# IYGB GCE

## Mathematics FM1

## Advanced Level

## Practice Paper R

Difficulty Rating: 3.58/1.6529

## Time: 1 hour 30 minutes

**Candidates may use any calculator allowed by the regulations of this examination.**

**Information for Candidates**

This practice paper follows closely the Pearson Edexcel Syllabus, suitable for first assessment Summer 2018.

The standard booklet "Mathematical Formulae and Statistical Tables" may be used.
Full marks may be obtained for answers to ALL questions.
The marks for the parts of questions are shown in round brackets, e.g. **(2)**.
There are 7 questions in this question paper.
The total mark for this paper is 75.

**Advice to Candidates**

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.
Non exact answers should be given to an appropriate degree of accuracy.
The examiner may refuse to mark any parts of questions if deemed not to be legible.

**Question 1**

A smooth uniform sphere $P$ is moving on a smooth horizontal plane when it collides obliquely with an identical sphere $Q$ which is at rest on the plane.

Immediately before the collision $P$ is moving with speed $u$ $\text{ms}^{-1}$ in a direction which makes an angle of $60°$ with the line joining the centres of the spheres.

The coefficient of restitution between the spheres is $7-4\sqrt{3}$.

**a)** Show clearly that after the collision $P$ is moving at an angle of $75°$ with the line joining the centres of the spheres. **(8)**

After the collision the respective speeds of $P$ and $Q$ are $U$ $\text{ms}^{-1}$ and $V$ $\text{ms}^{-1}$.

It is further given that $u=\left(6\sqrt{2}+2\sqrt{6}\right)$ $\text{ms}^{-1}$.

**b)** Find the value of $U$. **(4)**

**c)** Show further that $uV=4U$. **(4)**

---

**Question 2**

A car of mass 1300 kg is travelling on a straight road which lies on the line of greatest slope of a plane inclined at an angle $\theta$ to the horizontal, where $\sin\theta=\frac{1}{10}$.

The total non gravitational resistance experienced by the car is assumed to be a constant force of magnitude of 400 N. The engine of the car is working at the constant rate of 30 kW.

The car is passing through the point $A$ with a speed $10$ $\text{ms}^{-1}$ and continues to accelerate up the plane, passing through the point $B$ with speed 30 $\text{ms}^{-1}$, 30 s after passing through $A$.

By modelling the car as a particle, find …

**a)** … the acceleration of the car at $A$. **(4)**

**b)** ... the distance $AB$. **(7)**

---

**Question 3**

A smooth sphere $P$ of mass $m$ is moving with speed $u$ on a smooth horizontal plane when it collides directly with a smooth sphere $Q$ of mass $3m$, which is initially at rest. The spheres are modelled as particles and the coefficient of restitution between the two spheres is $e$.

**a)** Find, in terms of $e$ and $u$, the speeds of the two spheres after their collision. **(7)**

It is now given that $P$ reverses direction as a result of the collision.

**b)** State the range of the possible values of $e$. **(3)**

After the collision, $Q$ strikes at right angles a fixed smooth vertical wall, and rebounds at right angles.

The coefficient of restitution between the $Q$ and the wall is $2e$.

**c)** Show that there will always be another collision between $P$ and $Q$. **(5)**

---

**Question 4**

Two smooth particles, $A$ and $B$ of respective masses $2m$ kg and $5m$ kg, are moving in the same straight line and in opposite directions.

The motion takes place on a smooth horizontal surface.

The speeds of $A$ and $B$ are $8\ \text{ms}^{-1}$ and $3\ \text{ms}^{-1}$, respectively.

There is a direct collision between $A$ and $B$.

If, after the collision, the speed of one particle is twice as large as the speed of the other particle determine the possible values of he speed of $B$, after the collision. **(8)**

---

**Question 5**

A particle $P$, of mass $m$, is attached to one end of a light elastic string of natural length 0.5 m and modulus of elasticity $2mg$. The other end of the string is attached to a fixed point $A$ on a rough horizontal surface.

$P$ is held at a point $B$, where $|AB| = 0.5$ m and given a speed of 1.4 $\text{ms}^{-1}$ in the direction $AB$.

$P$ comes at rest at the point $C$.

Determine whether this position of rest is instantaneous or permanent. **(10)**

---

**Question 6**

Two identical elastic strings $AB$ and $BC$ are fastened together at $B$. The natural length and modulus of elasticity of each of the strings are $a$ and $2mg$, respectively.

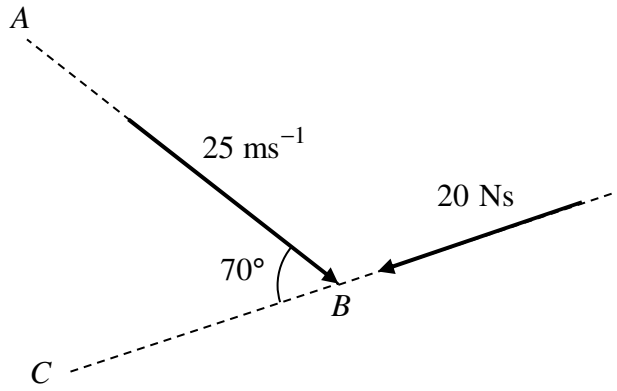
The end $A$ of the composite string is attached to a ceiling and the end $C$ is attached to a floor, so that $ABC$ lies in a vertical line where $|AC| = ka$.

Finally a particle of mass $m$ is attached to $B$ so that when the particle is in equilibrium $|BC| = \frac{7}{4}a$.

Determine the value of $k$. **(6)**

---

**Question 7**




The figure above shows the plan of the path of a ball of mass 0.2 kg, moving along $AB$ with constant speed 25 ms$^{-1}$.

At $B$ the ball receives an impulse of magnitude 20 Ns in the direction $BC$, where $\measuredangle ABC = 70°$, as shown in the figure.

The points $A$, $B$ and $C$, which lie on the same horizontal plane and the ball is modelled as a particle moving without any resistance, on the same horizontal level.

**a)** Find the speed of the ball after it receives the impulse. **(6)**

**b)** Determine the acute angle the speed of the ball makes with the line $AB$, after it receives the impulse. **(3)**