This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

# Stage Exam 02

## 19DEC2022

| Do NOT write in this box. Your MARK will be placed here. |
|---|
| |

| | |
|---|---|
| Subject : | A Level Maths : M1Mech |
| Class : | 11A and 12A |
| Teacher : | Dr Ruth Brett |
| Duration : | 40 miniues |
| Write with black pen on squared paper. You may use pencil for diagrams/sketch graphs. Remember that g = 9.8 m^2. | |
| Your name : | *Time taken to complete exam* |
| Your Class : | |
| Exam Room : | |
| How many sheets, including cover sheet : | |

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

**1.** A particle, $P$, is projected vertically upwards with speed $U$ from a fixed point, $O$. At the instant when $P$ reaches its greatest height $H$ above $O$, a second particle, $Q$, is projected with speed $\frac{1}{2}U$ vertically upwards from $O$.

($a$) Find $H$ in terms of $U$ and $g$.

**(2)**

($b$) Find, in terms of $U$ and $g$, the time between the instant when $Q$ is projected and the instant when the two particles collide.

**(6)**

**(Total 8 marks)**

---

**2.** Two trains, $P$ and $Q$, move on horizontal parallel straight tracks. Initially both are at rest in a station and level with each other. At time $t = 0$, $P$ starts off and moves with constant acceleration for 10 s up to a speed of 25 m s$^{-1}$ and then moves at a constant speed of 25 m s$^{-1}$. At time $t = 20$, where $t$ is measured in seconds, train $Q$ starts to move in the same direction as $P$. Train $Q$ accelerates with the same initial constant acceleration as $P$, up to a speed of 40 m s$^{-1}$ and then moves at a constant speed of 40 m s$^{-1}$. Train $Q$ overtakes $P$ at time $t = T$, after both trains have reached their constant speeds.

($a$) Sketch, on the same axes, the speed-time graphs of both trains for $0 \leqslant t \leqslant T$.

**(3)**

($b$) Find the value of $t$ at the instant when both trains are moving at the same speed.

**(2)**

($c$) Find the value of $T$.

**(8)**

**(Total 13 marks)**

---

**3.** [*In this question* **i** *and* **j** *are horizontal unit vectors due east and due north respectively.*]

A particle $P$ moves with constant acceleration $(-2\mathbf{i} + 3\mathbf{j})$ m s$^{-2}$. At time $t$ seconds, the velocity of $P$ is $\mathbf{v}$ m s$^{-1}$. When $t = 0$, $\mathbf{v} = 10\mathbf{i} + 4\mathbf{j}$.

($a$) Find the direction of motion of $P$ when $t = 6$, giving your answer as a bearing to the nearest degree.

**(5)**

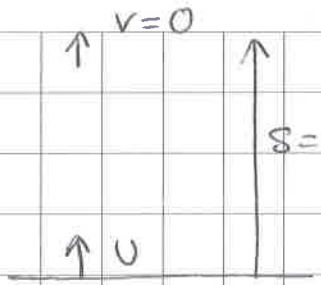
($b$) Find the value of $t$ when $P$ is moving north east.

**(4)**

**(Total 9 marks)**

1.

a) Consider P

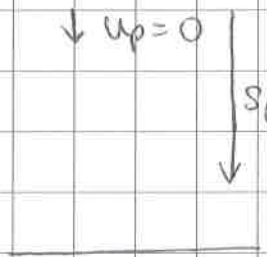



$v^2 = u^2 + 2as$

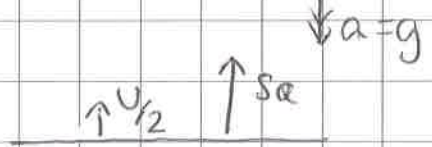
$0 = U^2 - 2gH$ ①

$H = \frac{U^2}{2g}$ ①

b) For P




For Q




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

$S_P = 0 + \frac{g}{2}t^2 = \frac{g}{2}t^2$ M① A①

$S_Q = \frac{U}{2}t - \frac{g}{2}t^2$ M① A①

But we know $S_P + S_Q = H$

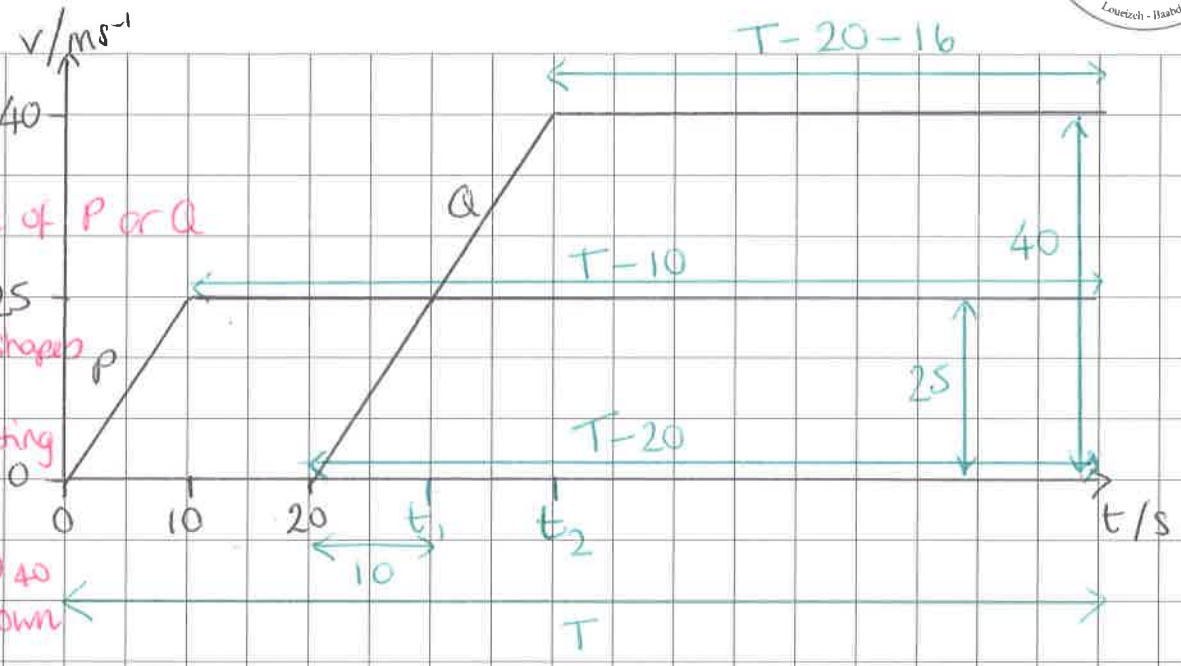
$\therefore \frac{g}{2}t^2 + \frac{U}{2}t - \frac{g}{2}t^2 = H$ M①

$\frac{Ut}{2} = H$ But we also know $H = \frac{U^2}{2g}$

$\therefore \frac{Ut}{2} = \frac{U^2}{2g}$ $\therefore t = \frac{U}{g}$ ①

Green indicates work for (b) and (c)

2 a)




① Shape of P or Q

① Both shapes and intersecting

① 10, 20, 25 AND 40 all shown

b) Since Q accelerates at the same rate as P, it will also take 10s to reach 25ms$^{-1}$

$\therefore t_1 = 10 + 20 = 30$ ① ①

c) When Q overtakes P, time = T and the distances are equal. We find the distance moved from the area under the line.

for P $s_P = \left(\frac{T + T - 10}{2}\right)(25) = 25T - 125$ M① A①

for Q, we first need to find $t_2$

$a_Q = a_P = \frac{25-0}{10} = 2{\cdot}5\text{ms}^{-2}$

So for Q $2{\cdot}5 = \frac{40-0}{t}$ M① A① $t = \frac{40}{2{\cdot}5} = 16$ A① [or use "36"]

$\therefore s_Q = \left(\frac{T-20+T-20-16}{2}\right)(40) = 40T - 56(40) = 40T - 1120$ A①

$S_P = S_Q$

$40T - 1120 = 25T - 125$ (1)

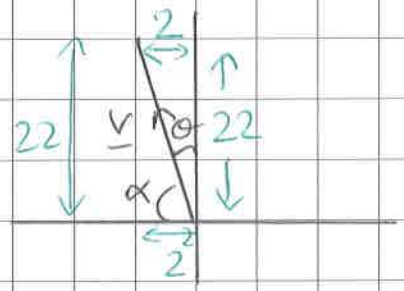
$15T = 995$

$T = 66\frac{1}{3}$ s (1) or 66·3 s

3 a) $\underline{v} = \underline{u} + \underline{a}t = 10\underline{i} + 4\underline{j} + t(-2\underline{i} + 3\underline{j})$ M(1)

$\underline{v} = (10 - 2t)\underline{i} + (4 + 3t)\underline{j}$

When $t = 6$ $\underline{v} = (10 - 12)\underline{i} + (4 + 18)\underline{j} = -2\underline{i} + 22\underline{j}$ A(1)




$\tan\theta = \frac{2}{22} = \frac{1}{11}$ M(1) $\theta = 5°$ A(1)

$\therefore$ bearing $= 360 - 5 = 355°$ (1)

OR $\tan\alpha = 22/2 = 11$ $\theta = 85°$ $\therefore$ bearing $= 270 + 85 = 355°$

b) When moving north east, $\underline{i}$ components = $\underline{j}$ components

$\underline{v} = (10 - 2t)\underline{i} + (4 + 3t)\underline{j}$ M(1) A(1)

$\therefore 10 - 2t = 4 + 3t$ A(1)

$6 = 5t$ $t = 1{\cdot}2$ s (1)