Phys2006 Classical Mechanics June 2018

This year's exam too often revealed inadequate revision of core relations and definitions, and marks were lost from all sections with only a few parts proving consistently poorly answered. Failure to keep things in vector form resulted in many answers going astray: students should not expect A-level simplifications to be valid at university level, particularly when it is a persistent subject throughout the module! Students were generally good at unpacking questions, but then often unable to apply core physics to simple but unseen examples, or even to make plausible assumptions about everyday situations; complex manipulations on the other hand could be reproduced faithfully, suggesting that many still approach physics by rote learning rather than understanding and synthesis. Many found it difficult to follow the instructions on the rubric.

The mean exam mark was 50.6%. For the 148 who sat the exam, the mean overall mark was 55.3%, while 17 failed the course.

Section A **mean 9.8/20**

Answers this year were often very sparse and vague. Some students really grasped the concepts and wrote down their working and thoughts, but too many did not, and lost both marks and a clear understanding of what they were doing. Many found it difficult to apply their knowledge to questions that were only slightly different from those they had previously met.

A1 Centre of mass position and momentum **mean 2.8/4**

This question was generally done well by those who attempted it. Some did not show explicitly how the centre of mass definition led to the given equation: a formal derivation was required.

A2 Centre of mass condition **mean 1.6/4**

This was again often done well, although many could not state the centre of mass condition, or assumed without showing that (R-dot + rho-dot)^2 = R-dot^2 + rho-dot^2, which was largely the point of the question.

A3 Properties of elliptical orbits **mean 3.2/4**

Also generally well done, though some thought the minor axis passed through the focus, and some identified only one of the points where the radial velocity component was zero.

A4 Coriolis deflection **mean 1.2/4**

Good answers to this question were rare. Many assumed that the ants would all point in a given direction, or trot round the turntable like hamsters on a treadwheel; most focused on centrifugal rather than Coriolis forces. Among the good answers were some excellent intuitive arguments; others did well by applying the usual formulae.

A5 Gravitational attraction **mean 1.0/4**

This gave a lot of trouble for a question that had been met during coursework and which, apart from the constants, resembled problems from first year electromagnetism. Too many bodged the integrals or neglected the vector nature of the force, giving the impression of over-reliance upon memory rather than intellect and understanding.

Section B **mean 20.6/40**

B1 Moment of inertia, torque and precession **65 attempts** **mean 8.5**

This was a mathematically simple question that instead tested students' conceptual understanding and its application to a practical example. Solutions revealed a poor knowledge of basic relations and definitions, including the moment of inertia, which many thought to depend upon the vector position rather than the scalar distance from the axis, and many read the torque of part (a) as if it were the force creating that torque. Poor visualization of the situation, and inconsistent use of vectors, led many answers astray.

B2 Normal modes of CO_2 **74 attempts** **mean 13.5**

In contrast to B1, this was a mathematically challenging question that required little insight, and was generally well done, with most students faithfully reproducing the complex manipulations required. Few started properly from Hooke's law in terms of a spring's extension, and indeed many seemed to confuse its extension and displacement. Solutions revealed a curious reluctance to use brackets, and a disturbingly widespread belief that $\sqrt{(a+b)} = \sqrt{a} + \sqrt{b}$. Marks were largely lost for poor definitions of SHM in (a)(i), and omission of (d).

B3 Centrifugal forces **15 attempts** **mean 7.0**

Like B1, this question was mathematically simple but required a modicum of understanding and the application of basic knowledge – (a)-(c) needed A-level material only – to the unseen situation. Most students interpreted the situation correctly, but subsequent analysis was often weak: many thought the centrifugal force to act parallel to the position vector, rather than perpendicular to the rotation axis; inertial and non-inertial reference frames were confused; and many equated the diameter to the radius. Calculations of the gravitational force were rarely correct, with students mistaking the inverse-square dependence or failing to cancel the mass of the test body, and generally revealed poor preparation for a question on this topic. Many wrongly assumed that the cylindrical arrangement would show the same artefacts as a spherical geometry.

B4 Orbital dynamics **137 attempts** **score 10.0**

This question required (a) consistent use of vectors and (b) attention to the situation described: students who answered a different question did poorly. Explanations often seemed to be let down by poor expression rather than comprehension, but credit can only be given for what is written. 10 marks should have been easy for anyone who had properly revised the core material, but marks were lost from all sections with little pattern, only part (g) proving consistently troubling. Note that when a question asks "Why does A imply B?", the answer "B occurs because of A" does not score highly.