DEC 2014

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets.

1. Solve for x in the following equation:

   $2(x-2)+4(x-3)=x-6$ (8)

2. A right-angled triangle is standing on its base which is 3.8 cm long. The perpendicular height is 2.24 times the base length.

   Calculate EACH of the following:

   (a) the other base angle; (3)

   (b) the difference between the perpendicular height and the hypotenuse. (5)

3. A solid right cone has a base diameter of 15 cm and a perpendicular height of 20 cm.

   Calculate EACH of the following:

   (a) the surface area of the cone in m^2; (5)

   (b) the volume of the cone in m^3. (3)

4. The following formula is used when electric cells are connected in series.

   $$I=\frac{nV}{R+nr}$$

   Make n the subject of the formula. (8)

5. A screw jack has a turning lever 260 mm in length which operates a single start screw thread of 5 mm pitch.

   Calculate the efficiency of the machine when an effort of 230 N just lifts a mass of 3.4 tonne. (8)

6. A body is travelling at 1.3 m/s when it is uniformly accelerated to 6.1 m/s in 12 seconds.

   Calculate EACH of the following:

   (a) the acceleration; (3)

   (b) the distance travelled during the acceleration period. (5)

7. An electric drive comes to rest from running speed in 106 seconds and turns through 1236 complete revolutions.

   Calculate EACH of the following:

   (a) the running speed in rev/min; (4)

   (b) the retardation in rad/s^2. (4)

8. A uniform horizontal beam AB is 5 m long and simply supported at its ends. A mass of 220 kg is applied at a point 2.8 m from the left hand end A, while a uniformly distributed load (UDL) of 12 kg/m run is applied over a distance of 1.2 m from end B.

   (a) Make a simple sketch of the loaded beam. (2)

   (b) Using the sketch in Q8(a), determine the value of the reactions R_A and R_B. (8)

11. A simple wall crane consists of a jib, 2.75 m long being of hollow tubular section, O.D. 150 mm, I.D. 136 mm and making an angle of 35° to the wall. The tie is 1.93 m long and makes a right angle with the jib. The wall crane is supporting a mass of 1.2 tonne at the jibhead.

(a) Produce a simple dimensional sketch of the crane. (2)

(b) Calculate EACH of the following:

(i) the load in the jib; (2)

(ii) the load in the tie; (2)

(iii) the direct stress in the jib. (4)

12. A bulkhead is 5.3 m deep and is flooded to the top on one side only with water of density 1014 kg/m^3.

Calculate EACH of the following:

(a) the hydrostatic pressure at the base of the bulkhead; (3)

(b) the width of the bulkhead if the hydrostatic force under these conditions is 1.16 MN. (5)

1. Solve for x in the following equation:

$2(x-2)+4(x-3)=x-6$ (8)

$2x-4+4x-12=x-6$

$5x-16=-6$

$5x=10$

$x=2$

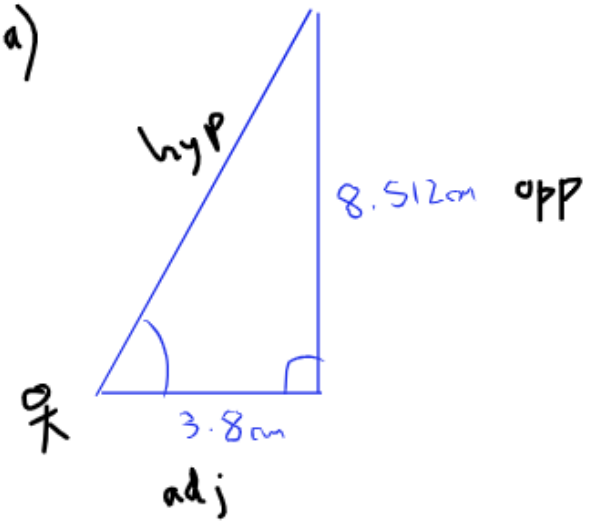
2. A right-angled triangle is standing on its base which is 3.8 cm long. The perpendicular height is 2.24 times the base length.

Calculate EACH of the following:

(a) the other base angle; (3)

(b) the difference between the perpendicular height and the hypotenuse. (5)

a)



SOH
CAH
TOA

$$\tan\theta = \frac{8.512}{3.8}$$

$$\theta = \tan^{-1}\left(\frac{8.512}{3.8}\right)$$

$$\theta = 65.94^{\circ}$$

b) $\sqrt{3.8^2 + 8.512^2} = 9.32170$

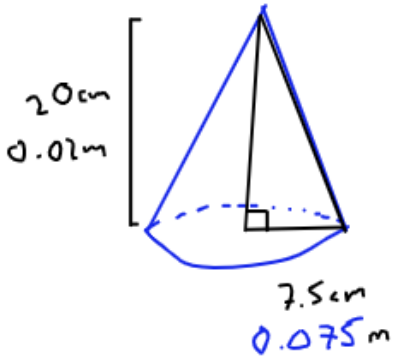
$9.32170 - 8.512 = 0.809700\text{cm}$

3. A solid right cone has a base diameter of 15 cm and a perpendicular height of 20 cm.

Calculate EACH of the following:

(a) the surface area of the cone in m^2; (5)

(b) the volume of the cone in m^3. (3)



Area = Curved SA + base

$\pi RL + \pi R^2$

Slant $= \sqrt{0.02^2 + 0.075^2} = 0.2136$ m

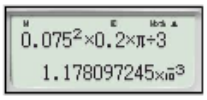
$\pi(0.075)(0.2136) + \pi(0.075)^2$

$0.06799977\ m^2$

Vdune

$\frac{1}{3} b \times h$

$\frac{1}{3} \pi (0.075)^2 \times 0.2 =$



4. The following formula is used when electric cells are connected in series.

$$I = \frac{nV}{R + nr}$$

Make n the subject of the formula. (8)

$I(R+nr) = nV$

$IR + Inr = nV$

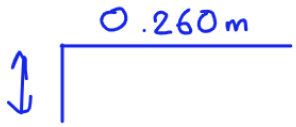
$IR = nV - Inr$

$IR = (V - Ir)n$

$$\frac{IR}{(V - Ir)} = n$$

5. A screw jack has a turning lever 260 mm in length which operates a single start screw thread of 5 mm pitch.

Calculate the efficiency of the machine when an effort of 230 N just lifts a mass of 3.4 tonne. (8)



$$\text{Force Ratio} = \frac{\text{Lifting Force}}{\text{Applied Force}} = \frac{3400 \times 9.81}{230} = \frac{33354}{230} = 145.0174$$

$$\text{Movement Ratio} = \frac{\text{Distance I travel}}{\text{Distance Load travels}} \quad \frac{2 \times 260 \times \pi}{5} = 326.73$$

$$\text{Eff} = \frac{145.0174}{326.73} \times 100 = 44.385\%$$

6. A body is travelling at 1.3 m/s when it is uniformly accelerated to 6.1 m/s in 12 seconds.

Calculate EACH of the following:

(a) the acceleration; (3)

(b) the distance travelled during the acceleration period. (5)

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

$v = u + at$

$s = \left(\frac{u+v}{2}\right)t$

s

$u = 1.3$

$v = 6.1$

$a = (0.4)$

$t = 12$

$v = u + at$

$6.1 = 1.3 + 12x$

$a = 0.4 m/s^2$

7. An electric drive comes to rest from running speed in 106 seconds and turns through 1236 complete revolutions.

Calculate EACH of the following:

(a) the running speed in rev/min; (4)

(b) the retardation in rad/s^2. (4)

$S = 1236$ Rev
$u = x$
$v = 0$
$a =$
$t = 106$ sec

$v = u + at$

$S = \left(\frac{u+v}{2}\right) t$

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

a) $1236 = \left(\frac{x+0}{2}\right) 106$

$x = 23.320$ Rev per sec

Running speed = 1399.25 Rev/min

b)

$S = 1236$ Rev $\xrightarrow{\times 2\pi}$ 7766.01704 Rads
$u = 23.320$ Rev $\xrightarrow{\times 2\pi}$ 146.5289 Rads/sec
$v = 0$
$a = x$
$t = 106$ sec

$v = u + at$

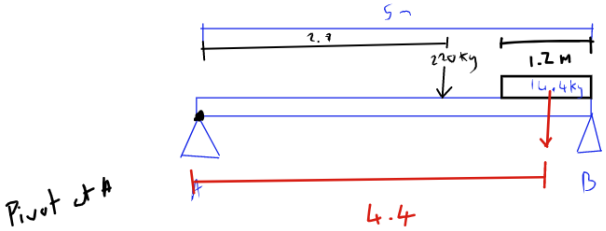
$0 = 146.5289 + 106\,a$

-1.382 Rads/sec^2

8. A uniform horizontal beam AB is 5 m long and simply supported at its ends. A mass of 220 kg is applied at a point 2.8 m from the left hand end A, while a uniformly distributed load (UDL) of 12 kg/m run is applied over a distance of 1.2 m from end B.

(a) Make a simple sketch of the loaded beam. (2)

(b) Using the sketch in Q8(a), determine the value of the reactions R_A and R_B. (8)



Pivot at A

12 kg × 1.2 = 14.4 kg

clockwise moments = anticlock wise moments

Force down = Force up

Name	Mass	Force	Distance	Moment	Clock/Anti:
Weight	220	2158.2	2.8	6042.96	C
UDL	14.4	141.264	4.4	621.5616	C
R_B		x	5	5x	A

clockwise moments = anticlock wise moments

$6042.96 + 621.5616 = 5x$

$x = 1332.9\ N$

Force down = Force up

$2158.2 + 141.264 = R_A + R_B$

$+ 1332.9$

$R_A = 966.564\ N$

11. A simple wall crane consists of a jib, 2.75 m long being of hollow tubular section, O.D. 150 mm, I.D. 136 mm and making an angle of 35° to the wall. The tie is 1.93 m long and makes a right angle with the jib. The wall crane is supporting a mass of 1.2 tonne at the jibhead.

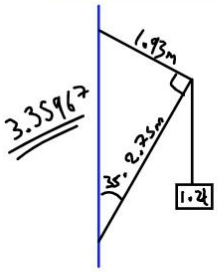
(a) Produce a simple dimensional sketch of the crane. (2)

(b) Calculate EACH of the following:

(i) the load in the jib; (2)

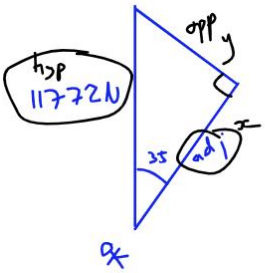
(ii) the load in the tie; (2)

(iii) the direct stress in the jib. (4)



$\sqrt{1.93^2 + 2.75^2} = wall = 3.35967\ m$

$1200 \times 9.81 = 11772\ N$



SOH CAH TOA

Jib

$\cos\theta = \frac{adj}{hyp}$

$\cos 35 = \frac{x}{11772}$

$11772 \cos 35 = x$

$Jib = 9643.057\ N$

tie

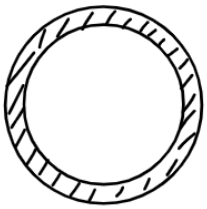
$\sin\theta = \frac{opp}{hyp}$

$\sin 35 = \frac{y}{11772}$

$tie = 6752.14\ N$

---

b(iii)



$Area = Big - Small$

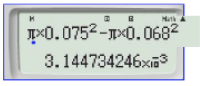
$\pi r^2 - \pi r^2$

$D = 150 \quad d = 136$

$R = 75\ mm \quad r = 68\ mm$

$R = 0.075\ m \quad r = 0.068\ m$

$$\pi(0.075)^2 - \pi(0.068)^2$$



$3.144734246 \times 10^{-3}\ m^2$

$$Stress = \frac{f}{A} = \frac{9643.057\ N}{3.144734246 \times 10^{-3}\ m^2} = 3066413.962\ N/m^2$$

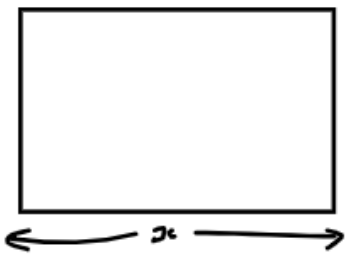
12. A bulkhead is 5.3 m deep and is flooded to the top on one side only with water of density 1014 kg/m^3.

Calculate EACH of the following:

(a) the hydrostatic pressure at the base of the bulkhead; (3)

(b) the width of the bulkhead if the hydrostatic force under these conditions is 1.16 MN. (5)

$F = \rho g a h$ $P = \rho g h$



$P = 1014 \times 9.81 \times 5.3$

$P = 52720.902$ (Pa)

b) $F = 1.16 \times 10^6$ N

$h = 2.65$ m

$a = 5.3x$

$1.16 \times 10^6 = 1014 \times 9.81 \times 5.3x \times 2.65$

$\frac{1.16 \times 10^6}{134710.39} = x = 8.302889\,98$

8.3029 m