2019 SINGAPORE-CAMBRIDGE A LEVEL H2 PHYSICS P1 SUGGESTED ANSWER KEY (9749)

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Preface

Dear JC students in Singapore,
Hope you will find this A Level examination solution set useful for your revision.

The answers and comments to this solution set are personally crafted and written by Mr Mitch Peh, an experienced former MOE JC lecturer and tutor in Singapore. Currently, Mr Peh is a full time A Level private tutor, specialising in the teaching of A Level subjects: Physics, Chemistry, Mathematics and Economics at both H1 and H2 Levels. You can find the A Level solutions for the other subjects under the various subject tabs at www.jcpcme.com.

Mr Peh has a proven track record in helping his students achieve success for the A Levels and internal school examinations including promos, advancement tests to JC2, block tests, mid years and prelims. Most of Mr Peh's students achieve "A's and 'B's grades for the A Level examinations. During his stint teaching at St Andrew's Junior College, Mr Peh has helped his classes achieve 100% promotion to JC2 on multiple occasions, attain close to 100% "A"s for H1 Project Work, clinch accolades like "Most Improved Class Award" and "Best Performing Class of the Cohort" for many of the internal school examinations. Mr Peh also has former students who subsequently went on to pursue H3 subjects and enroll in prestigious university courses like Dentistry, Medicine and Law.

If you are interested to be coached by Mr Peh for your preparations towards the A Levels, these are 3 more reasons why you should join Mr Peh's classes:

1. **Lessons can be fully customised to your needs**
- You have the full autonomy to decide the subject(s), content and pace that you want to cover for each lesson, out of any of the 4 subjects: Physics, Chemistry, Mathematics or Economics.
- Mr Peh will help to analyse your weaknesses in each individual subject and provide personalised feedback and suggestions for improvement.

2. **Answers to your questions can be addressed outside of the classroom**
- If you face any difficulty or challenge doing any of your tutorial questions, simply take a screenshot with your phone and send it to Mr Peh via Whatsapp. Mr Peh will answer your questions in the earliest possible time when he is available.

3. **You only pay the price of 1 subject but enjoy premium coverage for all 4 subjects**.
- Mr Peh provides resources for all 4 subjects including summarised notes, compiled topical questions sourced from past year school prelim examinations, Practical guides for Chemistry & Physics, examination checklists, mock papers etc.
- This is probably the only tuition service in Singapore which allows you to enjoy such extensive coverage and benefits.

Note that Mr Peh only takes in a limited number of students each year. You can find his lesson slots available under "Tuition Services" tab at www.jcpcme.com. For any further enquiries, you can directly whatsapp him at 9651 7737.

For the solution set below, if you find any discrepancies or you have any feedback or comments, please kindly direct them to Mr Peh through Whatsapp at 9651 7737.

The question paper has been omitted due to copyright reasons.

2019 A Level H2 Physics P1 Suggested Answer Key (9749)

30 marks, 15% weightage

1	**D**	6	**B**	11	**D**	16	**B**	21	**B**	26	**C**
2	**D**	7	**A**	12	**A**	17	**B**	22	**B**	27	**B**
3	**D**	8	**D**	13	**C**	18	**C**	23	**C**	28	**C**
4	**C**	9	**D**	14	**C**	19	**D**	24	**D**	29	**B**
5	**A**	10	**B**	15	**B**	20	**C**	25	**B**	30	**A**

Analysis of 2019 A Level Physics Paper 1 (9749)

Overall, I would say that this paper is more heavy on graphical analysis skills and there is less focus put into mathematical manipulation skills. In fact, most of the manipulation questions are simple, there is no need to apply techniques like ratio method or complicated simultaneous equations, which is frequently tested in many school prelim questions. Hence, to do well for this paper, strong graphical analysis skills is definitely a must.

Also, shockingly, there is an unprecedented 4 repeat MCQ questions from past year A Levels. In fact, there are quite a number of questions testing concepts similar to past year A Levels as well. Is this a sign that Cambridge A Level Physics examiners are starting to run out of ideas? For the repeat questions in this paper, if students are seeing it for the first time, they will definitely have to spend a significant amount of time working through them, creating additional pressure especially due to the time constraint of 2 minutes per question. Hence, I would say that students who have diligently completed their 10 year series and reviewed through it, have quite an advantage here. This is also a strong indicator that students should try to complete the 10 year series, before working on other school prelim questions.

Difficult Questions

Q5: It is not easy to tell whether the centre of gravity has shifted. We can apply principle of conservation of momentum to prove it by considering 2 cases: (1) the system as one body and (2) the 3 bodies separately

Q17: Not easy to see that the condition is to check that the number of waves passed in the specified amount of time for the 2 waves are n and (n+0.5) respectively, where n is an integer.

Q23: Students definitely have not done a similar practice question to this before. This question needs strong data interpretation skills, graphical analysis skills and good understanding of total current in a circuit with electrical components connected in parallel.

Tricky Questions

Q13: This question requires the use of a formula learnt in the topic of ideal gas. However, students may conveniently forget the need to convert the unit from g to kg. I was guilty of this but realised there was something strange with my answer when the root mean square speed value that I obtained was very low, usually the value should be in the hundreds to the thousands instead.

Q24: Students need to realise that when the resistance of variable resistor is 0 ohm, we have a case of short circuit.

Hybrid Skills Questions

Q4: Need graphical analysis skills and data interpretation by understanding the context

Q21: Need to know that the acceleration experienced by a charged particle in electric field is constant, and the gradient of velocity time graph represents acceleration.

Questions which require graphical analysis skills
Q7: Find area under force- distance graph to calculate work done in stretching wire
Q8: Manipulate equation to make KE the dependent variable and distance the independent variable
Q10: Make angular velocity the dependent variable and radius the independent variable

- **Questions which require manipulation skills**
Q6: Apply PCOM, find ratio of loss in KE to initial KE
Q9: Use gain in GPE divided by time
Q11: Simple application of centripetal acceleration formula
Q12: Apply conservation of energy to find escape velocity
Q23: Simple manipulation involving potential difference
Q25: Simple application of the induced e.m.f formula

Definition and Concept Based Questions (Supposed to be easy questions)
Q1: Definition of unit prefixes
Q2: Absolute uncertainty needs to be expressed to 1 s.f.
Q14: Internal energy is the sum of PE and KE
Q15: First law of thermodynamics: Increase to internal energy is the sum of heat supplied to system and work done on system
Q16: At 0 displacement, KE should be max and restoring force 0N.
Q20: Simple observation of the single slit formula
Q27: Understanding of how turns ratio in transformers affect voltage and current in secondary circuit (Secondary school knowledge is sufficient to do this question).
Q28: Max speed of electrons affects the minimum wavelength of X ray photons
Q29: Understanding of the Heisenberg uncertainty Principle
Q30: Understanding of decay constant

Repeat Questions
Q3: 2014 A Level P1/Q4: Kinematics Question
Q18: 2014 A Level P1/Q22: Wavelength is twice the distance between the two points with minimum voltage value
Q19: 2012 A Level P1/Q24: Need to know clearly what each variable in the diffraction grating formula represents
Q26: 2009 A Level P1/Q31: Find magnitude of magnetic flux density due to 2 coils

Detailed Solutions

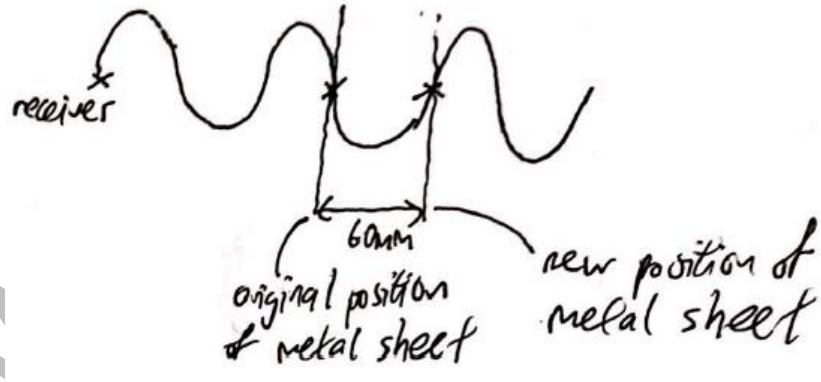
Qn	Ans	Detailed Explanations
1	D	• Topic: Measurements on unit prefixes • Nano: 10^{-9}, micro: 10^{-6}, deci: 10^{-1} Comments • An easy question which you should get correct as long as you study this section of the notes before
2	D	• Topic: Measurements on uncertainty • Absolute uncertainty value = $(4.072)(0.01)+0.01=0.05072\approx 0.05V(1.s.f)$ Hence, the meter reading should be recorded as (4.07 $\pm$ 0.05)V. Comments • Another easy question which you should get correct • You should know that absolute uncertainty value is recorded to 1 significant figure and the decimal placing of the reading will follow the decimal placing of the absolute uncertainty
3	D	• Topic: Kinematics • Repeat of 2014 A Level P1/Q4 • We can draw a velocity-time graph and examine the area under graph to understand. • Alternatively, we let s_2 be the total distance travelled in t s and s_1 be the distance travelled in the first (t-1)s. $s_1=\frac{1}{2}g(t-1)^2$ …. (1) and $s_2=\frac{1}{2}gt^2$ ….(2) $s_2-s_1=\frac{3}{4}s_2\Rightarrow s_1=\frac{1}{4}s_2$ …..(3) Subst (1) and (2) in (3). $\frac{1}{2}g(t-1)^2=\frac{1}{8}gt^2$ $4(t-1)^2=t^2\Rightarrow 3t^2-8t+4=0$ Hence, t= 2s or 2/3s (rejected) Comments • If this is the first time that you are attempting this question for the A Levels, it will certainly take you quite some time with the manipulations involved.

Qn	Ans	Detailed Explanations
4	C	• Topic: Kinematics on graph interpretation • Speed increases between times t_1 and t_2 as the gradient of the displacement-time graph, which represents speed, is increasing. • Acceleration decreases. This is because when speed increases, air resistance increases. Hence, the net force decreases acting on the ball will decrease. Since F_{net}=ma, a decreases when F_{net} decreases. <u>Comments</u> • An issue that some students face during this question is that they only focus on the graph and not on the context and information that is provided. If we purely focus on the graph, you will miss out on the information that air resistance is not negligible. • Then, you will be puzzled why constant acceleration is not in any of the options.
5	A	• Topic: Dynamics • There is no net external force acting on the system so centre of gravity does not shift. • This can be proven by considering the principle of conservation of momentum that the centre of gravity does not move. • Letting c.o.g represents centre of gravity, c represents the container, $\left(m_x + m_y + m_c\right)v_{c.o.g} = m_x v_x + m_y v_y + m_c v_c$ Since initial total momentum is 0kgms^{-2}, $v_{c.o.g}$ has to be 0ms^{-1} at all times for PCOM to hold since there is no net external forces acting on the body. <u>Comments</u> • This can be considered the most challenging question in the paper as you may not know the approach to show how the position of the centre of gravity moves.
6	B	Topic: Dynamics on conservation of momentum For principle of conservation of momentum to hold, mu = m(v) + m(2v) so u = 3v $\frac{\text{Loss in KE}}{\text{Initial KE}} = \frac{\frac{1}{2}m(3v)^2 - \frac{1}{2}m\left[(2v)^2 + v^2\right]}{\frac{1}{2}m(3v)^2} = \frac{4}{9}$ <u>Comments</u> • Manageable manipulations that an average student should get this question correct.

Qn	Ans	Detailed Explanations
7	A	• Topic: Forces • The point where the wire no longer obeys Hooke's Law is around 20mm extension. • Work done = Area under force-extension graph $=\frac{1}{2}(28)\left(20\times10^{-3}\right)=0.28J$ Comments • Note that the question is only asking us to find the work done in stretching the wire to the first point where it no longer obeys Hooke's Law, and not the entire work done. • Some students may try to use the longer method to find the value of the spring constant, k, first which is not necessary.
8	D	• Topic: Forces and Work, Energy and Power • $KE=\frac{1}{2}mv^2=\frac{1}{2}m\left(u^2+2as\right)=\frac{1}{2}mu^2+mas$ • Hence, the gradient of the curve is ma. • We should realise that a will decrease as weight will provide an increasing resistive force against the driving force and the motion of the object along the slope upwards. Comments • In terms of skills wise, this question is similar to A Level 2010 P1/Q11 which is to make the dependent variable KE and independent variable distance in the equation. • For students who miss out the information that there is a driving force applied to the object, they may choose option A instead where KE is decreasing.
9	D	Topic: Work, Energy and Power Minimum pump output power $=\frac{\text{Gain in GPE}}{\text{Time}}=\frac{\left(1.3\times10^9\right)(9.81)(2.0)}{(24)(60)(60)}=295kW\approx300kW$ Comments • Simple manipulation question where you should know power = $\frac{Energy}{Time}$
10	B	• Topic: Circular Motion • Given $v=R\omega$, $\omega=\frac{v}{R}$. • Since v is constant, $\omega\propto\frac{1}{R}$ • Hence, the graph will take on the shape of option B. Comments • Same skill as question 8 where we have to make ω the dependent variable and R the independent variable over here.

Qn	Ans	Detailed Explanations
11	D	Topic: Circular Motion $a = r\omega^2 \Rightarrow \omega = \sqrt{\frac{a}{r}} = \sqrt{\frac{20g}{7.0}} = 5.3 rads^{-1}$ <u>Comments</u> • Note that we have to be careful and notice that the radius of orbit is 7.0m, not 14.0m. • A Level examinations have some tendencies to use lengths to trick questions into choosing the wrong option for the topic of circular motion.
12	A	Topic: Gravitation and Work, Energy and Power To escape from the planet's gravitational field, the final GPE and KE are both 0J. Initial KE + Initial GPE = Final KE + Final GPE $\frac{1}{2}mv^2 - \frac{GMm}{R} = 0 \Rightarrow v = \sqrt{\frac{2GM}{R}}$ <u>Comments</u> • The above calculations is based on the conservation of energy which you should be familiar with
13	C	• Topic: Ideal Gas • Given that $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT \Rightarrow c_{r.m.s} = \sqrt{\frac{3kT}{m}}$ • $\therefore c_{r.m.s} = \sqrt{\frac{3(1.38\times10^{-23})(30+273)}{\frac{4.0\times10^{-3}}{6.02\times10^{23}}}} = 1374 ms^{-1}$ <u>Comments</u> • Tricky question where we have to remember changing the units • Note that for the above formula, m represents the mass of 1 helium gas atom and it needs to be expressed in kg. • Otherwise, we will get the wrong answer of option A. We should also realise something is not quite right when we obtain a very small value of 43ms^{-1} for the speed of an atom.
14	C	• Topic: Ideal Gas • Internal energy is the sum of the kinetic energy and potential energy of all the molecules. <u>Comments</u> • Straight forward question which is based on the definition of internal energy.

Qn	Ans	Detailed Explanations
15	B	• Topic: Thermal Physics on first law of thermodynamics • Note that the question wants the value of –Q since it is about heat transferred from the gas to the surroundings. • Applying the first law of thermodynamics, $\Delta U = Q + W$ $-Q = W - \Delta U$ <u>Comments</u> • Slightly tricky question where we must be very familiar with what each variable in the equation for first law of thermodynamics represents.
16	B	• Topic: Oscillations • When displacement is 0m, kinetic energy should be maximum and restoring force 0N. Hence, the answer should be option B and not option A. • When displacement is maximum, kinetic energy should be 0J and restoring force is at its maximum. Hence, the answer cannot be option C or D. <u>Comments</u> • Similar concept on displacement, kinetic energy and restoring force at the equilibrium position and maximum amplitude position for oscillation was tested in 2018 A Level P1/Q15.
17	B	• Topic: Superposition • For resultant of the two waves to be zero, destructive interference needs to occur. • Hence, at a particular instant, the total number of waves that have already passed through point P due to 1 of the sound waves should be n and the total number of waves due to the other sound wave should be n+0.5 where n is an integer. • At 0.25s, no. of waves that have already passed through point P for wave with frequency 480Hz = (480)(0.25)=120 and no. of waves that have already passed through point P for wave with frequency 482Hz =(482)(0.25) = 120.5 Hence, this is a possible time. • At 0.50s, no. of waves that have already passed through point P for wave with frequency 480Hz = (480)(0.50)=240 and no. of waves for frequency 482Hz = (482)(0.50)=241 Hence, this is not a possible time. • At 0.75s, no. of waves that have already passed through point P for wave with frequency 480Hz = (480)(0.75)=360 and no. of waves that have already passed through point P for wave with frequency 482Hz = (482)(0.75)=361.5. Hence, this is a possible time.

Qn	Ans	Detailed Explanations
17		• At 1.00s, no. of waves that have already passed through point P for wave with frequency 480Hz = (480)(1.00)=4800 and no. of waves that have already passed through point P for wave with frequency 482Hz = (482)(1.00)=482 Hence, this is not a possible time. • Since 0.50s and 1.00s are not possible times, we can effectively rule out option A, C and D already. The only option left is option B. <u>Comments</u> • Besides question 5, this is the other question that many students struggled with. • Students are unlikely to have come across similar question which requires such an approach to solve the question before. Usually, we use path difference when dealing with questions involving constructive and destructive interference instead. • We should use elimination method to get to the answer in a more efficient manner.
18	C	• Topic: Stationary wave • For the detected voltage at the receiver to be a minimum, stationary wave needs to be formed and the position of the receiver is a displacement node. • Also, note that since the metal plate is considered as a closed end, its position is a displacement node as well. • Next we examine the graph to realise that the detected voltage becomes a minimum after every 60mm moved. As a result, 60mm should correspond to half a wavelength. • Hence, the wavelength of the microwaves is 120mm. • Below is a diagram as an example to illustrate  <u>Comments</u> • Exact same question as 2014 A Level P1/Q22. • Again, if this is the first time you are attempting this question, you will probably have to spend quite a significant amount of time to work out the answers.

Qn	Ans	Detailed Explanations
19	D	Topic: Superposition on diffraction grating To find the angle between central maxima and third order maxima, we apply $d\sin\theta = n\lambda$ $\frac{10^{-2}}{4.0\times10^{3}}\sin\theta = 3\frac{3\times10^{8}}{6.0\times10^{14}}$ $\sin\theta = \frac{3}{5} \Rightarrow \theta = 37^{0}$ Hence, the angle between the two third-order maxima is 74^{0}. Comments • Have to be familiar with what each variable in the diffraction grating formula represents. • Repeat of 2012 A Level P1/Q24
20	C	• Topic: Superposition on single slit diffraction • Based on the single slit diffraction formula $\sin\theta = \frac{\lambda}{b}$, where θ represents the angle between the central maximum and the first minimum. • For the angle of diffraction to be reduced, wavelength λ should decrease or gap size b increases. • Then, sinθ will be of a smaller value and θ will be a smaller value as well. Comments • Straightforward question based on the single slit diffraction formula
21	B	• Topic: Electric Field • The weight of the electron can be considered negligible so the only force acting on the electron is electric force. Thus we have: $ma = qE \Rightarrow a = \frac{qE}{m}$. • Since the electric field strength remains constant throughout as it is a uniform electric field, acceleration should remain constant as well. • Hence, the gradient of the velocity against time graph must be a constant and positive value. Comments • Based on the options provided, you should realise that you need to find out how the acceleration of the electron which is the gradient of the velocity-time graph should be changing with time.

Qn	Ans	Detailed Explanations
22	B	• Topic: Electric Field on electric potential between parallel plates • Potential difference between top plate and X = $\frac{2}{10}\times 1000 = 200V$ • Hence, the potential at X is 800V • Potential difference between top plate and Y = $\frac{6}{10}\times 1000 = 600V$ • Hence, the potential at Y is 400V. • Thus the potential difference between X and Y is 400V. <u>Comments</u> • You should know that the electric potential gradient between two parallel plates is constant in order to perform the above calculations
23	C	• Topic: Current and Electricity, DC circuit • When potential difference across the parallel arrangement is less than 2V and the diode is non-conducting, current will only pass through the 4.0Ω resistor. When p.d. is 2V, the current passing through the 4.0Ω resistor will be V/R = 0.5A. • Beyond 2V, additional constant current will pass through the diode as well. Hence, there should be a spike in the current value. • For example, if the constant current is 0.2A, when potential difference is 2V, the total current will be 0.5+0.2=0.7A. <u>Comments</u> • This question requires strong interpretation skills on the spot as you are unlikely to encounter such a similar scenario before this A Level exam. • You must not miss out the information that the question is interested in the variation of total current across the parallel arrangement and not the current passing through the diode only. Otherwise, you may select the wrong option B.
24	D	• Topic: DC Circuit on the application of potential divider rule but can be a little tricky. • Maximum voltmeter reading occurs when the resistance of the variable resistor is set at 0Ω. Total resistance in circuit = 1.0kΩ Voltmeter reading = 12V as all the potential will be lost to the 1.0kΩ resistor connected parallel to the voltmeter. • Minimum voltmeter reading occurs when the resistance of the variable resistor is set at 1000Ω. Then the effective resistance across the parallel resistors will be 500Ω. • As a result, the minimum potential difference for the voltmeter reading is $\frac{1000}{1000+500}\times 12 = 8V$

Qn	Ans	Detailed Explanations
24		Comments • A common mistake made by students is to consider current flowing through the 1.0 kΩ resistor connected in parallel to the variable resistor when the variable resistor is set to 0Ω. Then these students will choose the incorrect option C. • Instead, when the variable resistor is set to 0Ω, current will just flow through the 0Ω variable resistor as current is able to flow through the path of least resistance. • Also, you should remember that potential divider rule can only be applied for resistors in series. Hence, we should find the effective resistance for the resistors in parallel before applying potential divider rule when the resistance of the variable resistor is set at 1000Ω.
25	B	• Topic: Electromagnetic Induction on the application of the induced e.m.f formula $\lvert\varepsilon\rvert = \frac{dNBA}{dt} = \frac{\left(2.0\times10^{-2}\right)\left(5.0\times10^{-3}+5.0\times10^{-3}\right)}{4.0} = 5.0\times10^{-5}V$ Comments • Simple and straightforward calculations
26	C	• Topic: Electromagnetism on the application of right hand grip rule to find the direction of magnetic field due to coil of wire • Suppose current is flowing in an anticlockwise direction in X. This will generate a magnetic field to be coming out of paper at centre O and magnetic field entering into paper at points P and Q. • For magnitude of the magnetic flux density at point O to decrease, current needs to flow in clockwise direction in Y. This will cause magnetic field to be entering into paper at points O and P and magnetic field coming out of paper at point Q. • As a result, the magnitude of the magnetic flux density at P will increase and the magnitude of the magnetic flux density at Q will decrease. Comments • Repeat of 2009 A Level P1/Q31 so you would have an advantage if you have attempted this question before.
27	B	• Topic: Alternating current on transformers • Recall the following formula applicable for ideal transformer $\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$ • Hence, when N_s doubles, $\frac{N_p}{N_s}$ is halved, $\frac{V_p}{V_s}$ is halved and $\frac{I_s}{I_p}$ is halved so $\frac{I_p}{I_s}$ is doubled. Comments • This is an easy question where students can do even with just secondary school knowledge.

Qn	Ans	Detailed Explanations
28	C	• Topic: Quantum Physics on X rays • When maximum speed of the electrons change, the maximum energy of the X ray photons emitted will change. Since $E = \frac{hc}{\lambda}$, maximum energy of X ray photons corresponds to the minimum wavelength of X rays. • Hence, minimum wavelength of X-ray must change as well.
29	B	• Topic: Quantum Physics on Heisenberg uncertainty principle • Definition of what the Heisenberg uncertainty principle is about.
30	A	• Topic: Nuclear Physics on radioactive decay • Option A is correct. Given $A = \lambda N$, activity is also known as the rate of decay of nuclei in the substance where $A = \frac{dN}{dt}$. Then, N is the number of undecayed nuclei. Hence, decay constant can be considered as the constant of proportionality in the equation relating the rate of decay of nuclei in the substance to the number of undecayed nuclei. • An alternative definition of decay constant is the <u>fraction</u> of the total number of undecayed nuclei which will decay per unit time where $\lambda = \frac{dN/dt}{N}$. Hence, options B and C are incorrect. • Option D is incorrect as the average time taken for half the nuclei initially present in the substance to decay refers to <u>half-life</u> instead. <u>Comments</u> • Another straight forward question based on the definition and properties of the decay constant.

End of Solutions