Physics

Report on Student Performance in the Practice Papers

The practice papers were administered in seven schools with more than 160 students participating in the research exercise. Despite the fairly small sample size; students' performance in this exercise should still reflect some weaknesses of students. Readers are advised to study this report together with the selected samples of student performance so that they can gain a better understanding of the high, mid and low performance levels of students in this research exercise.

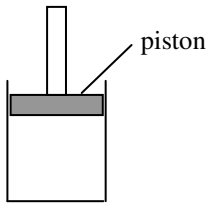
Paper 1

Paper 1 consisted of two sections, Section A (multiple-choice questions) and Section B (conventional questions). All questions in both sections were compulsory.

Section A (multiple-choice questions)

There were 36 questions. Some misconceptions of students were revealed from their performance in the following items:

1 *Q5 A fixed mass of an ideal gas is contained in a cylinder fitted with a frictionless piston as shown in the figure below. If the gas is cooled under constant pressure,

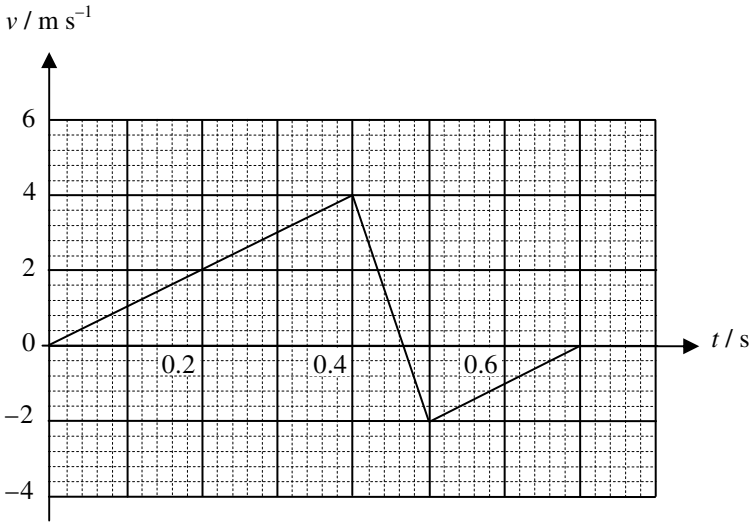


(1) the average separation of the gas molecules will decrease.
(2) the r.m.s. speed of the gas molecules will decrease.
(3) the number of collisions per second of the gas molecules on the piston will decrease.

A.*	(1) and (2) only	(29%)
B.	(1) and (3) only	(5%)
C.	(2) and (3) only	(33%)
D.	(1), (2) and (3)	(33%)

More than 60% of students wrongly thought that the number of collisions per second of the gas molecules on the piston will decrease when a gas is cooled under constant pressure, and wrongly chose options C or D.

2 Q13



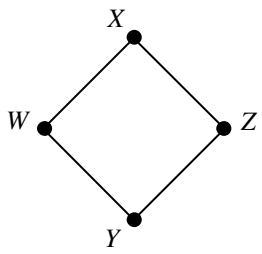
A ball of mass 0.2 kg is released from rest. It hits the ground and rebounds. The velocity-time graph of the ball is shown above. Which of the following statements are correct ?

(1) The magnitude of the change in momentum of the ball during the collision is 1.2 kg m s^{-1}.
(2) The magnitude of the average force acting on the ball by the ground during the collision is 12 N.
(3) There is mechanical energy loss during the collision.

A.	(1) and (2) only	(15%)
B.*	(1) and (3) only	(21%)
C.	(2) and (3) only	(27%)
D.	(1), (2) and (3)	(37%)

When considering the force acting on the ball by the ground during the collision, only 20% of the students considered the weight of the ball and correctly ruled out statement (2).

3 *Q25



The figure above shows four points *W*, *X*, *Y* and *Z* in a uniform electric field. *WXZY* is a square. The electric potential at *W*, *X* and *Y* are 1 V, 5 V and 5 V respectively. What is the electric potential at *Z* ?

A.	1 V	(46%)
B.	6 V	(15%)
C.*	9 V	(29%)
D.	11 V	(10%)

46% of the students wrongly thought that the electric potential at *Z* is the same as that at *W*, and wrongly chose option A.

4 Q26 Two metal rods, *X* and *Y*, of uniform cross-sectional area are made of the same material and have the same volume. The length and resistance of *X* are *l* and *R* respectively. What is the resistance of *Y* if it has a length of 2*l* ?

A.	*R*/4	(4%)
B.	*R*/2	(13%)
C.	2*R*	(64%)
D.*	4*R*	(19%)

64% of the students wrongly chose option C; they had probably overlooked the difference in the cross-sectional areas between wires *X* and *Y*.

5 *Q32 A Hall probe is placed in a uniform magnetic field. The slice of semiconductor inside the Hall probe is1.3×10^{-3} m thick and has 10^{25} charge carriers per cubic metre. When a steady current of 0.4 A passes through the slice, a Hall voltage of 2×10^{-5} V is set up. What is the magnetic field strength detected by the probe ? Assume that the magnitude of the charge of each charge carrier is 1.6×10^{-19} C.

A.*	0.104 T	(51%)
B.	0.962 T	(15%)
C.	1.04 T	(26%)
D.	9.62 T	(8%)

26% of the students wrongly obtained an answer 10 times bigger than it should have been, probably because of wrong entry of 10^{25} charge carriers per cubic metre into the calculator.

Section B (conventional questions)

Question Number	Performance in General
1	Generally well answered. In part (a)(ii), some students just answered "reduce heat loss to the surroundings" without pointing out the means of heat transfer. In part (a)(iii), some students tried to explain how the direction of oil circulation helps to heat the water.
2	Many students forgot to include the weight of the parcel in the calculations in part (a). Part (b) was generally well answered. In part (c), many students did not mention the parcel rises first after the string breaks.
3	In part (a), some students tried to find the speed of ball *X* by using the conservation of energy. In part (c), some students mistook the horizontal speed of ball *Y* to be the initial speed in vertical motion. In part (d), many students were unable to explain why the time of flight of ball *Y* remains unchanged.
4	In part (a)(i), not many students expressed *GM* in terms of r_E. In part (b)(i), and in general, students should be reminded to use a ruler when drawing straight lines. Quite a number of students just left this question unanswered.
5	This question was generally well answered. In part (a)(ii), some students made a mistake in the unit. In part (a)(iii), while most students pointed out that the wavelength will decrease, many did not mention the change in the degree of diffraction. In part (b), some students failed to calculate the path difference in terms of wavelength.

Question Number	Performance in General
6	Students used many different ways to describe the situation at critical angle. This shows that they have a good understanding of the phenomenon. While most students were able to describe the major steps of the experiment, they failed to mention important details. Only a few students mentioned that the centres of the glass block and the protractor should coincide and few described how the light ray should be directed (towards the centre through the curved side).
7	Parts (a) and (b) were generally well answered. Most students adhered to the conventions in drawing ray diagrams. In part (c), many students failed to explain the why the focal length becomes longer when the refractive index of the liquid decreases.
8	The general performances in parts (a) and (b) were fair, though their mistakes revealed that students did not read the question carefully. For example, students just added forces in Figure 8.1 instead of drawing a free body diagram as required. And in part (b)(ii), some students used 0.07 kg, instead of 0.07 g, in their calculations. Part (c) revealed some of the misconceptions of the students about a parallel-plate system. Some students suggested angle θ would remain the same when the plates' separation was adjusted, and some suggested the ball would swing if the electric field was non-uniform.
9	Parts (a)(i) and (a)(ii) were generally well answered. In part (a)(iii), many students failed to see that the current would double when one more identical parallel branch was connected, and they produced lengthy calculations to determine the new current. In part (b), some students showed no understanding of the concept of r.m.s. value of an alternating current.
10	In part (a), many students did not relate their answers to electromagnetic induction at all. Few students were able to explain the induced e.m.f. by a *change* of magnetic field. In part (b), most students pointed out that the secondary coil had a large number of turns, but failed to compare it to the primary coil. Very few students mentioned the high rate of change of field caused by the sudden interruption of current. In part (c), while many students knew that the resistance of a thick wire is small, they failed to point out why this is important for the primary coil.
11	In part (a), while most students were able to give a correct account of testing for α particles, very few mentioned that the GM tube should be very close to the source in the first place. Some students tried to use the method of electric / magnetic deflection but failed to give a full account. In part (b), most students found the correct numerical answer but failed to give the correct unit. In part (c), some students did not use the corrected count rates in their calculations.

Paper 2

Paper 2 consisted of four sections. Each section contains eight multiple-choice questions and one structured question which carries 10 marks. Section A contained questions set on Topic VI 'Astronomy and Space Science', Section B on Topic VII 'Atomic World', Section C on Topic VIII 'Energy and Use of Energy' and Section D on Topic IX 'Medical Physics'. Students were required to attempt all questions in two of the sections.

Question Number	Performance in General
1	In part (a)(i), some students used the wavelengths at points *A* and *B* in their calculations, instead of comparing the wavelength at *A* to the laboratory value. In part (a)(iii), some students missed the *kilo-* in the unit kpc. In part (b)(i), some students used the arc length formulae without converting the angle to radian measure. In part (c), some students failed to mention that the radiation of a star can be related to that of a black body.

Question Number	Performance in General
2	In part (a)(i), few students were able to explain why the wave theory fails to account for the photoelectric effect. In part (a)(iii), some students failed to mention that the work function is the *minimum* amount of energy required. In part (b)(ii), some students did not realize that more photons are emitted from a light source of higher intensity. Some students did not understand that a more sensitive detector means it will be triggered by less smoke.
3	In part (a)(i), few students stated that a doubled glazed glass is thicker. In part (a)(ii)(1), some students mixed up U and κ. They included the thickness of the glass in the calculation. In part (a)(ii)(2), some students wrongly suggested that the rate of heat transfer will be smaller as "heat loss to surroundings". In part (b)(i), some students described the complete cooling cycle of the refrigerant instead of focusing on the heat absorption part. Part (b)(ii) revealed that many students mixed up the quantities shown in the energy label and included unrelated quantities in the calculation.
4	In part (a), some students wrongly thought that there was water in the lungs. In part (c), some students used the number of half thickness to find the answer, but they wrongly calculated that there were 8/2 = 4 half thicknesses. In part (d), most students realized that the bone absorbs more X-ray although a few wrongly stated that bone reflects X-ray. Very few students could state that X-ray would blacken the film. In part (e), some students mixed up the use and properties of artificial contrast medium and tracer.

Due to the small number of students attempting each section, statistical analysis of the performance in multiple-choice questions in paper 2 has not been compiled.