^4) .

SOLUTION

H = 80W , $\mathcal{E}$ = 0.47 , T = 200^0C (to K)
T = 200 + 273 = 473^0k,σ = 5.67x10^{-8}W/m^2k^4
using H = σA$\mathcal{E}T^4$

$$A = \frac{H}{\sigma\mathcal{E}T^4} = \frac{80}{5.67x10^{-8}x0.47x473^4} = 0.059974m^2$$

PHYSICAL STATES OF MATTER (CHAPTER 15)

Share modulus is given by S.M= $\frac{shear\ strain}{strain}$ & shear stress = $\frac{F}{A}$, Shear strain = $\frac{e}{x_0}$, e = extension (or displacement) , x_0 = length

PAST QUESTION 2014/2015 (Q 15)

A sheer force of 2x10^3N is applied to one force of an aluminum cube with sides of 15cm . What is the resulting relative displacement ? (share modulus of aluminum 2.5x10^4Nm^4)

SOLUTION

F = 2x10^3N , length of cube = 0.15m (converted to m) , area of cube A = L^2 = 0.15^2
A = 0.0225m^2 , share modulus =2.5x10^{10}Nm^4
x_0 = 0.15m , using shear stress =$\frac{F}{A}$ = $\frac{2x10^3}{0.0225}$
shear stress = 8.89x10^4N/m^2, using
S.M= $\frac{shear\ strain}{strain}$, strain= $\frac{shear\ strain}{S.M}$
strain = $\frac{8.89x10^4}{2.5x10^{10}}$ = 3.556x10^{-6} , we find ''e'' using Shear strain = $\frac{e}{x_0}$, e = 3.556x10^{-6} x 0.15 = 5.33x10^{-7}m.

THEORETICAL ASPECT OF PHY111 (CHAPTER 16)

Some students think that the theory aspect of physics in exams are not too important but the truth is that in uniben physics exam you will be given at least 10 theory question out of 50 question , the remaining 40 will be calculations. If you are able to get up to 10 question correctly in theory and able to get 25 question out of 40 in calculations , that is an 'A' already because you need to get at least 35 correctly to get an 'A' , just make sure you take the theory aspect serious as well as the calculations if you want an easy 'A'.In this material I was able to put together **300 theory questions**, Let's begin.

MEASUREMENTS AND UNITS , VECTORS, MECHANICS , PROJECTILE MOTION

1. The accuracy of a stop watch is **0.1S**

2. The world most accurate time-keeping device is the? **ANSWER - ATOMIC CLOCK**

3. The inner diameter of a thin wire can be measured by means of
ANSWER - MICROMETER SCREW GUAGE . Thin wires and objects of such dimensions are measured with the most precise length-measuring instruments-the micrometer screw guage

4. The inner diameter of a test tube can be measured accurately using
ANSWER - A PAIR OF CALLIPER . Vernier calipers have inner and outer jaws for measuring inner and outer diameters respectively . The micrometer screw guage can only measure an outer diameter.

5. **SPRING BALANCE** measures the earth gravitational pull on a body . The spring balance measures weight i.e the earth's gravitational pull on the body

6. The physical quantity that has the same dimension as impulse is **MOMENTUM** . Impulse is equal to change momentum . If they are equal , they also have the same dimension

7. VOLUME is a property of steel that can be measured in terms of the dimension of length only .

8. __ NOT a vector quantity ?

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ANSWER – ALTITUDE
ALWAYS REMEMBER DAVIM TUT FOR FORM FILL MANAGEMENT WORK . to know vectors and scalars easily .
9. The magnitude of the resultant of the two forces is greatest when the angle between the forces is ? **ANSWER - 0^0** . Magnitude is highest when vectors are parallel.
10. If the angle between two vectors P and q is 0^0 , the vectors are said to be
ANSWER – PARALLEL
11. Rectilinear motion implies
ANSWER – MOTION ALONG A STRAIGHT LINE
Rectus means straight line and linear means line. Rectilinear motion means motion along a straight line.
12. The motion of the center of a ball rolling in a straight line, on a smooth level ground is **ANSWER – TRANSLATIONAL** . The center of the ball moves from one point to another , along a straight line as the balls rolls, thus its motion is translational. Every other point performs a rotational motion as the ball rolls
13. The balance wheel of a wrist watch performs . **ANSWER – VIBRATORY MOTION**
The balance wheel of a watch oscillates or vibrates about a fixed position.
14. Which type of motion do the wheels of a moving car undergo? **ANSWER – TRANSLATIONAL AND ROTATIONAL MOTION** . They move from one point to another in straight line and they also rotate as they do so
15. A body moving in a uniformly accelerated motion in a straight line would NOT
ANSWER – CHANGE IN THE RATE OF VELOCITY INCREASE . Uniform acceleration is constant rate of change of velocity with time . Thus the body wouldn't change in its rate of velocity increase.
16. In a motion at uniform velocity in a straight line __ . ANSWER – AVERAGE SPEED **EQUALS INSTANTANEOUS SPEED** . In uniform
motion, average and instantaneous speeds are the same. If velocity is uniform , then direction is the same.**velocity depends direction**
17. Which of the following statements is true of a body which sis moving in a straight line with uniform acceleration ? The velocity of the body **. ANSWER – WILL INCREASE WITH TIME IN THE DIRECTION OF THE ACCELERATION** . For a body that moves with uniform acceleration , velocity increases equally with time . If velocity increases , then it is non- uniform . Velocity becomes uniform or remains constant when the body stops accelerating . It is zero only when the body is at rest.
18. A moving body accelerates when it
ANSWER – CHANGES ITS DIRECTION AT CONSTANT SPEED. When a body changes direction at constant speed, it also changes velocity depends on direction . A change in velocity means the body is accelerating . This condition is seen in uniform circular motion. constant linear speed implies no acceleration. Equal distances covered in equal time means constant speed , which implies no acceleration . Balanced forces yield no net force and hence no acceleration.
19. A horizontal line in a distance –time graph shows . **ANSWER – SATIONARY BODY**
20. The motion of a projectile ------
ANSWER – IS INFLUENCED BY GRAVITY.
Projectile motion is a two dimensional motion- the vertical and horizontal motions. It has one acceleration i.e. g and its trajectory is parabolic.
21. To get a maximum range at given initial velocity , the launcher must project at ?
ANSWER - 45^0C .

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FORCE AND NEWTON'S LAW , CIRCULAR MOTION AND GRAVITATION , WORK ENERGY AND POWER , MOMENTUM ROTATIONAL MOTION

22. Uniform circular motion implies circular motion at__ **. ANSWER – UNIFORM SPEED** . uniform circular motion is motion round a circular path at uniform speed.

23. A body in a uniform circular motion would NOT__ .**ANSWER – CHANGE IN SPEED** . The speed is constant in uniform circular motion , thus it would not change in its speed.

24. Which of the following is TRUE of a body in uniform circular motion?

ANSWER – ITS DIRECTION CHANGES AT ANY NEW POSITION . Direction changes leading to change in velocity , which is acceleration. The speed is constant .

25. For a body moving with constant speed in a circular track ---**NO WORK IS DONE ON THE BODY , THE CENTRIPETAL FORCE IS DIRECTED TOWARDS THE CENTER**.

26. A body moving in a circle at constant speed has **--- A VELOCITY TANGENTIAL TO THE CIRCLE , CONSTANT KINECTIC ENERGY** . In uniform circular motion , speed is constant . Kinectic energy depends on speed not on velocity. Thus , kinectic energy is also constant. Note that kinectic energy is a scalar quantity , just like speed.

27. An object moves with uniform speed round a circle. Its acceleration has

ANSWER – CONSTANT MAGNITUDE AND CONSTANT DIRECTION. Centripetal acceleration has constant magnitude and direction while tangential acceleration has constant magnitude but varying direction.

28. A satellite in circular motion around the earth doesn't have__

ANSWER – A UNIFORM VELOCITY . It has a uniform speed but not uniform velocity. Please note that there is no such thing as circular motion at uniform velocity.

29. The force necessary to keep an object moving in a circle is known as the__

ANSWER – CENTRIPETAL FORCE

30. In a simple harmonic motion __

ANSWER – FORCE IS OPPOSITE IN DIRECTION TO DISPLACEMENT .

31. The product of the period and frequency of a harmonic oscillator is always equal to__

ANSWER – 1

32. The period of oscillation of a simple pendulum is independent of __

ANSWER – MASS OF THE BOB . The mass of the pendulum does not affect its period.

33. The amplitude of a simple harmonic oscillator may be defined as__

ANSWER – THE MAXIMUM DISPLACEMENT .

34. The gradual decrease in amplitude of a swinging pendulum bob is called__

ANSWER --- DAMPING

35. Marching soldiers crossing a suspension bridge are advised to break their steps to avoid collapse due to__

ANSWER – RESONANCE

36. Forced oscilliaton is when an external force maintains vibrating system. At resonance , the amplitude of the vibrating body__ . **ANSWER --- MAXIMIZES. amplitude is maximum at resonance.**

37. A non- contact force is

ANSWER – MAGNETIC

38. The time rate of change of momentum is

ANSWER – FORCE.

39. Impulse is dimensionally consistent with

ANSWER – MOMENTUM.

40. In a perfectly elastic collision , which of the following are conserved? . **ANSWER – MOMENTUM AND KINECTIC ENERGY**

41. __ is NOT a fundamental force of nature. **ANSWER – TENSION FORCE**.

42. Impulse is equal to __

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ANSWER – CHANGE IN MOMENTUM.
43. In a perfectly elastic collision__
ANSWER -- TOTAL MOMENTUM IS CONSTANT
44. INELASTIC COLLISION IS MORE DESTRUCTIVE TO THE BODIES INVOLVED.
45. If the total force acting on a particle is zero, the linear momentum will__
ANSWER – BE CONSTANT. In the absence of force , there is no change in momentum . The velocity and hence the linear momentum will be cosntant
46.IN A CLOSED SYSTEM , THE TOTAL ENERGY IS CONSTANT
47. Which of the following sources of energy is renewable? **. ANSWER – SUN.**
48. Which of the following has the same units as energy? **ANSWER – WORK.**
49. The energy in the nucleus of atoms produce heat which can be used to generate **ANSWER – ELECTRICAL ENERGY** .
50. **A MAN CLIMBING UP A STAIRCASE** is a condition that agrees with the condition of work done.
51.__ is a conservative field force? .
ANSWER – GRAVITY
52. When a stone is taken from the earth's surface to the moon, its mass__
ANSWER – REMAINS CONSTANT. Mass remains constant in all places but weight varies with variation in acceleration due to gravity.
53. A satellite is in a parking orbit if its period is **ANSWER – EQUAL TO THE PERIOD OF THE EARTH** .
54. The force responsible for holding the moon in its orbit around the earth against the gravitational pull of the earth is ?
ANSWER – CENTRIFUGAL . The gravitational pull of the earth on the moon is the centripetal force that maintains the moon in its orbit.
55. If the force of attraction between the sun and the planet is removed , the planets will
ANSWER – CONTINUE TO MOVE AT TANGENT TO THEIR ORIGINAL ORBIT. The orbital speed is directed at tangent to orbital circumference . Thus , if the force of attraction of a planet to the sun is removed, it continues its motion at tangent to its orbit.
56.The force with which an object is attracted to the earth is called its ?
ANSWER – WEIGHT . An object is attracted towards the center of the earth by its own weight .
57. IN FRICTION i. THE FORCE OF KINECTIC FRICTION IS LESS THAN THE FORCE OF STATIC FRICTION ii. THE FORCE OF KINECTIC FRICTION BETWEEN TWO SURFACES IS INDEPENDENT OF THE AREAS IN CONTACT PROVIDED THE NORMAL REACTION IS UNCHANGED iii. FRICTION MAY BE REDUCED BY LUBRICATION.
58. The frictional force between two bodies __
ANSWER – HAS ALL OF THESE CHARACTERISTICS .
59. When the brakes in a car are applied , the frictional force on the tyres is ?
ANSWER – AN ADVANTAGE BECAUSE IT IS IN THE OPPOSITE DIRECTION OF MOTION OF THR CAR . On application of brakes , it opposes the tyres.
60. The co- efficient of friction between two perfectly smooth surfaces is__
ANSWER – ZER0 .
61. The frictional force between a body and its resting surface and the normal reaction it receives can be rightly described as__
ANSWER – PERPENDICULAR
62. The surfaces of conveyer belts are made rough so as to __
ANSWER – PREVENT THE LOAD FROM

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SLIPPING . Roughness improves friction between belt and load allowing for better grip and to prevent slipping.

63 . The effect of a particle in a fluid attaining its terminal velocity is that the__
ANSWER – WEIGHT IS EQUAL TO THE RETARDING FORCE. At terminal velocity , weight is equal to retarding force

64. The terminal velocity of a ball – bearing falling through a viscous fluid is reached when the__ . **ANSWER – VELOCITY IS UNIFORM**

65. A parachute attains a terminal velocity when __ . **ANSWER – THE VISCOUS FORCE OF THE AIR AND THE UPTHRUST COMPLETELY COUNTERACT ITS WEIGHT** .

TEMPERATURE AND THERMOMETER, WORK DONE BY SYSTEM OF EXPANDINGGAS AND CALORIMETRY , THERMAL PROPERTIES OF MATTER , KINECTIC THEORY AND THERMODYNAMICS

ANOMALOUS EXPANSION OF WATER- While most other liquids expand with temperature rise and contract with its fall , water contracts from 0^0C to 4^0C (rise) and expands from 4^0C to 0^0C(fall) . This is abnormal expansion and contraction. Thus , anomalous expansion of water occurs between 0^0C to 4^0C

66. The difference in temperature between the upper fixed point and the lower fixed point is the__
ANSWER – FUNDAMENTAL INTERVAL

67. A liquid-glass thermometer should quickly register temperature changes . This achieved by choosing a liquid that
ANSWER – HAS A HIGH THERMAL CONDUCTIVITY . means the thermometer substance is a good conductor of heat. Thus, small changes in temperature produce marked changes in the thermometric property. This is called sensitivity

68.The absolute zero temperature is defined as the temperature at which__
ANSWER – THERMAL MOTION CEASES . The absolute zero temperature is characterized by . i. zero kelvin or -273^0 celsius ii. Temperature of minimum volume and pressure . This volume and pressure is theoretically zero. iii. Lowest possible temperature. Temperature is measure of average kinectic energy and hence thermal motion of molecules cease completely.

69. A clinical thermometer is different from other mercury-in-glass thermometers owing to__ . **ANSWER – THE CONSTRICTION OF ITS STEAM** .

70. The temperature and pressure where solid, liquid and gases of a particle substance are in
equilibrium is known as__
ANSWER – TRIPLE POINT

71. A short response time is obtained in a liquid-in-glass thermometer when the__
ANSWER – BULB IS THIN-WALLED AND LIQUID IS A GOOD CONDUCTOR OF HEAT.

72. Water is considered a poor thermometric liquid because it__ . **ANSWER- EXPANDS NON-UNIFORMLY , HAS A SMALL RANGE OF EXPANSION, WETS GLASS**.

73. The qualities of a good thermometer are
ANSWER- HIGH SENSIVITY , EASY READABILITY , ACCURACY OVER A WIDE RANGE OF TEMPERATURE. Thermal capacity is the quantity of heat required to raise the temperature of a substance by 1K . A good thermometric substance should have low thermal capacity so that amounts of heat will cause appreciable temperature change giving it a high sensivity.

74. The qualities of a good thermometer are
ANSWER – REPRODUCTIVITY , SENSITIVITY , HIGH ACCURACY.

75. One special advantage of alcohol over

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mercury as thermometric liquid is its
ANSWER – LOW FREEZING POINT
76. The thermometric property of a constant volume thermometer is __
ANSWER – CHANGE IN PRESSURE. For a constant-volume gas thermometer , pressure varies with temperature and for constant-pressure gas thermometer , volume varies with temperature. They operate on Amonton's law (pressure law) and charles's law respectively .
77. The thermometric property of the termocuople is that__
ANSWER – E.M.F CHANGES WITH TEMPERATURE .
78. The thermometric substance of an absolute thermometer is__
ANSWER – HELIUM . Absolute or thermodynamic thermometers are gas thermometers. They function as standard thermometers. Helium and hydrogen are mainly used.
79. What type of energy does a thermopile use in detecting and measuring temperature.
ANSWER – RADIANT ENERGY
80. What is likely to happen if the glass of a thermometer expands more upon heating than the liquid inside?
ANSWER – THE LIQUID WILL GO DOWN IN THE STEM. If glass expands more than the liquid; the liquid will go down the stem. The apparent cubic expansivity will be quite low compared to the real expansivity.
81. The sagging of overhead electric cables is the consequence of__ . **ANSWER – LINEAR EXPANSIVITY .** They sag because they extends in length.
82. __ Which of the following explains why is poured into it? **ANSWER – UNEQUAL EXPANSION OF THE INTERIOR AND EXTERIOR WALLS OF THE CUP. Because glass conducts** heat poorly, it takes much time for heat to be conducted from the interior wall to the exterior of the glass . Thus , the interior wall expands than more than the exterior. This uneven expansion is what the glass to crack. It is more marked in thick than thin glass tumbler.
83. During summer, the balance wheel of a clock expands. What effect does this have on the accuracy of the clock? .
ANSWER – THE CLOCK LOSES TIME
84. The design of the thermostat of the electric iron is based on the__
ANSWER – INCREASE IN SIZE OF METALS WHEN HEATED. Thermostats work on bimetallic . The metal with greater expansivity expands faster than the other thereby increasing the band or coil of the strip and triggering a switch mechanism.
85. An ice cube floats in a glass of water filled to the brim. What happens when the ice melts? . **ANSWER – THE WATER LEVEL IN THE GLASS OVERFLOWS**.
86. If a container is filled with ice to the brim , what happens to the level of water when the ice completely melts? **. ANSWER – THE LEVEL OF WATER DROPS** .The level of water resulting from melted ice will fall below for two reasons; I. ice occupies more volume than its water due to anomalous expansion ii. The blocks of ice used to fill the container must leave some air spaces between them. When they melt , the water occupies the entire space thereby falling below the brim level.
87. A quantity of water at 0^0C is heated to about 30^0C At each degree rise in temperature , its density will__
ANSWER – RISE THEN FALL
88. THE DENSITY OF A LIQUID DECREASES WHEN IT EXPANDS.

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89. expansion of solids is a disadvantage in__ **ANSWER – THE BALANCE WHEEL OF WATCH.** Expansion of balance wheel causes the watch to lose time.

CONDUCTION – In condition , heat is transferred between adjacent molecules due to their vibration about rest position. Conduction is seen mainly in solids. Solids that allow hear pass through them such as metals are good conductors of heat while those do not such as glass, ceramic, air, gases are insulators of heat.

CONVECTION: In convection , heat is transferred by the migration of molecules. This mode of heat transfer is seen in liquids and gases. Both of which are collectively called fluids.

89. Thermal equilibrium between to objects exist when__ . ANSWER – THE TEMPERATURE OF BOTH OB JECTS ARE EQUAL. Thermal equilibrium means equal temperatures not equal heat content

90. __ is a good conductor of heat

ANSWER – MERCURY .

SODIUM IS A CONDUCTOR

91. The time rate of loss of heat by a body is proportional to the__ **ANSWER- DIFFERENCE IN TEMPERATURE BETWEEN THE BODY AND ITS SURROUNDINGS.**

92. The mechanism of heat transfer from one point to another through the vibrations of the molecules of the medium is __

ANSWER – CONDUCTION

93. The blade of a hoe feels colder to touch in the morning than the wooden handle because the__ . **ANSWER – BLADE IS A BETTER CONDUCTOR OF HEAT THAN THE HANDLE.**

94. Which of the following is a reason why a concrete floor feels colder to the bare feet than a mat on the same floor during the rainy season? . ANSWER –MAT LOSES HEAT **TO THE BARE FEET WHILE THE CONCRETE FLOOR EXTRACTS HEAT FROM THEM**. Concrete is a better conductor of heat than mat. Thus heat from the feet is quickly conducted away by the concrete floor making the feet cold while the mat poorly conducts it away (it retains the heat) making the feet warm.

95. When equal weight of iron and water are subjected to an equal supply of heat , it is found that the piece of iron becomes much hotter than that of water after a short time because__ . **ANSWER – THE SPECIFIC HEAT OF WATER IS HIGHER THAN THAT OF IRON.** Specific thermal capacity is the amount of heat required to raise the temperature of 1kg by 1K , poor conductors of heat have high thermal capacities while good conductors have low thermal capacities

96. Cooking pots are usually made of metals because metals __ . **ANSWER –ARE GOOD CONDUCTORS OF HEAT**.

97. The following modes of heat transfer requires a material medium.

ANSWER- CONVECTION AND CONDUCTION

98. the chief mode(s) of heat transfer to bread placed in pan in an oven __

ANSWER – CONVECTION AND CONDUCTION.

99.HEAT TRANSFER BY CONDUCTION OCCURS ONLY IN SOLIDS. Conduction also occurs in liquids but to a much lesser extent than it occurs in solids. Thus, liquids are poor conductors of heat.

100. Heat transfer by convection in a liquid is due to the__ . **ANSWER- VARIATION OF THE DENSITY OF THE LIQUID**. Cool water is denser than warm water . When it receives heat, its density decreases , thus the warm water is displaced by cooler ones establishing a convection current which transmits heat..

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101. Cool breeze blows across a sandy beach in a sunny afternoon because__
ANSWER – WARM AIR ON THE BEACH IS REPLACED BY COOLER AIR FROM THE SEA.
102. In the formation of sea breeze wind blows from__ .**ANSWER- SEA TO LAND**
103. The heat from a heater in a room is transmitted to various parts of the room primarily by__ . **ANSWER- RADIATION**
104. Black and dull colored clothes are better not worn in a sunny afternoon [
105. BLACK SURFACE REDIATE HEAT ENERGY BEST.
106. Shiny and silvery surfaces are __
ANSWER – GOOD REFLECTORS OF HEAT
107. A hot metal ball is suspended in the open air. As it cools, it loses heat by__
ANSWER – RADIATION.
108. Heat is radiated by all hot objects in the form of __. **ANSWER – INFRARED RAYS.**
109. A DULL SURFACE IS A GOOD EMITTER OF HEAT.
110. A hot metal ball is suspended in the open air. As it cools , it loses heat by .
ANSWER – RADIATION
111. THE RADIATOR OF A MOTOR CAR IS COOLED BY CONVECTION
112. Two similar kettles containing equal masses of boiling water are placed on a table. If the surface of one is highly polished and the surface of the other is covered with soot THE KETTLE COVERED WITH SOOT COOLS DOWN MORE QUICKLY BECAUSE IT IS A GOOD RADIATOR OF HEAT.
113. The major component of the sun's electromagnetic spectrum that carries heat energy to the earth is the __
ANSWER – INFRARED RAYS.
114. The intensity of heat radiated by a surface depends on __. THERMAL CONDUCTIVITY .

115__ converts heat energy to electrical energy **.** **ANSWER – THERMOCOUPLE**
116. Tea pots are silver –coated to prevent heat loss by __ . **ANSWER: RADIATION ONLY.** silver-coating reduces heat loss by radiation .
117. The main reason for making the cover of a vacuum flask tight is to prevent heat loss by **ANSWER – EVAPORATION**. Poor closed cover will lead to evaporation of the molecules of the content. Evaporation causes cooling mof the content because the vapour molecules drae their latent het of vaporization from the content thereby cooling it.
118. The thermos flask is designed to __ .
ANSWER – PREVENT HEAT LOSS OR GAIN BY CONDUCTION , CONVECTION AND RADIATION. Thermos flask prevents both heat loss and heat gain via 3 modes of heat transfer . It keeps a hot content hot or a cold content cold.
119. The cork in a vacuum flask reduces heat loss due to __ . **ANSWER – CONDUCTION**.
120. In a good thermos flask , the main cause of heat loss is__ **. ANSWER – CONDUCTION THROUGH THE CORK** .
121. If a given mass of gas at constant pressu re obeys the relation--volume is proportional to the absolute temperature—the gas is said to obey __ . **ANSWER – CHARLES' LAW**
122. If the volume of a fixed mass of gas is kept constant , the pressure of the gas__
ANSWER- IS DIRECTLY PROPORTIONAL TO ITS ABSOLUTE TEMPERATURE.
123. A balloon inflated with helium gas at ground level is released. As it rises through a constant temperature atmosphere__
ANSWER – THE PRODUCT OF PRESSURE AND VOLUME REMAINS CONSTANT. The pressure of the atmosphere decreases as the balloon goes upwards. According to boyle's law, this fall in pressure is accompanied by

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proportionate rise in volume at a constant temperature rise in volume at a constant temperature – both are inversely proportional.

124. The average kinectic energy of the molecules of a perfect gas is directly proportional to the__

ANS-KELVIN TEMPERATURE OF THE GAS

Average kinectic energy of gas molecules is proportional to the kelvin temperature of the gas molecules.

125. One valid assumption of the kinectic theory of gases is that__

ANSWER – THE MOLECULES OF GAS ARE ALL IDENTICAL AND ARE VERY SMALL IN SIZE .

126. Why are collisions between gas molecules said to be elastic? . **ANSWER – NO LOSS OF TOTAL ENERGY AFTER COLLISION**

127. On the basis of the kinectic theory , an in crease in the temperature of a fixed volume of an ideal gas causes.

ANSWER – AN INCREASE IN THE AVERAGE SPEED OF THE GAS MELOCULES.

128. According to the kinectic theory of gases , the collision of gas molecules with the walls of their containers is mainly responsible for

ANSWER – PRESSURE OF THE GAS

129. If the air inside a rigid box is heated , the **AVERAGE SPEED OF THE MOLECULES INCREASES AND PRESSURE OF THE AIR INCREASES.**

130. Which of the following correctly describes events at absolute zero temperature? .

ANSWER – THERMAL MOTION CEASES.

Absolute zero is zero kelvin (0K) not Celsius .At this temperature , average kinectic energy of gas molecules is theoretically zero such that their motion ceases completely.

131. The pressure exerted by a given mass of gas in a container__ . **ANSWER – INCREASES IF THE MOLECULES OF THE GAS MOVES FASTER.**

WHAT YOU NEED TO KNOW ABOUT CALCULATORS TIPS AND HINTS (CHAPTER 17)

Calculators can be be used for solving questions and getting answer for equations like quadratic , simultaneous , fractions , permutation, combination, and complex number , vectors e.t.c. but for the sake of this course we will focus on quadratic and simultaneous equations only . Simple hints are

QUADRATIC EQUATION: e.g $x^2 - 5x + 6$

SOLUTION

PRESS **MODE · 5 · 3** , then input values e.g a = 1 b = −5 , c = 6 , and **PRESS =** , you get x = 3 or x = 2. CALCULATOR TO NORMAL MODE , **PRESS MODE · 1**

SULMULTANEOUS EQUATION: PRESS AC TO CLEAR SCREEN . e.g. 5x + 4y = 13 , 6x + 8y = 4

SOLUTION

PRESS MODE · 5 · 1 , a = 5 , b = 4 , c = 13 and for 2nd equation , a = 6 , b = 8 , c = 4 input values and **PRESS =** , you get $\frac{11}{2}$ & $\frac{-28}{8}$, TO **TAKE CALCULATOR TO NORMAL MODE , PRESS MODE · 1 .**

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THE END

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