CONTENTS

PHYSICS (960/1)

OVERALL PERFORMANCE

For Semester 1, 2482 candidates sat the examination for this subject and 66.80% of them obtained a full pass.

The percentage of the candidates for each grade is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	10.44	7.29	10.23	8.06	12.29	11.04	7.45	5.08	4.55	2.14	21.43

CANDIDATES' RESPONSES

SECTION A: *Multiple-Choice*

Answer Keys

Question number	Key	Question number	Key	Question number	Key
1	**B**	6	**C**	11	**A**
2	**–**	7	**D**	12	**B**
3	**A**	8	**C**	13	**C**
4	**A**	9	**D**	14	**C**
5	**B**	10	**B**	15	**A**

General comments

More than 70% of the candidates answered questions 1, 8, 10 and 14 correctly. Question 5 was very difficult for the candidates to answer with less than 30% of the candidates answered it correctly. The rest of the questions were in the medium range with 30% to 70% of the candidates obtained the correct answers.

SECTION B AND C: *Structure and Essay*

General comments

In general, a majority of good candidates were able to plan and present answers clearly and systematically. They wrote appropriate equations according to the topics, followed by simplifying to the required quantities and then substitute the correct known quantities. A few candidates made mistakes on the units of their final answers. The quantitative questions were answered satisfactorily. Less candidate lost marks due to inappropriate use of significant figures. While the qualitative questions were not very satisfactorily answered. Candidates showed less ability in understanding physics concepts and explaining it in their own words. Sometimes the candidates tend to be a bit lengthy with elaborating the same point rather than presenting the next point to obtain the next marks. This may be due to the inability of the candidates to recognise and differentiate concepts that are the same and concepts that are distinctly different.

Comments on the individual questions

Question 16

In part (*a*), most candidates were able to write the equation, $\omega = \frac{\theta}{t}$, to calculate the angular velocity of the deck. However, some candidates could not differentiate between tangential velocity and angular velocity, therefore they use the equation $v = r\omega$.

In part (*b*), most candidates were able to determine the centripetal force experienced by a man at the edge of a rotating deck using the formula, $F = mr\omega^2$.

In part (*c*), most candidates were successfully able to solve the tangential velocity of a man standing at the edge of the rotation deck using the equation, $v = r\omega$.

In part (*d*), most candidates were able to state the force that enables the man to stand on the rotating deck without sliding. The candidates stated the force as friction or some stated static friction as the correct answer.

Answers: (*a*) 0.105 rad s^{-1}; (*b*) 7.72 N; (*c*) 1.05 m s^{-1}

Question 17

In part (*a*), candidates were supposed to describe the behavior of the atoms at the hot end after gaining kinetic energy and how the atoms transfer the kinetic energy to the neighbouring atoms to explain the mechanism of heat conduction through a double-paned window that has a thin layer of air between two panes of glass. The candidates could not explain that the atoms vibrate more vigorously or with larger amplitudes and collide with neighbouring atoms, which causes the transfer of heat to the cold end. Some candidates wrote about diffusion of free electrons in metals instead of explaining about the atoms in the heat conduction. Some candidates describe particles vibration instead of atoms vibration that causes the heat conduction.

In part (*b*), most candidates were not able to give a reason on why the layer of air between the window-pane must be thin. Very few candidates could relate about reducing heat conduction by convection as the correct answer.

In part (*c*)(i), most candidates were able to calculate the rate of heat flow into the house through jointed layers of window-pane and air. They were able to write the equation, $\frac{dQ}{dt} = kA\frac{d\theta}{dx}$, and get the correct answer.

In part (*c*)(ii), most candidates were not able to determine the percentage of reduction in the rate of heat flow through the double-paned window compared to a single-paned window. They could only determine the rate of heat transfer by a single-paned window but not the percentage of reduction. The correct relation for the percentage of reduction in the rate of heat flow was $\frac{P_{single} - P_{double}}{P_{single}} \times 100\%$.

Answers: (*c*)(i) 429 W; (*c*)(ii) 97.6%

Question 18

In part (*a*), most candidates were able to define Newton's law of universal gravitation. They stated that the attractive force between two bodies is directly proportional to the product of the masses and inversely proportional to the square of the distance between the two bodies. Some candidates missed the key word *attractive force*. Some candidates defined it by using the formula and stated the meaning of the symbols used which were accepted.

In part (*b*), the candidates realised the centripetal force is provided by the gravitational force between the satellite and the Earth. They were able to derive the relationship between the period and the radius of the orbit for a satellite orbiting the Earth in a circular path. Most of them could obtain the first four marks. However, only a few candidates were able to complete the final answer in the simplest form and conclude that T is proportional to the square root of R^3.

In part (*c*)(i), most candidates were able to calculate the potential energy of a satellite orbiting at an altitude. They used the formula $U = -G\dfrac{Mm}{r}$ and substituted, $r = R + h$, at and substituted, $r = R + h$, at an altitude 45 000 km. Some candidates forgot to include the negative sign in the formula.

In part (*c*)(ii), most candidates were not able to calculate the change in energy of the satellite that descends to a lower orbit. The candidates misinterpreted the change in energy as the change in potential.

In part (*c*)(iii), most candidates were able to calculate the orbital speed of the satellite after descending to the final altitude. Most candidates used the equation $\dfrac{mv^2}{r} = \dfrac{GMm}{r^2}$ and calculated the orbital speed of the satellite. Some candidates just wrote the formula for velocity from memory, which were accepted.

Answers: (*c*)(i) -1.18×10^9 J; (*c*)(ii) -7.13×10^9 J; (*c*)(iii) 3.40×10^3 m s^{-1}

Question 19

In part (*a*), most candidates were able to state the conditions of equilibrium for a rigid body which was the resultant force acting on the body is zero and the net torque acting on the rigid body about any axis of rotation is zero. Some candidates mentioned the net torque is zero without mentioning the keywords *about any axis of rotation*. Some candidates also wrongly stated moment of forces about any axis of rotation is zero instead of the moment of forces about *any point* is zero.

In part (*b*)(i), most candidates were able to sketch a closed triangle with the correct direction of forces. The common mistake made by candidates was not labelling the angles correctly.

In part (*b*)(ii), most candidates were able to determine the angle θ and the tension of the wire correctly. Most candidates were able to resolve the forces into the horizontal and vertical components and solved it to get the answer. Some candidates used the triangle of forces formed in part (*b*)(i) and solved it using trigonometry, sine rule or cosine rule, which was accepted.

In part (*c*)(i), not many candidates were able to draw a free body diagram of a plank pivoted at its centre with loads placed on both sides of the plank. The candidates missed to label the normal reaction acting at the pivot point to the plank.

In part (*c*)(ii), most candidates were able to calculate the weight of block M. Those who managed to draw a correct free body diagram on part (*c*)(i) were able to solve this part easily.

In part (*c*)(iii), those candidates who drew a correct free body diagram in part (*c*)(i), were able to determine the reaction force acting at the pivot point.

In part (*c*)(iv), the candidates who managed to solve part (*c*)(ii) correctly were able solve this easily. The net torque about the pivot was the algebraic sum of the torques.

Answers: (*b*)(ii) 18.1 N, 33.7°; (*c*)(ii) 844 N; (*c*)(iii) 7390 N; (*c*)(iv) 381 N m

Question 20

In part (*a*)(i), most candidates were able to define the molar heat capacities correctly. The common mistakes made by the candidates were missing *one mole of gas and a change of* 1 *Kelvin* or 1 *degree* in their answers.

In part (*a*)(ii), the majority of candidates were not able explain the reason that the heat supplied to a gas experiencing change at constant volume to increase internal energy of the gas molecules. Whereas, for constant pressure, the additional energy is used to do work against the external pressure.

In part (*b*), most candidates were able to use the first law of thermodynamics to derive the relationship between molar heat capacity at constant pressure $C_{p,m}$, molar heat capacity at constant volume $C_{V,m}$ and the molar gas constant R. They were able to obtain full marks, three marks when considering constant volume, and three marks considering constant pressure. However, there were some candidates who did not follow instruction to use the first law of thermodynamics. Some candidates just wrote the equation from memory without giving proper explanation. For example, the expression for change in internal energy, $\Delta U = nC_{V,m}\Delta T$, without explaining where it came from.

In part (*c*), most candidates were able to calculate the amount of heat absorbed by monoatomic gas during heating at constant pressure. They understood that the heat supplied $Q = nC_{p,m}\Delta T$ and were aware that $C_{p,m} = \frac{f+2}{2}R$ with monoatomic gas, $f = 3$.

Answer: (*c*) 24.2 J

PHYSICS (960/2)

OVERALL PERFORMANCE

For Semester 2, 2478 candidates sat for the examination for this subject and 63.83% of them obtained a full pass.

The percentage of the candidates for each grade is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	10.57	4.84	7.91	4.88	11.90	12.87	10.86	5.21	4.12	4.04	22.80

CANDIDATES' RESPONSES

SECTION A: *Multiple-Choice*

Answer Keys

Question number	Key	Question number	Key	Question number	Key
1	**C**	6	**D**	11	**B**
2	**D**	7	**C**	12	**B**
3	**A**	8	**B**	13	**D**
4	**A**	9	**C**	14	**A & C**
5	**B**	10	**D**	15	**D**

General comments

More than 70% of the candidates answered questions 1, 7, 11, 12 and 14 correctly. Question 4 was very difficult for the candidates to answer with less than 30% of the candidates answered it correctly. The rest of the questions were in the medium range with 30% to 70% of the candidates obtained the correct answers.

SECTION B AND C: *Structure and Essay*

General comments

Generally, the performance of the candidates was better in calculation questions rather than descriptive questions. They were able to organise their working very well and gave the answers correctly. There were still candidates who did not give the answer within the required significant figures. Some candidates rounded up too early in the intermediate steps and consequently the final answer was not correct.

Comments on the individual questions

Question 16

In part (*a*), most candidates were able to determine the resultant magnetic field using the formula $B = \frac{\mu_o I}{2\pi r}$. However, some candidates wrongly calculate the resultant magnetic field by subtracting the magnetic field for wire P and wire Q, $B_{resultant} = B_P - B_Q$. Some candidates also used incorrect formula of magnetic field, $\frac{\mu_o I_P I_Q}{2\pi r}$. Majority of the candidates also did not state the direction of the resultant magnetic field, which was into the page.

In part (*b*), most candidates were not able to state that the direction of magnetic force could be determined from the cross product of the vectors of length and magnetic field. Most candidates could only obtain one mark by stating that the wires move away from each other due to the repulsive force between them. Only a few candidates managed to explain that each wire lies in the magnetic field acting into the page produced by another wire. Instead, most candidates explained the repulsion is due to the currents flowing in the opposite directions or using the right-hand rule.

Answer: (*a*) 1.867×10^{-4} T

SEMESTER 2

Question 17

In part (*a*), most candidates were able to calculate the impedance through a resistor and an inductor using a relation $Z = \sqrt{R^2 + X_L^2}$. Some candidates wrongly substituted X_L in the formula. They mistook the value of self-inductance L as reactance X_L.

In part (*b*), most candidates were able to get the correct answer using the formula $V_L = I_o X_L$ and substitute the formula $V_o = I_o Z$ to find the peak current I_o. Some candidates mistakenly used the formula $V_o = I_o R$ to calculate the peak current in the circuit.

In part (*c*), most candidates were able to use the relationship, $\tan\theta = \frac{X_L}{R}$, or equivalent equations to calculate the phase angle correctly. Most of them were able to get the correct answer, but some failed to draw the phasor diagram correctly.

Answers: (*a*) 55.46 Ω; (*b*) 103.8 V; (*c*) 25.6°

Question 18

In part (*a*), most candidates knew how to use Coulomb's law and the formula, $F = k\frac{Q_1 Q_2}{r^2}$, to determine the force experienced by the two objects. The candidates were able to compare the two forces to get the value of the second force, which experienced by the two objects when the distance was reduced.

In part (*b*)(i), only a few candidates were able to give the right answer. They were only able to state the formula for electric potential, but unable to substitute the values of r_a and r_b accordingly, showing that they had a poor understanding on the concept of electric potential.

In part (*b*)(ii), most candidates were able to determine the electric field as $E = \frac{q}{4\pi\varepsilon_o r^2}$ using Gauss's law. However, most of them lost marks because of not stating the enclosed surface in their derivation.

In part (c)(i), most candidates were able to determine the electric field between plates using formula, $E = \frac{V}{d}$. However, there were some candidates who used the formula, $E = \frac{Q}{4\pi\varepsilon_o r^2}$, which was only true for point charges. A few candidates lost mark for their answer because of the wrong unit for electric field strength.

In part (c)(ii), most candidates were able to determine the work done using the formula, $W = q\Delta V$. A few candidates who could not answer this part correctly because they substituted the potential difference of 250 V instead of 125 V as the electron is at the midpoint of the uniform electric field.

Answers: (a) 45 N; (c)(i) 1.92×10^4 V m^{-1}; (c)(ii) 2.0×10^{-17} J

Question 19

In part (a), most candidates were able to define capacitance of a capacitor correctly. Some candidates defined using formula, $C = \frac{Q}{V}$. However, they failed to define the symbols used, which was Q as the charge on either plate and V as the potential difference between the plates.

In part (b), most candidates were able to describe the mechanism of charging a parallel plate capacitor correctly. A few candidates could give a very detailed and complete explanation of the charging process in terms of the flow of free electrons. However, some candidates could not score full marks because they were not aware that it was the electrons that flow from the negative terminal of the battery to the plate and the other plate of capacitor was induced to be positively charged. Some candidates wrongly answered by explaining using the charging and discharging equation of capacitors arranging parallel to each other.

In part (c), most candidates were able to score full marks by giving a detailed explanation on the effect on capacitance if an insulating material was inserted between a parallel plate capacitor. Most candidates explained that the capacitance of a parallel plate capacitor increases when an insulating material was inserted into the capacitor due to polarisation of the molecules of the material, which caused a decrease in the electric field strength and the potential difference across the capacitor. Some candidates lost mark because they used back *e.m.f.* to explain the reducing of the electric field.

In part (d)(i), most candidates were able to determine the capacitance of the capacitor using $C = \frac{\varepsilon_o \varepsilon_r A}{d}$.

In part (d)(ii), most candidates were able to determine the electric field between plates using the formula, $E = \frac{V}{d}$. Again, common errors committed by the candidates such as using the expression for electric field strength caused by a point charge and writing the final answer with the wrong unit.

In part (d)(iii), nearly all candidates could remember the formula for energy stored in the capacitor well, which was $U = \frac{1}{2}CV^2$. Some candidates substituted the wrong value of V as 600 V instead of 6 V.

Answers: (d)(i) 6.88×10^{-11} F; (d)(ii) 600 V m^{-1}; (d)(iii) 1.24×10^{-9} J

Question 20

In part (*a*), a majority of candidates poorly explained the concept of potential divider. A few candidates were able to draw a correct circuit diagram and deduced the potential difference across the resistor as $V_1 = \frac{R_1}{R_1 + R_2} V_o$.

Most candidates attempted part (*b*)(i) satisfactorily although some gave an incorrect answer due to rounding up the value for equivalent resistor too early. Some candidates applied the potential divider equation wrongly without determining the equivalent resistance of the parallel arrangement first.

In part (*b*)(ii), most candidates were able to determine the current through resistors, R_1, R_2 and R_L, correctly. In determining current through resistor R_1, candidates should first calculate the total resistance of the circuit and use the equation, $I_1 = \frac{E}{R_{Total}}$, to obtain the solution. While in determining current through resistor R_2 and R_L respectively, the candidates could just substitute the value of V_{out} in part (*b*)(i) into the equation, $I_i = \frac{V_{out}}{R_i}$. Some candidates also managed to apply Kirrchhoff's laws to determine the current through resistors, R_1, R_2 and R_L, although it involved more tedious calculation.

In part (*b*)(iii), most candidates did very well by using formula, $P = I^2R$, or any related formula for power.

In part (*c*)(i), most candidates were able to determine the balanced length of slide wire *XJ* correctly by recalling the basic principle of a potentiometer and applying the equation $\frac{l}{100.0} = \frac{E_2}{V_{XY}}$.

In part (*c*)(ii), many candidates attempted to answer this question and got the correct answer satisfactorily. Some candidates who got incorrect answer were due to failure to find the voltage across slide wire *XY*. Candidates were expected to first calculate the potential difference across the slide wire *XY*, V_{XY}', by applying the potential divider equation and then determine the new balanced length from the equation $\frac{l}{100.0} = \frac{E_2}{V_{XY}'}$.

Answers: (*b*)(i) 4.8 V; (*b*)(ii) $I_1 = 1.44 \times 10^{-3}$ A, $I_2 = 4.8 \times 10^{-4}$ A, $I_L = 9.6 \times 10^{-4}$ A;
(*b*)(iii) 4.608×10^{-3} W

SEMESTER 2

PHYSICS (960/3)

OVERALL PERFORMANCE

For Semester 3, 2469 candidates sat for the examination for this subject and 59.54% of them obtained a full pass.

The percentage of each grade is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	11.42	6.93	4.70	8.67	8.18	10.00	9.64	6.68	5.31	4.90	23.57

CANDIDATES' RESPONSES

SECTION A: *Multiple-Choice*

Answer Keys

Question number	Key	Question number	Key	Question number	Key
1	**B**	6	**C**	11	**C**
2	**A**	7	**A**	12	**D**
3	**B**	8	**D**	13	**C**
4	**B**	9	**C**	14	**B**
5	**A**	10	**D**	15	**B**

General comments

More than 70% of the candidates answered questions 3, 4, 8, 10 and 11 correctly. The rest of the questions were in the medium range with 30% to 70% of the candidates obtained the correct answers.

SECTION B AND C: *Structure and Essay*

General comments

In general, the performance of the candidates was satisfactory especially in answering qualitative questions and derivation of expression using physics laws and principles. However, candidates' performances in answering quantitative questions were highly commendable. Most answers to calculations were well organized and presented systematically and logically. Some candidates were also careless, as they did not write the correct units in their final answer. There were still candidates who did not give the answer within the required significant figures. Some candidates rounded up too early in the intermediate steps and consequently the final answer was incorrect.

Comments on the individual questions

Question 16

In part (*a*), most candidates were able to state that the standing wave is formed when two progressive waves travelling in the opposite directions superposed. However, many candidates did not state that the progressive waves produced by the oscillator is reflected from the pulley. As a result, most candidates were awarded only one mark in this part.

In part (*b*), most candidates were able to get the correct answer. Candidates who wrote the final answer in one or two significant figure lost their marks because the minimum significant figures for the data given was three and therefore they should write the answers either in three or four significant figures.

In part (*c*), nearly all candidates could write the equation relating to the speed of the wave with its frequency and wavelength and hence determine the speed of the wave correctly. However, a substantial number of candidates made the same mistake as in part (*b*) by writing the final answer in only two significant figures.

In part (*d*), most candidates were able to write the equation for the speed of the wave, $v = \sqrt{\frac{T}{\mu}}$ and calculate the mass per unit length correctly. Unfortunately, some candidates mistook T as the period of a simple pendulum and could not obtain the correct answer. There were also some candidates who calculated using $\mu = \frac{m}{l}$ without realising that the load produced a tension in the string.

Answers: (*b*) 0.800 m; (*c*) 24.0 m s^{-1}; (*d*) 3.42×10^{-3} kg m^{-1}

Question 17

SEMESTER 3

In part (*a*), most candidates were able to recognise the nucleus X as ${}^{4}_{2}He$ or Helium-4. Unfortunately, a large number of candidates wrote the answer as Helium which was not accepted because it did not specify the exact isotope from the equation given.

In part (*b*), nearly all candidates were able to calculate the loss mass in the reaction and determine the energy released. Some candidates calculated the energy from the equation, $E = \Delta mc^2$, but did not convert the value of mass into S.I. unit.

In part (*c*), most candidates were able to obtain only one mark by stating strong electrostatic repulsive force. The candidates were not able to relate that the high temperature give enough kinetic/thermal energy or high speed.

Answer: (*b*) 22.37 MeV

Question 18

In part (*a*), most candidates were able to define simple harmonic motion (SHM) correctly. However, some candidates missed the key words *always act towards the equilibrium position/fixed point* or *the acceleration is directly proportional to the displacement from the equilibrium position*.

In part (*b*)(i), most candidates were able to resolve the forces acting on the bob and obtain the restoring force. Nearly all candidates could apply Newton's second law of motion to obtain an expression for the acceleration of the bob. Unfortunately, a significant number of candidates did not indicate the assumption that the angular displacement, θ, must be small, and hence $\sin\theta = \theta$, then $\theta = \frac{x}{l}$ but they went straight to take $\sin\theta = \frac{x}{l}$. Some candidates started their derivation by considering a spring-mass system, which indicates there were misconceptions in physics.

In part (*b*)(ii), most candidates were able to get the correct values for angular frequency, ω, and phase angle, ϕ. However, most candidates used the approximate amplitude, A, as $A = l \sin \theta_{max}$ rather than the actual amplitude of the SHM, $A = l\theta_{max}$. Some candidates used 10° given as the phase angle instead of $\frac{\pi}{2}$ radian without thinking and analysing the SHM.

In part (*b*)(iii), most candidates were able to determine the speed of the bob when the displacement was 10.0 m using $v = \omega\sqrt{A^2 - x^2}$. Some candidates used the differentiation equation but only managed to get one mark for the method as they could not get the correct time to be substituted into the velocity equation.

In part (*b*)(iv), most candidates were able to state that the period of the oscillation would be greater or the frequency would be lower. Some candidates went on to give an unnecessary lengthy explanation with formula to show how the period will change.

Answers: (*b*)(ii) $A = 0.262$ m, $\omega = 2.56$ rad s^{-1}, $\phi = \frac{\pi}{2}$ rad; (*b*)(iii) 0.620 m s^{-1}

Question 19

In part (*a*), most candidates were able to state that every point on a wave front may be considered as a source of secondary wavelets and that the new wave front is given by the surface tangential to the secondary wavelets. However, only a handful of candidates were able to apply the principle and draw a correct diagram to show the secondary wavelets and the new wave fronts after passing through the diffraction grating. Candidates were expected to draw circular secondary wavelets emerging from at least three slits, and at least two different orders of new wave fronts where bright fringes are produced. Most candidates drew double slit interference or single slit diffraction without realising the question was on multiple slits of a diffraction grating.

In part (*b*), most candidates managed to obtain one mark to state the differences between two-slit interference pattern and single-slit diffraction pattern by stating that the central bright fringe in two slits interference pattern was wider than that of single slit diffraction. The expected answers should be the two slits interference pattern has uniform fringe separation but the single slit diffraction pattern has a wide central maximum but narrower maxima on either side. From the aspect of intensity, all bright fringes in the two slits interference pattern have the same intensity but the central maximum in the single slit diffraction has much higher intensity than the other maxima. Instead of stating the differences in the pattern, some candidates stated that two slits interference consisted of two coherent sources but the single slit had only one source. This indicates that the candidates did not understand the question fully.

In part (*c*)(i), nearly all candidates were able to write the equations, $y = \frac{\lambda D}{a}$ and $c = f\lambda$, and subsequently used the equations to calculate the slits separation correctly. However, a small number of candidates made a serious mistake by substituting the value of frequency as wavelength into the equation.

In part (*c*)(ii), candidates were asked to calculate the thickness of the thin film placed in front of one of the slits so that the central bright fringe will become the 10th bright fringe. Candidates were expected to know how to calculate the optical path difference and the condition for bright fringes. Although most candidates could write the condition for bright fringes, $x = m\lambda$, not many candidates could determine the optical path difference, $x = (n - 1)t$, correctly. Many candidates did not know the concept of optical path but used the thin film interference formula instead. This indicates that these candidates have poor analytical skills in determining the correct physics concept.

SEMESTER 3

In part (c)(iii), the question was switches from a double-slit interference into a single slit diffraction by covering one of the slits. However, most candidates did not see it as they continue to use the double-slit interference formula to perform their calculations, incidentally arriving at the same answer in spite of question asking for the width of the single slit. Only a small number of candidates started with the correct formula for single slit diffraction, $a \sin \theta = n\lambda$, and were awarded full marks from this part.

Answers: (c)(i) 1.20×10^{-3} m; (c)(ii) 1.00×10^{-5} m; (c)(iii) 1.80×10^{-4} m

Question 20

In part (a), the performance of candidates in this part was satisfactory. Most candidates were able to state that the angular momentum of electron in an allowed orbit is quantised. Unfortunately, there were some candidates who stated that the momentum of the electron is quantised instead of angular momentum of the electron.

In part (b)(i), most candidates were able to derive an expression for the radius of the first orbit of the hydrogen atom successfully. They derived the expression by considering the motion of electron around the nucleus and application of Coulomb's law and quantisation principle. Scoring was high with most candidates getting four marks out of five marks allocated. Most candidates lost one mark because they did not substitute $n = 1$ into their final expression.

In part (b)(ii), candidates did not have much problem to determine the value of the radius of the first orbit by using the expression obtained in (b)(i), except for some candidates who substituted the mass of proton into the expression instead of the mass of electron.

In part (b)(iii), most candidates were able to calculate the kinetic energy and potential energy of the electron in the first orbit. Most candidates derived the expressions for kinetic energy and potential energy of the electron in term of the radius and calculated the values successfully. However, some candidates left out the negative sign for the numerical answer for the potential energy causing them to lose the mark. A small number of candidates misunderstood the question and gave the total energy instead.

In part (c), not many candidates were able to describe the formation of emission line spectra of a stable hydrogen atom. Candidates need to state that the electron at ground state absorb energy, causing them to be excited to a higher energy level. This being unstable will cause the electron to return to its lower energy state by emitting its energy in the form of photons with discrete/certain wavelength. Some candidates lost marks for not mentioning the key word *discrete wavelength* in their answers.

Answers: (b)(ii) 5.31×10^{-11} m; (b)(iii) $K = 2.17 \times 10^{-18}$ J, $U = -4.34 \times 10^{-18}$ J

PAPER 960/5 (*Written Practical Test*)

Question 1

In part (*a*), most candidates were able to calculate t^2 from the result of experiment with the correct significance figures.

In part (*b*), most candidates were able to determine the static friction using equation, $F_s = mg \sin \theta$.

In part (*c*), most candidates were able to plot a graph of D against t^2 with the correct labelled axes and units. The candidates also knew how to use a suitable scale and all the points were correctly plotted. Furthermore, some candidates were able to draw the best straight line through the plotted points.

In part (*d*)(i), most candidates were able to calculate the gradient of the graph with triangle size covering more than $\frac{1}{3}$ of the graph paper given. However, they did not get the full mark because of the incorrect significant figures or unit in the answer. Some candidates also did not give the coordinates to the nearest half division for calculation of gradient.

In part (*d*)(ii), most candidates recognised that the gradient of the graph was equal to $\frac{1}{2}a$ and were able to calculate the acceleration from part (*d*)(i).

In part (*d*)(iii), candidates were able to determine the dynamic friction once the acceleration was determined using equation, $F_d = Mg \sin \theta - Ma$.

In part (*e*)(i), only about half of the candidates were able to determine the normal reaction, N, on the wooden block using the equation $N = Mg \cos \theta$.

In part (*e*)(ii), candidates who were able to determine normal reaction in (*e*)(i) were only be able to determine the coefficient of dynamic friction, $\mu_d = \frac{F}{N}$.

Answers: (*b*) 2.50 N; (*d*)(i) 22.5 cm s^{-2}; (*d*)(ii) 0.450 m s^{-2}; (*e*)(i) 9.33 N; (*e*)(ii) 0.221

Question 2

In part (*a*), not many candidates were able to state the way to discharge the capacitor completely as to short circuit the capacitor or to connect a wire across the terminals of the capacitors.

In part (*b*), the candidates were asked to suggest a method to obtain a more accurate voltmeter reading. Most candidates answered to repeat measurement of V and determine the average value of V, which was one of the ways to do it. There were also a few candidates who suggested to switched off after the respective time interval and then read the voltmeter, which was also accepted.

In part (*c*)(i), most candidates were able to estimate the e.m.f. of the battery used in the experiment as 6.0 V. However, the candidates were not able to show the line drawn in the graph as the value of 6.0 V obtained.

In part (*c*)(ii), almost half of the candidates were able to determine the time constant for the charging circuit. They were extrapolating the value for V when the voltage is 63% of the maximum value.

In part (*c*)(iii), most candidates were able to determine the capacitance of the capacitor using the equation $\tau = RC$.

In part (*d*), most candidates were able to calculate the percentage of error for the value obtained in (*c*)(iii), if the capacitance labelled on the capacitor was 2200 μF.

In part (*e*), only a few candidates were able to state the precautions that should be taken as discharge the capacitor before second attempted and connect the capacitor with the correct polarity.

In part (*f*), most candidates were able to predict that the accuracy of the experiment will be less if a resistor of lower resistance is used. However, most of them were not able to explain the reasons, which was time constant is smaller when lower resistance is used.

Answers: (*c*)(i) 6.0 V; (*c*)(ii) In range 40.0 s – 45.0 s; (*c*)(iii) About 2 250 μF; (*d*) About 2.3%

Question 3

In part (*a*), only a few candidates were able to state precaution that should be taken to ensure a simple harmonic motion as the amplitude does not exceed the extension due to weight of the mass and the amplitude does not exceed the proportional limit of the spring.

In part (*b*), most candidates were able to calculate the value of period, T, and frequency, f. Then they were able to tabulate the value of T, f and A correctly.

In part (*c*), most candidates were able to plot a graph of A against f with the correct labelled axes and units. The candidates also used a suitable scale and plotted all the points correctly.

In part (*d*), most candidates were not able to state the error in measuring A as random error. Thus, they also did not able to suggest improving its accuracy by repeating the measurement of A.

In part (*e*)(i) and (ii), most candidates were able to indicate the resonance frequency on the graph of A against f and thus were able to determine the value of the resonance frequency.

In part (*f*), most candidates were not able to suggest a method to obtain a more accurate resonance frequency by stating more points should be obtained especially around the peak region of the graph.

Answer: (*e*)(ii) About 2.25 Hz