Physics (960)

OVERALL PERFORMANCE

The number of candidates for this subject was 3589. The percentage of candidates who obtained a full pass was 74.09%, which indicated a decrease of 0.97% compared to the results of the previous year.

The achievement of candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	6.38	5.66	8.89	10.92	13.40	14.13	14.71	4.90	5.52	4.32	11.17

RESPONSES OF CANDIDATES

PAPER 960/1 (MULTIPLE-CHOICE)

Keys

Question number	Key	Question number	Key	Question number	Key
1	**D**	18	**B**	35	**D**
2	**B**	19	**B**	36	**B**
3	**A**	20	**A**	37	**C**
4	**D**	21	**B**	38	**D**
5	**B**	22	**B**	39	**A**
6	**C**	23	**A**	40	**D**
7	**D**	24	**B**	41	**A**
8	**C**	25	**C**	42	**A**
9	**D**	26	**D**	43	**C**
10	**B**	27	**A**	44	**B**
11	**C**	28	**A**	45	**A**
12	**D**	29	**B**	46	**C**
13	**D**	30	**C**	47	**C**
14	**B**	31	**D**	48	**B**
15	**B**	32	**D**	49	**C**
16	**D**	33	**B**	50	**C**
17	**A**	34	**D**		

General comments

The mean score was 24.46 and the standard deviation of the scores was 8.47. More than 70% of candidates answered questions 10, 11, 12, 17, 20, 35, 42 and 48 correctly. Question 13, 19, and 28 were very difficult for candidates, with less than 30% of candidates answering correctly. The rest of the answers fell in the medium range with 30% to 70% of candidates obtaining correct answers.

PAPER 960/2 (STRUCTURE AND ESSAY)

General comments

Generally, most candidates showed low capability in answering questions that involved explanation or description, especially on fundamental concepts. Visualisation and conceptualisation were vital basic skills in exploring knowledges of Physics to the greater extant. This was obvious as good candidates gave complete answers and obtained good marks, while some got average marks, whereas poor candidates got very low marks. It was also quite obvious to see in some centers, their candidates performed very well. However, there were also centers where generally candidates could not even answer one complete question, especially essay questions. Some candidates answers indicated that they did not understand the concept very well, or perhaps did not understand the question very well, for examples questions 2(*b*), 12(*b*)(ii), 13(*b*) and 14(*b*). Some candidates in wrote a lot but could not get marks because they did not have the key points required in the marking scheme. The overall performance of candidates was average, with a mean of 34.07 and a standard deviation of 17.77.

Comments on the individual questions

Question 1

Most candidates knew the basic idea of centripetal force and Newton's second law for a circular motion which is $F = ma$ with $a = \frac{v^2}{r}$ or $a = r\omega^2$. However, they failed to relate the reaction force and the weight of a man, that is $mg - R = mr^2\omega$. Most of them thought that the reaction force on the man is in the same direction as the weight of the man. As a result, many candidates were not able to answer correctly.

Answers: 730 N

Question 2

In part (*a*), most candidates were able to write the Newton's gravitational law, $\frac{GMm}{r^2} = mr\omega^2$ with $\omega = \frac{2\pi}{T}$. Some candidates did not realize that the required answer is height h of the telescope from the surface of the Earth, and they calculate only the total distance r. Many candidates failed to secure a full mark because of arithmetical error and error in the significant figure given.

In part (*b*), only a few candidates were able to give the correct explanation. Nearly all the candidates wrote that the astronaut experienced weightlessness because the astronaut was far from Earth, or the mass of the astronaut was small compared to the mass of the Earth. In other words, they failed to see that the only force acting on a weightless body is the gravitational pull on the body, and therefore, there is no normal reaction pushing the body.

Answers: 640 km

Question 3

Almost all candidates failed to answer this question perfectly. Candidates were able to use the formula $c = f\lambda$ to find the wavelength. The crucial point is the path difference which made up of two parts, the physical distance and phase change due to reflection. Many candidates forgot about the phase change of π rad upon reflection by the wall despite knowing that the path difference was 12 m. Hence, many candidates gave the answer as constructive interference, which was the wrong answer.

Question 4

For parts (*a*) and (*b*), almost all candidates were able to answer, and got fairly satisfactory marks. The only problem was that candidates were not careful in calculating the correct area of the rod, and also made errors in the number of significant figures used. There were a few candidates who gave the wrong units of stress and Young modulus.

Answer: (*a*) 2.5×10^{8} N m^{-2} ; (*b*) 5.0×10^{10} N m^{-2}

Question 5

In part (*a*), some candidates were confused by using the expression relating to magnetic field $F = Bev$ instead of electric field $F = eE$ in determining the strength of the electric field.

In part (*b*), most candidates could not give the correct answer for the momentarily stop which relates it to loss in kinetic energy as work done against the field. Instead that, they mentioned the pulling force acts in an opposing direction.

In part (*c*), some candidates were simply written in a parabolic motion or a circular motion instead of a negative-x direction for the subsequent motion of the electron after it had stopped.

Answers: (*a*) 1.70×10^{3} N/C

Question 6

In part (*a*)(i), most candidates were able to answer correctly the expression for the potential difference of V across R.

In part (*a*)(ii), most candidates failed to answer correctly because they did not understand the potential divider rule and Kirchhoff's theorems.

In part (*b*)(i), most candidates were able to indicate the correct direction of the current in the circuit.

In part (*b*)(ii), most candidates were not able to answer correctly because they misunderstood the effective e.m.f to be 2ε instead of ε.

Answers: (*a*)(i) $V = \frac{R}{R + r}\varepsilon$; (*b*)(ii) $V = \frac{2R\varepsilon}{r + 2R}$

Question 7

In part (*a*), most candidates were able to calculate the maximum kinetic energy of photoelectrons correctly. However, surprisingly, there were candidates from some centers who failed to relate maximum kinetic energy of photoelectrons with stopping potential.

In part (*b*), most candidates were able to give the Einstein equation for photoelectric effect and solved for the photon wavelength. A few candidates made the mistake of not converting the energy from eV to J.

Answers: (*a*) 1.20 eV or 1.92×10^{-19} J ; (*b*) 200 nm

Question 8

In part (*a*), most candidates failed to write a complete nuclear equation which required for the amount of energy released.

In part (*b*), most candidates calculated the atomic mass of *Y* using the mass difference approach, and not from the mass-energy conservation approach, resulting in some confusion in the analysis. Some candidates also did not write the correct significant figures well.

Answers: (*b*) 54.002582 u

Question 9

In part (*a*)(i), most candidates had no problem in stating Newton's third law. However, most of the candidates did not write the correct statement for Newton's second law. They left out the direction of the momentum.

In part (*a*)(ii), a majority of candidates did not understand the question, so they started on wrong statements as proof, and concluded without any justification or proof. This shows that candidates did not have the basic knowledge to prove that total momentum is always conserved in a collision.

In part (*b*), most candidates failed to state the correct differences by comparing conservation of kinetic energy in elastic and inelastic collision. Some candidates carelessly stated that neither total energy nor momentum are conserved in an inelastic collision. Some candidates also compared the case of when the two bodies stick together in an inelastic collision, and separated in elastic collision.

In part (*c*)(i), only a few candidates were able to fully show that the collision is inelastic. Some candidates failed to relate the kinetic energy equation correctly.

In part (*c*)(ii), most candidates could write the conservation of momentum and kinetic energy equations correctly and proceeded to get the correct velocities for both bodies. However, a few candidates used the restitution approach and managed to obtain correct answers as well.

Answer: (*c*)(ii) $v_P = -\frac{1}{3}u$ and $v_Q = \frac{2}{3}u$

Question 10

In part (*a*), most candidates did not read the question carefully. They made a comparison between a standing wave and a transverse wave instead of describe the characteristic of a standing wave and a transverse wave. Surprisingly, some candidates think that standing wave is longitudinal wave and required medium. Very few candidates stated that transverse wave can be polarized.

In part (*b*)(i), a majority of candidates knew the superposition principle $y = y_A + y_B$, but they did not complete the calculation to get the correct expression of the wave *C*.

In part (*b*)(ii), most candidates could not realise that the amplitude of a standing wave varies with position 4.0 cos 20*x*. They just stated that the maximum value for amplitude is 4.0 m. Most candidates also knew of the formula $\omega = 2\pi f$ and $k = \frac{2\pi}{\lambda}$ to determine frequency and wavelength.

In part (*b*)(iii), a majority candidates failed to realise that the maximum displacement occurs when $\cos 20x = \pm 1$. Some of them just left the answer in terms of π or fractions.

Answers: (*b*)(ii) $A = 4.0 \cos 20x$, $f = 191$ Hz, $\lambda = 0.314$ cm

Question 11

In part (*a*), most candidates were able give the correct definition only for the *degree of freedom*. Most of them lost marks on the definition of *r.m.s. speed* and *principle of equipartition* by missing out the keywords.

In part (*b*)(i), most candidates did very well. They knew the formulae $pV = nRT$ to calculate the temperature of the gas. However, some of them were careless on the significant figures.

In part (*b*)(ii), most candidates used the correct formula $v_{rms} = \sqrt{\frac{3kT}{m}}$ or $v_{rms} = \sqrt{\frac{3RT}{M}}$, but they lost the mark for the answer because of the wrong substitution of mass $m = \frac{M}{N_A}$ in the formula above.

In part (*b*)(iii), most candidates did very well in determining the internal energy $U = \frac{f}{2}nRT$ with a degree of freedom $f = 5$.

In part (*c*)(i), a majority candidates were not able to state the correct practical conditions for adiabatic changes. They just answered $Q = 0$ instead of fast change and thick and insulated wall.

In part (*c*)(ii), most candidates were able to calculate the final pressure of the gas by using pV^{γ} = constant and the value of $\gamma = 1.40$.

Answers: (*b*)(i) 915 K, (ii) 844 m s^{-1}, (iii) 3.80×10^4 J (*c*)(ii) 8.02×10^5 Pa

Question 12

In part (*a*)(i), most candidates were not able to give an accurate definition of magnetic flux density.

In part (*a*)(ii), a majority of candidates knew that the weight of the charged particle is equal to the magnetic force acting on it. They were able to use the equation $mg = Bqv$ to obtain the magnetic field. However some candidates made a mistake by substituting the value of mass of the particle as 200×10^{-3} kg.

In part (*b*)(i), most candidates were able to use the formulae $\varepsilon = Blv$ to obtain the correct answer of induced e.m.f. in the rod *PQ*.

In part (*b*)(ii), many candidates were not able to explain why the rod *RS* starts to move to the right when the rod *PQ* enters the magnetic fields. They seemed to not be familiar with Faraday's and Lenz's laws. Some of them left out the word *induced* current produced in *RS* to explain the magnetic force on the rod.

In part (*b*)(iii), almost all candidates failed to calculate the final velocity of the rods correctly using the conservation of momentum.

In part (*b*)(iv), many candidates did not know that the energy dissipated is the kinetic energy loss, hence, they could not calculate the amount of the energy dissipated.

Answer: (*b*)(i) 0.080 V, (iii) 0.44 m s^{-1}, (vi) 7.3×10^{-3} J

Question 13

In part (*a*)(i), not many candidates were able to write the order of magnitude for X-ray wavelengths as 10^{-9} – 10^{-11} m. Some of the candidates left out the corresponding units for the wavelengths.

In part (*a*)(ii), most candidates were only able to state the differences between X-rays and γ-rays.

In part (*b*), surprisingly most candidates could not explain accurately the production of the characteristic of the X-ray spectrum. For example, majority candidates only mention due to transition of excited electron from higher to lower energy level. They failed to mention the difference in energy between the energy levels emitted as X-ray. However, most candidates could explain the continuous spectrum of X-ray well. Overall the explanations given by candidates were not succinct and sequential, underlying a poor grasp of both spectra production.

In part (*c*)(i), most candidates were able to give the formula for Bragg's law as $2d \sin \theta = n\lambda$. But for interplanar spacing d, many candidates were not able to calculate it and therefore could not give the correct answer for the Bragg angle.

In part (*c*)(ii), many candidates did not know how to sketch the other possible sets of crystal planes.

In part (*c*)(iii), very few candidates got the correct answer since most of them did not know various crystal planes have different interplanar spacing. They did not know that for the minimum Bragg angle, it comes from maximum interplanar spacing, which is atomic spacing.

Answers: (*c*)(i) 16.4°, (iii) 0.25 nm

Question 14

In part (*a*), most candidates were able to correctly state that nuclear strong force and repulsive electrostatic force are the acting focus between the nucleons in the nucleus.

In part (*b*)(i), most candidates were not able to explain why heavier nuclides have more neutrons than protons. Most of them explained that the mass of neutron is greater than that proton, instead of explaining that at more protons means that electrostatic repulsion becomes larger.

In part (*b*)(ii), only a few candidates were able to state the β-decay for P and α-decay for Q to become stable nuclides. However, candidates who could correctly state the emission of the particles faced difficulty in explaining the reasons.

In part (*c*)(i), most candidates had no problem in calculating the mass defect and then the binding energy of the deuteron.

In part (*c*)(ii), most candidates calculated the energy per nucleon rather than the supplying energy which is equivalent to the binding energy.

In part (*c*)(iii), a majority of the candidates were able to suggest fission or bombardment with high energy electrons as the answer, but failed to suggest that the energy of the particle must be more than 2.22 MeV.

Answers: (*c*)(i) 2.22 MeV; (ii) 2.22 MeV

PAPER 960/4 (WRITTEN PRACTICAL TEST)

General comments

In general, most candidates were able to derive and plot the secondary data from the primary data with a consistent number of significant figures and correct units. However, they still faced problems in extracting information from a graph for analysis and giving the answer for computation in the correct significant figures and units.

Comments on the individual questions

Question 1

In part (*a*), most candidates were able to suggest greasing the wall of the syringe but failed to suggest using soft materials for the piston in order to make the piston frictionless and airtight.

In part (*b*), most candidates correctly answered that the number of points which are almost equal are situated on both sides of the lines and all points lie closely to the line.

In part (*c*)(i) and (ii), the candidates had to extrapolate the graph of p_1 against $\frac{1}{V}$ to determine the pressure of the air column at a certain volume. Most candidates were able to accomplish this. However, there were candidates who failed to read the graph to the correct accuracy unit.

In part (*d*), most candidates were able to give the correct value of the intercept p_1 to the nearest accuracy. However, there were candidates who were unable to state what the value of the intercept p_1 represents.

In part (*e*), very few candidates were able to show the pressure inside the syringe is consistent with the ideal gas equation.

In part (*f*), most candidates were answered that the gradient will decrease if the temperature of the air column is higher than that at room temperature. However, some candidates also gave the answers which were not related to the gradient of the graph.

In part (*g*), most candidates were only able to suggest eliminating parallax error as a precautionary step. They forgot to suggest the use at a vertical syringe and to held the weight which is released gradually.

Answers: (*c*)(i) 2.60×10^4 Pa; (*c*)(ii) 7.50×10^4 Pa; (*d*) 10.15×10^4 Pa

Question 2

In part (*a*), very few candidates were able to state the reason why the thermistor is dipped in oil. The reason is that oil is a good thermal contact and is also an insulator.

In part (*b*), very few candidates were able to suggest the precautions which should be taken to ensure the measurements of the balanced length are more accurate. This is as not to slide the jockey hard on the resistance wire and open the switches if not in use.

In part (*c*), most candidates were able to calculate the resistance R_2 correctly and also tabulate R_2, ln R_2 and $\frac{1}{T}$ with the correct units and consistence number of significant figures.

In part (*d*), most candidates were able to plot the graph of $\frac{1}{T}$ against ln R_2 with a proper scale, and a correct axis and unit. However, some of them did not include the origin for the *y*-axis.

In part (*e*), as a consequence for part (*d*), most candidates were not able to determine the *y*- intercept of the curve which is value of *b*. While most of them were able to correctly determine the gradient of the graph which is the value of *a*, they still failed to get the correct units.

Answers: (*e*) $a = 3.10 \times 10^{-4}$ K^{-1} ; $b = 2.3$ K^{-1}