CSSC ENGINEERING SCIENCE MARKING SCHEME.

1

(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	X
B	B	C	A	A	B	A	C	A	B
(XI)									
C									

10 marks @ 1 mark

5 marks @ 1 mark

2.

List A	(I)	(II)	(III)	(IV)	(V)
List B	F	D	A	C	C

3(a) (I) Data given:

Effort = 40 N.

Mass of body = 50kg.

Weight of body = $50kg \times 10m/s^2$ = 500N.

Distance raised = 30mm (Load distance).

Effort distance = 540mm.

Velocity ratio (V.R.) = $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

$= \frac{540\,mm}{30\,mm} = \underline{18}$

3(a)(II)

(II) Mechanical Advantage (M.A.) = $\frac{\text{Load}}{\text{Effort}} = \frac{500N}{40N}$ = 12.5

= 12.5

3(a) (III) Efficiency, η_{th}

$$= \frac{\text{Mechanical Advantage (M.A)}}{\text{Velocity Ratio}} \times 100\%$$

$$= \frac{12.5}{18} \times 100\%$$

1 marks

$$= 0.694 \times 100\%$$

Therefore, the Efficiency, η_{th} of the machine = 69.4%

3(b) (I) Mechanical advantage: Is the measure of the output force to input force in the system.

OR

The ratio of the load to the effort in a system.

(II) Velocity ratio: The ratio of the distance moved by the point at which the effort is applied in a simple machine to the distance moved by the point at which the load is applied at the same time.

(III) Static friction: Is the type of friction that exists between a stationary object and the surface on which it is resting.

(IV) Dynamic friction: Also known as kinetic friction, it is the force that opposes the motion of an object as it slides or moves across a surface.

1 marks

4(a)(I) Velocity: It is defined as the change of displacement per unit time in a specific direction, or the rate of change of displacement with time. 2 marks

(II) Acceleration: The rate of change of velocity 2 marks

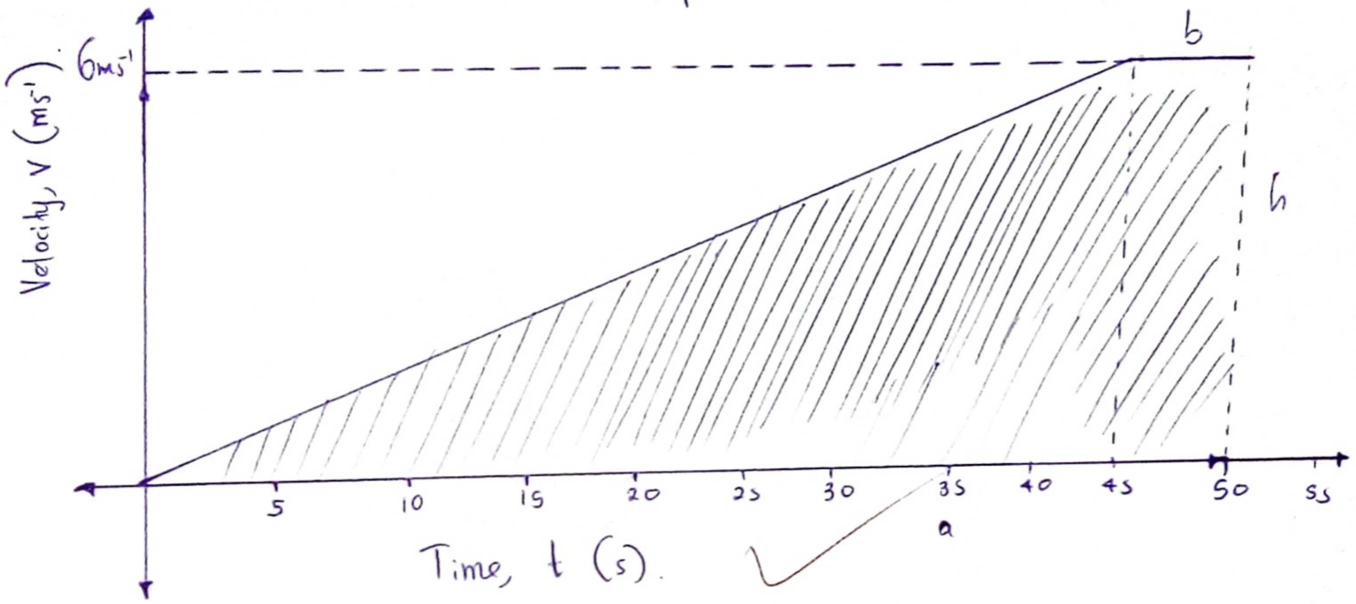
4 (b) (i) Data given:

Initial velocity = $0 \, ms^{-1}$

Final velocity = $6 \, ms^{-1}$.

Time taken during acceleration = 45 seconds.

Time taken to move with uniform speed after acceleration = 5 seconds.



(II) Distance covered by the cyclist = Area under the graph

$= \frac{1}{2} \times h(A + B)$

$= \frac{1}{2} \times 6(50 + 5)$

$= \frac{1}{2} \times 3 \times 55$

$= \left(\frac{1}{2} \times 165\right) \times 2$

$\therefore$ Distance covered by the cyclist $= 82.5$ metres $\times 2$

$= 165$ metres

7 marks

5(a)(I) Pressure is the force acting normally/perpendicularly per unit area.

(II) - Density
- Gravity
- Height.

3 marks

(b) Data given.

Height, $h = 15cm = 0.15m$.

Density of mercury $= 13.6g/cm^3$

Gravity, $g = 10m/s^2$

$13.6g/cm^3$ to kg/m^3.

$1kg = 1000g$.

$x = 13.6g$

$\frac{13.6g \times 1kg}{1000g} = 0.136kg$.

$1m^3 = 1000000 cm^3$

$x = 1cm^3$

$\frac{1\cancel{cm^3} \times 1m^3}{1000000 \cancel{cm^3}}$

$\frac{1}{1000000} = 0.000001m^3$

$= \frac{0.0136kg}{0.000001m^3}$

$= \frac{136}{10000}kg \div \frac{1}{1000000}m^3$

$= \frac{136}{10000}kg \times \frac{1000000}{1}m^3 = 13600kg/m^3$

5(b) Pressure = Density × Gravity × Height

$= \rho \times g \times h$

$= 13600 \times 10 \times 0.15$

Pressure = 20,400 Pascals. 3 marks

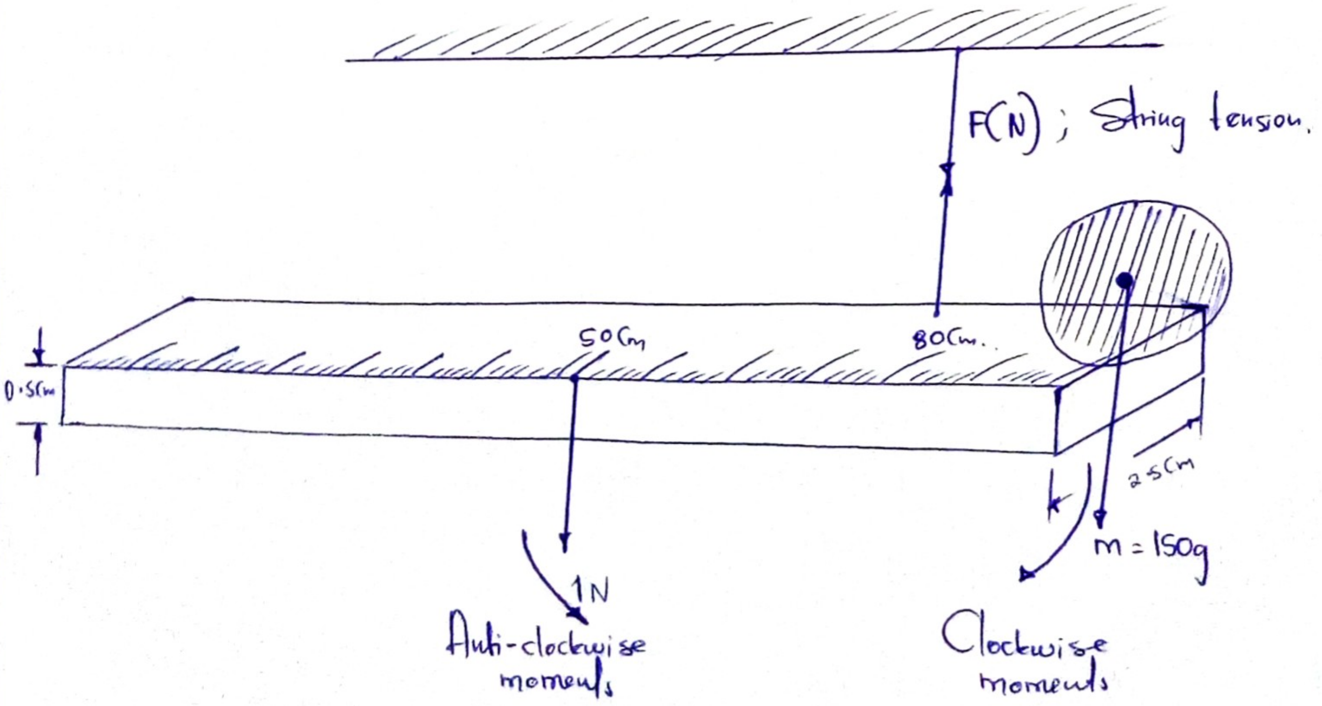
6(a) Density refers to the mass of a substance per unit volume, while relative density refers to the ratio of the density of a substance to that of water. 3 marks

(b)(i) Mass of the gas cylinder = 3.65×10^2 kg 3 marks

(ii) Density of the gas = 9.2×10^{-5} g/Cm³. 3 marks

7(a) The principle of moments states that: "For a system to be in equilibrium, the sum of clockwise moments acting about a point should be equal to the ~~sum of~~ anticlockwise moments acting about the same point. 2 marks

(b)



7 b) Length of the metre ruler = 100 Cm.

(I) Suspended at the 80 - Cm mark.

150 g mass.

Width = 2.5 Cm.

Thickness = 0.5 Cm.

Let M = Mass of the ruler.

So, its centre of gravity is at the 50 - Cm mark.

Moments about the point of suspension (80 - Cm)

Clockwise moments = $150g \times (100 - 80)$

$= 0.15kg \times 0.2m$

$= 1.5N \times 0.2m$

$= 0.3\ Nm.$

Anticlockwise moments = $M \times (80 - 50)$

$= M \times 0.3$

$= 0.3M$

$$\frac{0.3M}{0.3Nm} = \frac{0.3\ Nm}{0.3\ Nm}$$

$\therefore M = 1N$

$1N = 0.1kg$

$0.1kg = 100g.$

3 marks

Therefore, the mass of the metre rule is equal to 100 grams.

7(b)(II) Density of the metre ruler;

$\rho = \frac{m}{V}$ where $m = 100g$.

and $V = L \times w \times h = 100 \times 2.5 \times 0.5$

$= 125 \, cm^3$.

$\frac{100g}{125 \, cm^3} = 0.8 \, g/cm^3$

3marks

Therefore, the density of the metre rule is $0.8 \, g/cm^3$

(III) $1N \times 0.3 = T \times 0.3$

$\frac{0.3 \, Nm}{0.3} = \frac{0.3 \, T}{0.3}$

3marks

Therefore, the tension in the string is $0.3N$.

8(a) (I) A body tends to remain in its state of rest or in a uniform motion along a straight line unless acted upon by an external force.

(II) Force is a product of mass and acceleration.

2marks

(III) Action and reaction are equal and opposite.

(b) $m_1 = 8000kg$ $V_1 = 4ms^{-1}$

$M_2 = 10,000kg$ $V_2 = 2ms^{-1}$.

$M_1V_1 + M_2V_2 = v(M_1 + M_2)$

$(8000kg \times 4ms^{-1}) + (10,000kg \times 2ms^{-1}) = V(8000kg + 10,000kg)$

$32,000kgms^{-1} + 20,000kgms^{-1} = 18,000kg V$

$\frac{40,000 \, kgms^{-1}}{18,000kg} = \frac{18,000kg \, V}{18,000kg}$

8marks

$\therefore V = 2.2 \, ms^{-1}$

9(a) 1st Equation:

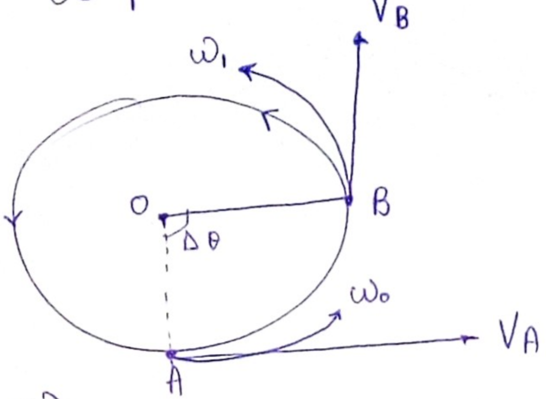
Let: ω_o = Initial angular speed at $t = 0$

ω = Final angular speed at $t \neq 0$

Then, angular acceleration can be defined as:

$$\alpha = \frac{\Delta\omega}{t} \quad ; \quad \Delta t = t$$

and $\Delta\omega = \omega_1 - \omega_o$



$$\frac{\alpha}{1} \times \frac{\omega_1 - \omega_o}{t}$$

$$\alpha t = \omega_1 - \omega_o$$

$$\boxed{\therefore \omega_1 = \omega_o + \alpha t}$$ —— Equation I

2 marks

Average angular speed; $\bar{\omega} = \frac{\omega_o + \omega_1}{2}$ —— (1)

And $\bar{\omega} = \frac{\text{Total Angular displacement } (\theta)}{\text{Total time taken } (t)}$

So that $\bar{\omega} = \frac{\theta}{t}$ —— (2)

Comparing the two equations;

$$\frac{\theta}{t} = \frac{\omega_o + \omega_1}{2}.$$

$$\theta = \left(\frac{\omega_o + \omega_1}{2}\right) t.$$

9(a) But $\omega_1 = \omega_0 + \alpha t$

$$\therefore \theta = \left(\frac{\omega_0 + \omega_0 + \alpha t}{2}\right) t$$

$$\theta = \left(\frac{2\omega_0 + \alpha t}{2}\right) t$$

$$\theta = \frac{\cancel{2}\omega_0 t}{\cancel{2}} + \frac{\alpha t^2}{2}$$

2 marks

$$\boxed{\therefore \theta = \omega_0 t + \frac{1}{2}\alpha t^2}$$ Equ. (II)

Recall: $\omega_1 = \omega_0 + \alpha t$

Squaring both sides: $\omega_1^2 = (\omega_0 + \alpha t)^2$

$$\omega_1^2 = \omega_0^2 + 2\omega_0 \alpha t + \alpha^2 t^2$$

$$= \omega_0^2 + 2\alpha\left(\omega_0 t + \frac{1}{2}\alpha t^2\right)$$

But $\omega_0 t + \frac{1}{2}\alpha t^2 = \theta$

2 marks

$$\boxed{\therefore \omega_1^2 = \omega_0^2 + 2\alpha\theta}$$ Equ. (III)

ACE Scanner

9. (b) (I) Data given -

Initial rotation = 1 rev/s = 1 rads^{-1} ;

Final rate of rotation = 8 rev/s = 8 rad s^{-1}

Time taken = 20 seconds

Angular acceleration of each wheel, α ;

$$\alpha = \frac{\Delta \omega}{t} = \frac{\omega_1 - \omega_0}{t}$$

$$= \frac{8 \text{ rad}s^{-1} - 1 \text{ rad}s^{-1}}{20 s}$$

$$= \frac{7 \text{ rad}s^{-1}}{20 s}$$

$$= \underline{\underline{0.35}} \text{ rad}s^{-2}$$

3 marks

(II) $V = r\omega$

$r = 350mm = 0.35m.$

$\omega = 8 \text{ rad}s^{-1}$

$\therefore V = 8 \times 0.35$

$V = 2.8 ms^{-1}$

3 marks

10 (a) (I) Sinking is when something which is denser than water drops beneath the ~~surface~~ and falls to the bottom, e.g. a stone. 1 mark

(II) Floating is ~~when~~ something stays on top of the water surface. 1 mark

(III) Upthrust – Is the force which pushes upwards an object submerged in a fluid. 1 mark

(IV) Buoyancy – Is the ability of an object to float when submerged in a fluid. 1 mark

(V) Real weight – Real weight = Upthrust + O ; Real weight is equal to the upthrust; and the floating body displaces its own weight of the fluid in which it floats. 1 mark

(VI) Apparent weight – Is the weight of an object in a fluid. 1 mark

(b) (I) Data given:

Weight of object in air = 2.5N. (Real weight)

Weight of object in water; (Apparent weight) = 2.2 N

Upthrust Force ; U = Real Weight, R – Apparent weight, A

$$U = R - A$$

$$U = 2.5N - 2.2N$$

$$U = 0.3N$$

2 marks

10b(II) R.D = $\frac{\text{Weight of substance in air}}{\text{Weight of displaced water}}$ = $\frac{\text{Weight of body in air}}{\text{Upthrust in water}}$

$\therefore$ R.D. = $\frac{2.5N}{0.3N}$ = $\underline{\underline{8.3}}$

From R.D. = $\frac{\text{Density of substance}}{\text{Density of water}}$;

R.D. = $\frac{x}{1000}$

$8.3 = \frac{x}{1000}$

$x = 8,300$

2marks

Therefore, the density of the object is $\underline{8,300}\ kg/m^3$

10(c)(I) Real weight = 60 N.

Apparent weight, A = 2.2 N.

Upthrust = Real Weight − Apparent weight

U = R − A

U = 60N − 2.2N

U = $\underline{\underline{57.8N}}$

3marks

(II) R.D. = $\frac{\text{Weight in air}}{\text{Upthrust}}$ = $\frac{60N}{57.8N}$ = 1.03.

$1.03 = \frac{x}{1000}$

$x = 1000 \times 1.03$

$x = 1030$

2marks

Therefore, the density of the object is $\underline{1030\ kg/m^3}$

MARKS DISTRIBUTION PER QUESTION.

Q1 10 marks @ 1 mark.
Q2 5 marks @ 1 mark.
SECTION A (15 marks)

SECTION B: (70 marks)

Q

3(a) 7 marks.

(b) 7 marks.

4(a) 4 marks

(b) 7 marks.

5(a) 3 marks

(b) 3 marks.

6(a) 3 marks.

(b)(I) 3 marks.

(II) 3 marks.

7(a) 2 marks.

(b) (I) 3 marks.

(II) 2 marks

(III) 1 mark

8 (a) 2 marks.

(b) 8 marks.

9(a) 6 marks.

(b)(I) 3 marks.

(II) 3 marks.

SECTION C (15 marks)

10(a) (I) 1 mark.

(II) 1 mark.

(III) 1 mark.

(IV) ; 1 mark

(V) 1. mark.

(VI) 1 mark.

(b) (I) 2 marks

(II) 2 marks.

(c) (I) 3 marks.

(II) 2 marks