6.

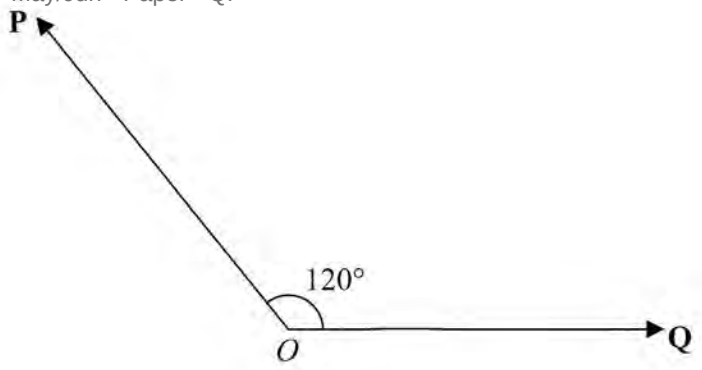


Figure 4

Two forces **P** and **Q** act on a particle at O. The angle between the lines of action of **P** and **Q** is 120° as shown in Figure 4. The force **P** has magnitude 20 N and the force **Q** has magnitude X newtons. The resultant of **P** and **Q** is the force **R**.

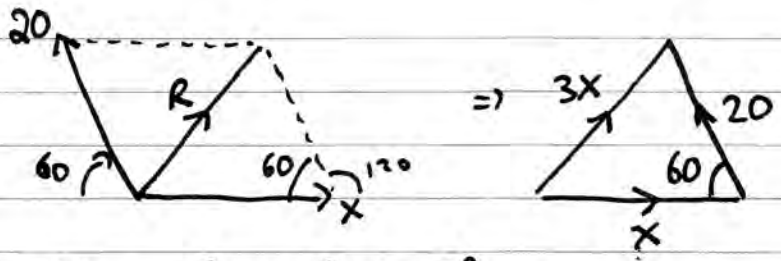
Given that the magnitude of **R** is $3X$ newtons, find, giving your answers to 3 significant figures

(a) the value of X,

(5)

(b) the magnitude of $(\mathbf{P} - \mathbf{Q})$.

(4)



$\cos 60 = \frac{x^2 + 20^2 - (3x)^2}{2(x)(20)} \Rightarrow 20x = x^2 + 400 - 9x^2$

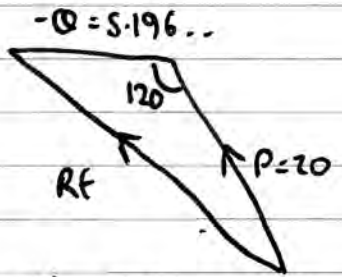
$\therefore 8x^2 + 20x - 400 = 0$

$\Rightarrow 2x^2 + 5x - 100 = 0$

$\therefore x = \frac{-5 \pm \sqrt{5^2 - 4 \times 2 \times -100}}{4}$

$x = 5.93$

b)



$|P-Q|^2 = 20^2 + (5.93)^2 - 2(20)(5.93...)\cos 120$

$\therefore |P-Q| = 23.5$

7.

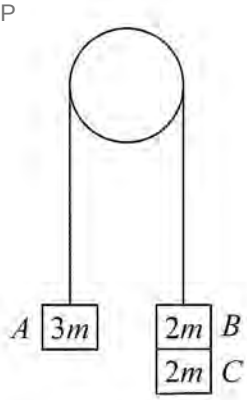


Figure 5

Three particles A, B and C have masses $3m$, $2m$ and $2m$ respectively. Particle C is attached to particle B. Particles A and B are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut and the hanging parts of the string vertical, as shown in Figure 5. The system is released from rest and A moves upwards.

(a) (i) Show that the acceleration of A is $\frac{g}{7}$

(ii) Find the tension in the string as A ascends.

(7)

At the instant when A is 0.7 m above its original position, C separates from B and falls away. In the subsequent motion, A does not reach the pulley.

(b) Find the speed of A at the instant when it is 0.7 m above its original position.

(2)

(c) Find the acceleration of A at the instant after C separates from B.

(4)

(d) Find the greatest height reached by A above its original position.

(3)

a) $3mg \leftarrow (3m) \xrightarrow{a} (4m) \rightarrow 4mg$ $\quad T \; T$

$\vec{RF} = mg = 7ma$

$\therefore a = \frac{1}{7}g$ ✓

ii) $T - 3mg = 3ma \Rightarrow T = \frac{3}{7}mg + 3mg$

$\therefore T = \frac{24}{7}mg$ ✓

b) $s = 0.7$, $u = 0$, v, $a = 1.4$, t

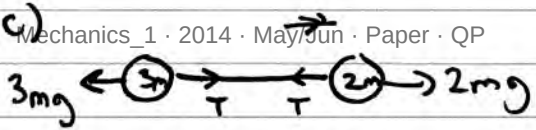
$v^2 = u^2 + 2as$

$v^2 = 2(1.4)(0.7)$

$v^2 = 1.96$

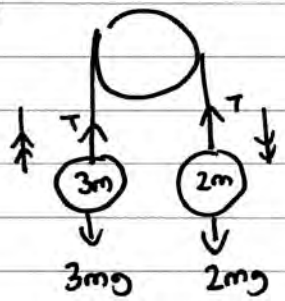
$v = 1.4$

c)



$3mg - 2mg$

c)



$2mg - 3mg = 5a$

$-mg = 5ma \therefore a = -\frac{1}{5}g$

d) $s =$
$u = 1.4$
$v = 0$
$a = -1.96$
t

$v^2 = u^2 + 2as$

$0 = 1.4^2 + 2(-1.96)s$

$s = \frac{1.4^2}{3.92} \therefore s = 0.5m$

$\therefore gh = 1.2m$ above starting point