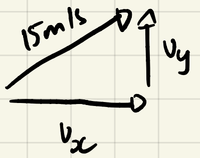
Q5) 30°, 60°

Q6) initial velocity = 15m/s



$V_x = 15 \times \cos(\theta)$

$= 15 \times \cos(20^\circ)$

$=$

$\theta = 20^\circ$
degrees!!

Q7) Increases from 10° to 40°

Decreases from 50° to 80°

Symmetrical

Q8) Largest horizontal displacement occurs at 45°.

Can Infer because it is symmetrical at 40° and 50°.

Thus midpoint of 45° should have largest horizontal displacement

Pg. 1

Pg. 2

Item 1.

$\sim 27^\circ$

Item 2.

max range at 45°

initial velocity = 4.77m/s

$u_x = 4.77 \times \cos(45)$

$=$

Pg. 3 Inclined Plane

a) $F = mg\sin\theta$

$\frac{F}{\sin\theta} = mg$

using gradient formula

(0.3, 2.0)
(0.5, 3.4)

$\frac{F}{\sin\theta} = \frac{3.4 - 2.0}{0.5 - 0.3}$

$= \frac{1.4}{0.2}$

$= 7$

$= mg$

as long as process is right, answer doesn't matter

$m = \frac{7}{9.8}$

$= 0.714$

$\approx 0.71\,kg$

Circular Motion

a) $r = 0.8m$, mass is constant

$F = \frac{mv^2}{r}$

$\therefore$

$\frac{m}{r} = k$

$F = kv^2$

if consistent then force should be proportional to velocity squared

F	v	v^2	
1.0	4.8	23.04	+23.2
2.0	6.8	46.24	+22.65
3.0	8.3	68.89	

after squaring, it looks like it is consistent

b) (1.0, 4.8) using 1 point

$1.0 = \frac{M \times 4.8^2}{0.8}$

$m = \frac{1 \times 0.8}{4.8^2}$

$= 0.03472\,kg$

$= 34.7g$

$\approx 35g$

OR

$\frac{F}{v^2} = \frac{m}{r}$

→ Find gradient
→ divide by r (0.8m)

Pg. 4 Gravity

a) $F = \frac{GMm}{r^2}$

$F = m \times \frac{GM}{r^2}$

$m = 125kg$

$r = 50cm$
$= 50 \times 10^{-2} m$

$G = ?$

$y\text{-int} \approx 0.1$

$\therefore c = 0.1 \times 10^{-6}$

$$F = \frac{mv^2}{r}$$

gradient 6

$v = 5 m/s$

$$r = \frac{mv^2}{F}$$

$$\frac{F}{m} = \frac{v^2}{r}$$

$$6 = \frac{5^2}{r}$$

$$r = \frac{25}{6} = 4.1$$

gradient

(100, 3.25)

(20, 0.75)

$$\frac{(3.25 - 0.75) \times 10^{-6}}{100 - 20} = 3.13 \times 10^{-8}$$

$\therefore F = 3.13 \times 10^{-8} M + 0.1 \times 10^{-6}$

b) $\frac{F}{M} = \frac{Gm}{r^2}$

$$G = \frac{F}{M} \times \frac{r^2}{m}$$

$$= 3.13 \times 10^{-8} \times \frac{(50 \times 10^{-2})^2}{125}$$

$$= 6.3 \times 10^{-11}$$

expected 6.67×10^{-11}

Orbits

Mars

6.44×10^{23} kg

Check if $\frac{4\pi^2}{G \times 6.44 \times 10^{23}} = 9.19 \times 10^{-13}$

$= ✓$

Keplers law

$$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$$

Mars ✓

Earth $= 9.91 \times 10^{-14}$

Neptune $= 5.80 \times 10^{-15}$

Jupiter ✓

or

Check

$$\frac{T^2}{r^3} \times M = \frac{4\pi^2}{G}$$

If all the same then confirm relationship

$S = ut + \frac{1}{2}at^2$

Question 7

"launched horizontally"

$\therefore u = 0$

$\therefore S = \frac{1}{2}at^2$

gradient ≈ 2.6 y-int ≈ 0

$S = \text{gradient} \times t^2 + \text{y-intercept}$

$S = 2.6t^2$

$S = ut + \frac{1}{2}at^2$

$u = 0$

$S = \frac{1}{2}at^2$

$2.6 = \frac{1}{2}a$

$a = 5.2 \, m/s^2$

Q25 - Circular motion

$r = 20 \times 10^{-2} m$

$F = \frac{mv^2}{r}$

gradient $= \frac{F}{M} \approx 30$

$\frac{F}{m} = \frac{v^2}{r}$

$r \times \frac{F}{m} = v^2$

$\sqrt{r \times \frac{F}{m}} = v$

$\sqrt{20 \times 10^{-2} \times 30} = 2.4 \, m/s$

Q8) $M = 250kg$

$F = \frac{G \times 250 \times m}{r^2}$

$F = \underset{\text{(gradient)}}{K} \times \frac{1}{r^2}$

$Fr^2 = G \times 250 \times m$

$\frac{Fr^2}{G \times 250} = m$

$= 3.52 \times 10^{20} \, kg$

gradient $= \frac{26-6}{(46-12) \times 10^{-13}}$

$= \frac{20}{34 \times 10^{-13}}$

$= 5.88 \times 10^{12}$

$F = \frac{GMm}{r^2}$

y-axis $\rightarrow F$

x-axis $\rightarrow \frac{1}{r^2} (10^{-13})$

$\therefore$

$F = \underset{\text{gradient of graph}}{GMm} \times \frac{1}{r^2}$

$r^3 = k \times T^2$

Q9

remember

T is in days squared

rearrange

$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

$r^3 = \frac{GM}{4\pi^2} \times T^2$

gradient of graph

$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$

(40,000, 10)
(0, 0)

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{10 \times 10^{32} m^3}{40000 \text{ days}^2}$

change to days

$\sqrt{40000}$

200 days

to seconds

$200 \times 60 \times 60 \times 24$
$= 1.72 \times 10^7$ seconds

to seconds^2 (because it is in T^2)

$(1.72 \times 10^7)^2$
$= 2.985... \times 10^{14}$

$\therefore$ gradient
$= \frac{10 \times 10^{32} m^3}{2.985 \times 10^{14} s^2}$

$= 3.348 \times 10^{18}$

$\frac{GM}{4\pi^2} = 3.348 \times 10^{18}$

$M = \frac{3.348 \times 10^{18} \times 4\pi^2}{G}$

$= 1.98 \times 10^{30}$ kg $\approx 2.0 \times 10^{32}$ kg

Q8)

$V = K \times t$

$a = \frac{v}{t}$

$v = at$

$\therefore k = a$

gradient = acceleration

Inclined Plane $\rightarrow F = mg\sin\theta$

$F = ma$

(If you think about it)

$\left(\frac{\text{velocity (m/s)}}{\text{time (s)}} = (m/s^2) \right)$

use $(5, 30)$ $(0, 0)$ $\frac{30}{5} = 6$

$a = 6 m/s^2$

$ma = mg\sin\theta$

$a = g\sin\theta$

$\sin\theta = \frac{a}{g}$

$\theta = \sin^{-1}\left(\frac{6}{9.8}\right)$

$\approx 38^\circ$

$x(t)$

$\frac{d}{dx}$

$v(t)$