# *PHYSICS* (PHY415115)

## PART A - FEEDBACK FOR STUDENTS AND TEACHERS

The paper proved to be a good assessment tool. On reviewing student performances in the exam, the paper was of the correct length and there was a good distribution of marks, enabling the setting of cut-offs for A, B and C ratings at values of about 32, 25 and 18 respectively. As in 2017, Part 3 (Waves) was the section of the exam where few candidates received A ratings, however, few t ratings were given.

The usual issues of calculators in radians mode, significant figures, units, and lack of direction on vector quantities were present but not major reasons for lost marks this year.

The final section of this report contains sample answers to the exam, different approaches are usually referenced in the 'comments' section of this report; students should discuss alternative answers with their teacher.

## PART 1 – CRITERION 5

### QUESTION 1

In general this question was well answered by most students.

Part (b) required an area under the graph calculation, which proved challenging for some.

It was pleasing to see students who did not understand parts (a) and (b) managed to complete part (c) successfully.

### QUESTION 2

Momentum questions occur each year and it was pleasing to see that most students were well prepared, answering parts (a) and (b) very well.

Part (c) required the use of the cosine rule, which proved difficult for a number of students. Common errors included poor algebraic manipulation, calculating wrong angles and calculator error.

Some students knew that the law of conservation of momentum dictates that in collisions such as this the balls will travel in paths at 90° to each other, thus gaining full marks and avoiding the complicated calculations involved in the alternative approach.

## QUESTION 3

This straightforward projectile motion question was answered well by most.

Part (c) produced a variety of solutions; the most common, and perhaps the easiest method, was to calculate the two 'time' values (up motion and down motion) prior to calculating horizontal distance. Some students, attempting to use the quadratic equation to solve for time, made numerous errors and scored poorly.

## QUESTION 4

Many students made calculation errors in part (a), despite having identified the right formula. Conversion from km h-1 to m s-1 was consistently a problem.

Many different approaches were possible in part (b), but the majority of candidates did not properly account for the slope.

Issues in the first two parts meant that very few candidates calculated the correct answer in part (c), but many still received full, or near full, marks for applying a valid process.

## QUESTION 5

Very few students understood the aim of this question. Those that did generally achieved full or most marks. Students were rewarded wherever possible for either making an assumption or creating some data as a starting point, and then following the process outlined in the question. Students were given full marks for a correct answer in part (e), regardless of whether or not they used the slope from their graph.

## Question 6

This question was generally very well done. In parts (a), (b) and (c), most students took the correct approach and the majority of errors were mistakes of calculation or transcription.

Part (d) generated some interesting responses. Many students correctly mentioned the normal force but did not properly account for the centripetal force in their analyses.

## PART 2 – CRITERION 6

### QUESTION 7

Those who could correctly identify the forces on the suspended charge usually managed the rest of the question well. A common small error was to miss the radius of the van de Graaf generator when completing the calculation of the charge on the generator.

### QUESTION 8

Generally well done, although many students failed to include directions of fields and had poorly expressed arguments for the direction of the electric field between the parallel plates.

For part (c), students were expected to recognise that the field was very weak behind the anode, so little force was exerted on the electrons.

### QUESTION 9

This question was generally answered well, although a few students were not able to use sine and cosine ratios correctly to calculate velocities perpendicular and parallel to the field lines.

In part (b) the most common errors were to use the total velocity rather than the parallel component, and incorrect rearrangement of $v = s/t$.

The radius of gyration was generally calculated well in part (c).

### QUESTION 10

The use of RHR to attribute charge in part (a) was rarely explained. Part (b) was generally answered well, but some students were confused about the units of emf (V).

In part (c) the direction of the applied force was often not mentioned.

### QUESTION 11

In part (a) of this question the instruction to sketch the magnetic field of the wire in one diagram and of the magnet in the second diagram was poorly understood.

In parts (b) and (c) many students mentioned an initial repulsion of the magnet or wire but did not recognise that the force and motion would continue, leading to rotation around the fixed part of the motor.

### QUESTION 12

Most students could calculate the strength of the magnetic field, but many failed to mention the direction in part (a) and the majority did not complete a vector diagram of the field strengths to find the direction of the compass needle in part (b).

## PART 3 – CRITERION 7

### QUESTION 13

Parts (a) and (b) were done exceptionally well by most students.

In part (c) any two points in time were accepted as responses and, as such, there was a wide range of possible answers. However, many students lost part marks for drawing the resultant of A+B as being a higher-amplitude version of A. Since the waves do not have the same wavelength, this is not the case. Some students missed the instruction that they had to draw two diagrams.

### QUESTION 14

Part (a) was generally done well by most students. Some students attempted to the use the wave equation and the speed of sound, even though the wave is not travelling at the speed of sound in the string.

Most students at least received part marks for their answers to part (b) as most recognised that they needed to use the tension equation, although some missed that the mass per length given needed to be converted to kg m-1. Some again attempted to use the speed of sound in air as the velocity of the wave rather than calculating it using the wavelength from part (a) and the wave equation.

Some students clearly had no understanding of beats and did not sensibly attempt part (c). Most students could recognise that the beat frequency was either 650 or 670 Hz, although some failed to identify which it was, or identified the wrong one.

## QUESTION 15

This question was generally done well. Most could find the velocity and use this to calculate the time in part (a), although a small number of students used the speed of sound rather than the speed of light and others rearranged the equations incorrectly.

Part (b) was done well by most candidates.

Part (c) included some tricky geometry and many students failed to recognise that the angle of refraction was 90° minus the angle from part (b). Those that recognised this usually got full marks as it was then a straightforward refraction question from air into a denser medium.

## QUESTION 16

This question was poorly answered.

Part (a) was best answered by referencing a dictionary; this was rarely done.

In part (b) many students incorrectly drew standing waves across the mouth of the glass or vertically within the glass rather than on the rim. This also meant the calculation in part (d) was actually trivialised and incorrect. However, 'error carried forward' was partially applied in this case.

## QUESTION 17

Good answers to this question relied on a good diagram of the interference pattern being drawn in the space provided. Unfortunately, this was rarely done. Students either scored very well or very badly based on this. Interestingly, many students thought radar was based on sound waves and used the wrong velocity in part (c).

### QUESTION 18

Parts (a) and (b) were well done but part (c) was very poorly answered. It was obvious most students were not familiar with the notation used to represent polarisation. Those that used words to say 'partial polarisation in the horizontal plane' scored best.

## PART 4 – CRITERION 8

### QUESTION 19

Parts (a) and (b) were mostly done well, although very few students could identify the colour, as they assumed all light was at the peak wavelength.

Most students calculated the energy correctly in part (c) but not all of these students identified the relevant transition.

### QUESTION 20

This question was answered well by the majority of students.

### QUESTION 21

Part (a) was done very well.

Responses to part (b) varied greatly, with many students drawing a picture of the apparatus rather than constructing a conservation of momentum diagram.

In part (c) many students failed to perform the vector addition correctly. It was common for student to omit the direction. Some students gave the correct angle but did not convert the electron momentum to a velocity.

### QUESTION 22

In part (a) most students correctly identified the mass number and atomic number of the beta positive particle, however, many students labelled this as a neutron. Each beta positive particle is associated with a neutrino.

Part (b) was well done.

Students lost valuable marks in part (c) due to poor setting out.

Parts (d) and (e) were mostly well done.

## QUESTION 23

Generally well done. A common error in part (c) was assuming that the same electron transitioning up and then back down produced K lines.

## QUESTION 24

Most students were unable to correctly calculate a percentage. All but a few students commented on the difference between activity and count rate in part (d).