WORK, ENERGY, POWER

Work = Force × Displacement

Work = scalar

Unit of Work = Nm = Joule

P126 Q7, 8, 9

1 Joule = work done when a force of 1N acts for a distance of 1m in the direction of the force

ENERGY = Ability to do work

Amount of ENERGY a body has is the amount of work it can do → unit = Joules

Kinetic Energy = $\frac{1}{2}mv^2$ Energy due to motion

Potential energy = Energy due to position in a Force field

Heat energy

Chemical Energy released or absorbed during a chemical reaction

Sound energy = kinetic or potential due to vibration

Electrical Energy electric Potential energy due to electric current

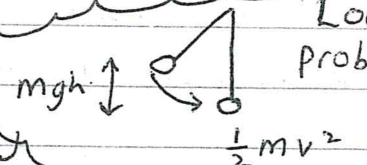
NUCLEAR energy Fusion or Fission

PRINCIPLE OF CONSERVATION OF ENERGY
Energy can neither be created or destroyed – it is converted from one form to another

p128 Q6,7,8,10
129

Look at problem 11
problem 12, 13
p130, 131

Do Q
7, 8, 9
p132



POWER: rate at which work gets done $\frac{W}{t}$

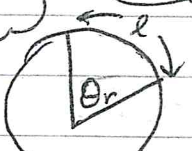
Unit of Power = $\frac{\text{Energy}}{\text{Time}}$ $\frac{J}{s}$ 1 watt = 1J per s

P134 Q8, 9, 10, 11

% Efficiency = $\frac{\text{Power out}}{\text{Power in}} \times \frac{100}{1}$

Q3 p135

CIRCULAR MOTION

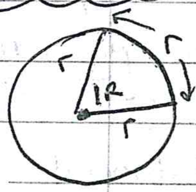


$l = r\theta$ (ω = angular velocity)

$v = \frac{l}{t} = \frac{r\theta}{t}$ $\left(\frac{\theta}{t} = \omega\right)$

$\therefore v = r\omega$

Circumference = $2\pi r$

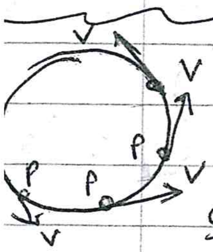


So since there are 2π radius's in the circumference
⇒ there are 2π radians in 360°

2π radians = 360°

$\frac{2\pi}{360} = 1°$

1 radian = $\frac{360°}{2\pi}$



at any instant P is moving along a tangent ⇒ v = tangential speed
v is of constant magnitude but its direction is changing
So velocity is changing ⇒ it is accelerating. P10 p139

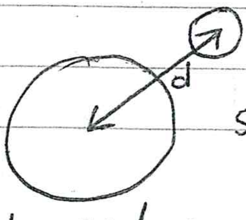
Q3 p139, Q6 p140*

The acceleration of an object moving in a circle is directed towards the centre. This means that the overall force on the object is directed towards the centre. $F = \frac{mv^2}{r}$ or $v = r\omega$ so $F = mr\omega^2$ = centripetal force

Q7 p141 Q5 p141

PERIOD of orbit = time for one orbit (T)
T = Dist / speed

For a satellite in orbit:



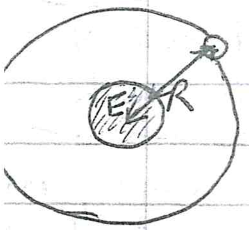
$F = \frac{GM_E \cancel{M_s}}{d^{\cancel{2}}} = \frac{\cancel{M_s} v^2}{\cancel{d}}$ where d = radius of orbit

so $\frac{GM_E}{d} = v^2$

$\sqrt{\frac{GM_E}{d}} = v$

$T = \frac{2\pi d}{v}$

Derive the relationship between the Period of orbit & Radius of orbit:



$$\frac{m_s v^2}{R} = \frac{G m_s M_E}{R^2} \Rightarrow v^2 = \frac{G M_E}{R}, \quad T = \frac{2\pi R}{v}$$

$$T^2 = \left(\frac{2\pi R}{v}\right)^2 = \frac{4\pi R^2}{v^2} \quad T^2 = \frac{4\pi R^2 . R}{G M_E} = \frac{4\pi R^3}{G M_E}$$

REM!
Earth's orbit around sun = 1 Year, 365 days, 365 x 24 hours etc.
Earth does one rotation in 24 hours

Geostationary orbit means the satellite is moving at same angular velocity as earth → so it is always above the same spot

* Prob 17 p144] p144 Q5

* an electron moving at right angles to a magnetic field will experience a force that will make it move in a circle.

F on $\bar{e}$ = Bqv but, since it moves in a circle $F = \frac{mv^2}{R}$

So $Bq\cancel{v} = \frac{mv^{\cancel{2}}}{R} \Rightarrow \frac{BqR}{m} = v$

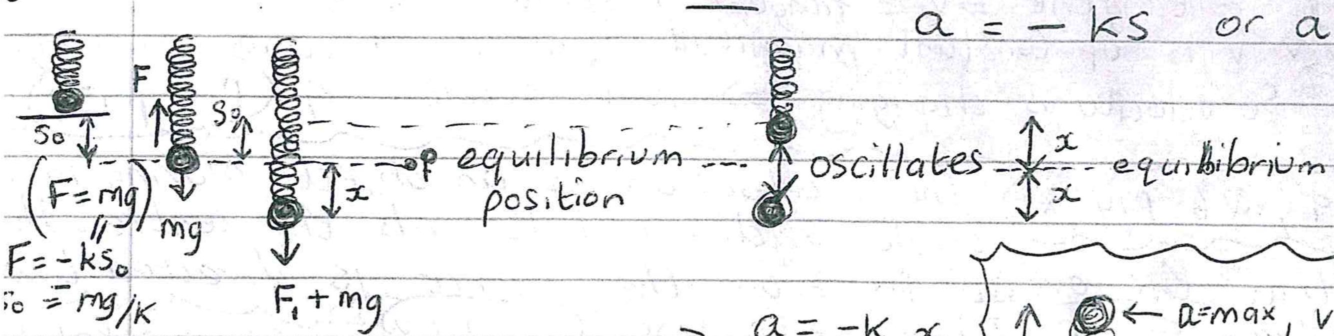
SHM

$F = -kS$ (restoring force) (Displacement)

Hooke's Law: When an object is bent, stretched or compressed by a displacement s, the restoring force $F \propto s$ provided the elastic limit is not exceeded Q2 p147

A body is said to be moving with Simple Harmonic Motion if:
(i) $a \propto s$ (displacement from a fixed point in it's path
(ii) a is directed towards that point (opp sign to s)

$a = -ks$ or $a = -\omega^2 s$



$F_1 + mg = -k(S_0 + x)$

$F_1 + mg = -k(\frac{mg}{k} + x)$

$F_1 + mg = \cancel{k}(\frac{mg}{\cancel{k}}) + x\cancel{k}$

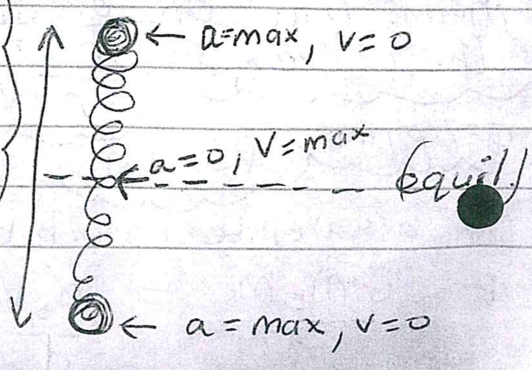
$F_1 = -kx$ $\quad F/m = a$

$a = \frac{-k}{m} x$

$a = \frac{-k}{m} x$

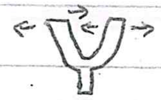
$a = -\omega^2 x$

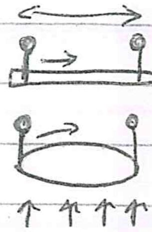
$\omega = \sqrt{\frac{k}{m}}$



SHM Cont'd: Examples of SHM:

(i) mass vibrating up/down on a spring

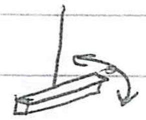
(ii) tuning fork prong 



(iii) Uniform circular motion projected on diameter

(iv) Pendulum swing for small θ 

(v) Tides coming in and out every 6 hours

(vi) Magnet when displaced from north pointing 

One cycle - movement from A - B and Back - or from any point back to the same point

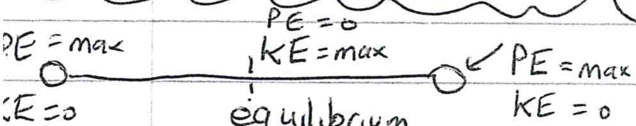
Freq = # cycles/sec

UNITS of FREQ = Hertz

PERIOD = time for 1 cycle (T)

T measured in secs !!!

AMPLITUDE = greatest displacement from equilibrium

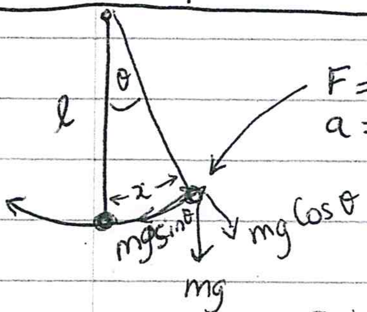


$$T = \frac{2\pi}{\omega}$$

$-\omega^2 = a$

Q 6, 7, 8 p 150 (4, 5)

SIMPLE PENDULUM:



$F = mg\sin\theta$

$a = g\sin\theta$

for small θ, $\sin\theta \approx \theta$

$a = -g\theta$

SHM $\Rightarrow a = -\omega^2 x$

~~accel~~ $x = g\theta$ but $x = r\theta$ and $r = l$

$-\omega^2 x = -\omega^2 l\theta = g\theta \Rightarrow -\omega^2 = \frac{g}{l}$, $\omega = \sqrt{\frac{g}{l}}$

$$T = \frac{2\pi}{\omega}, \quad T = 2\pi\sqrt{\frac{l}{g}}$$

TO MEASURE g (using Simple Pendulum)