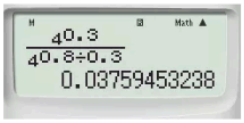
1. (a) Evaluate x in the following expression giving your answer to TWO decimal places when a=2, b=4 and m=0.3. Show all working stages.

$$x = \left(\frac{a \times b}{a}\right)^{m} \div \left(\frac{a \times b}{a^2}\right)^{\frac{m+0.5}{m}} \qquad (4)$$

$$x = \left(\frac{2 \times 4}{2}\right)^{0.3} \div \left(\frac{2 \times 4}{2^2}\right)^{\frac{0.3+0.5}{0.3}}$$

$$4^{0.3} \div 4^{\frac{0.8}{0.3} = \frac{8}{3}}$$

$$x = 4^{0.3} \div 4^{8/3}$$



0.038 2dp

(b) Determine the value of 'n' using logarithms in the following expression when $P_2 = 3 \times P_1$ and $T_1 = 2 \times T_2$:

$$P_1 T_1^n = P_2 T_2^n \qquad (4)$$

$P_1 (T_1)^n = P_2 (T_2)^n$ $\quad P_2 = 3P_1 \quad T_1 = 2T_2$

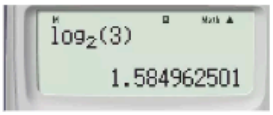
$P_1 (2T_2)^n = 3P_1 (T_2)^n$

$\cancel{P_1} (2T_2)^n = 3\cancel{P_1} (T_2)^n$

$2^n (T_2)^n = 3 (\cancel{T_2})^n$

$2^n = 3$

$\log_2 3 = n$



$n = 1.58496$

2. (a) The ratio of carbon : hydrogen : sulphur in a fuel is given as 26:4:1. Express these proportions as percentages. (4)

$26 + 4 + 1 = 31$

Carbon $\frac{26}{31} \times 100 = 83.871\ \%$

Hydrogen $\frac{4}{31} \times 100 = 12.903\ \%$

sulphur $\frac{1}{31} \times 100 = 3.2258\ \%$

check total $99.9998\ \%$ ✓

(b) Simplify to the following giving the answer as the simplest mixed fraction.

$$\left(\frac{2}{3} + 3\frac{4}{5}\right) \times 2\frac{1}{2} \qquad (4)$$

$$\left(\frac{2\times5}{3\times5} + \frac{19\times3}{5\times3}\right) \times \frac{5}{2}$$

$$\left(\frac{10}{15} + \frac{57}{15}\right) \times \frac{5}{2}$$

$$\frac{67}{15} \times \frac{5}{2}$$

$$\frac{335}{30} = \frac{67}{6} = 11\frac{1}{6}$$

3. (a) State the law of a straight line graph explaining the terms. (2)

(b) Plot and join the pairs of points shown in Table Q3. (4)

(c) From the graph determine the equation linking X and Y. (4)

X	-2	-1	0	1	2	3
Y	-8.5	-5.5	-2.5	0.5	3.5	6.5

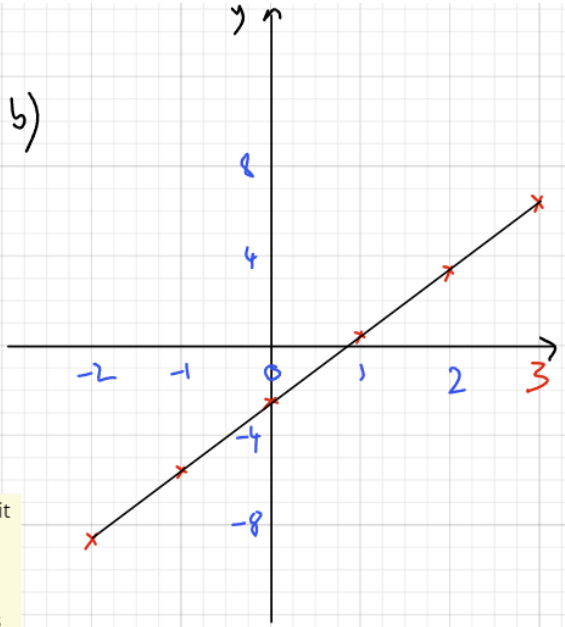
Table Q3

a) $y = mx + c$

m is the gradient, and shows the steepness of the line, it can be calculated by dividing the rise (change in y) by the run (change in x) between any 2 points on the line

c is the y intercept, it is the point where the line crosses the y axis.

b)



c) $m = \frac{\text{Rise}}{\text{Run}} = \frac{3}{1} = 3$

$c = -2.5$

$y = 3x - 2.5$

4. (a) Define Pythagoras' Theorem. (2)

(b) For the triangle shown in Fig Q4 determine the length AB. (2)

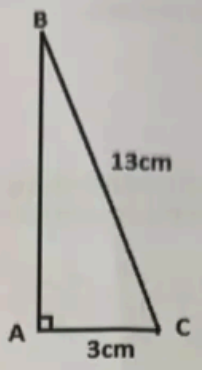


Fig Q4

a) $a^2 + b^2 = c^2$

the sum of the square of the 2 shorter sides is the same as the square of the longer side of a right angle triangle.

b) $\sqrt{13^2 - 3^2} = \sqrt{169 - 9} = \sqrt{160}$

$= 12.649$ cm

(c) An engine crankshaft has an angular velocity of 5027 rads/min. Determine the angle in degrees through which a crankpin rotates in 3 seconds. (4)

5027 Rad/min

↓ ÷ 2π

×360

2880 25.883 °/min

↓ ÷ 60

4800.43 °/sec

↓ ×3

14401.29° in 3 sec

Deg	Rev	Rad
360	1	2π

×360 ÷2π

5. (a) State TWO fundamental units. (2)

(b) Explain what is meant by derived units using an example. (2)

(c) A cylinder with an internal cross sectional area of 4250 mm^2 contains fluid with a depth of 6 cm. The fluid has a mass of 300 grammes.

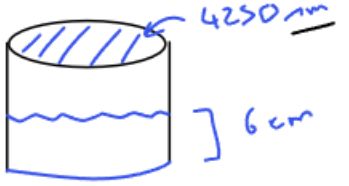
Determine the density of the fluid. (4)

a) Seconds, meters, Newtons, Joules

b) a derived unit is a unit derived from fundamental units

eg miles per hour = $\frac{\text{Number of miles travelled}}{\text{Number of hours travelled}}$

c)

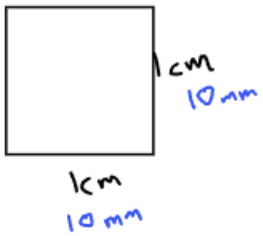


mass 300g

density = $\frac{\text{mass}}{\text{volume}}$

g/cm^3 ✓

ok this is hard becuase of the units, I can give the density in cm3/g, but I need to convert those mm2 to cm2



$1cm^2 = 100mm^2$

$4250 \div 100 = 42.5cm^2$

$Vol = \pi r^2 h = 42.5 \times 6 = 255\ cm^3$

$\text{density} = \frac{300}{255} = 1.17647\ g/cm^3$

6. (a) Define the term scalene triangle. (2)

(b) For the shape shown in Fig Q6 determine the angle MBD describing your reasoning. (6)

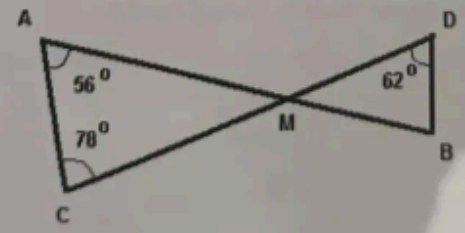
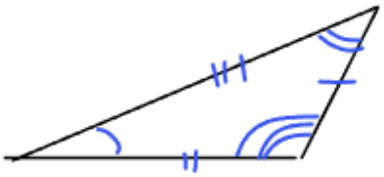


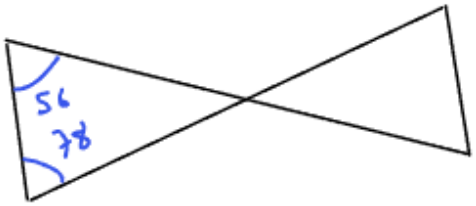
Fig Q6

a)



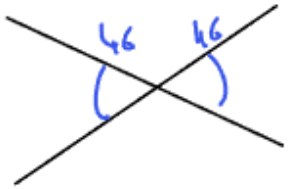
scalene triangles have all sides different lengths
all angles different values.

b)



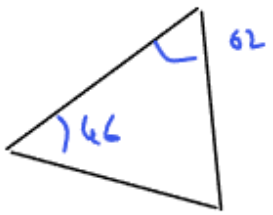
angles inside of a triangle sum to 180°

$180 - (56 + 78) = 46$



vertical angles have the same value

$180 -$



angles inside of a triangle sum to 180°

$v = u + at$

$9 = 0 + 1.5x$

$\frac{9}{1.5} = 6$

c) $v = u + at$

$1 = 9 + 13.5x$

$\frac{-8}{13.5} = x$

$-0.592592\ m/s^2 = \text{accel}$

$0.592592\ m/s^2$ Retardation

d)

①	②	③
$s =$	s	s
$u = 0$	$u = 9$	$u = 9$
$v = 9$	$v = 9$	$v = 1$
$a = 1.5$	a	a
$t = 6$ sec	$t = 25$	$t = 13.5$ sec

Find $s = \left(\frac{u+v}{2}\right)t$ $\left(\frac{0+9}{2}\right)6$ $\left(\frac{9+9}{2}\right)25$ $\left(\frac{9+1}{2}\right)13.5$

$s_1 = 27\ m$ $s_2 = 225$ $s_3 = 67.5\ m$

total distance = 319.5 m

Section B

7. A vehicle starts from rest and accelerates with constant acceleration of 1.5 m/s² to a speed of 7.0 m/s. It then travels at 7 m/s for 25 seconds after which it is retarded to a speed of 1 m/s. if the complete motion takes 44.5 seconds:

Determine EACH of the following:

(a) sketch the velocity/time diagram; (2)

(b) the time taken to reach 9 m/s; ? typo? 7 m/s (2)

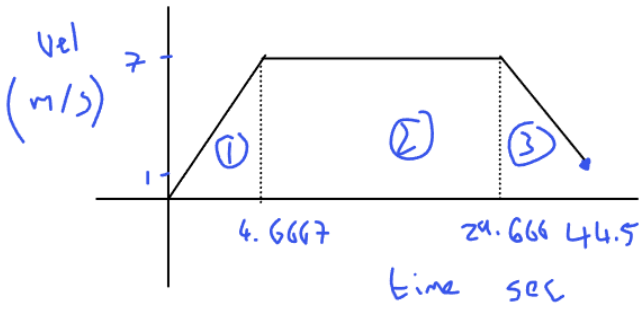
(c) the retardation (Deceleration); (2)

(d) the total distance travelled. (2)

I will take this as a typo, as the object never reaches 9 m/s, if not a typo then t = NA

not to scale

a)



b)

① $s =$ $u = 0$ $v = 7$ $a = 1.5$ $t = 4.6667 \text{ sec}$

② s u v a $t = 25$

③ s $u = 7$ $v = 1$ a $t = 14.8333 \text{ sec}$

$v = u + at$

$7 = 0 + 1.5x$

$\frac{7}{1.5} = 4.66667 \text{ sec}$

c) $v = u + at$

$1 = 7 + 14.833x$

$\frac{-6}{14.833} = x$

$-0.404494 \text{ m/s}^2 = \text{accel}$

0.404494 m/s² Retardation

d)

① $s =$ $u = 0$ $v = 7$ $a = 1.5$ $t = 4.6667 \text{ sec}$

② s $u = 7$ $v = 7$ a $t = 25$

③ s $u = 7$ $v = 1$ a $t = 14.8333 \text{ sec}$

find $s = \left(\frac{u+v}{2}\right)t$ $\left(\frac{0+7}{2}\right)6$ $\left(\frac{7+7}{2}\right)\times 25$ $\left(\frac{7+1}{2}\right)14.8333$

$s_1 = 21 \text{ m}$ $s_2 = 175$ $s_3 = 59.3333 \text{ m}$

total distance = 255.33 m

8. A beam of uniform cross section and density is loaded as shown in Fig Q8. The beam has a mass of 1100 kg.

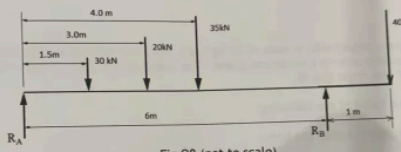
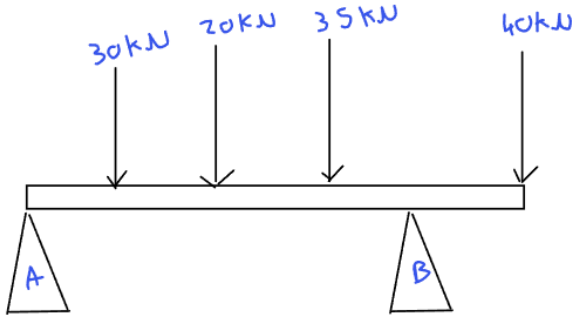


Fig Q8 (not to scale)

Determine EACH of the following:

(a) the reaction force, R_A; (6)

(b) the reaction force, R_B. (2)



taking moments about A

Name	Mass (t)	Force (kN)	Distance (m)	Moment (kNm)	Dir AC
W_1		30	1.5	45	C
W_2		20	3	60	C
W_3		35	4	140	C
W_4		40	7	280	C
Beam	1.1	10.791	3.5	37.7685	C
R_B		x	6	6x	A

sum of clockwise moments = sum of anticlockwise moments

45
60
140
280
37.7685
} 6x

$562.7685 = 6x$

$93.79475\ KN = R_B$

sum of DOWN = sum of UP (forces)

30
20
35
40
10.791

$= R_A + R_B$

$135.791 = R_A + 93.79475$

$41.99625\ kN = R_A$

9. Fig Q9 shows a mass of 150 kg suspended from points A and B by chains.
Determine EACH of the following:
(a) the forces in chain AC; (4)
(b) the force in chain BC. (4)

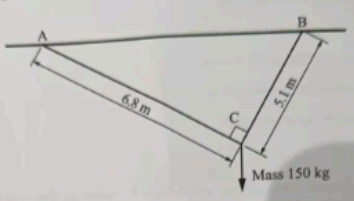
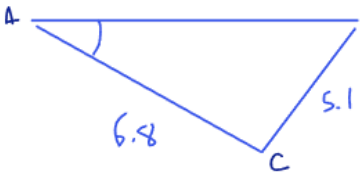


Fig Q9

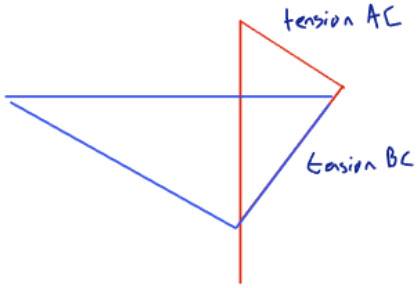
Distance



$\tan^{-1}\left(\frac{5.1}{6.8}\right)$

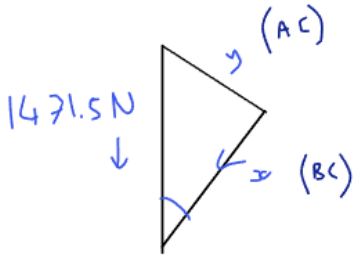
$36.869897°$

Mixed



150×9.81

Force



$36.869897°$

tension BC	tension AC
CAH	SOH
$1471.5 \cos(36.8699) = x$	$1471.5 \sin(36.8699) = y$
1177.1999 N	882.9 N

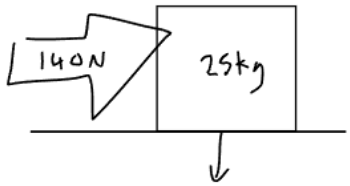
10. A stationary object with a mass of 25 kg has a force of 140 N applied to it which causes acceleration in a horizontal plane. The coefficient of friction between the body and the plane is 0.35.

Determine EACH of the following:

(a) the acceleration of the body; (4)

(b) the distance the body will travel from rest in 6 seconds. (4)

a)



$25 \times 9.81 = 245.25$ N

Friction

$F_{fric} = \mu N$

0.35×245.25

85.8375

Net Horizontal

Push − Fric

$140 - 85.8375$

$= 54.1625$

Accel $F = ma$

$54.1625 = 25\,a$

2.1665 m/s²

b)

s

$u = 0$

v

$a = 2.1665$ m/s²

$t = 6$

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

$+ 0.5 \times 2.1665 \times 6^2$

$s =$ **38.997 m**

11. A piston rod 0.8 m long has a diameter of 80 mm and when subjected to an axial load of 1050 kN, it is compressed by 0.65 mm.

Determine EACH of the following:

(a) the direct stress in the rod; (4)

(b) the direct strain in the rod; (4)

(c) the Modulus of Elasticity (E) for the rod. (2)

a) $\text{stress} = \frac{\text{Force}}{\text{Area}} = \frac{1050,000\ N}{5.026548 \times 10^{-3}\ m^2} = 208890862.8\ N/m^2$

$208.89\ MN/m^2$

$d = 80mm \quad r = 40mm$

$r = 0.04\ m$

$\pi r^2 = \pi\ 0.04^2 = 5.026548 \times 10^{-3}\ m^2$

b) $\text{Strain} = \frac{\Delta L}{L} \quad \frac{0.65}{800} = 8.125 \times 10^{-4}$

c) $\text{Elasticity} = \frac{\text{stress}}{\text{strain}} \quad \frac{208890862.8}{8.125 \times 10^{-4}} = 2.57096 \times 10^{11}\ N/m^2$

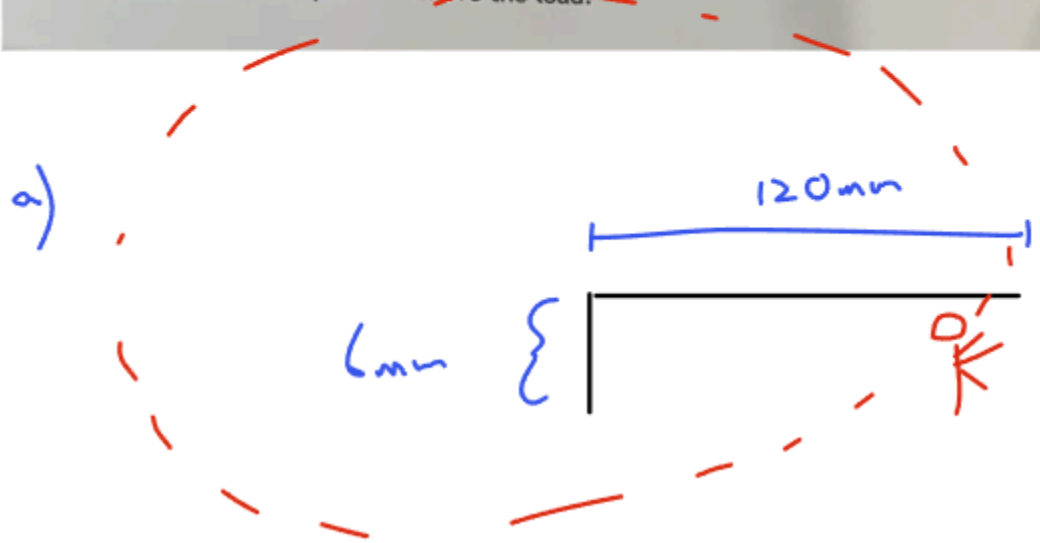
12. A screw jack is used to support a load of 300 kg. The jack has a single start square thread with a 6 mm pitch on an effective effort radius of 120 mm. The applied effort is 80 Newtons.

Determine EACH of the following:

(a) the force ratio; (3)

(b) the movement ratio; (3)

(c) the effort required to move the load. (2)



a) Force Ratio $= \frac{\text{Force Out}}{\text{Force In}} = \frac{300 \times 9.81}{80} = 36.7875$

b) Maemat Ratio $= \frac{\text{Distance I travel}}{\text{Dis lock}} = \frac{\pi D}{\text{pitch}} = \frac{\pi \times 240}{6} = 125.6637$

c) effort is stated in question as 80 N

as I think this is a typo, I think you were asking for effciency, so ill calculate that

$\text{eff} = \frac{F}{M} = \frac{36.7875}{125.6637} \times 100 = 29.27456\%$.

efficiency.