THE PHYSICS WORKBOOK

$\vec{A} \cdot \vec{B} = AB \cos \theta$; $\vec{A} \times \vec{B} = AB \sin \theta \hat{n}$; $v = u + at$;$s = ut + \frac{1}{2}at^2$; $v^2 = u^2 + 2as$;$s = \frac{1}{2}(u+v)t$; $p = mv$; $J = F\Delta t$; $J = \Delta p = mv - mu$; $f = \mu N$; $W = Fs \cos \theta$; $K = \frac{1}{2}mv^2$; $U = mgh$; $U_x = \frac{1}{2}kx^2 = \frac{1}{2}Fx$; $P_{ave} = \frac{\Delta W}{\Delta t}$; $P = Fv$; $F_c = \frac{mv^2}{r} = mv\omega = mr\omega^2$; $s = r\theta$; $v = r\omega$; $a_t = r\alpha$; $\omega = \omega_o + \alpha t$; $\theta = \omega_o t + \frac{1}{2}\alpha t^2$; $\omega^2 = \omega_o^2 + 2\alpha\theta$; $\tau = rF \sin \theta$; $I = \Sigma mr^2$; $I_{\text{solid sphere}} = \frac{2}{5}MR^2$; $I_{\text{solid cylinder/disk}} = \frac{1}{2}MR^2$; $I_{\text{ring}} = MR^2$; $I_{\text{rod}} = \frac{1}{12}ML^2$; $\tau = I\alpha$; $L = I\omega$; $x = A \sin \omega t$; $v = \frac{dx}{dt} = \pm\sqrt{A^2 - x^2}$; $a = \frac{dv}{dt} = \frac{d^2x}{dt^2} = -\omega^2 x$; $K = \frac{1}{2}m\omega^2(A^2 - x^2)$; $U = \frac{1}{2}m\omega^2 x^2$; $E = \frac{1}{2}m\omega^2 A^2$; $\omega = \frac{2\pi}{T} = 2\pi f$; $T = 2\pi\sqrt{\frac{l}{g}}$; $T = 2\pi\sqrt{\frac{m}{k}}$; $k = \frac{2\pi}{\lambda}$; $v = f\lambda$; $y(x,t) = A \sin(\omega t \pm kx)$; $y = A \cos kx \sin \omega t$; $I = \frac{P}{A}$; $f = \frac{nv}{2l}$; $f_n = \frac{n}{2l}\sqrt{\frac{T}{\mu}}$; $f = \frac{nv}{4l}$; $v = \sqrt{\frac{T}{\mu}}$; $\mu = \frac{m}{l}$; $f_n = \left(\frac{v \pm v_o}{v \pm v_s}\right) f$; $\sigma = \frac{F}{A}$; $\varepsilon = \frac{e}{l_o}$; $Y = \frac{\sigma}{\varepsilon}$; $U = \frac{1}{2}Fe$; $\Delta L = \alpha L_o \Delta T$; $\Delta A = \beta A_o \Delta T$; $\Delta V = \gamma V_o \Delta T$; $\beta = 2\alpha$; $\gamma = 3\alpha$; $pV = nRT$; $n = \frac{m}{M} = \frac{N}{N_A}$; $v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$; $pV = \frac{1}{3}Nmv_{rms}^2$; $p = \frac{1}{2}\rho v_{rms}^2$; $K_{tr} = \frac{3}{2}\left(\frac{R}{N_A}\right)T = \frac{3}{2}kT$; $U = \frac{1}{2}fNkT = \frac{1}{2}fnRT$; $Q = \Delta U + W$; $W = nRT \ln \frac{V_2}{V_1} = nRT \ln \frac{p_1}{p_2}$; $W = \int p \, dV = p(V_2 - V_1)$

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LIST OF SELECTED CONSTANTS

Speed of light in vacuum	c	$= 3.00 \times 10^{8}\, ms^{-1}$
Permeability of free space	μ_o	$= 4\pi \times 10^{-7}\, H\, m^{-1}$
Permittivity of free space	ε_o	$= 8.85 \times 10^{-12}\, F\, m^{-1}$
Electron charge magnitude	e	$= 1.6 \times 10^{-19}\, C$
Planck constant	h	$= 6.63 \times 10^{-34}\, Js$
Electron mass	m_e	$= 9.11 \times 10^{-31} kg$ $= 5.49 \times 10^{-4}\, u$
Neutron mass	m_n	$= 1.674 \times 10^{-27} kg$ $= 1.008665u$
Proton mass	m_p	$= 1.672 \times 10^{-27} kg$ $= 1.007277u$
Hydrogen mass	m_H	$= 1.673 \times 10^{-27} kg$ $= 1.007825u$
Deuteron mass	m_d	$= 3.34 \times 10^{-27} kg$ $= 2.014102u$
Molas gas constant	R	$= 8.31\, J\, K^{-1}\, mol^{-1}$
Avogadro constant	N_A	$= 6.02 \times 10^{23}\, mol^{-1}$
Boltzmann constant	k	$= 1.38 \times 10^{-23} JK^{-1}$
Free-fall acceleration	g	$= 9.81 ms^{-2}$
Atomic mass unit	$1u$	$= 1.66 \times 10^{-27} kg$ $= 931.5 \frac{MeV}{c^2}$
Electron volt	$1eV$	$= 1.6 \times 10^{-19}\, J$
Constant of proportionality for Coulomb's Law	$k = \frac{1}{4\pi\varepsilon_o}$	$9.0 \times 10^{9}\, N\, m^{2}\, C^{-2}$
Atmospheric pressure	$1atm$	$= 1.013 \times 10^{5} Pa$
Density of water	ρ_w	$= 100 kgm^{-3}$

LIST OF SELECTED FORMULAE

C2	1	$v = u + at$	23	$\theta = \frac{1}{2}(\omega_o + \omega)t$	
	2	$s = ut + \frac{1}{2}at^2$	24	$\omega^2 = \omega_o^2 + 2\alpha\theta$	
	3	$v^2 = u^2 + 2as$	25	$\tau = rF \sin\theta$	
	4	$s = \frac{1}{2}(u + v)t$	26	$I = \Sigma mr^2$	
C3	5	$p = mv$	27	$I_{\text{solid sphere}} = \frac{2}{5}MR^2$	
	6	$J = F\Delta t$	28	$I_{\text{solid cylinder/disc}} = \frac{1}{2}MR^2$	
	7	$J = \Delta p = mv - mu$	29	$I_{ring} = MR^2$	
	8	$f = \mu N$	30	$I_{\text{rod}} = \frac{1}{12}ML^2$	
C4	9	$W = \vec{F} \cdot \vec{s} = Fs \cos\theta$	31	$\sum \tau = I\alpha$	
	10	$K = \frac{1}{2}mv^2$	32	$L = I\omega$	
	11	$U = mgh$	33	$y = A \sin \omega t$	C7
	12	$U_s = \frac{1}{2}kx^2 = \frac{1}{2}Fx$	34	$v = \omega A \cos \omega t = \pm\omega\sqrt{A^2 - y^2}$	
	13	$W = \Delta K$	35	$a = -\omega^2 A \sin \omega t = -\omega^2 y$	
	14	$P_{av} = \frac{\Delta W}{\Delta t}$	36	$K = \frac{1}{2}m\omega^2(A^2 - y^2)$	
	15	$P = \vec{F} \cdot \vec{v} = Fv \cos\theta$	37	$U = \frac{1}{2}m\omega^2 y^2$	
C5	16	$a_c = \frac{v^2}{r} = r\omega^2 = v\omega$	38	$E = \frac{1}{2}m\omega^2 A^2$	
	17	$F_c = \frac{mv^2}{r} = mr\omega^2 = mv\omega$	39	$\omega = \frac{2\pi}{T} = 2\pi f$	
C6	18	$s = r\theta$	40	$T = 2\pi\sqrt{\frac{l}{g}}$	
	19	$v = r\omega$	41	$T = 2\pi\sqrt{\frac{m}{k}}$	
	20	$a_t = r\alpha$	42	$k = \frac{2\pi}{\lambda}$	
	21	$\omega = \omega_o + \alpha t$			
	22	$\theta = \omega_o t + \frac{1}{2}\alpha t^2$			

LIST OF SELECTED FORMULAE – PAGE 2

	43	$v = f\lambda$	63	$\gamma = 3\alpha$	
	44	$y(x,t) = A\,sin\,(\omega t \pm kx)$	64	$n = \frac{m}{M} = \frac{N}{N_A}$	C9
	45	$v_y = A\omega\,cos\,(\omega t \pm kx)$	65	$v_{rms} = \sqrt{< v^2 >}$	
	46	$y = 2A\,cos\,kx\ \ sin\,\omega t$	66	$v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$	
	47	$f_n = \frac{nv}{2L}$	67	$PV = \frac{1}{3}Nmv_{rms}^2$	
	48	$f_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$	68	$P = \frac{1}{3}\rho v_{rms}^2$	
	49	$f_n = \frac{nv}{4L}$	69	$K_{tr} = \frac{3}{2}\left(\frac{R}{N_A}\right)T = \frac{3}{2}kT$	
	50	$v = \sqrt{\frac{T}{\mu}}$	70	$U = \frac{1}{2}fNkT = \frac{1}{2}fnRT$	
	51	$\mu = \frac{m}{L}$	71	$\Delta U = Q - W$	
	52	$f_a = \left(\frac{v \pm v_o}{v \mp v_s}\right)f$	72	$W = nRT\,ln\left(\frac{V_f}{V_i}\right) = nRT ln\left(\frac{P_i}{P-f}\right)$	
C8	53	$\sigma = \frac{F}{A}$	73	$W = \int P\,dV = P(V_f - V_i)$	
	54	$\varepsilon = \frac{\Delta L}{L_o}$	74	$W = \int P\,dV = 0$	
	55	$Y = \frac{\sigma}{\varepsilon}$			
	56	$U = \frac{1}{2}F\Delta L$			
	57	$\frac{U}{V} = \frac{1}{2}\sigma\varepsilon$			
	58	$\frac{Q}{t} = -kA\left(\frac{\Delta T}{L}\right)$			
	59	$\Delta L = \alpha L_o \Delta T$			
	60	$\Delta A = \beta A_o \Delta T$			
	61	$\Delta V = \gamma V_o \Delta T$			
	62	$\beta = 2\,\alpha$			

QUANTITIES & SI UNITS

Quantities	Symbols used	SI Units	Quantities	Symbols used	SI Units
Displacement	s, x	m	Angular acceleration	α	$rad\, s^{-2}$
Velocities	u, v	ms^{-1}	Torque	τ	Nm
Accelerations	a	ms^{-2}	Moment of Inertia	I	$kg\, m^2$
Time	t	s	Angular Momentum	L	$kg\, m^2\, rad\, s^{-1}$
Momentum	p	$kg\, ms^{-1}$ or Ns	Period	T	s
Force	F	N or $kg\, ms^{-2}$	Wavenumber	k	$rad\, m^{-1}$
Work	W	J or Nm	Coefficient of thermal conductivity	k	$Wm^{-1}K^{-1}$
Energy	E		Coefficient of thermal expansion	α (linear) β (area) γ (volume)	K^{-1}
Power	P	W or $N\, ms^{-1}$	Molar mass	M	$kg\, mol^{-1}$
Angular displacement	θ	rad	Density	ρ	$kg\, m^{-3}$
Angular velocities	ω	$rad\, s^{-1}$			

Formal Assessments

Chapter	1	2	3	4	5	6	7	8	9
Assessment									
UPS 1				X	X	X	X	X	X
UPS 2	X	X	X				X	X	X
UPS 3	X	X	X	X	X	X			X
Assignment	CHAPTER 6: ROTATION OF RIGID BODY								
Practical Test	SIMPLE HARMONIC MOTION EXPERIMENT								
PSPM Weightage (%)	3(2)	12(10)	17(13)	10(8)	5(5)		29(23)	10(8)	14(11)

Chapter 1: Physical Quantities & Measurements (mgy)

Question 1
Determine the S.I unit of impulse using dimensional analysis.

Question 2
Show that the expression $v = at$ is dimensionally correct, where *v*, a and *t* represent the speed, acceleration, and time interval of an object respectively.

Question 3
Verify the homogeneity of equation $a = \frac{1}{2}(u + v)t^2$ where a is acceleration, *u* and *v* are velocities, and *t* is time.

Question 4
Shown that the expression $A = \pi r^2$ is homogenous.

Question 5
A force F is given by $F = at + bt^2$, where t is the time. Find the dimension of 'a'.

Question 6
The pressure P of a liquid with density ρ and moving with velocity v is given by $P = a - bpv^2$? What is the dimension of b?

Question 7
Shafiq have a ladder that has a length of 5.5 m leaning against a building at an angle 65° to the horizontal. You climb from the bottom of the ladder to the top. How far do you move

i. horizontally?
[2.32m]

ii. vertically?
[4.98m]

Question 8
Two forces F_1 and F_2 acted upon a box resting on a floor. $F_1 = 50\ N$ acted horizontally to the left while $F_1 = 35\ N$ acted upwards. Determine the magnitude of the net force experienced by the box.
[$\mathbf{61.03\ N}$]

Question 9
Mr John walks 5 m at 50° north of east and then 15 m to the south. Calculate the resultant of vertical displacement.
[$\mathbf{11.17\ m}$**; downward**]

Chapter 2: Kinematics (sr)

Question 1

a. A ball is thrown horizontally from the top of a building of height 80m. The ball strikes the ground at a horizontal distance of 15m from the building. Calculate the

   i. the time of flight.
   [4.0386 s]

   ii. initial speed of the ball.
   [3.7142 $m\ s^{-1}$]

   iii. angle at which the trajectory of the ball makes with the ground just before the impact.
   [84.64^o]

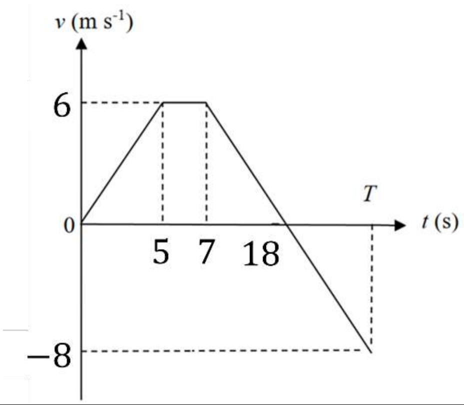
b. The speed of a car travelling along a straight road decrease uniformly from $26ms^{-1}$ to $12ms^{-1}$ over 75m. Calculate

   i. the deceleration of the car.
   [$-3.55\ m\ s^{-2}$]

   ii. the time taken for the speed to decrease from $26ms^{-1}$ to $12ms^{-1}$.
   [3.944 s]

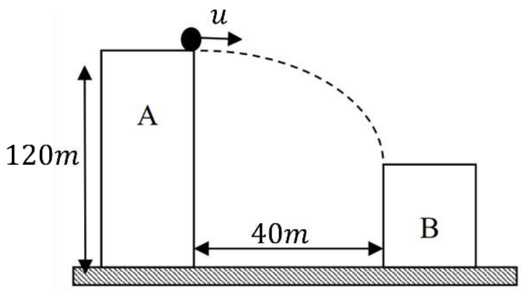
Question 2

The figure shows a graph of velocity against time for a remote-control car travelling along a straight smooth horizontal track. Sketch the displacement-time graph from 5s to 7s. Determine the value of T.
[32.67 s]



Question 3

The figure shows a ball is thrown from the top of the building A with an initial horizontal speed of u. The ball reaches the top of another building B after 2.4s. The height of building A is 120m. Calculate the initial speed, u of the ball and the height of building B.
[16.67 $m\ s^{-1}$; 91.75 m]



Question 4

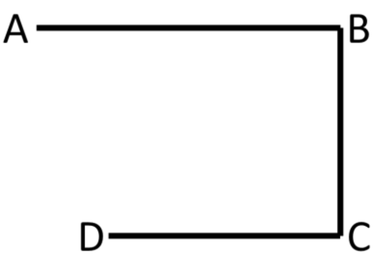
The figure shows a pathway of a car. The car moves from A to B at $7ms^{-1}$ for 15s, then from B to C at $6ms^{-1}$ for 12s and finally from C to D at $8ms^{-1}$ 10s.
Calculate

a. the distance of each pathway passed by the car.
   [$\{105, 72, 80\}m$]

b. the displacement of the car
   [76.22m at -70.852^o]

c. the average speed of the car
   [6.946 ms^{-1}]

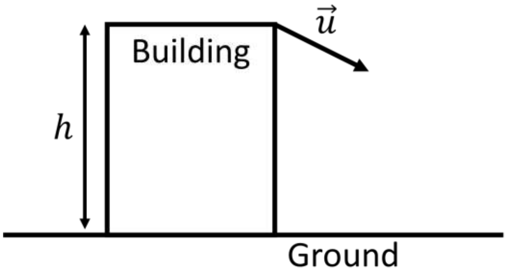
d. the average velocity of the car.
   [$2.06\ ms^{-1}$ at -70.852^o]



Question 5

In the figure shown, a ball is thrown from the edge of the roof at height h above the ground. The ball hits the ground $1.85s$ later at a distance $d = 30m$ from the building and at an angle 55^o with the horizontal. Calculate h and the initial velocity of the ball upon being thrown.

[26.074m; 16.98ms^{-1} at 17.20^o]



Question 6

a) A car moving from rest on a straight road and accelerates $2.5ms^{-2}$ until it reaches a velocity of $30ms^{-1}$. Then the car travels 300m at constant velocity before the brakes are applied. The car was stopped after 6.5s.

   i. How long did the car travel before it stopped?
   [28.5s]

   ii. Determine the average velocity of the car from rest until before the brakes are applied.
   [21.82 ms^{-1}]

b) A cheetah running with a constant acceleration covers the distance between two points 90m apart in 6.7s. Its speed as it passes the second point is $15ms^{-1}$. Calculate the cheetah's speed at the first point.
[11.866ms^{-1}]

Question 7

a) An athlete throws a shot at 40^o with the horizontal and the shot lands at a distance of 15.8m. Calculate the initial speed of the shot and the maximum height of the shot.
[12.546ms^{-1}, 3.315m]

b) An object is thrown horizontally from the edge of a table with an initial velocity of $2.8ms^{-1}$. If the height of the table is 1.2m, calculate

   i. the final velocity of object before it reaches the floor.
   [5.6ms^{-1}]

   ii. the horizontal displacement of the object.
   [1.384m]

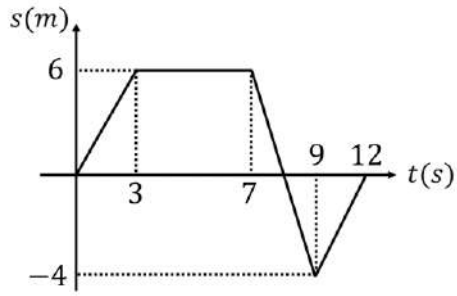
Question 8

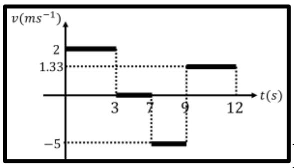
A package of supplies is dropped from a plane that is flying horizontally with a velocity of $55ms^{-1}$ at an altitude 200m. Calculate the time taken by the package to reach the ground and the speed of the package when it strikes the ground.

[6.383s; 83.3643 ms^{-1}]

Question 9

The figure shows a displacement-time graph of a tricycle moving along x-axis. Calculate the instantaneous velocity at $t = 1.0s$ and sketch the velocity-time graph for the tricycle motion.

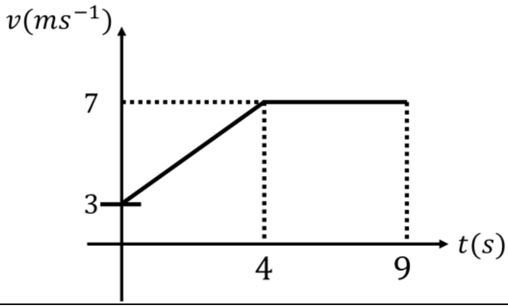


[2ms^{-1}; 

]

Question 10

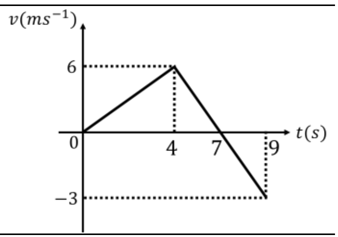
A bus moves linearly in the direction of positive x-axis. The graph in figure shows the bus's velocity as a function of time. Calculate the car's average velocity during the first 5 seconds? **[5.4 $\boldsymbol{m\,s^{-1}}$]**



Question 11

The figure shows velocity-time graph of the motion for a ball moving in a straight line. Determine the average acceleration of the particle for the whole journey.

[$\boldsymbol{-0.333\ m\,s^{-2}}$]



Question 12

An arrow is launched with a velocity $23ms^{-1}$ at an angle of 45° to the horizontal from the roof of a building of height 40m. Determine

i. the maximum height reached by an arrow from the ground
[53.481 m]

ii. the time taken for it to hit the ground.
[1.6442 s]

iii. the horizontal distance travelled.
[26.74 m]

Question 13

A water rocket is launched upward from ground at speed $\boldsymbol{u}$. The rocket returns to the Ground 9.2seconds later. Determine

i. the value of $\boldsymbol{u}$?
[45.13 $\boldsymbol{ms^{-1}}$]

ii. maximum height can be achieved by the rocket.
[103.81m]

iii. velocity of the rocket just before it hits the ground.
[$\boldsymbol{-45.13ms^{-1}}$]

Question 14

A person throws a ball with velocity $20ms^{-1}$ at angle of 30° above the horizontal. The distance between the initial velocity to the wall is 50m. What is the vertical velocity of the ball just before it hits the wall?

[$\boldsymbol{-18.322ms^{-1}}$]

Question 15

A jet lands on an aircraft carrier at a speed of $68ms^{-1}$.

i. What is its acceleration if it stops in 1.8s due to an arresting cable that snags the airplane and brings it to a stop?
[$\boldsymbol{-37.78ms^{-2}}$]

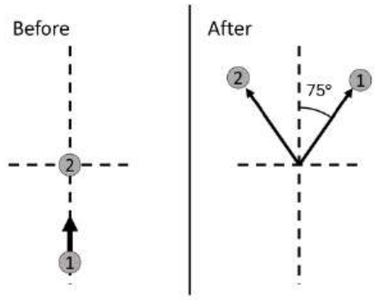
ii. If the plane touches down at front of the aircraft carrier (assume initial position when landing s = 0 m), what is the final position of the plane?
[61.196m]

Chapter 3: Dynamics of Linear Motion (sr)

Question 1

The figure shows ball 1 of mass 250g and velocity $5ms^{-1}$ collides obliquely with a stationary ball 2 of mass 450g. After the collision, ball 1 moves with velocity of 12 ms^{-1} at an angle 75° from its initial direction. Calculate the velocity of ball 2 after collision.

[6.53 ms^{-1} at 9.28^o]

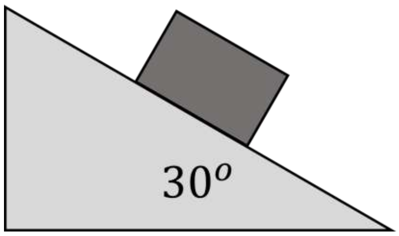


Question 2

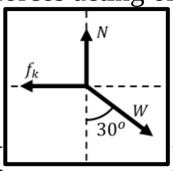
a. A bullet of mass 4g is fired horizontally with a velocity of 800 ms^{-1}. It hits a wooden block initially at rest and embedded inside it. Both of them move with a common velocity of $4.20ms^{-1}$. Determine the mass of the wooden block and the type of collision.

[$0.758kg$; $K_i \neq K_f \Rightarrow$ Inelastic]

b. A box of mass 4kg is placed on an inclined rough surface as shown in the figure shown. It is released from rest and accelerates at a constant rate of $3.2ms^{-2}$.



i. Sketch a free body diagram showing all forces acting on the box.

[ **]**

ii. Determine the coefficient of kinetic friction.

[0.2]

Question 3

A 5kg body moves towards the west with a momentum of $45kg\ ms^{-1}$. A 30N force to the east acts on the body for a period of 12s. Determine the magnitude of

i. the impact of the force

[360Ns]

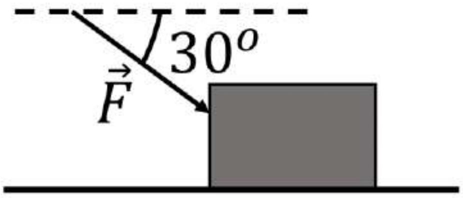
ii. the final velocity of the body.

[$63ms^{-1}$]

Question 4

A 30kg box is pushed at constant speed across a horizontal floor with a 20N force angled at 30^o below the horizontal, as shown in the diagram below. Sketch the free-body diagram of the box and calculate the reaction force on the box.

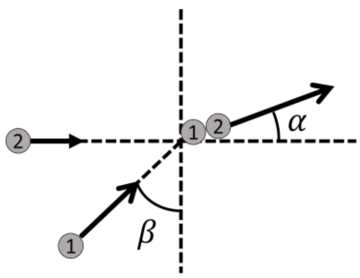
[304.3N]



Question 5

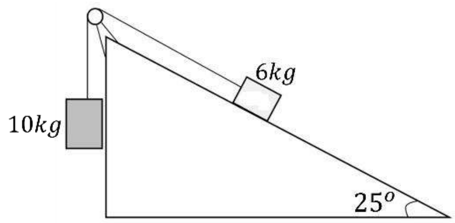
Suppose two identical balls collide obliquely as shown in the diagram and sticks together after the collision. Determine the velocities after the impact. Assume $u_1 = u_2 = 45ms^{-1}$ and $\beta = 35^o$.

[$39.92ms^{-1}$ with $\alpha = 27.50^o$]



Question 6

Two boxes of mass 6kg and 10kg are connected by a light string that passes over a frictionless pulley as shown in the figure. The 6kg box is on a rough inclined plane of angle 25^o. If the coefficient of kinetic friction is 0.22, determine the acceleration and tension of the system.

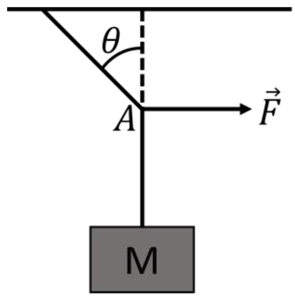


[59.667 N; $T = 3.84\ ms^{-2}$]

Question 7

A 10kg mass is suspended by a 2m rope from the ceiling and 50N force is applied midpoint (point A) of the rope, as shown in the diagram. What is the angle the rope makes with the vertical in equilibrium?

[$\theta = 27^o$]



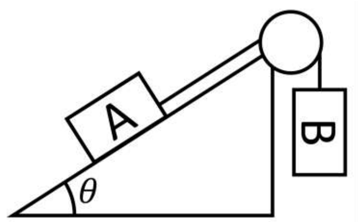
Question 8

a) A 6.2kg object moves towards the north with a momentum of $30kgms^{-1}$. A 4.1N force acts on the object in the south direction for a period of 30s. Determine the final speed of the object.
[$15ms^{-1}$]

b) A 25g bullet moving $275ms^{-1}$ to the right strikes a piece of wood. Assume that the bullet undergoes uniform deceleration and stops in 8s. Find the average force experienced by the bullet.
[0.86N]

Question 9

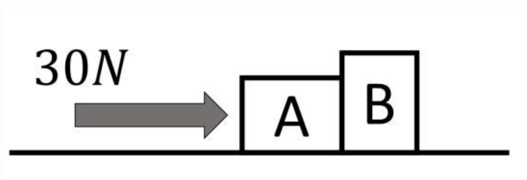
a) The figure shows a 18kg box A placed on a frictionless inclined plane at 30^o. The box is connected to a 12kg box B by a string through a pulley. Determine the acceleration of the system.
[$0.981ms^{-2}$]



b) A 2.5kg ball is released from rest and falls under gravity through a height *h* from the ground. Just before it hits the ground, it is found that the ball has a velocity of $12.53ms^{-1}$. Determine height of release, *h*.
[8m]

Question 10

The figure shows two wooden blocks A and B placed side by side on a smooth horizontal table. Blocks A and B weigh 350g and 700g respectively. A horizontal force of 30 N is applied on block A so that both blocks accelerate together. Determine the acceleration of the blocks. Find the force exerted on block B due to block A.



[28.57 ms^{-2}; 20.0N]

Question 11

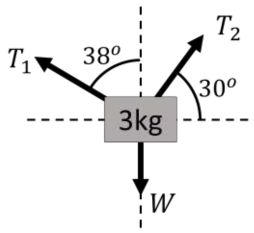
a. A 75N force is applied horizontally to a 15kg block resting on a table. After traveling 8.2m, the speed of the block is $6.1ms^{-1}$. Calculate the coefficient of kinetic friction.
[0.28]

b. An object A of mass 2.1kg moves in a straight line and eventually collides with a stationary object B of mass 1.8kg. After the collision, the objects stick together and continue to move in the same direction. The system loses energy of 0.45J after the collision. Determine the velocity of A before the collision.
[$\pm 0.963\ ms^{-1}$]

Question 12

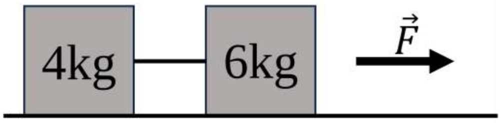
The figure shows a system is in equilibrium. Sketch free-body diagram and calculate the magnitude of T_1 and T_2.

[$\{25.74, 18.30\}N$]



Question 13

The figure shows two blocks of masses 4kg and 6kg are connected with each other via a string and moves with the same acceleration on a frictionless horizontal surface. A constant horizontal force 30N is applied to the block of mass 6 kg.



i. Find the acceleration of the blocks
[$3ms^{-2}$]

ii. Calculate the tension in the cord connecting them.
[$T = 12N$]

Question 14

An object of mass 420kg moves at a speed of $30ms^{-1}$ to the right. It breaks up into two parts, one having a mass of 55kg moving at a speed of $15ms^{-1}$ in the opposite direction. Determine the magnitude and direction of the velocity for the second part.

[to the right, 36.78ms^{-1}]

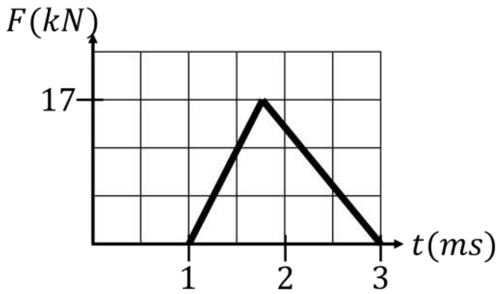
Question 15

A force-time curve for a ball struck by a bat is shown in the figure.

From this curve, determine

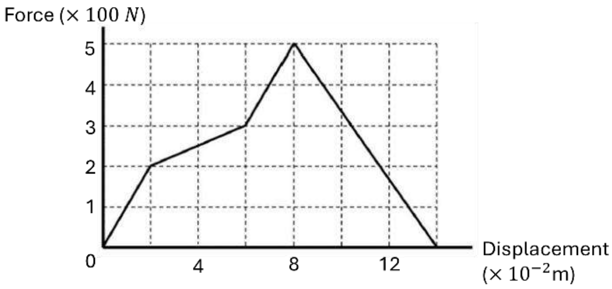
i. the impulse delivered to the ball,
[$17Ns$]

ii. the average force exerted on the ball.
[8500N]

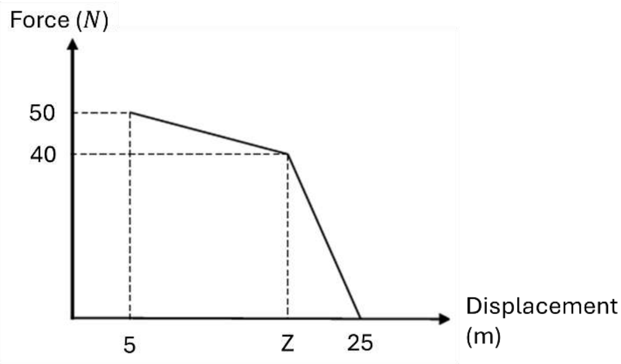


Chapter 4: Work, Energy & Power (jl)

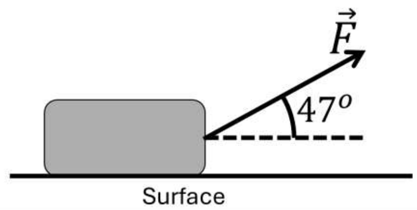
Question 1
The figure shows a force-displacement graph for an object is being pushed along a certain distance. Determine the work done from the graph.
[35 J]



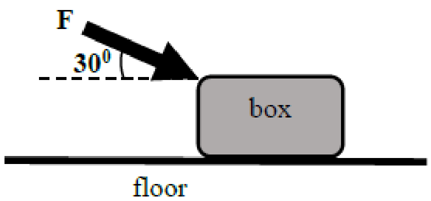
Question 2
The force applied to a body versus its displacement is shown in the graph. Determine the value of Z if the work done by the force applied is 700J.
[Y=17 m]



Question 3
The figure shows a block of mass 60kg pulled by a constant force, $F = 200N$ on rough surface at an angle of 47º to the horizontal.
Calculate the net work done on the block is the block moves 20m and the frictional force between the block and the surface is 70N.
[1327.99 J]

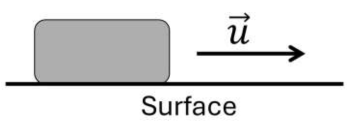


Question 4
The figure shows a box being pushed by a constant force, F of 35N, at an angle of 30° with the horizontal. The kinetic frictional force between the box and the floor is 10N. How much total work is done if the box is pushed through 6m?
[121.87 J]



Question 5
A block of mass 2kg is pushed 2.5m along a frictionless horizontal table by a constant 20N force directed 30º above the horizontal. Calculate the work done by
i) the applied force. **[43.30 J]**
ii) the force of gravity. **[0 J]**

Question 6
A 500g block is shot on the surface in the figure shown with an initial speed of $2ms^{-1}$. How far will it go if the coefficient of friction between it and the surface is 0.250?
[0.8155 m]



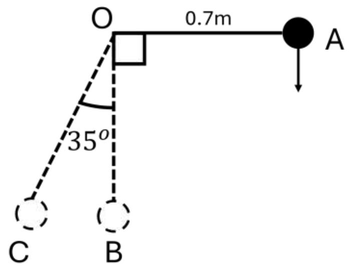
Question 7

The figure shows a pendulum of length 0.7m with a bob of mass 0.14kg is released from rest at A.

Calculate the

(i) speed of the bob at B.
[3.71 m s^{-1}]

(ii) potential energy of the bob at C.
[0.179 J]

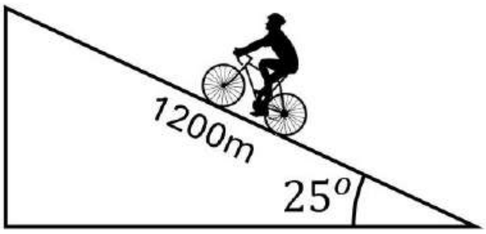


Question 8

The figure shows cyclist travels 1.2km along the steep road of angle 25° at an average speed of $4.5ms^{-1}$ during the mountain stage of the Tour de Langkawi. The mass of the cyclist and bicycle is 70kg.

Calculate the total mechanical energy of the cyclist and bicycle at the end of the finishing line.

[3.48$\times$ $10^5 J$]

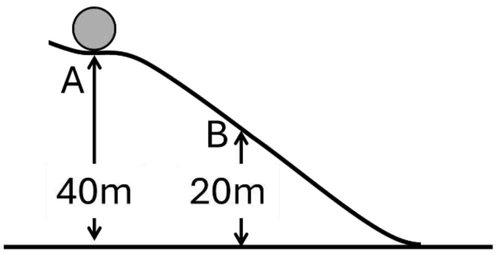


Question 9

A ball of mass 4kg initially at rest slides along a smooth and curvy surface as shown in figure. Calculate

(i) the potential energy of the sphere at point A **[1569.6 J]**

(ii) The speed of the sphere as it passes point B **[19.81 ms^{-1}]**



Question 10

A horizontal spring attached to a wall has a force constant of $850Nm^{-1}$. A block of mass 1.5kg is attached to the opposite end of that spring and rests on a frictionless horizontal spring. The block is pulled to a position of 6.0cm from equilibrium and released. Calculate the speed of the block as it passes through the equilibrium point.

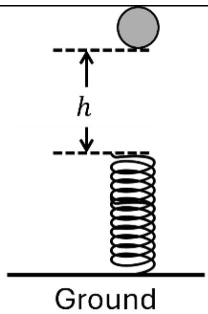
[1.43 m s^{-1}]

Question 11

An object of mass 2.0kg is placed 30cm directly above the top end of a vertical spring as shown in the figure. It is then released from that height. The spring constant $k = 20Nm^{-1}$.

i) Calculate the speed of the object just before it strikes the spring.
[2.43 m s^{-1}]

ii) Determine the maximum compression, *x*.
[2.2264 m]



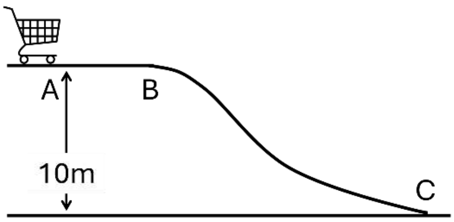
Question 12

In the figure shown, a small shopping cart of 8 kg moves on the frictionless track with a speed of 20 m s^{-1} along **AB** and down to **C**. Calculate the

i) kinetic energy of the cart as it moves along **AB.**
[1600 J]

ii) potential energy of the cart at point **B**.
[784.8 J]

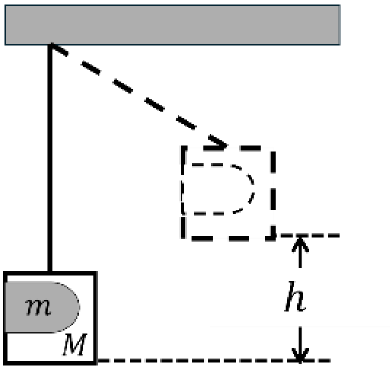
iii) speed of the cart at point **C**.
[24.42 m s^{-1}]



Question 13

In a block-bullet experiment, h = 5.0cm, m = 5.0g and M = 1kg. Find the common velocity after the bullet embedded into the block, v.

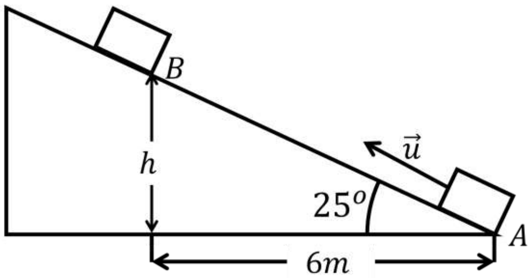
[0.990 m s^{-1}]



Question 14

An object of mass 2kg moves up a rough inclined plane with an initial velocity of $14.14 ms^{-1}$, which makes an angle 25° with the horizontal. The coefficient of kinetic friction between the object and the plane is 0.20. Using the work-energy theorem, calculate the kinetic energy of the object at point B

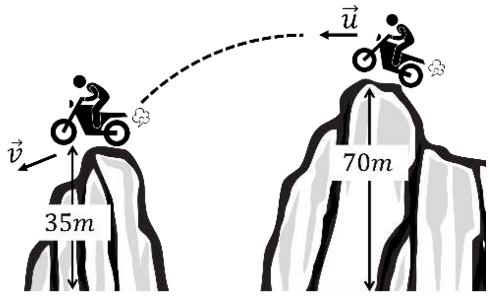
[141.49 J]



Question 15

A daredevil on his bike is trying to leap across the canyon shown in the figure by driving horizontally off the cliff at a speed of $38 ms^{-1}$. By ignoring air resistance, find the speed with which the cycle strikes the ground on the other side.

[46.16 m s^{-1}]



Question 16

A 65 kg man climbs up a staircase of total height 342m in 30 minutes. Calculate the average power exerted by the man. **[121.15 W]**

Question 17

An electric powered machine pulls a rope tied to a wooden crate fully loaded with fruits upward at a constant speed of $0.25 ms^{-1}$. The electric power used is 68W. What is the tension in the rope?

[272 *N*]

Question 18

A 5kg block is placed on a horizontal rough surface. If the coefficient of friction is 0.30, calculate the power required to pull the block at a constant speed of $1.25 ms^{-1}$.

[18.39 W]

Question 19

A 10kg box is lifted through a vertical distance of 15m in 5s with constant velocity. Calculate the applied power to lift the box.

[294.3 W]

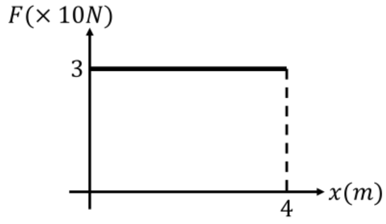
Question 20

A 0.25hp motor is used to lift a load at the rate of 5.0 $cm\ s^{-1}$. Determine the mass of the load at this constant speed? [1 hp = 746 W]

[380.22 kg]

Question 21

A person applies a horizontal force to a stationary 40kg box and pushes it from point A to point B. The figure shows variations of horizontal force exerted by the man versus the displacement of the box during the process.

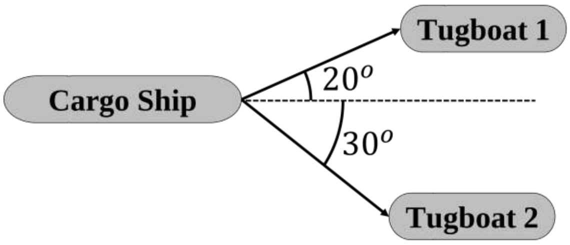


i) Determine the work done by the applied force to displace the box from point A to point B.
[120 J]

ii) Calculate the velocity at point B using work-energy theorem.
[2.45 m s^{-1}]

Question 22

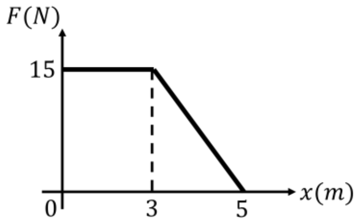
a. Two tugboats tow a cargo ship. Each tug exerts a constant force of $7.5 \times 10^6 N$ in the direction of 30^o and 20^o as shown in the figure. They pulled the tanker 1.25 km along the horizontal line. What is the total work they do on the oil tanker?
[$1.693 \times 10^{10} Ns$]



b. An electric powered machine pulls a rope tied to a wooden crate fully loaded with bricks upward at a constant speed of $0.34ms^{-1}$. The electric power used is 68W. What is the tension in the rope?
[200N]

Question 23

The graph in the figure shows how the force *F* on a body of mass 8 kg varies with displacement from the origin.

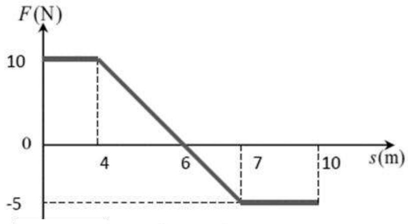


i. What is the work done by the force when the body is displaced 5.0 m from the origin?
[60 J]

ii. The velocity of the body at the origin is 6.0 m s-1. What its velocity when it is 5.0 m from the origin?
[7.14 m s^{-1}]

Question 24

An object of mass 2.0 kg travels along horizontal floor under the action of force, F. The figure shows the graph of force, *F* against displacement, *s*. The speed of the object at *s* = 0 is $10ms^{-1}$. Determine the kinetic energy of an object at *s* = 10 m. **[132.5 J]**



Question 25

An object with a mass of 5 kg is lifted vertically upwards by 10m in 2s. Calculate the

(i) work done by gravity on the object.
[$-490.5J$]

(ii) potential energy gained by the object.
[$490.5J$]

(iii) average power exerted to lift the object.
[$245.25W$]

Question 27

a) A winch accelerates a 250kg crate at $0.5ms^{-2}$ upwards. If the crate travels a total of 4m,

i. Calculate work done by the winch. **[10310Ns]**

ii. Determine work done by gravity. **[-9810Ns]**

iii. Find total work done on the lift. **[500Ns]**

b) A 9000W engine propels a boat at $15kmh^{-1}$. How much force is water resistance exerting on the speedboat? **[2160W]**

Chapter 5: Circular Motion (sr)

Question 1
The diameter of curvature of a bend along a level road is 25m. The coefficient of friction between the road and tyres of vehicle is 0.45.

i. Calculate the maximum speed such that the vehicle can go around the bend safely. **[7.43 $m\,s^{-1}$]**

ii. Discuss how the maximum speed is affected in a wet road condition.
[small μ, small v_{max}]

Question 2

a. A High-Volume Low Speed fan with diameter of 480cm is used in order to circulate air. If this fan is spinning with angular velocity 240rpm, calculate the
   i. frequency of the motion
   [4Hz]
   ii. centripetal acceleration of the tips of fan blade.
   [$1515.97\ m\,s^{-2}$]

b. A car is making a turn at a 45m radius roundabout. The coefficient of friction between the tyres of the truck and the road is 0.5. Calculate the maximum speed so the car can make a turn without skidding.
[14.86 $m\,s^{-1}$]

Question 3
An elder sibling places his 30kg younger sister on a 8kg cart to which a 1.8m long rope is attached. He then holds the end of the rope and spins the cart and child around in a horizontal circle, keeping the rope parallel to the ground. If the tension in the rope is 150 N and rolling friction between the cart's wheels and the ground is negligible, determine the speed of the cart during the motion and the revolutions per minute that the cart makes.
[2.67 $m\,s^{-1}$; 14.165 rpm]

Question 4
A conical pendulum bob has a constant speed of $3ms^{-1}$. If the pendulum bob traces a circular path of 40cm diameter, determine the angle the string makes with the vertical.
[77.7^{o}]

Question 5
A 0.5kg ball attached to the end of a string is rotated in a horizontal circle of diameter 2m on a frictionless table surface. Calculate the maximum speed of the ball if the string snaps when the tension exceeds 50N.
[10 $m\,s^{-1}$]

Question 6
A swing ball game moving in a circular motion at a radius of 0.8m. If the ball completes one full circle in 2.1s.

i. Calculate the centripetal acceleration of the ball.
[$7.162\ m\,s^{-2}$]

ii. If a new 900 g swing ball is used and completes the same circle in 3 minutes, calculate the centripetal force of the circular motion.
[0.88 mN]

Question 7
A toy train moving at a constant speed completes one lap around a 210cm circular track in 7s.

i. Calculate the speed of the car.
[0.3 ms^{-1}]

ii. Determine the magnitude of the centripetal force that keeps the car in a circle if its mass is 1.5 kg.
[0.409 N]

Question 8

Car A and Car B travels in a uniform circular motion around a circular racetrack with a centripetal acceleration of α_A and α_B respectively.

a. Determine the ratio $\frac{\alpha_B}{\alpha_A}$ is velocity of car A is one-third of car B. **[$\frac{1}{9}$]**

b. If the mass of car B is 1200kg and the radius of the racetrack is 200m, calculate the static friction between car B tyres and the track such that the car achieves a speed of $60ms^{-1}$. **[21.6kN]**

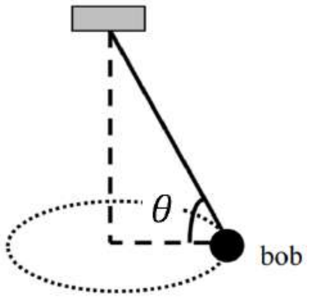
Question 9

a. A 0.8kg object is swung in a vertical circular motion on a string 0.75m long. If its speed is $4ms^{-1}$ at the top of the circle, what is the tension of the string there? **[9.22N]**

b. A conical pendulum with a bob of mass 0.35kg and a 0.7m string swings in a horizontal circle of diameter of 0.5m as shown in the diagram.

   i. Find the angle θ which the string makes with the horizontal axis. **[69.075^o]**

   ii. Find the tension in the string. **[3.68 N]**



Question 10

A 0.25kg mass is tied at the end of a 2m light inextensible string. What is the tension T of the string at the top and bottom of the circle if the mass makes one revolution in one second?
[17.2867N; $22.1917N$]

Chapter 7: Oscillations and Waves (mgy)

Question 1

An object undergoes a simple harmonic motion according to the following equation:

$$y = 10\sin(2.2t)$$

where y is in centimetre and t is in seconds. At $t = 3\ s$, determine the object's

i. displacement
[3.11cm]

ii. velocity
[20.91ms^{-1}]

iii. acceleration
[$15.08cms^{-1}$]

Question 2

An object is executing a simple harmonic motion with an amplitude of $20cm$ and a maximum acceleration of 10.5 ms^{-2}. Calculate

i. the period of the motion
[0.87 s]

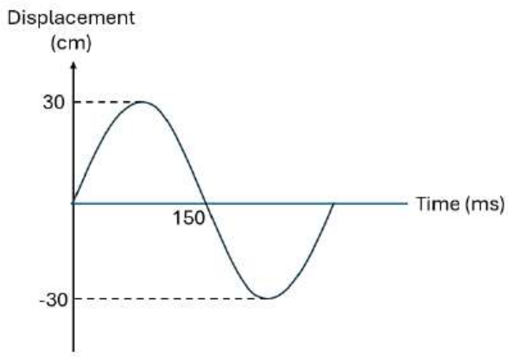
ii. the speed of the object when it is at 5cm from the amplitude
[$1.40\ ms^{-1}$]

Question 3

The figure shows the displacement of a particle undergoing a simple harmonic motion.

i) Determine the angular frequency of the motion.
[$20.94\ rad\ s^{-1}$]

ii) Sketch velocity against time graph for the particle.



Question 4

A spring is mounted horizontally, with its right end held stationary and a 0.43 kg body is attached to the left end. The body is freely oscillating with a period of 0.75s and maximum displacement is 3cm.

i) Calculate the spring constant.
[$30.17\ Nm^{-1}$]

ii) Calculate the angular frequency of the oscillation.
[$8.38\ rad\ s^{-1}$]

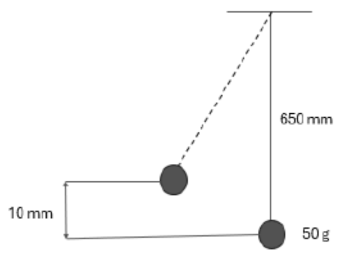
iii) Write the equation of the motion of the body.

iv) Calculate the velocity and acceleration of the body at displacement 0.015 m.
[$0.22\ ms^{-1}$; $-1.05\ ms^{-2}$]

v) Calculate the kinetic and potential energies at maximum displacement.
[$0\ J$; $0.014\ J$]

Question 5

A simple pendulum consists of a 50g mass tied to the end of a light string 650mm long. The mass is drawn to one side until it is 10mm above its rest position, as shown in the figure. When released, it swings with simple harmonic motion.



i. Calculate the frequency of the pendulum
[$0.62Hz$]

ii. Calculate the maximum speed of the mass during the first oscillation.
[$0.44\ ms^{-1}$]

iii. Sketch a graph of kinetic energy against displacement.

Question 6

Two progressive waves in a long string are given by,

$$y_1 = 0.01\sin\left(25t - \frac{x}{3}\right)$$

$$y_2 = 0.01\sin\left(25t + \frac{x}{3}\right)$$

Where y_1, y_2 and x are in meters and t in seconds.

i) Determine the expressions for the new wave when both waves are superimposed.

ii) Calculate the wavelength of the progressive waves.
[6π m]

Question 7

Two identical sinusoidal progressive waves travelling in opposite directions undergoes superposition to produce a standing wave with the wave function.

$$y = 5\cos(0.5x)\sin(50t)$$

Where y and x are in meters and t in seconds. Determine

i) the amplitude of the standing wave
[5m]

ii) the amplitude of the progressive wave
[2.5m]

iii) the maximum velocity of the wave
[$250ms^{-1}$]

iv) the distance between two consecutive antinodes
[6.28m]

Question 8

The water waves in Tasik Biru is represented by the equation.

$$y = 0.70\sin(40t - 3.5x)$$

Where x and y are in meters and t is in seconds.

i) Calculate the velocity of the water waves.
[$\mathbf{11.43\ ms^{-1}}$]

ii) A surfer is surfing on the water waves in Tasik Biru. When the surfer is at the position x = 1.6 m at the instant t = 60 s, determine the displacement of the surfer and the speed of the surfer.
[$\mathbf{0.34m; 23.19\ m\ s^{-1}}$]

iii) Write an equation which represents the water waves in Tasik Danu which have the same frequency as the water waves in Tasik Biru but the amplitude is half of that in Tasik Biru and propagates at a speed twice of that in Tasik Biru in the opposite direction.

Question 9

A 1.36m long horizontal tube with both ends open produces a loud sound of frequency 750Hz when a vibrating tuning fork is placed at one end of the tube. The loud sound occurs at the fifth overtone.

i) Sketch and label the standing waveform in the tube.

ii) Calculate

a. the speed of sound in the tube.
[$340ms^{-1}$]

b. the new fundamental frequency of the sound if one end of the tube is closed.
[$\mathbf{62.5\ Hz}$]

Question 10

When a guitarist plucked a guitar, the string vibrates with a velocity of 450 ms^{-1} to a tension of 850 N, it produces a fundamental frequency of 500 Hz. Calculate the mass and the length of the string. [$\mathbf{0.45\ m ; 1.89 \times 10^{-3}\ kg}$]

Question 11

A guitar string is tied down at both ends and placed under a tension of 200 N. A guitarist plucks the string of length 50cm and mass of 0.5g to produce its fundamental frequency.

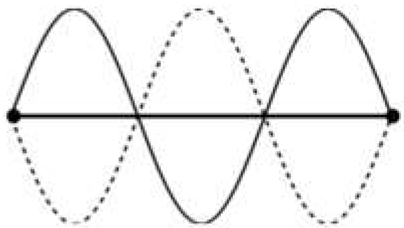
i) Sketch the stationary wave pattern formed in the guitar string at its fundamental frequency. Label all the nodes and antinodes at their respective positions.

ii) Calculate the fundamental frequency.
$[\mathbf{447.21\ Hz}]$

iii) The same length of string with different mass 4.0g is replaced into the guitar under the same tension. Explain quantitatively, what will happen to the fundamental frequency formed?
$[\mathbf{158.11\ Hz}]$

Question 12

Two sinusoidal waves with the same amplitude and wavelength travel in opposite direction along a string that is stretched along an axis. Their resultant wave is shown in the figure. The node-antinode distance is $4cm$. The mass of the string is $40g$ and the tension force applied is $55N$. Determine



i) the speed of waves travelling along the string.
$\left[\mathbf{18.17\ ms^{-1}}\right]$

ii) the wavelength and frequency of the standing waves formed.
$[\mathbf{0.16\ m}\ ;\ \mathbf{112.44\ Hz}]$

Question 13

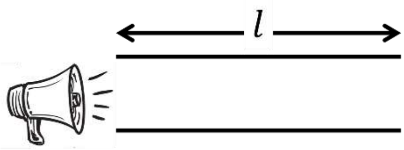
A copper wire of mass 400g and length 5.0m has one of its ends fixed to a wall and the other end is forced to vibrate transversely with a frequency of 250 Hz. If the tension of the wire is 140N, calculate

i) the speed and wavelength of the progressive wave produced.
$[\mathbf{41.83ms^{-1}; 0.17m}]$

ii) the number of harmonics for stationary wave produced.
[59]

Question 14

The figure shows a loudspeaker emitting sound wave of 550Hz in front of an open pipe of length, l. The air column resonates at its fifth harmonics. Given the speed of the sound in air is 340 ms^{-1}. Calculate



i) the length of the pipe, l
[1.55m]

ii) the wavelength of the sound wave in the air column.
[0.62m]

iii) the first overtone frequency.
[219.35 Hz]

Question 15

A lorry producing 1.50kHz waves moves towards a stationary listener at one-half the speed of sound. Determine the apparent frequency of the sound wave heard by the listener when the lorry moves with 20 m s^{-1} toward him? Given the speed of the sound in air is 340 ms^{-1}.

[1593.75 Hz]

Question 16

An ambulance emits siren frequency 1050Hz. The speed of sound is 340 ms^{-1}. The ambulance travel at 45 ms^{-1} towards a stationary listener and rides away. Determine the change in the apparent frequency detected by the listener.

[160.2 Hz]

Question 17

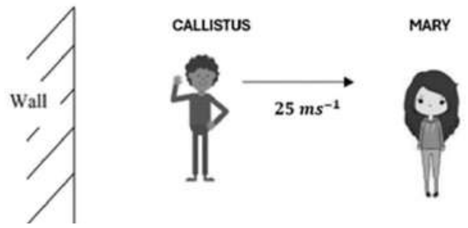
Misinah standing at a bus stop when the police motorcycle with velocity 47 ms^{-1} emitting siren with frequency 650 Hz pass through her. If the speed of sound in air is 340 ms^{-1}, calculate the frequency heard by Misinah when it is

i) Approaching her
[$\mathbf{754.27}\boldsymbol{Hz}$]

ii) Moving away from her
[$\mathbf{571.06}\boldsymbol{Hz}$]

Question 18

The figure shows that Mary is standing still. Callistus is walking towards Mary away from the wall with speed 25 ms^{-1} while talking to her. Callistus emits a frequency of 600 Hz. The speed of sound in air is 340 ms^{-1}. Determine



i) The apparent frequency heard by Mary directly from Callistus.
[$\mathbf{647.62}\boldsymbol{Hz}$]

ii) The apparent frequency heard by Mary due to reflection of the wall
[$\mathbf{558.9}\ \boldsymbol{Hz}$]

Question 19

A train that has a 200 Hz horn is moving at 45 ms^{-1} in still air on a day when the speed of sound is 340 ms^{-1}. Calculate the

i) Frequencies observed by a stationary person at the side of the tracks as the train approaches and after it passes.
[$\mathbf{230.51}\boldsymbol{Hz}; \mathbf{176.62}\boldsymbol{Hz}$]

ii) Frequency observed by the train's engineer traveling on the train.
[200Hz]

Chapter 8: Physics of matter (jl)

Question 1

A copper wire (of Young Modulus, Y=1.30 × 10^{11} Pa) with initial length of 0.766m and cross-sectional area 3.85 × 10^{-7} m^2 is stretched until it reaches 0.777 m. Calculate the force applied to the wire.

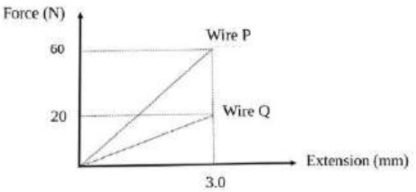
[560.05 *N*]

Question 2

A 10kg load is attached to a vertical 2.0m steel wire causes the wire to extend by 0.60mm. If the Young's modulus of steel is 200 GPa, calculate the extension of the wire causes by another 4 kg load added to the system.

[2.4 x 10^{-4} m]

Question 3



The figure shows the force-extension graphs of two wires P and Q of the same material. Both wires have the same length of 2m but different diameters. If the diameter of wire P is 0.60mm, determine the diameter of wire Q.

[3.46 x 10^{-4} m]

Question 4

A load of 10kg hangs from a steel wire with a length of 4.50m and cross-sectional area of 1.50mm^2. The Young's modulus of steel is 190GPa. Calculate

(i) the stress.

[6.54 x 10^7 N m^{-2}]

(ii) the strain energy per volume in the wire.

[1.09 x10^4 J m^{-3}]

Question 5

A load of 3kg hangs from a steel wire with a length of 1.50m and experiences a strain of 2.15 × 10^{-5}. The Young's modulus of steel is 200GPa. Calculate the diameter of the wire when subjected to this load.

[2.95 x 10^{-3} m]

Question 6

A copper wire with initial length of 0.75m and cross-sectional area of 2.75 × 10^{-7} m^2 is stretched until the strain in the wire is 0.015. If the Young's Modulus for copper is 1.30 × 10^{11} Pa, calculate

(i) the force applied

[536.25 Pa]

(ii) the strain energy in the wire

[3.02 J]

Question 7

A 2.5 m length of copper wire with a diameter of 0.4 mm is suspended from the ceiling. When a 5.0 N load is suspended from the bottom of the wire, it extends by 0.9 mm. Calculate the

(i) stress on the wire.

[5.09 x 10^7 Pa]

(ii) strain energy stored in the wire.

[2.50 x 10^{-3}]

Question 8

In steady state, a well-insulated copper rod of length 30.0cm and diameter of 1.8cm. One end held at 100 °C while the opposite end remains at 0 °C. Calculate the rate of heat flow through the rod.

[Thermal conductivity copper is 380 $W\ m^{-1}\ K^{-1}$]

[32.23 *W*]

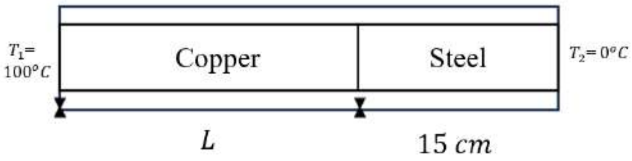
Question 9

A 55 m² composite wall of a building consists of brick and concrete with the thickness of 20.0 cm and 40.0 cm respectively. The temperature of the outside surface of the brick and concrete is 50 °C and 25 °C respectively. Given coefficient of the thermal conductivity of brick and concrete are 0.6 W m^{-1} °C^{-1} and 0.8 W m^{-1} °C^{-1} respectively.

(i) Determine the temperature of the interface between the brick and the concrete.
[40°C]

(ii) How much heat flows through the concrete in 2 hour?
[11.88 x 10^6 J]

Question 10

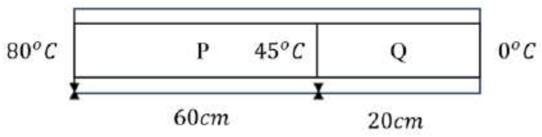


The figure shows two insulated plates, one made of copper and the other of steel, each with an area of 50.0 cm² and joined together at their ends. The steel rod has a length of 15 cm, while the copper rod has a length of L. At the steady state, the temperatures at the ends of copper and steel are T_1 = 100 °C and T_2 = 0 °C and temperature at the joint is 60 °C. Given the thermal conductivity for both plates are k_{copper} = 380 W m^{-1} °C^{-1} and k_{steel} = 46 W m^{-1} °C^{-1}.

(i) Calculate the temperature gradient of the steel rod.
[-400 °Cm^{-1}]

(ii) Determine L.
[82.6 cm]

Question 11



Metal rods **P** and **Q** are well insulated as in the figure shown. The thermal conductivity of metal rods **P** and **Q** are k_P and k_Q respectively. Calculate the value of $\frac{k_P}{k_Q}$? **[3.857]**

Question 12

A metal coin having a coefficient of linear expansion 4.0 × 10^{-5} °C^{-1} with diameter of 3.00 cm at a temperature of 30 °C, determine the coin's diameter when the temperature is raised to 80 °C.
[3.006×10^{-2} m]

Question 13

A sheet of aluminium has an initial area of 555cm² when the temperature is 10°C. If the linear expansion coefficient for aluminium is 2.5 × 10^{-5} °C^{-1}, what is the final temperature when the area of the sheet becomes 666cm^2?
[4010 °C]

Question 14

A glass container is initially filled with 400 cm³ of a liquid at a temperature of 30°C. The coefficient of volume expansion for the liquid is 6.0 × 10^{-4} °C^{-1} and the coefficient of volume expansion for the glass is 5.0 × 10^{-6} °C^{-1}. Calculate the volume of overflow when the temperature of both glass and liquid reaches 90°C.
[14.28 m^3]

Question 15

A steel rod has a length of 0.8 m and a cross-sectional radius of 2.0 cm when the temperature is 25 °C. Take α = 12 × 10^{-6} K^{-1} and Young's modulus of the rod to be Y = 250 × 10^9 Nm^{-2}.

(i) What is its change in length on a hot day when the temperature is 50 °C?
[2.40 x 10^{-4} m]

(ii) If the rod's ends were originally fixed, then determine the compression force on the rod.
[9.42 x 10^5 N]

Chapter 9: Kinetic Theory of Gases and Thermodynamics (jl)

Question 1

The root mean square speed of helium gas is 1140 m s^{-1}. The pressure of the gas is tripled, while the volume and the number of moles of the gas are kept constant. Calculate the

i new root mean square speed of the gas.

[1.97 x 10^3 m s^{-1}]

ii new temperature of the gas if the molar mass of helium gas is 4 g mol^{-1}.

[625.56 K]

Question 2

An ideal gas has a molar mass of 46 g mol^{-1}. Calculate the root mean square speed of the molecules at -20°C.

[370.29 m s^{-1}]

Question 3

The RMS speed of helium at STP is 2.5 km s^{-1}. Determine the density of helium at STP if the pressure at STP is 1.01 x 10^5 Pa.

[0.0485 kg m^{-3}]

Question 4

A gas of mass 345g is held in a square container with a volume of 0.60m^3 at a pressure of 1.8 x 10^5 Pa. Determine the root mean square speed of the gas molecules.

[969.09 ms^{-1}]

Question 5

Calculate the pressure exerted by hydrogen gas if the density of hydrogen gas is 0.1kgm^3 and rms speed of hydrogen molecule at that pressure is 1.65$km\,s^{-1}$.

[9.08 x 10^4 Nm^{-2}]

Question 6

A 2mol hydrogen gas has a temperature of 410K. Assuming the gas behaves ideally, calculate the internal energy of the gas.

[17036 J]

Question 7

A closed cylinder contains 0.2mole of nitrogen gas. What is the internal energy, U, of the system if the root mean square velocity of nitrogen molecules is 650ms^{-1}?

Molar mass of nitrogen= 28$gmol^{-1}$.

[1971.67 J]

Question 8

A 1.6mol ideal monoatomic gas is stored in a container at 27°C. Calculate the

(i) translational kinetic energy per molecule.

[6.21 x 10^{-21} J]

(ii) internal energy of the gas.

[5.98 x 10^3J]

Question 9

A cylinder of volume 0.06 m^3 contains oxygen gas at a temperature of 280 K and pressure of 100 kPa. Calculate the

(i) root mean square speed of the oxygen molecules in the cylinder.

[467.05 ms^{-1}]

(ii) mass of oxygen in the cylinder.

[82.5 g]

(iii) translational kinetic energy of an oxygen molecule.

[5.80 x 10^{-21} J]

[Given: molar mass of oxygen = 32 g mol^{-1}]

Question 10

An ideal polyatomic gas of molar mass 46 g mol^{-1} is cooled from 35 ºC to –8 ºC at constant volume 80L. If there are 1000 moles of the gas, determine the

(i) root mean square speed of the molecules at −10 ºC.
[377.53 m s^{-1}]

(ii) change in its internal energy.
[-1.0725 x 10^{6} J]

Question 11

The temperature in outer space is about 5.3K with about one hydrogen molecule per cm^3. The mass of a hydrogen molecule is 4.57 x 10^{-27} kg. Calculate the

(i) rms speed of the hydrogen molecules.
[219.2 m s^{-1}]

(ii) hydrogen density in outer space.
[4.57 x 10^{-21} kg m^{-3}]

(iii) pressure of hydrogen gas at the outer space.
[7.32 x 10^{-17} N m^{-2}]

(iv) mean translational kinetic energy of the hydrogen molecules.
[1.0971 x 10^{-22} J]

Question 12

A gas confined in a container undergoes a thermodynamic process where it absorbs 2500 J of heat from its surroundings. If the internal energy decreases by 1300 J calculate the work done by the gas during the process.

[3800 J]

Question 13

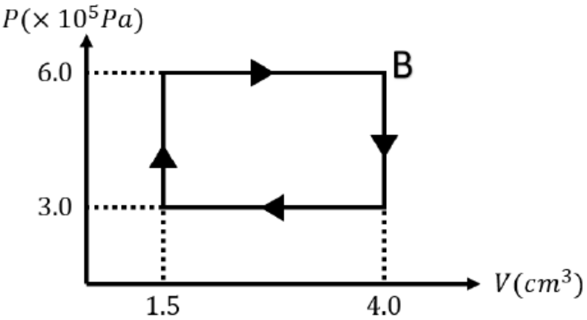
A system absorbs 1380 J of heat and at the same time 520 J of work is done on it. Calculate the change in internal energy of the system.

[1900 J]

Question 14

The graph shows a monoatomic gas that contained in a piston undergoes various processes. Determine its internal energy at point B.

[3.6 J]

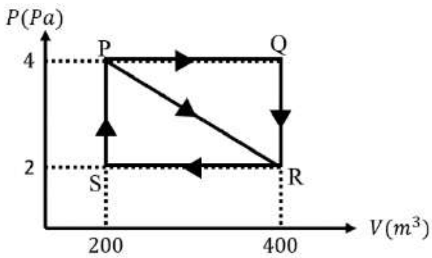


Question 15

The figure shows a $P-V$ graph of an ideal gas. If the change of an internal energy from **P** to **R** is +300 J. Determine

i) the work done by the system during the process of R to S
[-400 J]

ii) the heat energy during the process RSP
[-700 J]

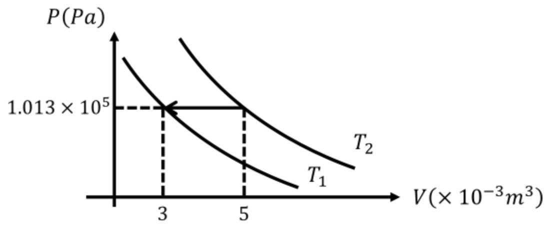


Question 16

A gas is compressed at a constant pressure of 1atm from 5L to 3L. In the process, 500 J of heat is leaving the gas.

(i) Sketch a P-V graph for the process.

(ii) Calculate the change in internal energy.
[-297.4 J]

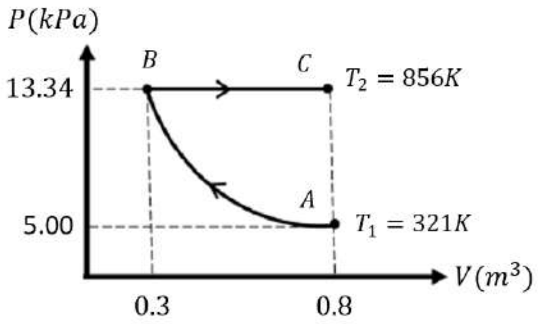


Question 17

The figure shows a 1.5 mole diatomic gas is filled in a 0.8 m^3 container at 321 K and pressure of 1.45 kPa. The gas is isothermally compressed to a volume of 0.3 m^3 and a pressure of 3.22 kPa. Then the gas expands isobarically to its original volume, and the final temperature of the gas is 856 K. Calculate the

i total work done in the whole process.
[-245.4 J]

ii change in the internal energy of the gas for the isobaric process.
[1.67 x 10^4 J]



Question 18

Three moles of an ideal gas are compressed isothermally from 900 cm^3 to 300 cm^3 at 100 °C. What is the work done on the gas?

[-10215.9 J]

Question 19

A 1.5 mol gas is compressed at a constant temperature of 222 K from 9 L to 5 L.

(i) State the type of thermodynamic process.
[Isothermal compression]

(ii) Calculate the work done on the gas.
[-1626.54 J]

(iii) Calculate the heat transferred during this process.
[-1626.54 J]

===End of Workbook===

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