FURTHER MATHEMATICS

General Certificate of Education (New)

Summer 2018

Advanced Subsidiary/Advanced

FURTHER MECHANICS A - AS UNIT 3

General Comments

The standard of this paper compares favourably with previous legacy mechanics papers. Therefore, all questions should be accessible to candidates and many high-scoring scripts were seen.

Nevertheless, this turned out to be a challenging paper, mainly due to a lack of the necessary algebraic skills required for Further Mathematics. However, this was the first assessment of this unit in the new specification and was taken primarily by candidates at the end of the first year of a two year programme of study.

Comments on individual questions

1. This was by far the best received question on the paper and generally well done by almost all candidates.

   For part (*b*), sign errors were frequent in both the conservation of momentum and the restitution equations, but the most common error was not recognising that objects *A* and *B* have opposing velocities.

   Candidates who used the ratio method to find e, the coefficient of restitution, were less successful as sign errors were much more common.

   Parts (*c*), (*d*) and (*e*) were generally well answered. In particular, for part (*d*), some candidates who made earlier mistakes were content when their solutions indicated a gain in energy.

2. Very few candidates managed to achieve full marks on this question. One of the main problems was due to the resistance to motion being dependent upon velocity.

   Some common responses were:

   - writing $R = v^2$ leading to expressions such as

     $$\frac{P}{14} - 75g - 196 = 0 \quad \text{and} \quad \frac{P}{28} - 75g - 784 = 0;$$

   - using one common resistance so that

     $$\frac{P}{14} - 75g - R = 0 \quad \text{and} \quad \frac{P}{28} - 75g + R = 0;$$

   - not realising that the tractive force is dependent upon the velocity so that

     $$F - 75g - 196k = 0 \quad \text{and} \quad F - 75g + 784k = 0.$$

3. In part (*a*) of this question, most candidates were aware that conservation of energy was required to connect potential and elastic energy. Relatively few included an incorrect term involving a kinetic energy. Unfortunately, in many cases, candidates' points of reference were ambiguous.

   In part (*b*), overall, candidates correctly stated the necessary assumption, yet surprisingly many did not state the correct distance *AP*.

4. For part (*a*), almost all candidates recognised that differentiation was required to obtain an expression for the velocity vector. They also knew that this vector is zero when the particle is at rest. Disappointingly, very few candidates realised that for a vector to be zero, all its components must also be zero. Therefore, very few candidates were able to determine *any* values of t such that the particle is at rest. A few candidates decided to look at

$$v^2 = 34\cos^2 t + 64\sin^2 2t = 0.$$

   and hence were unable to solve the resulting equation as it involved a compound angle formula.

   For those who correctly identified that the individual components could simply be equated to zero, many gave responses in degrees.

   Parts (*b*) and (*c*) were generally done very well. Notably, few candidates spotted the fact that the required force in part (*c*) could have been obtained by differentiating their expression for momentum in part (*b*).

5. Responses to this question were either very good or extremely poor, possibly since it was in a purely algebraic setting. The main error was in establishing the potential energy component(s) for the energy equation in part (*a*).

   Many candidates worked relative to the base of the circle and hence initially obtained the equivalent correct response below

$$\frac{1}{2}mu^2 + mgl\left(1-\cos 60^\circ\right) = \frac{1}{2}mv^2 + mgl\left(1-\cos\theta\right).$$

   Sadly, sign errors were frequent when rearranging such equations and many interchanged u and v at various stages of their solutions.

   Some candidates treated the problem as if motion started at the bottom of the circular path instead of at 60° to the downward vertical.

   In parts (*b*) and (*c*), most candidates were aware of the concepts required. However, many candidates were unable to succinctly describe the motion of the particle after circular motion breaks down.

6. Efforts were generally disappointing in this question, especially since there was no tendency to sideslip.

For part (*a*), many candidates erroneously opted to resolve perpendicular to the plane or along the plane. Therefore, $R = 1200g\cos 60^{\circ}$ was frequently seen.

As expected, misconceptions in part (*a*) were mirrored in part (*b*). However, once the radius was found, candidates were generally able to find the angular speed, correctly stating its units.

Overall for part (*c*), candidates were able to recognise that, without appropriate assumptions, the radius would differ. However, many candidates were unable to provide an assumption, other than ‘no friction’.