Physics (960)

OVERALL PERFORMANCE

The number of candidates for this subject was 3638. The percentage of candidates who obtained a full pass was 73.45%, an increase of 0.16% compared with 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	6.68	6.18	8.91	9.73	12.89	15.26	13.88	5.22	4.95	4.97	11.41

RESPONSES OF CANDIDATES

PAPER 960/1 (MULTIPLE-CHOICE)

Keys

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

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General comments

The mean score was 25.46 (50.92%) and the standard deviation of the scores was 8.04. More than 70% of candidates answered questions 11, 19, 24, 25, 30, 44, 45 and 46 correctly. Question 3, 4, 15 and 42 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, in qualitative questions not much planning were required so candidates were able to present the answers in a proper manner, while for quantitative questions candidates lacked proper planning in presenting their answers. The majority of candidates could not get marks for definition of physical terms. They showed association to the terms asked, but lacked correct details. The overall performance of candidates was average with a mean of 32.57 and a standard deviation of 19.93.

Comments on the individual questions

Question 1

In part (*a*), most candidates did not have the skill of using a free-body diagram which was a necessity in recognising all the forces acting on a rigid body. Those candidates who could sketch the triangle of forces did not realise that $R_A = R_B$, thus they could not solve part (*b*) correctly. Some candidates tried to solve this part by taking moment at the hinges but failed to get the angle between the forces correctly.

Answer: (*b*) 149 N

Question 2

In part (*a*), many candidates were able to determine the gravitational field strength using the formula $g = -\dfrac{GM}{R^2}$.

In part (*b*), most candidates were not able to get the correct answer for the gravitational potential. They wrongly substituted the value of $r = R$ instead of $r = R + h$ in the formula $V = -\dfrac{GM}{r}$. Candidates also lost marks when they omitted the minus sign in the formula and the final answer.

Answers: (*a*) 3.77 m s^{-2}; (*b*) -1.17×10^7 J kg^{-1}

Question 3

In part (*a*), most candidates found this part relatively easy. The majority were able to state that the repulsive force and attractive force were the forces that maintained the equilibrium separation between the two particles.

In part (*b*), many candidates sketched the graph of the variation of interatomic force F with separation r of the resultant force instead of the component forces as in part (*a*).

Question 4

In part (*a*), candidates was required to draw the electric field of the equipotential surface. Most candidates just drew the line of electric field with the correct direction. They lost the second mark by not indicating the electric field perpendicular to the equipotential surface.

In part (*b*), most candidates knew how to calculate the change in kinetic energy of the electron using the formula $\Delta E = e\Delta V$. However, they did not state that there was a loss in kinetic energy or put the negative sign in the final answer to indicate the loss in kinetic energy.

Answer: (*b*) -1.28×10^{-18} J

Question 5

In part (*a*), surprisingly many candidates were unaware that there was no magnetic force for side *PQ* which was parallel to the magnetic field. While for side *PS*, most candidates missed the number of turns of wire in calculating the magnetic force.

In part (*b*), most candidates used the formula $\tau = NIAB$ to determine the torque on the coil and gave the correct answer and unit. Some candidates used the formula $\tau = F \times l$, but they forgot to take into account that there were two forces to make the torque.

Answers: (*a*) $F_{PQ} = 0$, $F_{PS} = 50.0$ N; (*b*) 7.5 N m

Question 6

In part (*a*), the vast majority of candidates correctly answered this part.

In part (*b*), most candidates were able to determine the correct value of the velocity using the formula $v = f'$. However, a significant number of candidates did not notice that *x* and *y* were measured in centimetres and thus, gave an incorrect unit for the final answer.

In part (*c*), most candidates failed to get the correct answer because they were not able to differentiate the expression of displacement to determine the velocity of the particle.

Answers: (*b*) 16.67 cm s^{-1}; (*c*) 35.12 cm s^{-2}

Question 7

In part (*a*), many candidates were unable to mention about metastable or population inversion which is required in the production of laser. It could be seen from their answers that they were familiar with the change of energy from the excited state to the ground state.

In part (*b*), most candidates correctly stated the characteristics of the emitted photons.

Question 8

Most candidates were able to perform conversion of quantities u → kg and MeV → J, but weaker candidates were not able to proceed with their calculation to solve the problem to find the total amount of mass of uranium-235 required per day.

Answer: 2.11 kg

Question 9

In part (*a*), almost all candidates were not able to give the correct definitions of moment of inertia and angular momentum because most of them referred *r* as radius or distance from the centre of the mass instead of the distance of the particle to the axis of rotation.

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In part (b), many candidates knew how to use conservation of angular momentum to explain why the period of rotation of the Earth increases. Quite a number of candidates made the mistake by saying that the radius of the Earth increases or water flows into ocean near the equator.

In part (c)(i), the performance of candidates was not satisfactory because most candidates calculated the moment of inertia of the wheel and the boy's younger brother separately without adding both of them. Some candidates wrongly substituted the distance of the younger brother from the central axis as $r = 0.50$ m instead of $r = (R - 0.5)$ m.

In part (c)(ii), most candidates had no problem using kinematics of rotation to calculate the angular speed correctly.

In part (c)(iii), many candidates used their calculated value in (c)(i) to determine the angular momentum of the wheel just before the boy jumped onto the wheel. However, some candidates made a mistake by giving the answer to more than four significant figures.

In part (c)(iv), most candidates used the principle of conservation of angular momentum to calculate the angular speed of the wheel just after the boy jumped onto the wheel.

Answers: (c)(i) 138 kg m^2, (ii) 4.5 rad s^{-1}, (iii) 620 kg m^2 s^{-1}, (iv) 2.7 rad s^{-1}

Question 10

In part (a)(i), most candidates had difficulty in defining the intensity of sound and beats. Some candidates just mentioned A as the area instead of cross-sectional area in defining the intensity of sound, whereas some candidates missed the keyword *rise and fall* or *superposition* and *slightly different frequency* in defining beats.

In part (b)(i), the majority of candidates were able to use the formula $I = \frac{P}{A}$ and then $\beta = 10 \log \frac{I}{I_0}$ to determine the intensity level of sound. However, some candidates mistakenly substituted A for πr^2 instead of $4\pi r^2$.

In part (b)(ii), only candidates who could answer part (a)(i) correctly could obtain the correct answer for this part.

In part (c)(i), many candidates had difficulty in giving the meaning of fundamental frequency as being the lowest or smallest frequency produced. They wrongly stated that it was the first resonant frequency.

In part (c)(ii), although many candidates were unable to give the meaning of fundamental frequency in part (c)(i), majority of them were able to write the expression for fundamental frequency as $f_0 = \frac{v}{2l}$.

In part (c)(iii), the majority of candidates were able to answer this part satisfactory.

In part (c)(iv), most candidates were unable to state the expression of $f_{beat} = f_2 - f_1$ and failed to realise that the frequency produced by a string with greater tension was higher.

Answers: (b)(i) 120 dB, (ii) 1995 m ; (c)(iv) 136.5 Hz

Question 11

In part (*a*), only a few candidates were able to state a satisfactory difference between thermal energy and heat. Most candidates just said that thermal energy is heat energy and heat is a form of energy which was incorrect.

In part (*b*)(i), many candidates knew that free electrons in metal help to conduct heat, but they did not explain the mechanism well.

In part (*b*)(ii), candidates knew that heat was conducted by vibration of atoms in non-metal but failed to explain the actual process of increase in amplitudes of vibration of atoms when heated, and the collisions of these atoms with the neighbouring atoms was how heat was conducted to the cooler end.

In part (*c*), candidates were able to define the thermal conductivity satisfactorily. Some candidates who used mathematical expression in giving the definition failed to explain the symbols of cross-sectional area correctly. Most candidates had no difficulty in identifying the appropriate SI unit of the thermal conductivity correctly.

In part (*d*)(i), many candidates knew how to use the formula $\frac{dQ}{dt} = \frac{dm}{dt}c\Delta\theta$ to calculate the rate of heat flow. Fewer candidates forgot to substitute the correct value for $\Delta\theta$ and to convert the unit from g min^{-1} to kg s^{-1}.

In part (*d*)(ii), most candidates were able to use their calculated value in part (*d*)(i) to calculate the thermal energy of aluminium. However, there were still some candidates who wrongly used the formula for the cross-sectional area of the aluminium.

Answers: (*c*) W m^{-1} K^{-1}; (*d*)(i) 26.3 Js $^{-1}$, (ii) 226.2 W m^{-1} K^{-1}

Question 12

In part (*a*)(i), only few candidates were able to give a satisfactory statement of Kirchhoff's law. Most of them missed the keywords *at a point or junction* for the first Kirchhoff's law and *in a closed loop* for the second Kirchhoff's law.

In part (*a*)(i), many candidates stated the answer as Ohm's law instead of conservation of charge or energy.

In part (*b*)(i), almost all candidates knew the algebraic sum of currents at any junctions was zero, but they did not know that the algebraic sum of the e.m.f. and potential difference in a closed loop was zero. Quite a number of candidates made a mistake by giving the answer to one significant figure and they also forgot to write the unit.

In part (*b*)(ii), most candidates simply summed up E_2 and the potential difference across R_5 in determining the potential difference V_{AB}. Point B should be taken as the reference and therefore $V_{AB} = I_2R_5 - E_2$.

In part (*c*), most candidates knew that in order for the galvanometer to be used to measure currents up to a maximum of 5.0 A, a shunt must be connected parallel to the galvanometer. Most of them just explained how the shunt was used to divert the current, but did not determine the resistance of the shunt that should be connected to the galvanometer. For those who tried to determine the resistance of the shunt, they made the mistake by using 5.0 A as currents flowing through the shunt instead of (5.0 – 0.020) A.

Answers: (*b*)(i) I_1 = 1.0 A, I_2 = 2.0 A, I_3 =1.0 A, (ii) 4.0 V; (*c*) 0.20 Ω

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Question 13

In part (*a*), almost all candidates were not able to explain the production of colourful light in billboards. They were confused about the principle of laser. Some candidates who were able to answer this part gave the explanation which lacked proper and logical steps. They did not start their answer with the excitation of atoms by electric discharge and missed to explain that photons emit lights according to the wavelength and types of gas in the bulb.

In part (*b*), most candidates poorly answered this part. They explained how emission line spectrum and absorption line spectrum were produced instead of describing what the emission line spectrum and absorption line spectrum were.

In part (*c*)(i) and (ii), most candidates correctly answered this part. They were able to describe Bohr's model of an atom and stated Bohr's postulates correctly.

In part (*d*)(i), most candidates were able to determine the energy of the photon emitted ΔE for the transition from $n = 4$ to $n = 1$ using the formula $E_n = -\dfrac{13.6}{n^2}$.

In part (*d*)(ii), candidates were able to calculate the wavelength of the photons correctly using the formula $E = \dfrac{hc}{\lambda}$.

In part (*d*)(iii), most candidates were able to deduce that the type of radiation emitted was ultraviolet.

Answers: (*d*)(i) 12.75 eV, (ii) 9.75×10^{-8} m

Question 14

In part (*a*)(i), (ii) and (iii), most candidates were able to answer correctly. This shows that they had a good understanding about radioactivity.

In part (*b*)(i), most candidates used the wrong relation by stating $\dfrac{m}{3.01605} \times N_A$. They confused μ for 10^{-6} with u for atomic mass unit. The ratio of $\dfrac{m}{3.01605}$ was not consistently used in term of unit. The majority of them did not obtain the value of N correctly. Some simply took 3.01605 as the atomic mass in gram instead of converting from u to gram per mole.

In part (*b*)(ii), many candidates knew how to use the decay law either $N = N_0 e^{-\lambda t}$ or $m = m_0 e^{-\lambda t}$ to determine the mass of tritium. Some candidates also used the formula $m = m_0 \left(\dfrac{1}{2}\right)^n$, where n is the number of half-life.

In part (*c*), most candidates used the expression $\dfrac{dN}{dt} = \lambda N$ to determine the number of nuclei N required, but they had a problem converting the number of nuclei N to the mass in order to get to the final answer.

Answers: (*b*)(i) 1.28×10^{18} nucleus, (ii) 4.53 μg; (*c*) 1.9×10^{-5} μg

PAPER 960/4 (WRITTEN PRACTICAL TEST)

General comments

In general, most candidates still had problem extracting information from the graph for analysis and analysing the sources of error associated with the experiment. Candidates also did not have the skill to use graphical method to draw the maximum and minimum lines through the centroid.

Comments on the individual questions

Question 1

In part (*a*), most candidates failed to recognise the main sources of error in measuring diameter D as being a random error and thus, they were not able to suggest the procedure to reduce the error.

In part (*b*), since there were four equations given in question 1 and three of which contained the variable for acceleration a, many candidates did not know which equation to be used to calculate acceleration a which was needed for the calculation of tension T subsequently. For candidates who used the correct equations, they failed to record the data in the proper significant figures. However, most candidates were able to tabulate the mean value of t correctly.

In part (*c*), most of the candidates who were able to tabulate the data in (*b*), could plot the graph of a against T with the proper scales and axes and managed to obtain and draw a straight line curve.

In part (*d*)(i), most candidates were not able to read the data according to the precision of the axes and were not able to calculate the gradient with the correct significant figures and unit.

In part (*d*)(ii), most candidates were not able to obtain the correct answer for moment of inertia I, because they were not aware that from the equation $a = \frac{D^2}{4I}T$, the gradient of the graph was equivalent to $\frac{D^2}{4I}$.

In part (*e*), a few candidates were able to give the systematic error and friction as the reasons why the graph did not pass through the origin.

Answers: (*d*)(i) 0.171 kg^{-1}, (ii) 2.18×10^{-3} m^2 kg

Question 2

In part (*a*), very few candidates were able to answer that in the fundamental mode, the separation between the supports was equal to $\frac{1}{2}$ the wavelength.

In part (*b*), since the oscilloscope was used to view the vibration of the wire, the magnitude of the vibration was recorded with respect to time. Again, very few candidates got this part correct.

In part (*c*)(i), most candidates knew how to use more than half of the data set to calculate the gradient of the graph. However, most of them had a problem giving the correct unit for the gradient that they obtained.

In part (*c*)(ii), most candidates failed to recognise that from the equation $f_0^2 = \frac{g}{\lambda_0^2\mu}m$, the gradient of the graph of f_0^2 against m was equivalent to $\frac{g}{\lambda_0^2\mu}$. Thus, they were not able to determine the mass per unit length μ correctly.

In part (d)(i), most candidates were not able to give the correct answer for the usage of centroid in drawing a linear graph.

In part (d)(ii), most candidates were also not able to draw two possible lines through the centroid that would give maximum and minimum gradient.

In part (d)(iii), since most candidates did not get the right line curves that went through the centroid in part (d)(ii), they did not get any marks for this part.

In part (e), the standing wave was not observable in the experiment. Most candidates were not able to give the correct or reasonable methods to determine the standing wave formed. The suggested methods were by listening to the loudness of the sound produced by the wire and observing the maximum amplitude of the wave formed from the oscilloscope.

Answers: (c)(i) 1.21×10^4 kg^{-1} s^{-2}, (ii) 5.63×10^{-4} m^2 kg m^{-1}; (d)(iii) 0.21×10^4 kg^{-1} s^{-2}

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