This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

Lighting the fires that burn for eternity

Loueizeh - Baabda

Lebanon Evangelical School

for Boys and Girls Loueizeh - Baabda

Stage Exam 01

17FEB2025

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 :	1 hour

Remember that you must include sufficient working, or you may get no credit for a correct answer.

You are to answer the questions to this exam on : Squared paper

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.

Where necessary, use $g = 9.8\ ms^{-2}$

1. At time $t = 0$ a ball is projected vertically upwards from a point O and rises to a maximum height of 40 m above O. The ball is modelled as a particle moving freely under gravity.

(a) Show that the speed of projection is 28 m s^{-1}.

(3)

(b) Find the times, in seconds, when the ball is 33.6 m above O.

(5)

(Total 8 marks)

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2. A girl runs a 400 m race in a time of 84 s. In a model of this race, it is assumed that, starting from rest, she moves with constant acceleration for 4 s, reaching a speed of 5 m s^{-1}. She maintains this speed for 60 s and then moves with constant deceleration for 20 s, crossing the finishing line with a speed of V m s^{-1}.

(a) Sketch a speed-time graph for the motion of the girl during the whole race.

(2)

(b) Find the distance run by the girl in the first 64 s of the race.

(3)

(c) Find the value of V.

(5)

(Total 10 marks)

Q3 is on the next page

3. [*In this question* **i** *and* **j** *are unit vectors due east and due north respectively. Position vectors are given relative to a fixed origin O.*]

Two ships P and Q are moving with constant velocities. Ship P moves with velocity $(2\mathbf{i} - 3\mathbf{j})$ km h^{-1} and ship Q moves with velocity $(3\mathbf{i} + 4\mathbf{j})$ km h^{-1}.

(*a*) Find, to the nearest degree, the bearing on which Q is moving.

(2)

At 2 p.m., ship P is at the point with position vector $(\mathbf{i} + \mathbf{j})$ km and ship Q is at the point with position vector $(-2\mathbf{j})$ km.

At time t hours after 2 p.m., the position vector of P is $\mathbf{p}$ km and the position vector of Q is $\mathbf{q}$ km.

(*b*) Write down expressions, in terms of t, for

(i) $\mathbf{p}$,

(ii) $\mathbf{q}$,

(iii) $\overrightarrow{PQ}$.

(5)

(*c*) Find the time when

(i) Q is due north of P,

(ii) Q is north-west of P.

(4)

(Total 11 marks)

Q4 is on the next page

Where necessary, use g = 9.8 ms^{-2}

4.

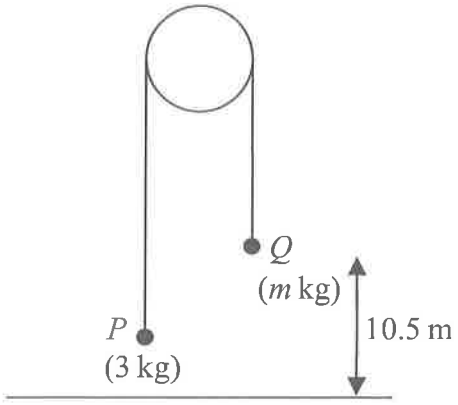


Figure 5

Two particles P and Q have masses 3 kg and m kg respectively ($m > 3$). The particles 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.

The particle Q is at a height of 10.5 m above the horizontal ground, as shown in Figure 5.

The system is released from rest and Q moves downwards. In the subsequent motion P does not reach the pulley. After the system is released, the tension in the string is 33.6 N.

(*a*) Show that the magnitude of the acceleration of P is 1.4 m s^{-2}.

(3)

(*b*) Find the value of m.

(3)

(*c*) State how you used the information that the string is inextensible.

(1)

The system is released from rest at time $t = 0$. At time T_1 seconds after release, Q strikes the ground and does not rebound. The string goes slack and P continues to move upwards.

(*d*) Find the value of T_1

(3)

At time T_2 seconds after release, P comes to instantaneous rest.

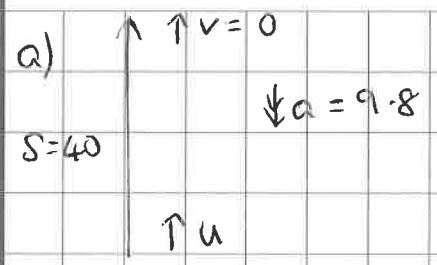
(*e*) Find the value of T_2
(Note, this is a two-step calculation)

(3)

(Total 13 marks)

(1)

a)



$s = 40 \quad u = ? \quad v = 0 \quad a = -9.8$

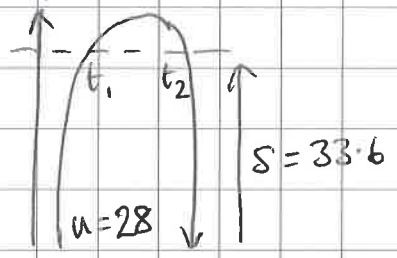
$v^2 = u^2 + 2as$

$0 = u^2 + 2(-9.8)(40)$ M(1) A(1)

$u^2 = 784$

$u = \sqrt{784} = 28 \text{ ms}^{-1}$ A(1)

b)



↓ a = 9·8

$s = 33.6 \quad u = 28 \quad a = -9.8 \quad t = ?$

$s = ut + \frac{1}{2}at^2$ M(1) A(1)

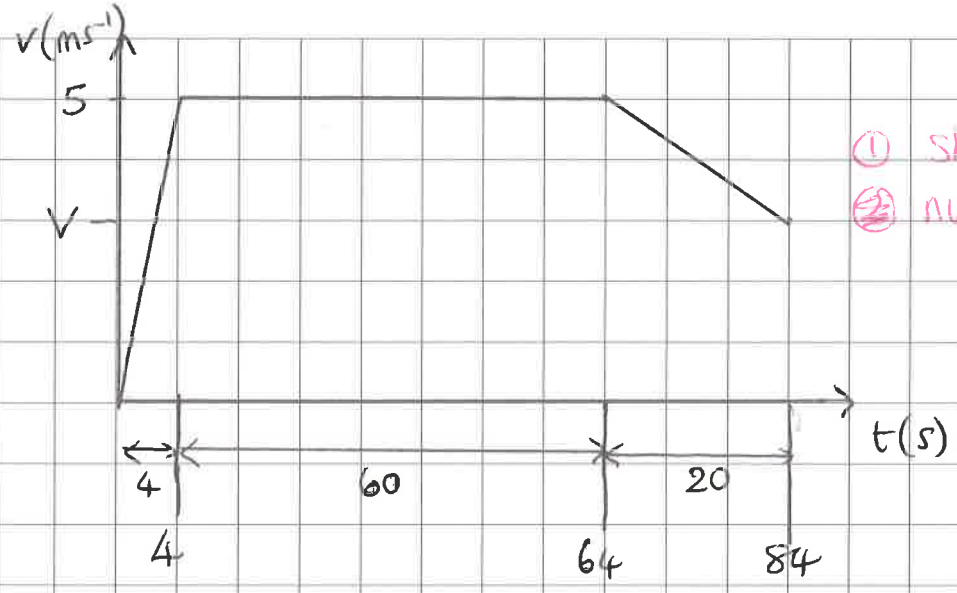
$33.6 = 28t + \frac{(-9.8)}{2}t^2$

$4.9t^2 - 28t + 33.6 = 0$ M(1)

$t = 1.71 \text{ s}$ A(1)

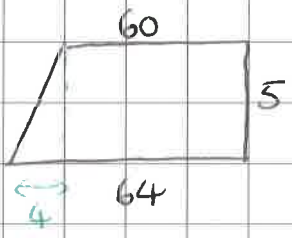
$t = 4 \text{ s}$ A(1)

(2)

a) 

① shape
② numbers ①

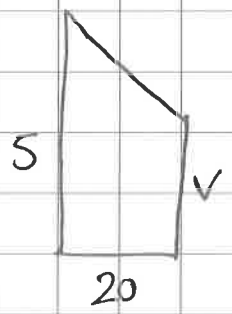
b) In first 64s, distance = area under line



$s = \frac{1}{2}(64+60)(5) = 62 \times 5 = 310\,m$ M① A① A①

or $\frac{1}{2}(4 \times 5) + (60 \times 5) = 310\,m$

c) In last 20s, distance = $400 - 310 = 90m$ A① allow ecf



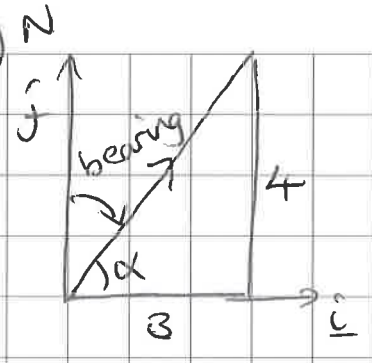
$90 = \frac{1}{2}(5+v)(20)$ M① A① A①

$90 = 50 + 10v$

$10v = 40$

$v = 4\,ms^{-1}$ A① correct answer only

③ a)



$\tan\alpha = \frac{4}{3}$ M①

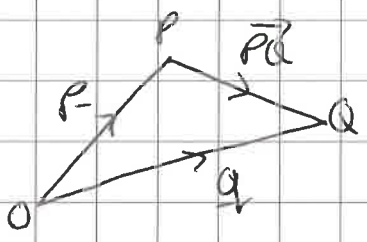
$\alpha = 53°$

so bearing $= 90 - 53 = 037°$ A①

b) i) $\underline{p} = \underline{i} + \hat{j} + t(2\underline{i} - 3\hat{j}) = (1+2t)\underline{i} + (1-3t)\hat{j}$ M① A①

ii) $\underline{q} = -2\hat{j} + t(3\underline{i} + 4\hat{j}) = 3t\underline{i} + (4t-2)\hat{j}$ A①

iii)



$\vec{PQ} = -\underline{p} + \underline{q}$

M①

$\vec{PQ} = -\underline{i} - 2t\underline{i} - \hat{j} + 3t\hat{j} + 3t\underline{i} + 4t\hat{j} - 2\hat{j}$

$\vec{PQ} = (t-1)\underline{i} + (7t-3)\hat{j}$ A①

c) i) When Q is north of P, $\underline{i}$ components of $\underline{p}$ and $\underline{q}$ are equal.

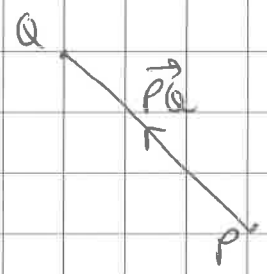
$1 + 2t = 3t$ M①

$1 = t$ so time = 3pm A①

or $\underline{i}$ component of $\vec{PQ} = 0$

$t - 1 = 0$ $t = 1$ so time = 3pm

ii) When Q is north-west of P



$-\underline{i}$ component of $\vec{PQ}$ = $\underline{j}$ component of $\vec{PQ}$

$$-(t-1) = 7t - 3 \quad \text{M}①$$

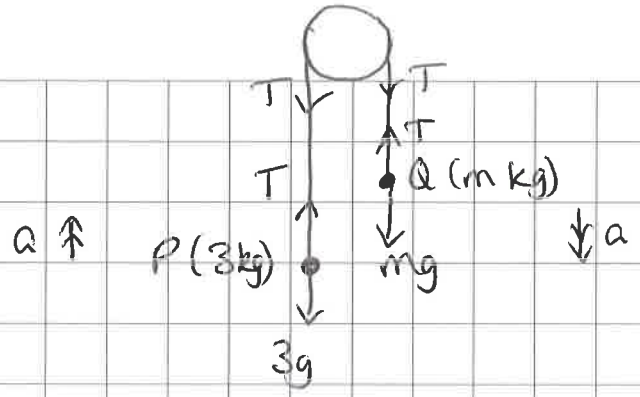
$$-t + 1 = 7t - 3$$

$$4 = 8t$$

$$t = \frac{4}{8} = 0.5$$

So time = 2:30 A①

(4)



a) for P $\Sigma F = ma$

$T - 3g = 3a$ M(1)

$T = 33.6$

$33.6 - 3(9.8) = 3a$ A(1)

$a = \frac{4.2}{3} = 1.4\ ms^{-2}$ A(1)

b) for Q $\Sigma F = ma$

$mg - T = ma$ M(1)

$T = 33.6$ and $a = 1.4$

$9.8m - 33.6 = 1.4m$ A(1)

$8.4m = 33.6$

$m = \frac{33.6}{8.4} = 4\ kg$ A(1)

c) Acceleration of both particles is the same. A(1)

d) For Q $u = 0$ $s = 10.5$ $a = 1.4$ $t = ?$

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

$10.5 = 0 + \frac{1.4}{2}t^2$ M(1) A(1)

$t^2 = \frac{10.5}{0.7}$ $t = \sqrt{15} = 3.87s$ or $3.9s$

A(1)

e) For P What is v at time T_1?

$u = 0 \quad a = 1.4 \quad t = 3.87 \quad v = ?$

$v = u + at$

$v = 0 + 1.4(3.87) = 5.42 \text{ ms}^{-1}$ m①

or

$u = 0 \quad a = 1.4 \quad s = 10.5 \quad v = ?$

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

$v^2 = 0 + 2(1.4)(10.5) = 29.4$

$v = \sqrt{29.4} = 5.42 \text{ ms}^{-1}$

THEN new situation

$u = 5.42 \quad v = 0 \quad a = -9.8 \quad t = ?$

$v = u + at$

$0 = 5.42 - 9.8t$ m①

$t = \frac{5.42}{9.8} = 0.55$

T_2 = time from ~~rest~~ release

so $T_2 = T_1 + t = 3.87 + 0.55 = 4.42\text{s}$ A①