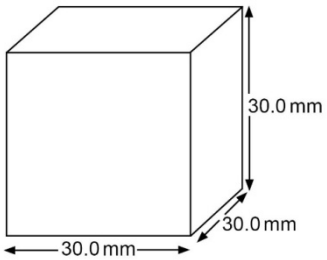
BA SANGAM COLLEGE
YEAR 13
PHYSICS
WORKSHEET 1

STRAND 1

1. The dimensions of a cube are measured with Vernier calipers. The measured length of each side is 30.0 mm. If the Vernier callipers can be read with an uncertainty of **+/- 0.1 mm**. What is the approximate percentage uncertainty in the value of the volume?

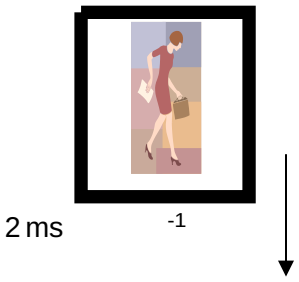


A. 4%
B. 3%
C. 0.01%
D. 1%

2. A record is dropped onto a turntable of a rotating record player. The angular speed of the turntable will

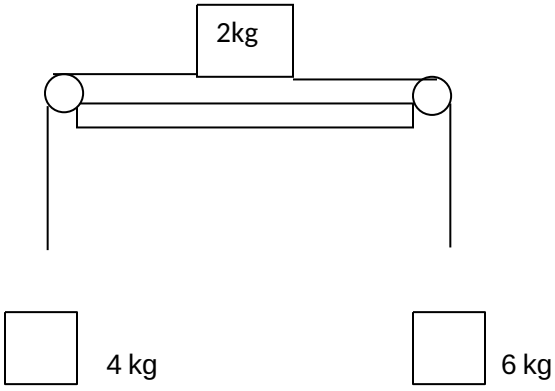
A. increase because energy is conserved
B. decrease because energy is conserved
C. increase because momentum is conserved
D. decrease because momentum is conserved

3. The force that a 200 N woman exerts on the floor of an elevator when it descends with a constant velocity of 2 ms^{-1} is



A. 240 N
B. 200 N
C. 160 N
D. 40 N

4. What is the acceleration of the 6 kg mass in the diagram below? Assume that there is no friction. Express the result in terms of g, the acceleration of free fall.



A. $\frac{1}{5}$

B. $\frac{1}{3}$

C. $\frac{1}{6}$

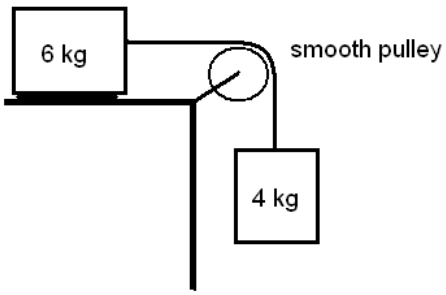
D. g

5. Kepler's law of **orbits** states that

A. all planets move in an elliptical orbit having the moon as its focus
B. a line joining any planet with the sun sweeps out equal areas in equal times
C. a line joining any planet with the moon sweeps out equal areas in equal times
D. all planets move in an elliptical orbit having the sun as its focus

6. Two masses are connected by a light string that passes over a frictionless pulley.

The coefficient of sliding friction between the 6 kg mass and the bench is 0.20



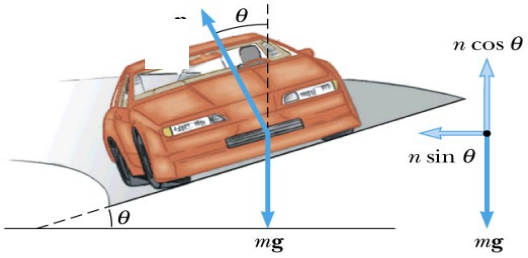
Calculate :

(i) the force of friction on the 6kg mass

(ii) the acceleration

(iii) the tension in the string

7. The diagram shows a car on the banked turn of a test track. The speed of the car is constant as this is the speed for which no frictional force is needed to keep the car in its circular path.

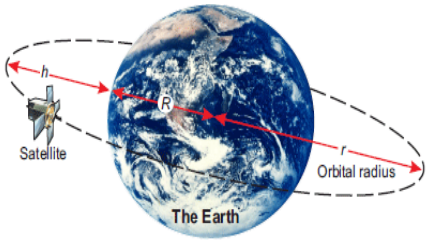


EX 721

(i) Calculate the centripetal force and the angle, θ, required to keep a 2 000 kg car in a circular path of radius 157 m if the speed is 100 km/hr. (2 marks)

(ii) Make a force diagram showing all forces acting on the car as it travels along a banked curve. (1 mark)

8. A 60 kg satellite orbits 600 km above the surface of the earth.



Calculate the following energy of the satellite:

(i) gravitational potential energy

(ii) kinetic energy

(iii) total energy

9. The earth spins on its axis every 24.0 hours. Its mass is 6.0 x 10^{24} kg and its radius is 6.4 x 10^6 m.

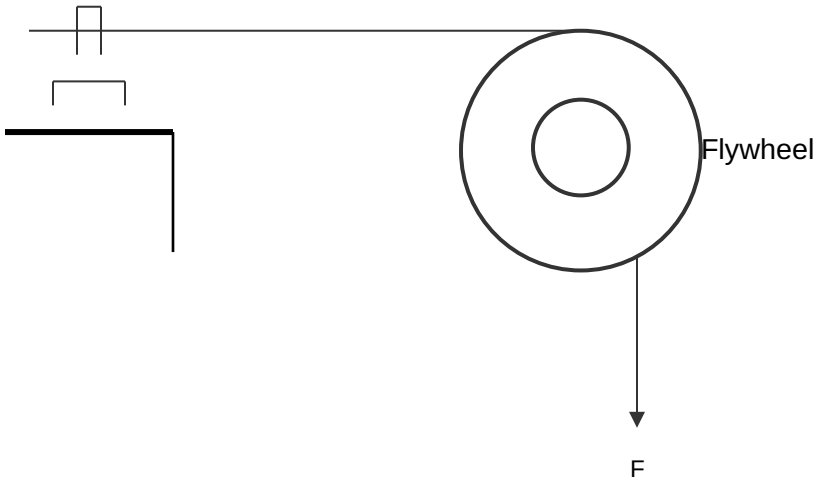
(i) Show that the **speed** on the earth's equator is about 465 m/s

(ii) Find the **angular velocity** of the earth about its axis.

(iii) What is the value of the **angular momentum** of the earth about its axis?

(The earth is a solid sphere with moment of inertia, I, given by $\frac{2}{5}$)

10. The diagram below shows the experimental set-up to study **rotational** motion.



(i) If the radius at which a force **F** is applied is *r*, what is the torque on the wheel

(ii) Explain how the angular acceleration of the wheel can be calculated, using the information on the ticker tape

(iii) What graph can be plotted to calculate inertia from the slope?

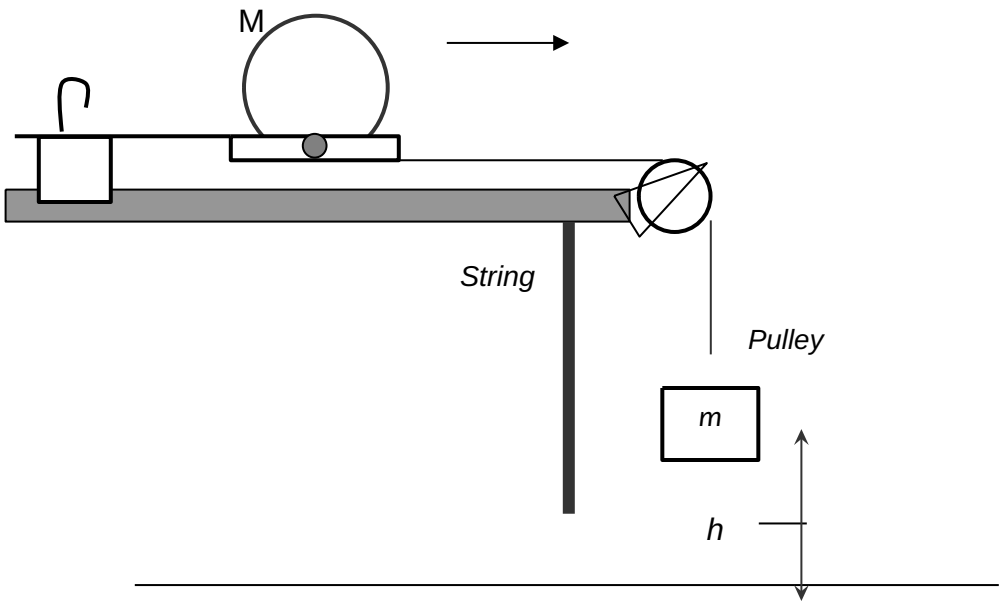
11. Savou tries to examine how the time (t) taken to fill a 100 ml measuring cylinder with oil varies with the radius (R) of the tube used.
His physics teacher suggests the possible relationship between t and R is of the form:

$$t = AR^n$$

where n is the power and A is a constant which depends on the specifications of the apparatus used.

(i) Express the above equation in logarithmic form.
(ii) What shape will the graph of log t versus log R be?

12. An experiment was set-up to study the **translational and rotational kinetic energies** of a solid cylinder.



The data gathered from the above experiment can be used to calculate the inertia of the solid cylinder with mass M.

Mass (m) = 0.150 kg *Mass of cylinder (M)* = 0.700 kg

Height (h) = 0.600 m *Velocity of m at impact* = 1.00 m/s

Radius of cylinder = 0.03 m

(i) Find the potential energy lost by the mass *m*.

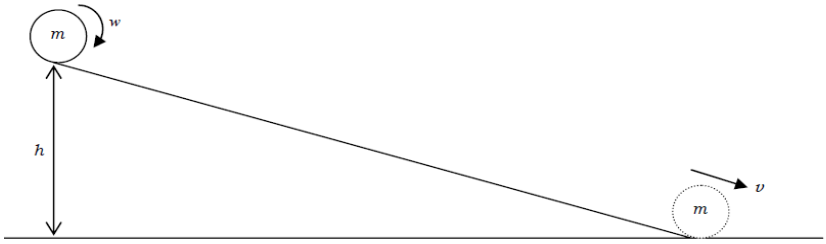
(ii) Find the translational kinetic energy of the combined mass of the system.

(iii) Determine the rotational kinetic energy of the cylinder.

(iv) Calculate the angular velocity of the cylinder when the mass *m* hits the floor.

(v) Calculate the moment of inertia of the cylinder.

13. A ball rolls from rest down a slope without slipping and then on to a horizontal surface. At the end of the slope it has a linear velocity *v*. The ball has mass *m* and radius *r*.



Given that the rotational inertia of the ball is $I = mr^2$ show that the linear velocity *v*, of the ball at the bottom of the slope is

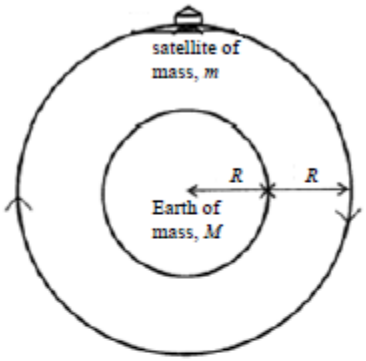
$$V = \sqrt{gh}$$

GRAVITATION

Kepler's third Law of Planetary motion states: In a circular orbit, the square of the orbital period (T^2) is directly proportional to the

A. radius (R) of the orbit.
B. diameter (2R) of the orbit.
C. cube of the radius (R^3) of the orbit.
D. square of the radius (R^2) of the orbit.

The diagram below shows a satellite of mass m, in a circular orbit, at a height above the earth's surface equal to the radius of the earth.



The kinetic energy ($\mathbf{E_k}$), potential energy ($\mathbf{E_p}$) and total energy ($\mathbf{E_T}$) of the satellite, respectively is

	$\mathbf{E_k}$	$\mathbf{E_p}$	$\mathbf{E_T}$
A.	$\frac{GmM}{2R}$	$-2E_k$	$-E_k$
B.	$\frac{GmM}{4R}$	$-2\,E_k$	$-E_k$
C.	$\frac{GmM}{4R}$	$-\frac{GmM}{2R}$	E_k
D.	$\frac{GmM}{2R}$	$-\frac{GmM}{2R}$	0

A 60 kg satellite moves in a circular orbit 500 km above the surface of the earth.
[$M_E = 5.98 \times 10^{24}$kg, Radius of Earth = 6.37×10^{6} m]

(a) Calculate the gravitational potential energy of the satellite at its current height above the surface of the earth.

(b) Determine the kinetic energy of the satellite.

A satellite moves in a circular orbit around the earth at a speed of 500 m/s.

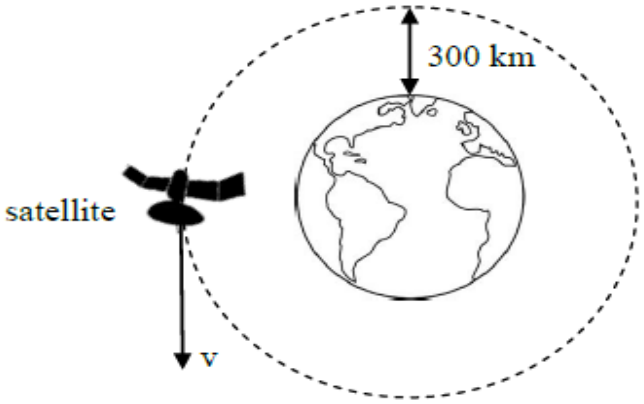
[radius of earth = 6.37×10^6 m].

Determine the:

(i) satellite's altitude above the earth's surface.

(ii) period of the satellite's orbit.

A communication satellite is placed in a circular orbit, 300 km above the earth's surface.



Calculate the:

(i) orbital speed of the satellite.

(ii) period of the satellite.

A 50 kg satellite orbits 300 km above the surface of the earth.

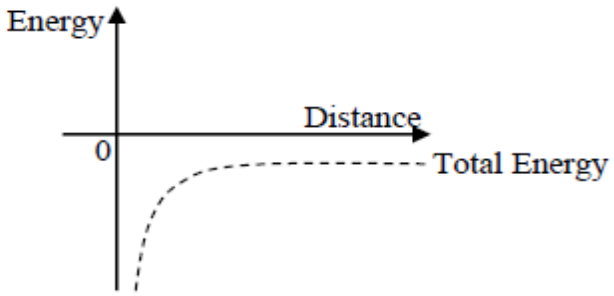
Calculate the following energies of the satellite.

(i) Kinetic energy

(ii) Gravitational potential energy

(iii) Total energy

The graph below shows the total energy of a satellite versus distance.



Draw a similar graph in your **Answer Book** showing the Kinetic Energy and Potential Energy of a satellite versus distance.

OSCILLATIORY MOTION

For an object in simple harmonic motion (SHM), at the point where displacement is a maximum,

A. KE is a maximum.
B. PE is a minimum.
C. acceleration is a minimum.
D. velocity is a minimum.

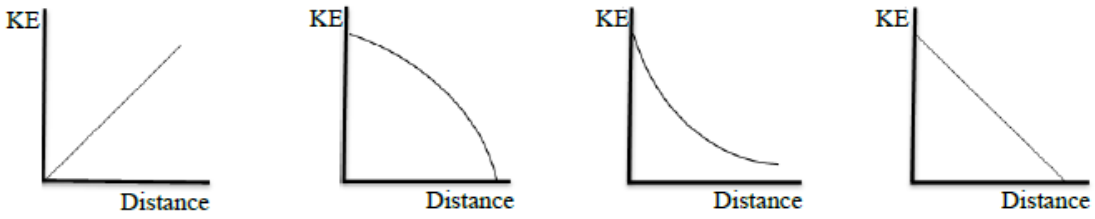
A simple pendulum of length *l* has period T. If another pendulum of length 4*l* was tested, it would have a period of

A. 4 T
B. 2 T
C. 0.5 T
D. 0.25 T

In order for an object to move in a simple harmonic motion (SHM) when it is released from its equilibrium position, the object must

A. be suspended like a pendulum.
B. experience a gravitational force.
C. move in a circular path at a constant speed.
D. experience a restoring force proportional to its displacement.

A body executes simple harmonic motion. Which one of the graphs, A to D, best shows the relationship between the kinetic energy (KE) of the body and its distance from the center of oscillation?

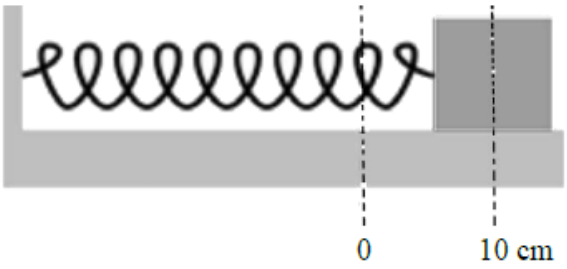


A. B. C. D.

The number of oscillations that a particle undergoes per unit time interval is its

A. amplitude.
B. frequency.
C. angular frequency.
D. angular acceleration.

A block at the end of a spring is pulled to position 10 cm from equilibrium and released. In one full cycle of its motion, what will be the total distance travelled?



A. 0 cm
B. 10 cm
C. 20 cm
D. 40 cm

An object in a horizontal Simple Harmonic Motion (SHM) has amplitude of 0.2 m. The kinetic energy of the object is 6 J when its displacement is zero.

Consider the following statements:

I. The total energy of the object is 6 J.

II. The potential energy of the object is zero when its displacement is zero.

III. The potential energy of the object is 6 J when its displacement is 0.2 m.

Which of the statements given above describes the motion?

A. I only
B. I and II only
C. II and III only
D. I, II and III

If the potential energy of the object is 1 J when its displacement is 0.1 m, its kinetic energy at this point is

A. 5 J
B. 2 J
C. 1 J
D. 0 J

An object undergoing simple harmonic motion (SHM) has its displacement y, at time t seconds given by the equation:

$$y = 5\text{Sin}\,(4t + \frac{\pi}{4})$$

(i) What is the initial phase angle ϕ?

(ii) Calculate the velocity at time t = 0 sec.

An object undergoing simple harmonic motion (SHM) has its displacement x, at time t seconds given by the equation:

$$x = 0.5 \text{ Cos } (4\pi t + \frac{\pi}{4})$$

(i) Determine the amplitude and its initial phase angle.

(ii) Calculate T, the period of the motion.

(iii) Calculate the maximum speed.

A spring having a force constant of 240 Nm^{-1} is loaded with a mass of 10 g.

(i) Find the period of vibration.

(ii) If the mass is displaced 30 cm and then released, find the maximum velocity with which it passes through the equilibrium position.

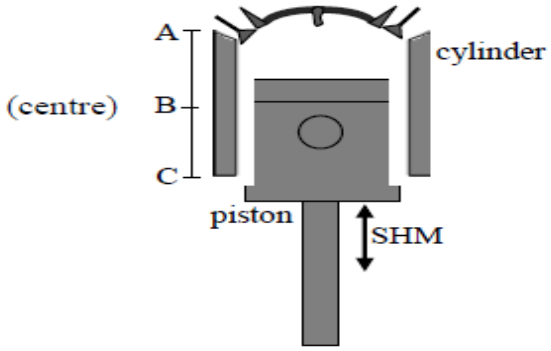
(iii) Calculate the total energy of the vibrating mass.

A SHM has the equation $y = 6.8 \sin (4t + \frac{\pi}{4})$

(i) What is the initial phase angle, Θ?

(ii) Calculate the velocity at time 0 sec.

The piston inside a car cylinder oscillates up and down in simple harmonic motion, as shown, at 6 000 cycles per minute. It travels up and down through a total distance of 24 cm for each cycle.



(i) What is the amplitude of the piston's motion?

(ii) Calculate the motion's angular frequency.

(iii) At what position does the piston have maximum acceleration?

(iv) Calculate the maximum acceleration of the piston.

A small mass vibrating with SHM has a velocity of 0.5 ms^{-1} as it passes through its equilibrium position – the midpoint of the motion.

(i) What is the velocity of the mass at its maximum displacement?

(ii) If the amplitude of the vibration is 5 cm, what is the period?

An object undergoing simple harmonic motion (SHM) has its displacement, **x**, at time, **t** seconds given by the equation below.

$$\mathbf{x = 5.2\,Cos(2\pi t + \frac{\pi}{3})}$$

(i) Determine the phase constant of the motion.

(ii) Calculate the displacement at time, t = 1 second.

A pendulum with a length of 1.2 m oscillates with the amplitude of 0.2 m.

(i) Determine the period of the pendulum.

(ii) Calculate the maximum velocity of the pendulum.

WAVES

The equation of a transverse wave travelling along a string is given as :

$Y = 0.1 \sin \pi (2x + t)$ where all measurements are in S.I. units .

(i) Find its wavelength.

(ii) What is the frequency of the wave ?

(iii) Calculate the speed of propagation.

(iv) Write the equation of another wave with half the amplitude, same frequency and wavelength but moving in the opposite direction.

(v) Sketch the displacement of the wave against the position along the string at time $t = 0$. Mark the amplitude and wavelength on the graph. **(6 marks)**

The wavelengths of the visible spectrum are approximately 400 nm (violet) through 700 nm (red).

Find the angular width of the first order visible spectrum produced by plane gratings with 600 lines/mm when white light falls normally on the grating.

(2 marks)

Red light of wavelength 6×10^{-7} m shines on a double slit and an interference pattern is produced. The angular position of the third order maximum is 30°.

(a) Find the distance between the two slits.

(b) A bright band at the third order maximum was observed.
Explain how this bright band is produced. **(3 marks)**

A police siren emitting a sinusoidal wave with a frequency of 500 Hz drives away from a stationary listener at 15 ms^{-1}. If the speed of sound in air is 340 ms^{-1}, calculate :

(a) the wavelength of the sound reaching the listener.

(b) The apparent frequency of the sound heard by the listener. **(3 marks)**

A metal string of mass 0.50 g and length 50 cm is under a tension of 88.2 N. The frequency of the string in its fundamental tone is

A. 1188 ms^{-1}

B. 891 ms^{-1}

C. 594 ms^{-1}

D. 297 ms^{-1}

When two tuning folks are sounded at the same time, a beat frequency of 6 Hz occurs. If one fork has a frequency of 245 Hz, the frequency of the other fork could be

A. 239 Hz
B. 245 Hz
C. 248 Hz
D. 490 Hz

Two sound waves of frequencies 540 Hz and 550 Hz respectively, travel through the air. Then they both travel through water at a speed of 1440 ms^{-1}.

(i) What is the beat frequency heard when the waves travel through the air ?

(ii) Calculate the wavelengths of the two waves when travelling through water.

(2 marks)

The forward component wave of a standing wave is represented by :

$$Y = 0.02 \sin 2\pi \left(\frac{-x}{0.5} + 50\, t\right)$$

where all measurements are in S.I. units.

(i) Find its frequency.

(ii) Calculate the velocity of the wave.

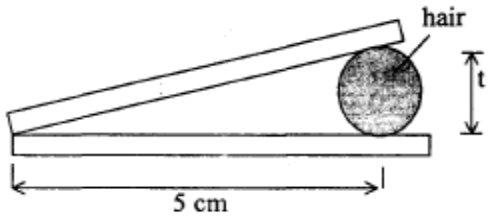
(iii) Write the equation for the reflected component of the standing wave.

(3 marks)

A plane transmission grating has 5 000 lines/cm. The α and δ lines of atomic hydrogen have wavelengths of 656 nm and 410 nm respectively.
Assuming normal incidence, determine the angular separation between these lines in the second-order spectrum.

(3 marks)

The air wedge shown in the diagram below is formed between two glass plates by putting a strand of hair under one edge of the upper plate. When the plates are illuminated from above with monochromatic light of wavelength 360 nm, parallel fringes are observed having a spacing of 0.25 mm.



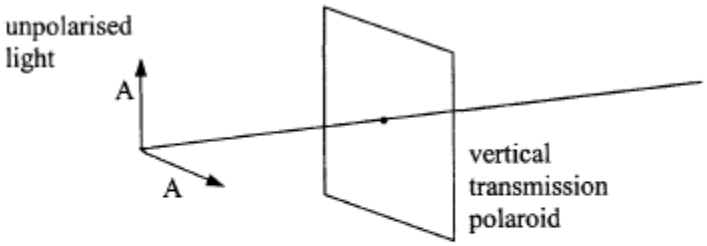
Calculate the thickness of the strand of hair.

(3 marks)

A pipe, closed at one end, is caused to produce its fundamental sound wave of wavelength 3.4 m. The length of the pipe is

A. 3.4 m.
B. 2.55 m.
C. 1.7 m.
D. 0.85 m.

The diagram below shows unpolarised light passing through a polaroid.



It is **not** true to state that unpolarised light

A. is made up of transverse waves.
B. has waves of amplitude $\sqrt{2}$ A.
C. has waves vibrating in one direction only.
D. when passing through the polaroid, is vertically polarized.

A metal rod held at the center and hit with a hammer at the end, a plucked guitar string and the sound produced by a vibrating tuning fork, all undergo modes of vibrations that are respectively

A. longitudinal, transverse and transverse.
B. longitudinal, transverse and longitudinal.
C. longitudinal, longitudinal and transverse.
D. longitudinal, longitudinal and longitudinal.

Some electromagnetic waves are : radio waves, X-rays, microwaves and gamma rays. The waves with the lowest wavelength is

A. X-rays.
B. radio waves.
C. microwaves.
D. gamma rays.

(i) Define the term **"plane-polarised"** light.

(ii) Two Polaroid sheets are placed in the unpolarised beam of a light source. The angle between the axes of polarisation of the two polaroid sheets is 45°. If the intensity of the incident beam is I_o, calculate the intensity of the beam of light transmitted through the second polariser. **(2½ marks)**

A soap film appears green when viewed with white light incident normally to the film. If the wavelength of green light is 540 nm and the index of refraction of the film is 1.32, calculate the minimum thickness of the film. **(2½ marks)**

(i) Define the term **"Doppler Effect"**.

A car travelling at 15 m/s, sounds its horn of frequency 950 Hz. A stationary listener, in front of the car hears the horn of the approaching car.

(ii) What is the apparent frequency of the sound heard by the listener ?

(iii) Calculate the apparent wavelength. **(3 marks)**

A wave travelling along a string is represented by the equation

$$y = 0.8 \sin 2\pi (t - 0.5x)$$

where all units are in SI.

(i) State the direction in which the wave is travelling.

(ii) Determine the wave number of the wave.

(iii) What is the wavelength of the wave ?

(iv) Calculate the speed of the wave. **(3 marks)**

A diffraction grating made of glass has 5500 lines per centimeter. Monochromatic light striking the grating normally forms a second-order image diffracted at an angle of 36.5° from the normal. Determine the wavelength of the light. **(2 marks)**

(a) Calculate the frequency of the first overtone of an organ pipe of length 80 cm. **(2 marks)**

Some electro magnetic waves are : x-rays, microwaves, gamma rays and TV radar. The waves when placed in order, of decreasing frequency are :

A. microwaves, TV radar, x-rays, gamma rays.
B. gamma rays, x-rays, TV radar, microwaves.
C. TV radar, microwaves, x-rays, gamma rays.
D. gamma rays, x-rays, microwaves, TV radar.

Which **one** of the following is **true** for Tsunamis travelling from deep ocean to the shore where the water gets shallower ?

	VELOCITY	FREQUENCY	WAVELENGTH
A.	decreases	same	decreases
B.	increases	same	increases
C.	decreases	same	increases
D.	increases	same	decreases

The wavelengths of visible spectrum are approximately 400nm and 700nm. A white light falls normally on a plane gratings with 600 lines/mm. The angular width of the first order visible spectrum produced by the plane gratings is

A. 10.9°
B. 13.9°
C. 24.8°
D. 38.7°

An air wedge is formed by placing a thin strip of a metal foil between two glass plates. Monochromatic light of wavelength 465 nm is directed normally onto the wedge, and a number of dark bands are seen across the reflected light. If 360 dark bands are observed in a 10.0 cm length of glass plates, then the thickness of the foil is

A. 8.37×10^{-5}m.
B. 4.19×10^{-5}m.
C. 0.23×10^{-5}m.
D. 1.67×10^{-4}m.

A pure musical tone can cause a thin wooden panel to vibrate. This is an example of

A. an overtone.
B. a harmonic.
C. an interference.
D. a resonance.

The wavelengths of the visible spectrum are approximately 389 nm through 650 nm. Find the angular width of the first-order visible spectrum produced by a plane grating with 500 lines per millimeter when white light falls normally on the grating. **(3 marks)**