L-Università ta' Malta

MATSEC
Examinations Board

Examiners’ Report

IM Applied Mathematics

First Session 2021

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A. STATISTICAL INFORMATION

The total number of candidates who registered to sit for Applied Mathematics was **40**.

Table 1 shows the distribution of grades for the First 2021 session of the examination

GRADE	A	B	C	D	E	F	ABS	TOTAL
NUMBER	4	7	3	3	2	15	6	40
% OF TOTAL	10.0	17.5	7.5	7.5	5.0	37.5	15.0	100

Table 1: Distribution of grades for Applied Mathematics 2021 First Session

B. COMMENTS

Question 1

Most candidates correctly drew the forces acting on the square.

a) In order to obtain the single force acting through point P, some failed to properly resolve in the i and j direction. Although the question explicitly states "System reduces to a single force" hence implying there is a resultant, some equated the *i* and *j* components to zero to find F.
The original system moments about a point, (in this case it would have been easier to find the moments about point P) equals the moment of the resultant about the same point. Hence F would be found.

b) Knowing the magnitude of F (still along SQ), the resultant of the forces acting can be found in magnitude and direction with (Below) PQ, using Pythagoras' theorem and $\tan^{-1}$ for the angle.

Question 2

The question described a system of two elastic strings AB and BC in "equilibrium", and explicitly states that C is 2.5 m below A. The only possible way that the system rests in equilibrium is if A → B → C, are colinear in a vertical plane.

Some candidates drew the diagram with A and C in the same horizontal plane and B below, whilst others drew A vertically below C, but drew B on the left or right hand side. The latter configuration is not a system in equilibrium because there is no force pulling B to the side.

Once the layout is established half of the candidates gave the correct equilibrium of forces in the vertical plane as $T_{AB} = 3g + T_{BC}$. Few did not recall that $T = \lambda x/L$. whilst those who appreciated that the λ and L are different for each elastic string, some did not appreciate that the extension x, for each string will be different.

Question 3

The question was generally answered well. The question described a simple setup of a rod resting on a smooth ground and smooth peg. The resulting rod AB rests at an inclined angle of $\sin^{-1}$ (1/2). Most of the candidates, who drew the rod inclined, drew the horizontal force P correctly (parallel) to the ground and the weight of 8g acting vertically downwards at the midpoint of rod AB. The biggest problem encountered was drawing the reaction forces. Many drew the reaction at A, on the ground correctly, as perpendicular to the ground, but at point B since the rod is tangential to the peg, then the reaction force at B is also perpendicular to the rod. Although many knew the conditions for equilibrium, $\sum X = 0$, $\sum Y = 0$ and $\sum M = 0$, only few obtained fully correct numerical answers.

Question 4

The question was generally answered well.

a) Two square laminae of same thickness but different densities are glued **ON** each other with corners D coincident. The common mistakes were that either the different densities or areas were omitted from the calculations. Barring these mistakes, the method of solution was generally known.

b) Attention had to be paid that when suspended from A the question asked for the angle AD (not AB) makes with the vertical.

Question 5

Question was about the reaction time and the scenario of a car braking to arrive to traffic lights.

a) There are many methods of approach to achieve the total distance travelled for the car to come to rest. The best method of solution is to start with a v-t plot, to visualise the problem. The area under the v-t graph represents the distance travelled. It is composed of a rectangular area depicting the distance travelled during the reaction time of 2/3 s with the distance travelled of (2u/3) m, and triangular area representing to deceleration during braking, giving the distance travelled during braking of (u^2/12), in time (u/6) s. Adding the distances results in the requested solution (u(U+8)/12) m and total time of travel of ((u+4)/6) s. Candidates who did not draw the v-t plot found it very hard to visualise the problem and in addition did not apply the correct motion formulae to the decelerating region.

b) The total distance travelled of 90 m needed to be equated to (u(u+8)/12). Whilst some did not correctly solve the resulting quadratic equation many equated the 90 m to the decelerating region only.

c) Having found the value of u, many just found the total time of travel or just the time during deceleration and also omitted the need to subtract the 3 s during which the light remained amber from the total.

Question 6

Very few of the candidates drew a correct sketch of the different situations discussed in the problem. As a result of this, the calculation of the potential energy, kinetic energy and elastic potential energies at the different situations were not always correctly evaluated. In the stretched situation, the total energy consists of elastic potential energy, while in the slack situation the total energy consists of potential energy and kinetic energy. When these total energies are equated due to the conservation of energy, the velocity of the particle needed in part (a) of the problem can be obtained. In the situation where the particle comes to rest, the total energy consists only of potential. The result of part (b) of the problem can be obtained when appropriate total energies are equated. Although it was stated in the problem that the principle of conservation of energy was to be applied, some candidates ignored this. Only few candidates answered this problem properly.

Question 7

To obtain the frictional force acting on the 4 kg mass, the reaction of the mass perpendicular to the inclined plane had first to be evaluated. Newton’s 2nd law of motion is applied to the forces acting on the two masses involved in this problem. Parts (b) and (c) of the problem are answered by solving the resulting two equations. Using the acceleration obtained in part (b) of the problem, part (d) of the problem can then be worked by considering the motion of the 4 kg mass on the inclined plane. The problem was attempted by the majority of the candidates, but only a few candidates were awarded the majority of the problem’s marks.

Question 8

The main mistake in part (a) of this problem was that there is a single mass after the collision and not two separate masses; the candidates ignored the fact stated in the problem that the collision was perfectly inelastic. Some candidates ignored the sign related to the initial velocities of the two masses. If the first result obtained in part (a) of the problem was correct, then the other part of the problem was properly answered. This problem was properly attempted by a good number of candidates.

Question 9

In part (a) of the problem, the forces acting on the car mentioned on the problem are expressed in the horizontal and vertical directions. The resulting equations can be easily solved to obtain the maximum velocity to prevent slipping. Some candidates provided the results in m/s. The question requested the speed to be given in km/hr. In part (b), the road is banked at 20^o to the horizontal; the forces acting on the car are expressed in the horizontal and perpendicular directions. The resulting equations are harder to derive than those of part (a) of the problem. Appropriate mathematical techniques are used to solve these equations and evaluated to find the maximum safe velocity. Most of the candidates failed to work part (b) of the problem properly.

Question 10

The horizontal and vertical distances travelled by the particle were defined correctly by a good number of candidates in part (a) of the problem. Some candidates found it difficult to obtain the trajectory equation of the particle when it is expressed in terms of the horizontal distance and the angle of projection. Using the information provided in the problem, a trigonometric equation is obtained and when this is solved, the two possible angles of projections are obtained. Most of the candidates who worked the first two parts of the problem answered the third part of the problem properly.

Chairperson
Examination Panel 2021