SHRI KRISHNA ACADEMY

NEET, JEE AND BOARD EXAM (10, +1, +2) COACHING CENTRE
SBM SCHOOL CAMPUS, TRICHY MAIN ROAD, NAMAKKAL
CELL: 99655-31727, 94432-31727

PUBLIC EXAMINATION - MARCH - 2020

STD: XI 18.03.2020

SUBJECT: PHYSICS **TENTATIVE ANSWER KEY** **MARKS : 70**

Q.N	SECTION-I		MARKS
	CODE – A	CODE - B	
1	a) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$	b) inertia of direction	1
2	c) 0.017 m to 17m	c) $\frac{3}{2}k$	1
3	d) 1.0 m	d) 0.28%	1
4	b) 1.93kms^{-1}	a) Speed	1
5	a) Speed	b) 1032	1
6	d) 0.28%	c)	1
7	d) 20m	d) 1.0 m	1
8	b) inertia of direction	a) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$	1
9	d) 26.8%	d) ML^2	1
10	c) $\frac{3}{2}k$	d) 20m	1
11	d) ML^2	c) 0.017 m to 17m	1
12	c)	d) $\frac{1}{2}$Mr^2	1
13	b) $\sqrt{3}:\sqrt{2}$	d) 26.8%	1
14	b) 1032	b) 1.93kms^{-1}	1
15	d) $\frac{1}{2}$Mr^2	b) $\sqrt{3}:\sqrt{2}$	1

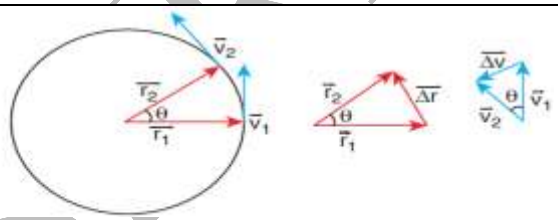
Q.N	SECTION-II	MARKS
16	Dimensional formula for $\frac{1}{2}mv^2 = [M][LT^{-1}]^2 = [ML^2T^{-2}]$ Dimensional formula for $mgh = [M][LT^{-2}][L] = [ML^2T^{-2}]$ $[ML^2T^{-2}] = [ML^2T^{-2}]$ Both sides are dimensionally the same, hence the equations $\frac{1}{2}mv^2 = mgh$ is dimensionally correct.	1 1
17	**Distance and displacement:** **Distance** is the actual path length travelled by an object in the give interval of time during the motion. It is a positive scalar quantity. **Displacement** is the difference between the final and initial positions of the object in a given interval of time. It is a vector quantity.	1 1
18	If the orbits of the Moon and Earth lie on the same plane, during full Moon of every month, we can observe lunar eclipse. If this is so during new Moon we can observe solar eclipse. But Moon's orbit is tilted 5° with respect to Earth's orbit. **Due to this 5° tilt, only during certain periods of the year, the Sun, Earth and Moon align in straight line leading to either lunar eclipse or solar eclipse depending on the alignment.**	2
19	When no external torque acts on the body, the net angular momentum of a rotating rigid body remains constant. This is known as law of conservation of angular momentum. **(OR)** $\tau = 0$ then, $\frac{dL}{dt} = 0$; L = constant (only formula 1 mark)	2
20	It is defined as the ratio of velocity of separation (relative velocity) after collision to the velocity of approach (relative velocity) before collision. **(OR)** $e = \frac{\text{velocity of separation (after collision)}}{\text{velocity of approach (before collision)}} = \frac{(v_2 - v_1)}{(u_1 - u_2)}$	2

21	The efficiency of heat engine is given by $\eta = 1 - \frac{Q_L}{Q_H}$ $\eta = 1 - \frac{300}{500} = 1 - \frac{3}{5}$ $\eta = 1 - 0.6 = 0.4$ The heat engine has 40% efficiency, implying that this heat engine converts only 40% of the input heat into work.	1 1
22	As the root mean square speed of hydrogen is much less than that of nitrogen, it easily escapes from the earth's atmosphere.	2
23	❖ Pressure ❖ Temperature ❖ Density ❖ Moisture ❖ Wind	4 X ½ = 2
24	$T \propto \sqrt{l}$ T= Constant × $\sqrt{l}$ $\frac{T_f}{T_i} = \sqrt{\frac{l + \frac{44}{100} l}{l}} = \sqrt{1.44} = 1.2$ Therefore, $T_f = 1.2\ T_i = T_i + 20\%\ T_i$	1 1
Q.N	**SECTION-III**	**MARKS**
25	❖ The word RADAR stands for radio detection and ranging. A radar can be used to measure accurately the distance of a nearby planet such as Mars. In this method, radio waves are sent from transmitters which, after reflection from the planet, are detected by the receiver. ❖ By measuring, the time interval (t) between the instants the radio waves are sent and received, the distance of the planet can be determined as ❖ **Speed = distance travelled / time taken** **(Speed is explained in unit 2)** ❖ **Distance(d) = Speed of radio waves × time taken** ❖ where v is the speed of the radio wave. As the time taken (t) is for the distance covered during the forward and backward path of the radio waves, it is divided by 2 to get the actual distance of the object. This method can also be used to determine the height, at which an aeroplane flies from the ground.	1 1 1

26	**Given:** Initial speed of object, $u = 5\ ms^{-1}$, angle of projection, $\theta = 30^0$, Height h = ?, Range R = ? **Solution:** Height $h = \frac{u^2 sin^2\theta}{2g} = \frac{u^2 sin^2\theta}{2g} = \frac{5^2 sin^2 30^0}{2 \times 9.8} = \frac{25 \times \frac{1^2}{2}}{2 \times 9.8} = \frac{25}{19.6} \times \frac{1}{4} = 0.318$ m Range $R = \frac{u^2 \sin 2\theta}{g} = \frac{5^2 \sin 2\,(30^0)}{9.8} = \frac{25 \times \frac{\sqrt{3}}{2}}{9.8} = \frac{25 \times 1.732}{9.8 \times 2} = 2.209\ m \approx 2.21$ m (with out unit reduce 1 mark for both)	1 ½ 1½
27	❖ If he stops his hands soon after catching the ball, the ball comes to rest very quickly. ❖ It means that the momentum of the ball is brought to rest very quickly. So the average force acting on the body will be very large. ❖ Due to this large average force, the hands will get hurt. To avoid getting hurt, the player brings the ball to rest slowly.	3
28	**Law of orbits:** Each planet moves around the Sun in an elliptical orbit with the Sun at one of the foci. **Law of area:** The radial vector (line joining the Sun to a planet) sweeps equal areas in equal intervals of time. **Law of period:** The square of the time period of revolution of a planet around the Sun in its elliptical orbit is directly proportional to the cube of the semi-major axis of the ellipse. $T^2 \propto a^3$ $\frac{T^2}{a^3} = constant$	1 1 1
29	see table below	1 1 1
30	Due to difference in pressure, between straw and atmosphere, soft drink raises in the straw. **(OR)** When we suck through the straw, the pressure inside the straw becomes less than the atmospheric pressure. Due to the pressure difference, the soft drink rises in the straw and we are able to take the soft drink easily. (Any relevant answer)	3

Question 29:

S.No.	Transverse waves	Longitudinal waves
1.	The direction of vibration of particles of the medium is perpendicular to the direction of propagation of waves.	The direction of vibration of particles of the medium is parallel to the direction of propagation of waves.
2.	The disturbances are in the form of crests and troughs.	The disturbances are in the form of compressions and rarefactions.
3.	Transverse waves are possible in elastic medium.	Longitudinal waves are possible in all types of media (solid, liquid and gas).

31	❖ It is a special case of forced vibrations where the frequency of external periodic force (or driving force) matches with the natural frequency of the vibrating body (driven). ❖ As a result the oscillating body begins to vibrate such that its amplitude increases at each step and ultimately it has a large amplitude. ❖ Such a phenomenon is known as resonance and the corresponding vibrations are known as resonance vibrations. ❖ **Example** The breaking of glass due to sound	2 1
32	❖ The process should proceed at an extremely slow rate. ❖ The system should remain in mechanical, thermal and chemical equilibrium state at all the times with the surroundings, during the process. ❖ No dissipative forces such as friction, viscosity, electrical resistance should be present.	1 1 1
33	Torque, $\vec{\tau} = \vec{r} \times \vec{F}$ $\vec{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 4 & -2 \\ 4 & -3 & 5 \end{vmatrix}$ $\vec{\tau} = \hat{i}(20-6) - \hat{j}(35+8) + \hat{k}(-21-16)$ $\vec{\tau} = (14\hat{i} - 43\hat{j} - 37\hat{k})$ N m (without unit reduce ½ mark)	1 1 1
Q.N	**SECTION-IV**	**MARKS**
34 (a)	 ❖ Let the directions of position and velocity vectors shift through the same angle θ in a small interval of time Δt. For uniform circular motion, $r = \|\vec{r_1}\| = \|\vec{r_2}\|$ and $v = \|\vec{v_1}\| = \|\vec{v_2}\|$ ❖ If the particle moves from position vector $\vec{r_1}$ *to* $\vec{r_2}$ the displacement is given by $\Delta\vec{r} = \vec{r_2} - \vec{r_1}$ and the change in velocity from $\vec{v_1}$ to $\vec{v_2}$ is given by $\Delta\vec{v} = \vec{v_2} - \vec{v_1}$. ❖ The magnitudes of the displacement Δr and of Δv satisfy the following relation $\frac{\Delta r}{r} = -\frac{\Delta v}{v} = \theta$ ❖ Here the negative sign implies that Δv points radially inward, towards the center of the circle.	1 1

	$$\Delta v = -v\left(\frac{\Delta r}{r}\right)$$ $$a = \frac{\Delta v}{\Delta t} = \frac{v}{r}\left(\frac{\Delta r}{\Delta t}\right) = -\frac{v^2}{r}$$ ❖ For uniform circular motion $v = \omega r$, where ω is the angular velocity of the particle about the center. Then the centripetal acceleration can be written as $a = -\omega^2 r$	2 1
34 (b)	**Work-kinetic energy theorem:** The work done by the force on the body changes the kinetic energy of the body. This is called work-kinetic energy theorem. The work (W) done by the constant force (F) for a displacement (s) in the same direction is, W= Fs The constant force is given by the equation, F = ma $v^2 = u^2 + 2as$ $a = \frac{v^2 - u^2}{2s}$ $F = m\left(\frac{v^2 - u^2}{2s}\right)$ $W = m\left(\frac{v^2}{2s}s\right) - m\left(\frac{u^2}{2s}s\right)$ $W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ **The expression for kinetic energy**: The term $\left(\frac{1}{2}mv^2\right)$ in the above equation is the kinetic energy of the body of mass (m) moving with velocity (v). KE=$\frac{1}{2}mv^2$ Kinetic energy of the body is always positive. $\Delta KE = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ Thus, $W = \Delta KE$ 1. If the work done by the force on the body is positive then its kinetic energy increases. 2. If the work done by the force on the body is negative then its kinetic energy decreases. 3. If there is no work done by the force on the body then there is no change in its kinetic energy, which means that the body has moved at constant speed provided its mass remains constant.	1 1 1 1 1

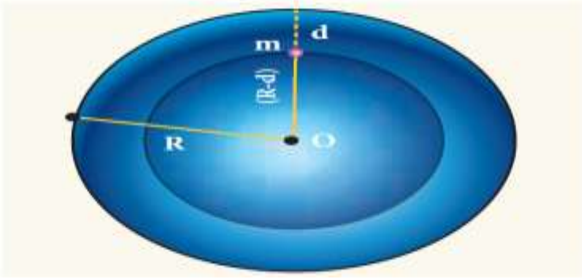
35 (a)	A number of measured quantities may be involved in the final calculation of an experiment. Different types of instruments might have been used for taking readings. Then we may have to look at the errors in measuring various quantities, collectively. The error in the final result depends on (i) The errors in the individual measurements (ii) On the nature of mathematical operations performed to get the final result. So we should know the rules to combine the errors.	2
	Error in the division or quotient of two quantities Let ΔA and ΔB be the absolute errors in the two quantities A and B respectively. Consider the quotient, $Z = \frac{A}{B}$ The error ΔZ in Z is given by $Z \pm \Delta Z = \frac{A \pm \Delta A}{B \pm \Delta B} = \frac{A\left(1 \pm \frac{\Delta A}{A}\right)}{B\left(1 \pm \frac{\Delta B}{B}\right)} = \frac{A}{B}\left(1 \pm \frac{\Delta A}{A}\right)\left(1 \pm \frac{\Delta B}{B}\right)^{-1}$ or $Z \pm \Delta Z = Z\left(1 \pm \frac{\Delta A}{A}\right)\left(1 \mp \frac{\Delta B}{B}\right)$ [using $(1+x)^n \approx 1+nx$, when $x<<1$] Dividing both sides by Z, we get, $1 \pm \frac{\Delta Z}{Z} = \left(1 \pm \frac{\Delta A}{A}\right)\left(1 \mp \frac{\Delta B}{B}\right) = 1 \pm \frac{\Delta A}{A} \mp \frac{\Delta B}{B} \pm \frac{\Delta A}{A}.\frac{\Delta B}{B}$ As the terms ΔA/A and ΔB/B are small, their product term can be neglected. The maximum fractional error in Z is given by $\frac{\Delta Z}{Z} = \left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$ (1.6)	3

35 (b)	**Work done in an adiabatic process:** Consider μ moles of an ideal gas enclosed in a cylinder having perfectly non conducting walls and base. A frictionless and insulating piston of cross sectional area A is fitted in the cylinder Let W be the work done when the system goes from the initial state (P_i,V_i,T_i) to the final state (P_f,V_f,T_f) adiabatically.	1
	$W = \int_{V_i}^{V_f} PdV$ By assuming that the adiabatic process occurs quasi-statically, at every stage the ideal gas law is valid. Under this condition, the adiabatic equation of state is PV^γ = constant (or) $P = \frac{\text{constant}}{V^\gamma}$ can be substituted in the equation (8.40), we get	1
	$\therefore W_{adia} = \int_{V_i}^{V_f} \frac{\text{constant}}{V^\gamma} dV$ $= \text{constant} \int_{V_i}^{V_f} V^{-\gamma} dV$ $= \text{constant} \left[\frac{V^{-\gamma+1}}{-\gamma+1}\right]_{V_i}^{V_f}$ $= \frac{\text{constant}}{1-\gamma}\left[\frac{1}{V_f^{\gamma-1}} - \frac{1}{V_i^{\gamma-1}}\right]$ $= \frac{1}{1-\gamma}\left[\frac{\text{constant}}{V_f^{\gamma-1}} - \frac{\text{constant}}{V_i^{\gamma-1}}\right]$	1
	But, $P_iV_i^\gamma = P_fV_f^\gamma = constant.$ $\therefore W_{adia} = \frac{1}{1-\gamma}\left[\frac{P_fV_f^\gamma}{V_f^{\gamma-1}} - \frac{P_iV_i^\gamma}{V_i^{\gamma-1}}\right]$ $W_{adia} = \frac{1}{1-\gamma}[P_fV_f - P_iV_i]$ (8.41)	1
	From ideal gas law, $P_fV_f = \mu RT_f$ and $P_iV_i = \mu RT_i$ Substituting in equation (8.41), we get $\therefore W_{adia} = \frac{\mu R}{\gamma - 1}[T_i - T_f]$ (8.42) In adiabatic expansion, work is done by the gas. i.e., W_{adia} is positive. As $T_i > T_f$, the gas cools during adiabatic expansion. In adiabatic compression, work is done on the gas. i.e., W_{adia} is negative. As $T_i < T_f$, the temperature of the gas increases during adiabatic compression.	1

36 (a) (i)

Variation of g with depth:

Consider a particle of mass m which is in a deep mine on the Earth. (Example: coal mines in Neyveli). Assume the depth of the mine as d. To calculate g' at a depth d, consider the following points.



½

The part of the Earth which is above the radius $(R_e - d)$ do not contribute to the acceleration. The result is proved earlier and is given as

$$g' = \frac{GM'}{(R_e - d)^2}$$

Here M' is the mass of the Earth of radius $(R_e - d)$

Assuming the density of Earth ρ to be constant, $\rho = \frac{M}{V}$ ½

where M is the mass of the Earth and V its volume, Thus,

$$\rho = \frac{M'}{V'}$$

$$\frac{M'}{V'} = \frac{M}{V} \text{ and } M' = \frac{M}{V}V'$$

$$M' = \left(\frac{M}{\frac{4}{3}\pi R_e^{\ 3}}\right)\left(\frac{4}{3}\pi (R_e - d)^3\right)$$

$$M' = \frac{M}{R_e^{\ 3}}(R_e - d)^3 \qquad (6.49)$$

$$g' = G\frac{M}{R_e^{\ 3}}(R_e - d)^3 . \frac{1}{(R_e - d)^2}$$ 1

	$$g' = GM\frac{R_e\left(1-\frac{d}{R_e}\right)}{R_e^{\,3}}$$ $$g' = GM\frac{\left(1-\frac{d}{R_e}\right)}{R_e^{\,2}}$$ $$g' = g\left(1-\frac{d}{R_e}\right) \qquad (6.50)$$ Here also $g' < g$. As depth increases, g' decreases. It is very interesting to know that acceleration due to gravity is maximum on the surface of the Earth but decreases when we go either upward or downward.	1
	(ii) At height $h = R/2 = \frac{R_E}{2}$ $$g'_h = \frac{g}{\left(1+\frac{h}{R_E}\right)^2} = \frac{g}{\left(1+\frac{R_E/2}{R_E}\right)^2}$$ $$= \frac{g}{(1+1/2)^2} = \frac{g}{(3/2)^2} = \frac{g}{9/4}$$ $$g' = \frac{4g}{9}$$ At depth $d = R/2 = R_E/2$ $$g'_d = g\left(1-\frac{d}{R_E}\right)$$ $$= g\left(1-\frac{R_E/2}{R_E}\right)$$ $$= g\left(1-1/2\right) = \frac{g}{2}$$	1

Therefore

$$\frac{g'_h}{g'_d} = \frac{4g/9}{g/2} = \frac{4g}{9} \times \frac{2}{g} = \frac{8}{9}$$ 1

Note: Binomial theorem not applicable in 1st case as $h = R/2$
when $\frac{h}{R_E} << 1$ Binomial theorem is applicable.

36 (b)

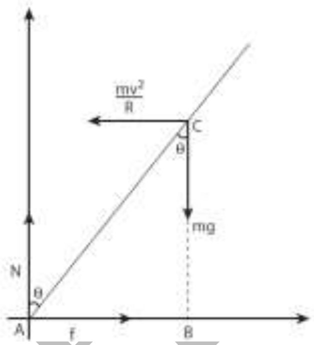
Let us consider a cyclist negotiating a circular level road (not banked) of radius r with a speed v. The cycle and the cyclist are considered as one system with mass m. The center gravity of the system is C and it goes in a circle of radius r with center at O. Let us choose the line OC as X-axis and the vertical line through O as Z-axis

The system as a frame is rotating about Z-axis. The system is at rest in this rotating frame.

The forces acting on the system are,

(i) gravitational force (mg),
(ii) normal force (N),
(iii) frictional force (f) and
(iv) centrifugal force 1

As the system is in equilibrium in the rotational frame of reference, the net external force and net external torque must be zero.



1

For rotational equilibrium, $\vec{\tau}_{net} = 0$

$$-mg\,AB + \frac{mv^2}{r}BC = 0$$

$$mg\,AB = \frac{mv^2}{r}BC$$

$$mg\,AC\,\sin\theta = \frac{mv^2}{r}AC\cos\theta$$

$$\tan\theta = \frac{v^2}{rg}$$

$$\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$$ 3

37 (a)	Let us consider a uniform rod of mass (M) and length (*l*). Let us find an expression for moment of inertia of this rod about an axis that passes through the center of mass and perpendicular to the rod. First an origin is to be fixed for the coordinate system so that it coincides with the center of mass, which is also the geometric center of the rod. The rod is now along the x axis. We take an infinitesimally small mass (dm) at a distance (x) from the origin. The moment of inertia (dI) of this mass (dm) about the axis is, $dI=(dm)x^2$ DIAGRAM $\lambda = \frac{M}{\ell}$ $dm = \lambda\, dx = \frac{M}{\ell} dx$ $I = \int dI = \int (dm) x^2 = \int \left(\frac{M}{\ell} dx \right) x^2$ $I = \frac{M}{\ell} \int x^2 dx$ $I = \frac{M}{\ell} \int_{-\ell/2}^{\ell/2} x^2 dx = \frac{M}{\ell} \left[\frac{x^3}{3} \right]_{-\ell/2}^{\ell/2}$ $I = \frac{M}{\ell} \left[\frac{\ell^3}{24} - \left(-\frac{\ell^3}{24} \right) \right] = \frac{M}{\ell} \left[\frac{\ell^3}{24} + \frac{\ell^3}{24} \right]$ $I = \frac{M}{\ell} \left[2 \left(\frac{\ell^3}{24} \right) \right]$ $I = \frac{1}{12} M \ell^2$	½ ½ 1 3
37 (b)	**Types of Oscillations:** **Free Oscillations** When the oscillator is allowed to oscillate by displacing its position from equilibrium position, it oscillates with a frequency which is equal to the natural frequency of the oscillator. Such an oscillation or vibration is known as free oscillation or free vibration. In this case, the amplitude, frequency and the energy of the vibrating object remains constant. **Exmaples:** (i) Vibration of a tuning fork (ii) Vibration in a stretched string (iii) Oscillation of a simple pendulum (iv) Oscillations of a spring mass system **Damped Oscillations:** During the oscillation of a simple pendulum we have assumed that the amplitude of the oscillation is constant and also the total energy of the	1 ½

oscillator is constant. But in reality, in a medium, due to the presence of friction and air drag, the amplitude of oscillation decreases as time progresses. It implies that the oscillation is not sustained and the energy of the SHM decreases gradually indicating the loss of energy. The energy lost is absorbed by the surrounding medium. This type of oscillatory motion is known as damped oscillation. **1 ½**

Examples:

- (i) The oscillations of a pendulum or pendulum oscillating inside an oil filled container
- (ii) Electromagnetic oscillations in a tank circuit
- (iii) Osicllations in a dead beat and ballistic galvanometers.

Maintained oscillations:

While playing in swing, the oscillations will stop after a few cycles, this is due to damping. To avoid damping we have to supply a push to sustain oscillations. By supplying energy from an external source, the amplitude of the oscillation can be made constant. Such vibrations are known as maintained vibrations. **1**

Example: The vibration of a tuning fork getting energy from a battery or from external power supply.

Forced oscillations:

Any oscillator driven by an external periodic agency to overcome the damping is known as forced oscillator or driven oscillator. In this type of vibration the body executing vibration initially vibrates with its natural frequency and due to the presence of external periodic force, the body later vibrates with the frequency of the applied periodic force. Such vibrations are known as forced vibrations. **1**

Example: Sound boards of stringed instruments.

38 (a)

(i) Triangulation method for the height of an accessible object

Let AB = h be the height of the tree or tower to be measured. Let C be the point of observation at distance x from B. Place a range finder at C and measure the angle of elevation, ∠ACB = θ **½**

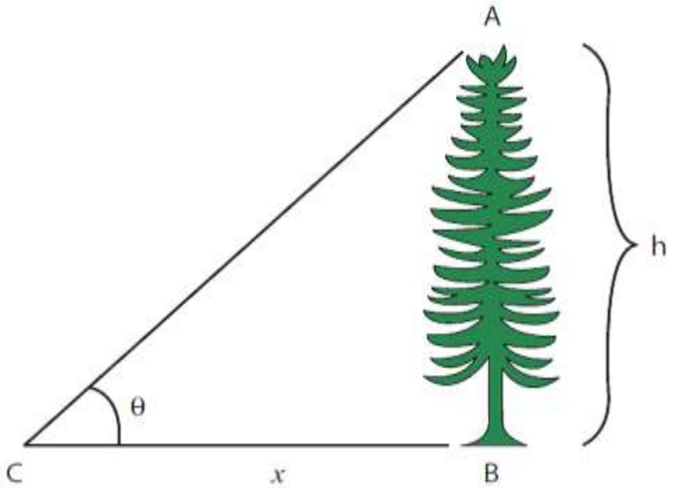
From right angled triangle ABC, **1**

$$\tan\theta = \frac{AB}{BC} = \frac{h}{x}$$

(or)

$$\text{height } h = x\tan\theta$$ **1**

Knowing the distance x, the height h can be determined.

	 (ii) $h = x \tan\theta$ $= 50 \times \tan 60^\circ$ $= 50 \times 1.732$ $h = 86.6\ \text{m}$	½ 2
38 (b)	Consider a sphere of radius *r* which falls freely through a highly viscous liquid of coefficient of viscosity η. Let the density of the material of the sphere be ρ and the density of the fluid be σ. DIAGRAM Gravitational force acting on the sphere, $F_G = mg = \frac{4}{3}\pi r^3 \rho g$ (downward force) Up thrust, $U = \frac{4}{3}\pi r^3 \sigma g$ (upward force) viscous force $F = 6\pi\eta r v_t$ At terminal velocity v_t. downward force = upward force $F_G - U = F \Rightarrow \frac{4}{3}\pi r^3 \rho g - \frac{4}{3}\pi r^3 \sigma g = 6\pi\eta r v_t$ $v_t = \frac{2}{9} \times \frac{r^2(\rho - \sigma)}{\eta} g \Rightarrow v_t \propto r^2$ Here, it should be noted that the terminal speed of the sphere is directly proportional to the square of its radius. If σ is greater than ρ, then the term (ρ - σ) becomes negative leading to a negative terminal velocity. That is why air bubbles rise up through water or any fluid. This is also the reason for the clouds in the sky to move in the upward direction.	½ 1 1 ½ 2