Mechanics 2 – 2018: Tutorial Test 1

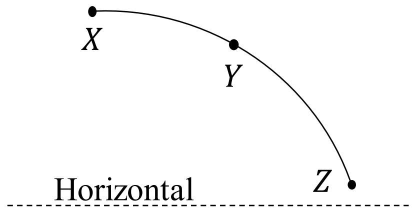
Initials and Surname:

Constant acceleration formulae

$v = u + at$; $s = u + \frac{1}{2}at^2$; $s = \frac{1}{2}(u + v)t$; $v^2 = u^2 + 2as$

Projectile motion

1. A stone is thrown point Z and follows the path XYZ shown below. The direction of the acceleration of the stone at point Y is: [2]



(A) ↘	(B) ↑	(C) ↓	(D) ↖	(E) ↗

2. An object is shot from the back of a flatbed truck moving at 20 m/s on a straight horizontal road. The launcher is aimed upward, perpendicular to the bed of the truck. The object lands [2]

(A) in front of the truck.
(B) inside the bed of the truck.
(C) behind the truck.
(D) either behind or in front of the truck, depending on the initial speed of the object.
(E) to the side of the truck.

3. A ball is projected with velocity 25 m s^{-1} at an angle of 70° above the horizontal from a point O on horizontal ground. The ball subsequently bounces once on the ground at a point P before landing at a point Q where it remains at rest. The distance PQ is 17.1 m.
   (i) Calculate the time taken by the ball to travel from O to P and the distance OP. [3]
   (ii) Given that the horizontal component of the velocity of the ball does not change at P, calculate the speed of the ball when it leaves P. [4]

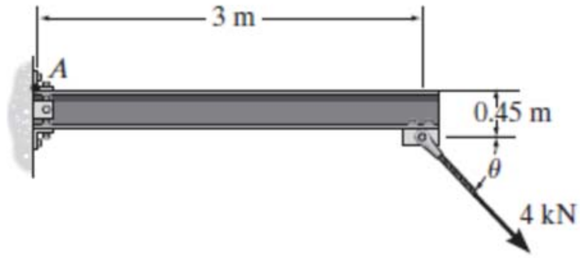
(i) $0 = (25\sin70)t - gt^2/2$	M1	Uses $0 = ut - gt^2/2$
$t = 4.7(0)$ s	A1	
$OP = (25\cos70 \times 4.7) = 40.2$ m	A1	
(ii) $t[=17.1/(25\cos70)] = 2$ s	B1	Finds time of flight
$-v = v - g \times 2$	B1ft	Finds vertical component of speed
$V^2 = 10^2 + (25\cos70)^2$	M1	For squaring components
$V = 13.2$ ms^{-1}	A1 [4]	

Moments

1. Moment of a force F is defined as [2]

(A) Product of force F and the distance d from the force to the pivot point
(B) F/d with d the perpendicular distance from the force to the pivot point
(C) Product of force F and perpendicular distance d from line of action of force to pivot
(D) F/d with d the perpendicular distance from line of action of force to pivot

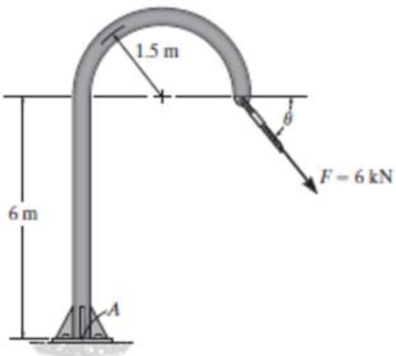
2. If $\theta = 45°$, determine the moment produced by the 4-kN (4 000 N) force about point A. [2]



$$\circlearrowleft + M_A = 4\cos 45°(0.45) - 4\sin 45°(3)$$
$$= -7.21\text{ kN}\cdot\text{m} = 7.21\text{ kN}\cdot\text{m (clockwise)}$$

(Or 7210 N · m (clockwise))

3. The member is subjected to a force of $F = 6\,100\ N$. If $\theta - 45°$, determine the moment produced by F about point A. [2]

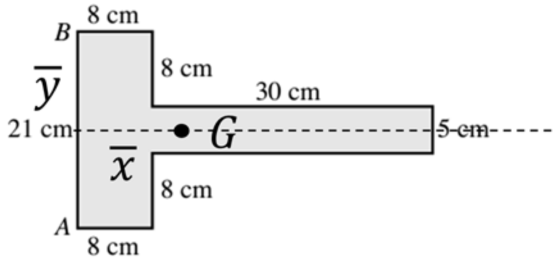


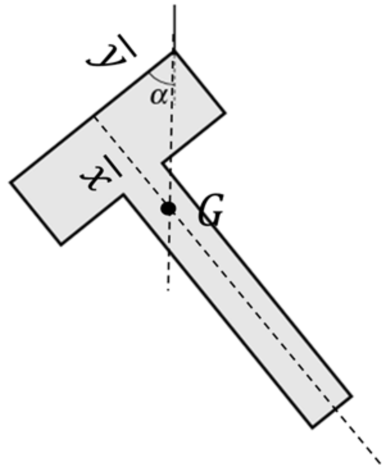
$$\circlearrowleft + M_A = -6\cos 45°(6) - 6\sin 45°(3)$$
$$= -38.18\text{ kN}\cdot\text{m} = 38.2\text{ kN}\cdot\text{m (clockwise)}$$

(Or 38200 N · m (clockwise))

Centre of mass and equilibrium

1. The diagram shows a uniform lamina; all the corners are right angles. The lamina is suspended in equilibrium as shown in the diagram on the right. Calculate the angle α. The dimensions of the lamina are given in the diagram on the left. [6]





From symmetry: $\bar{y} = \frac{21}{2} = 10.5$ cm

$$\bar{x} = \frac{4\cdot(8\cdot 21)K + \left(8+\frac{30}{2}\right)(5\cdot 30)K}{\left((8\cdot 21)+(5\cdot 30)\right)K} = 12.982 \text{ cm}$$

(Note: $K = \rho t$ for a lamina with thickness t and density ρ. You do NOT have to include it and may only work with the areas)

$$\therefore \tan\alpha = \frac{\bar{x}}{\bar{y}} = \frac{12.982}{10.5}$$

$$\therefore \alpha = \tan^{-1}\left(\frac{12.982}{10.5}\right) = 51°$$