2018 HKDSE Physics & Combined Science (Physics)

Report on Assessment

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Overview

Paper	Physics	CS(Phy)
1A (MC)	Mean: 18.0 out of 32* (i.e. 56%) (2017: 21.5 out of 33)	Mean: 9.8 out of 21* (i.e. 47%) (2017: 11.1 out of 22)
1B	<50% (2017: >50%)	~>30% (2017: >30%)
2	~<50% (2017: ~>50%)	N.A.
SBA	~>70% (~2017)	~<70% (~2017)
Candidature	ALL: 11 118 SCH: 10 605	ALL: 381 SCH: 373

* one item deleted

Marking & Grading

On-Screen Marking (OSM) panels	
Physics	**CS(Phy)**
1B-1: Q.1, 3, 4, 6 (31M) 1B-2: Q.7, 8, 9 (30M)	1B-1: Q.1, 2, 3, 4 (31M) 1B-2: Q.5, 6, 7 (25M)
1B-3: Q.2, 5, 10 (23M)	---
2A: Astronomy (19%) 2B: Atomic World (67%) 2C: Energy (86%) 2D: Medical Physics (28%)	---

SBA marks stat. moderated (outlining cases ~10% schools reviewed by Supervisors)

Marking & Grading

- Expert Panel (Examiners, 4 ~ 5 persons) determine level boundaries/cut scores based on **Level descriptors / Group Ability Indicator (GAI) / Viewing student samples**.
- CS(Phy) graded by **Common items / Viewing student samples.**
- Endorsement by Senior Management/Public Exam Board

Note: GAI is calculated from Physics candidates' actual percentage awards obtained in 4 core subjects CEML.

Results

Physics

Cut score difference Δ = 45 %

Level	5**	5+	4+	3+	2+	1+
Percentage	2.5%	25.3%	49.2%	73.3%	90.2%	97.9%
No. of MC	**29**	**23**	**19**	**14**	**10/11**	**7**

CS(Phy)

Cut score difference Δ = 41 %

Level	5**	5+	4+	3+	2+	1+
Percentage	1.8%	8.1%	25.7%	46.7%	70.1%	89.8%
No. of MC	**19**	**15**	**12**	**9**	**7**	**4/5**

Paper 1A

Physics (32* MC)

>70%	50%-70%	<50%
8	15	9

Easy ⟷ Difficult

CS (Phy) (21* MC)

>70%	50%-70%	<50%
2	6	13

Easy ⟷ Difficult

PHYSICS MC

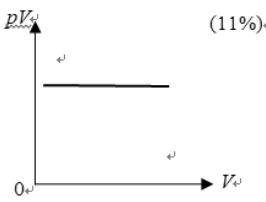
Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (4*)	43%	1
Force & Motion (9)	52%	3
Wave Motion (8)	62%	2
Electricity & Magnetism (9)	59%	2
Radioactivity (3)	59%	1

CS(PHY) MC

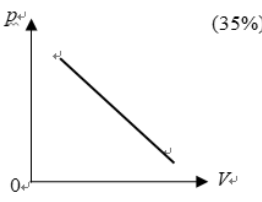
Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (3*)	47%	1
Force & Motion (7)	36%	6
Wave Motion (6)	50%	3
Electricity & Magnetism (6)	56%	3

4. From which graph below can one deduce that the pressure p of a fixed mass of an ideal gas is inversely proportional to its volume V when the temperature of the gas is kept constant?

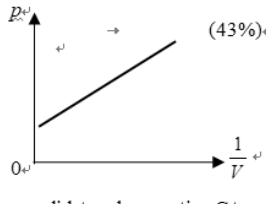
*A. (11%)



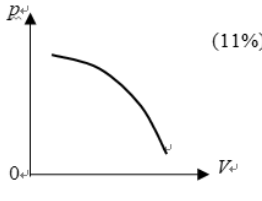
B. (35%)



favourable distractor C. (43%)

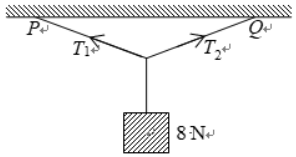


D. (11%)



Over 40% of the candidates chose option C to represent a directly proportional relationship, which is incorrect.

5. A block of weight 8 N is suspended from a horizontal ceiling by light inextensible strings to two different points P and Q as shown. The strings are equal in length.



Which of the following descriptions about the tensions T_1 and T_2 in the two strings is/are correct?

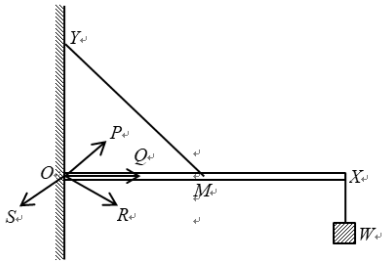
(1) The magnitude of T_1 must be greater than 4 N.
(2) The maximum value of T_2 would not exceed 8 N.
(3) The resultant force of T_1 and T_2 is zero.

		PHY	CS(PHY)
*A.	(1) only	(38%)	(22%)
B.	(3) only	(10%)	(14%)
C.	(1) and (2) only	(28%)	(28%)
D.	(2) and (3) only	(24%)	(36%)

favourable distractor

Less than 40% of the candidates were able to demonstrate a clear understanding of the vector nature of force.

6.



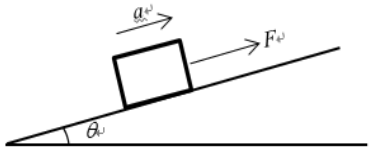
A uniform light rigid rod OX is hinged smoothly to a wall at one end O. Its mid-point M is connected by a light inextensible string to a point Y directly above O while a weight W is suspended from the other end X of the rod as shown. Rod OX remains horizontal. The reaction force acting on the rod due to the wall is along the direction

A.	OP.	(30%)
B.	OQ.	(39%)
*C.	OR.	(21%)
D.	OS.	(10%)

favourable distractor

Just over one-fifth of the candidates were able to make use of the conditions for static equilibrium and chose the correct option.

8. A block of mass m is placed on a smooth incline making an angle θ with the horizontal as shown. When a force of magnitude F parallel to the incline is applied to the block, it travels up the incline with an acceleration a. If the applied force becomes $2F$, what would the magnitude of the acceleration be?

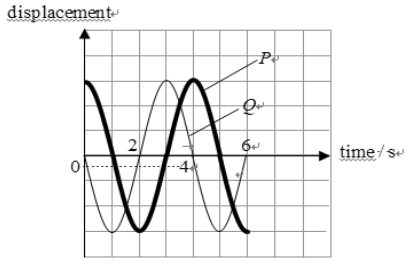


		PHY	CS(PHY)
*A.	greater than $2a$	(37%)	(21%)
B.	equal to $2a$	(26%)	(35%)
C.	between a and $2a$	(26%)	(24%)
D.	whether it is greater than $2a$, equal to $2a$ or between a and $2a$ depends on the value of θ	(11%)	(20%)

favourable distractors

Less than 40% of the candidates realised that the component of the block's weight remains unchanged and deduced the correct answer.

15. The figure below shows the displacement-time graph of particles P and Q on the same transverse travelling wave of wavelength λ.



Which of the following statements **MUST BE** correct? Upward displacement is taken to be positive.

(1) At time $t = 2$ s, P is momentarily at rest.
(2) At time $t = 4$ s, Q is moving downwards.
(3) The separation between the equilibrium positions of P and Q is 0.25λ.

		PHY	CS(PHY)
A.	(2) only	(16%)	(19%)
B.	(3) only	(22%)	(26%)
*C.	(1) and (2) only	(32%)	(27%)
D.	(1) and (3) only	(30%)	(28%)

favourable distractor

Over half of the candidates chose options B and D which suggests they wrongly thought that the separation between the equilibrium positions of P and Q was 0.25λ.

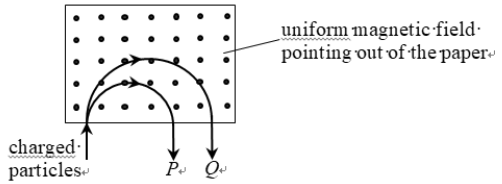
21. Which of the following is **NOT** a typical sound intensity level that occurs in daily life?

		PHY	CS(PHY)
A.	130 dB : when an airplane take-off	(33%)	(32%)
B.	110 dB : at a rock concert	(17%)	(16%)
*C.	80 dB : having a normal conversation	(39%)	(38%)
D.	30 dB : inside a library	(11%)	(14%)

favourable distractor

Candidates in general were not familiar with the typical sound intensity level that occurs in daily life.

28.



P and Q are two particles carrying the same amount of charge but of different masses. They travel with the same speed and enter a uniform magnetic field pointing out of the paper as shown. Semi-circular paths with different radii are described before they emerge from the field. Which descriptions below are correct?

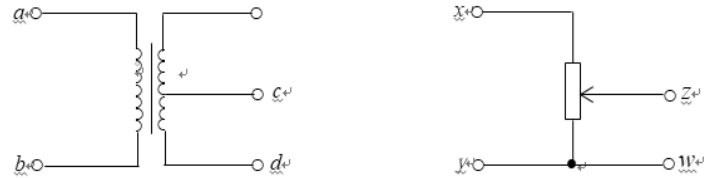
(1) Both P and Q are positively charged.
(2) P and Q emerge from the field with the same speed.
(3) The mass of Q is greater than that of P.

A.	(1) and (2) only	(19%)
B.	(1) and (3) only	(28%)
C.	(2) and (3) only	(17%)
*D.	(1), (2) and (3)	(36%)

favourable distractor

Nearly 30% of the candidates did not realise that the speeds of the particles remained unchanged in the magnetic field and wrongly chose option B.

30. In the circuits below, if a 12 V sinusoidal a.c. is applied across ab and across xy respectively, the voltages across cd and zw are both 6 V. Now if a 6 V sinusoidal a.c. is applied across cd and across zw respectively, what would be the voltages across ab and xy respectively?



	voltage across ab	voltage across xy	PHY	CS(PHY)
A.	12 V	12V	(19%)	(23%)
*B.	12 V	6 V	(46%)	(45%)
C.	6 V	6 V	(14%)	(18%)
D.	12 V	0 V	(21%)	(14%)

favourable distractor

As 40% of the candidates chose options A and D, this suggests quite a number of them did not fully understand how a potential divider works.

32. → X and Y are two radioactive nuclides. The ratio of the mass of an atom of X to that of an atom of Y is 1 : 2. The half-lives of X and Y are T and $2T$ respectively. If two samples consisting of purely X and Y respectively have the same initial mass, find the ratio of the number of undecayed nuclei of X to that of Y after a period of $4T$.

A.	1 : 4	favourable distractor (36%)
*B.	1 : 2	(40%)
C.	1 : 1	(13%)
D.	2 : 1	(11%)

Only 40% of the candidates managed to obtain the correct answer by manipulating the ratio of half-lives of the two radioactive nuclides.

分節符號 (下一頁)

Observations

- Candidates were competent in calculations but misconceptions were revealed in various questions which require qualitative answers.
- Not quite understand some experimental procedures and precautions which are subtle.
- Weak or careless in handling/converting units or scientific notations.
- Weaker candidates ~20 – 25%.
- Performance better in Paper 1 than in paper 2.

Points to note

- ~70% of Paper 1 from core part.
- Method marks 'M' awarded to correct formula / substitution / deduction
- In general, numerical ans. with 3 sig. fig. Answer marks 'A' awarded to correct numerical answer with correct unit within tolerance range.
- Accept using g = 9.81 or 10 m s^{-2}.

Points to note

- Equating Electives (Total = 80 each) using Paper 1

Before equating: Mean 38 to 45 / SD 17 to 22
After equating: Mean 43 to 47 / SD 16 to 18

2A Astronomy:	↑
2B Atomic World:	↑
2C Energy:	~ unchanged
2D Medical Physics:	~ unchanged

Points to note

- Samples of performance of candidates (Levels 1 to 5) available in late October (HKEAA website).
- SBA Conference on 3 Nov 2018
- SBA Online Submission in Jan 2019

THANK YOU

2018
DSE PHYSICS
Q 1, 3, 4, 6

1. Figure 1.1 shows a domestic water heater. Tap water entering the heater is heated when it passes through the coil duct and exits as hot water at a certain temperature.

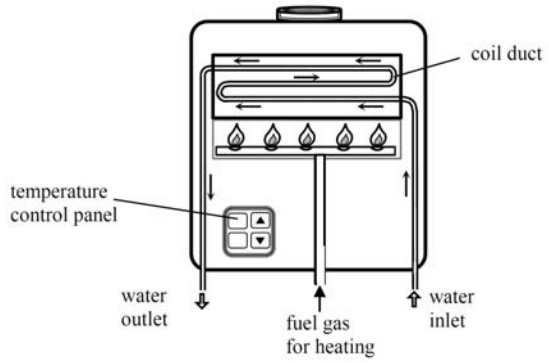


Figure 1.1

On a certain day in winter, the temperature of tap water is 15 °C. When the heater is in use, it delivers 6 kg of hot water at a temperature of 50 °C in 1 minute. Assume that there is no heat exchange between the heater and the surroundings. Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

1(a)
Estimate the power supplied to the tap water by the heater. (3 marks)

Suggested Solutions	Students' Response
Amount of energy required $E = mc\Delta T$ $= 6 \times 4200 \times (50 - 15)$ (1M corr. sub) $= 882\,000$ J (or 882 kJ) Power $P = \frac{E}{t} = \frac{882000}{60}$ (1M) $= 14700$ W (or 14.7 kW) (1A)	$P(60) = (6)(4200)(50-15)$ $P = 14700$ W ✓ $P = mc/\Delta T$ $= 6(4200)(50-15)$ ✓ $= 882000$ J $= 882$ kJ ✗

1(b)
Assuming the power estimated in (a) remains unchanged, determine the flow rate of tap water into the heater, in kg per minute, such that hot water at a temperature of 40 °C is delivered by the heater. (2 marks)

Suggested Solutions	Students' Response
Let m kg per minute be the water flow rate $mc\Delta T = Pt$ $m(4200)(40 - 15) = 14700 \times 60$ (1M) $m = 8.4$ (kg min^{-1} or kg) (1A)	$14700(60) = m(4200)(40-15)$ $m = 8.4$ kg min^{-1} ✓ $60 \times 14700 = m \times 4200 \times (50-40)$ ✗ $m = 21$ kg min^{-1} 0 $E = Pt = mc\Delta T$ $(14.7 \times 10^{-3}) = (\frac{m}{t})(4200)(40-15)$ $\frac{m}{t} = 0.14$ kg s^{-1} ✓ $= \frac{7}{3000}$ kg min ✗

+ This question tested candidates' knowledge and understanding on heat capacity and electric power. It was generally *well answered*.

+ Some weaker candidates *did not know the correct relation between energy and power*.

+ In (b), quite a number of the candidates had *difficulties working out the correct flow rate of water in kg per minute*.

Q2

Read the following passage about **braking in vehicles** and answer the questions that follow.

Mechanical braking is the most common braking method in vehicles. In this method, wheels of vehicles are fitted with brake pads which apply frictional forces that inhibit the motion of the wheels. Frictional braking results in a conversion of the vehicle's kinetic energy to thermal energy which then dissipates to the atmosphere in the form of waste heat.

The thermal energy (in J) generated during braking is approximately given by :

$$\text{thermal energy generated} = F_r \times d$$

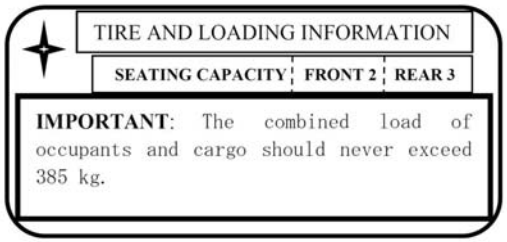
where F_r is the frictional forces (in N), and
d is the braking distance (in m).

Applying the principle of energy conservation :

$$\text{kinetic energy dissipated} = \text{thermal energy generated}$$
$$\frac{1}{2}mv^2 = F_r \times d$$

From this equation it can be seen that increasing the velocity v or mass m of an object means the applied frictional forces must be increased in order to bring the object to a stop within the same distance.

(a) Referring to the passage, explain why there should be a maximum load limit for a vehicle (see the vehicle label example below). (2 marks)



Students' Response

AS stated, when there's an increase in m, a greater frictional force has to be applied so that the vehicle can be stopped in its required distance. Since the road cannot provide infinite amount of Fr, there's a maximum m for the vehicle to ensure that it can be braked with the Fr the road can provide.

If the loading of a vehicle is over to the limit. The applied frictional forces must be increased or even not enough in order to bring the object to a stop within the same distance.

3(a)
Referring to the passage, explain why there should be a maximum load limit for a vehicle (see the vehicle label example below). (2 marks)

Suggested Solutions

If the maximum load is exceeded, the braking distance will increase if the *friction provided remains the same*.
Vehicles would *not be able to stop in time in case of emergency (thus dangerous).*

OR
A larger friction is required in *braking the vehicle within the same distance*, accident may occur if *the brakes cannot provide such frictional forces*.

Marking guideline

1st mark: maximum friction exists
2nd mark: dangerous, not able to stop in emergency

Students' Response

According to passage, $\frac{1}{2}mv^2 = Fr \times d$, increasing mass implies a larger frictional force required to stop an object within same distance. Thus, the load should be limited to ensure that the frictional force provided is adequate to stop the vehicle in a certain distance and hence to ensure the braking system can function well and prevent accident because of insufficient braking force.

As the increase of mass of vehicles will result in a increase in the applied frictional force to stop the vehicles. Therefore it is more difficult to brake the heavy vehicles. More heat will be generated as well. It is too dangerous if the mass of vehicles are too large. 0

(b) (i)
It is known that the brake pads would provide much smaller frictional forces or even brake failure would occur (i.e. without any friction provided) when reaching a temperature of over a few hundred degrees Celsius. Explain why it is not recommended for a vehicle driver to **apply the brakes continuously** during a long downhill trip. (1 mark)

Suggested Solutions

If the brakes are applied continuously, *thermal energy* generated will heat up the brake pads / brakes to too high a temperature that the brakes may fail.

Students' Response

During a downhill trip, applying brakes continuously can reduce acceleration due to gravity. However, it also implies that kinetic energy gained from gravitational potential energy is keep converting to thermal ✓ energy of brake pad. As a result, the brake pad would be at a high temperature and cause brake failure. It would affect effectiveness of brake pad.

When the driver apply the brakes continuously, the frictional force between the brake pads and the wheel will generate large amount of heat, causing ~~the~~ rising the temperature ✓ brake failures

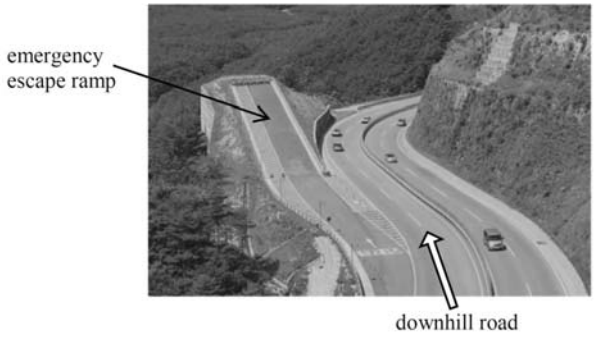
Students' Response

If the driver apply the ~~t~~ brakes continuosly during a long downhill trip, the brake pads will overheated ✗ and can no longer brake the car, so the driver will lost control of the car. 0

As continuously, breaking would mean a lot of friction between the vehicle and the road ✗ which would cause heat. As the process produce heat, it may cause the brake pads to break when over a few hundred ~~the~~ degrees 0

When the brakes applied continuosly, the frictional between the wheels and the ground ✗ will turns into thermal energy. and the temperature may rise up to a few hundred temperature. and the 0

(ii) The figure shows an emergency escape ramp (slanting upwards) built for stopping vehicles with brake failure resulting from the situation described in (b)(i). If such a ramp makes an angle of 30° with the horizontal and a vehicle with brake failure enters the bottom end of the ramp at a speed of 25 m s^{-1}, estimate how far it will travel along the ramp before it stops. Neglect air resistance and mechanical resistances within the vehicle. (g = 9.81 m s^{-2}) (2 marks)



3(b)(ii) (2 marks)

Suggested Solutions	Students' Response
Let D be the distance travelled along the ramp. *Kinetic energy of vehicle becomes its gravitational potential energy*: (1M) $D = 63.710\text{ m} \approx 63.7\text{ m}$ (62.5 m for $g = 10\text{ m s}^{-2}$) (1A) OR $v^2 - u^2 = 2as$ applied to *motion up the ramp* (1M) OR using 4 equations which can finally find out the answer (1A)	$\frac{1}{2}(25)^2 = (9.81)\,d\sin 30$ ✓ $d = 63.7\text{ m}$ ✓ $mgh = \frac{1}{2}mv^2$ ✓ $(9.81)h = \frac{1}{2}(25)^2$ $h = 31.9\text{ m}$ $\text{Distance} = \frac{31.9}{\sin 30°}$ $= 63.7\text{ m}$ ✓

Students' Response

By $\frac{1}{2}mv^2 = Fs$ ✓
$\frac{1}{2}mv^2 = mg\sin 30 \times s$
$\frac{1}{2}(25)^2 = g\sin 30 \times s$
$s \geq 63.7\text{ m}$ ✓

$0 = 25^2 + 2(-g\sin 30)(s)$ ✓
$s = 63.7\text{ m}$ ✓

By $F = ma$
$mg\sin 30° = ma$
$g\sin 30° = a$
The deceleration of car is $9.81 \times \sin 30° = 4.905\text{ ms}^{-2}$
$v^2 = u^2 + 2as$, taking direction of car travelling as positive
$0 = 25^2 + 2(-4.905)(s)$ ✓
$s = 63.7\text{m}$ ✓

Students' Response

By conservation of energy,
KE loss = PE gain ✓
$\frac{1}{2}mu^2 = mgh$
$0.5(25)^2 = (9.81)h$
$h = 31.8\text{ m}$ ✗

By $v^2 = u^2 + 2as$ ✓
$0 = (25)^2 + 2(-9.81)s$ ✗
$s = 31.9\text{ m}$.
∴ it will travel 31.9m before it stops.

$v^2 = u^2 + 2as$ ✓
$0^2 = (25\cos 30)^2 + 2(9.81)s$ ✗
$s = 23.891$
$= 23.9\text{ m}$
∴ it will travel 23.9 m.

+ Candidates' performance was *satisfactory*.

+ In (a), many candidates *missed the point* that if the *friction* F_r *remained unchanged* (at its maximum value) while the maximum load limit was exceeded, the braking distance d would be longer according to the equation $\frac{1}{2}mv^2 = F_r \times d$ given.

+ In (b)(i), when explaining why it was not recommended to apply the brakes continuously, *only the more able ones pointed out that the thermal energy generated would cause the temperature to reach over a few hundred degrees Celsius as mentioned in the passage*.

+ In (b)(ii), some candidates *had difficulties estimating* how far the vehicle would travel up the ramp *by applying either the principle of energy conservation or the equations for uniformly decelerated motion*. A few even did not know that the deceleration up the ramp was $g\sin\vartheta$.

4. Figures 4.1 (a) and (b) show the cross-section of a fixed spring gun fitted with a small cannon ball.

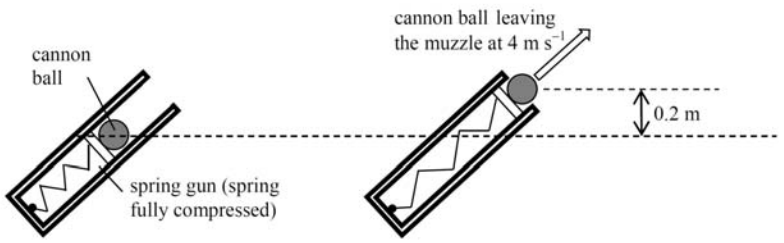


Figure 4.1(a) Figure 4.1(b)

The fully compressed light spring (Figure 4.1(a)) is released so that the cannon ball of mass 0.3 kg leaves the muzzle of the gun at a speed of 4 m s^{-1} (Figure 4.1(b)). Neglect air resistance. ($g = 9.81$ m s^{-2})

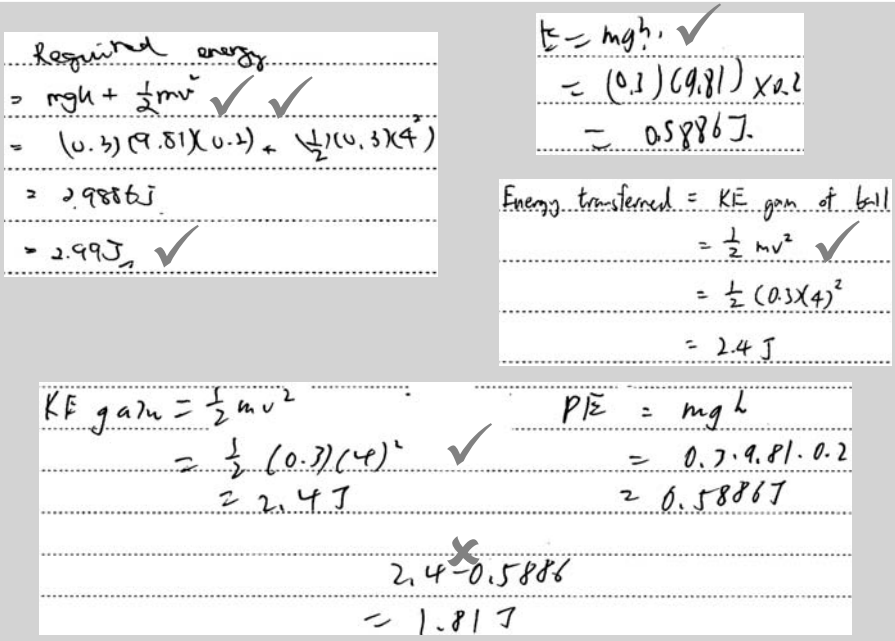
4(a) During the process from the time when the spring is fully compressed till the cannon ball just leaves the muzzle,
(i) how much energy is transferred from the spring to the cannon ball ? (3 marks)

Suggested Solutions

K.E. + P.E.

$= \frac{1}{2}(0.3)(4)^2 + (0.3)(9.81)(0.2)$ (1M + 1M)
$= 2.4 + 0.5586 = 2.9886$ J
≈ 2.99 J (3.0 J for $g = 10$ m s^{-2}) (1A)

Students' Response



4(a)(ii) explain whether the total momentum of the spring gun and the cannon ball is conserved. (2 marks)

Suggested Solutions

As the spring gun is fixed, *there is external force* acting on the system / the gun,

total momentum (of the spring gun and cannon ball) is *not conserved*.

Marking guideline

0 mark : Correct conclusion (not conserved) without correct explanation (there is external force)

Students' Response

Momentum is not conserved.
The law of conservation of momentum can only be applied when there is no external force acting on the system.
In this case, there is a gravitational force acting on the ball and the spring gun. Due to the external force, momentum is not conserved. ✓ ✓

N.A. As the initial potential and kinetic energy is 0 ✗ 0

✗ The total momentum ~~momentum~~ of the spring gun and the ball is conserved because the ball gain all energy transferred from the spring gun. 0

*(b) The cannon ball is projected at 50° to the horizontal initially and reaches a point horizontally away from the muzzle of the gun at a distance R. Find R and the time of flight t_f of the cannon ball to that point. (4 marks)

Suggested Solutions

Vertical : $s = ut + \frac{1}{2}at^2$

$0 = 4\sin 50^\circ t_f - \frac{1}{2}(9.81)t_f^2$ (1M)

$t_f = 0.6247$ s (0.6128 s for $g = 10$ m s^{-2})

≈ 0.625 s (0.613 s for $g = 10$ m s^{-2}) (1A)

Horizontal : $R = 4\cos 50^\circ \times t_f$

$R = 4\cos 50^\circ \times 0.625$ (1M)

$= 1.6062$ m

≈ 1.61 m (1.57 m for $g = 10$ m s^{-2}) (1A)

Students' Response

Consider the vertical components, take upwards as positive.

$v = u + at$

$0 = (4\sin 50°) + (-9.81)t$ ✓

$t = 0.312$ s

$t_f = 2t = 0.625$ s ✓

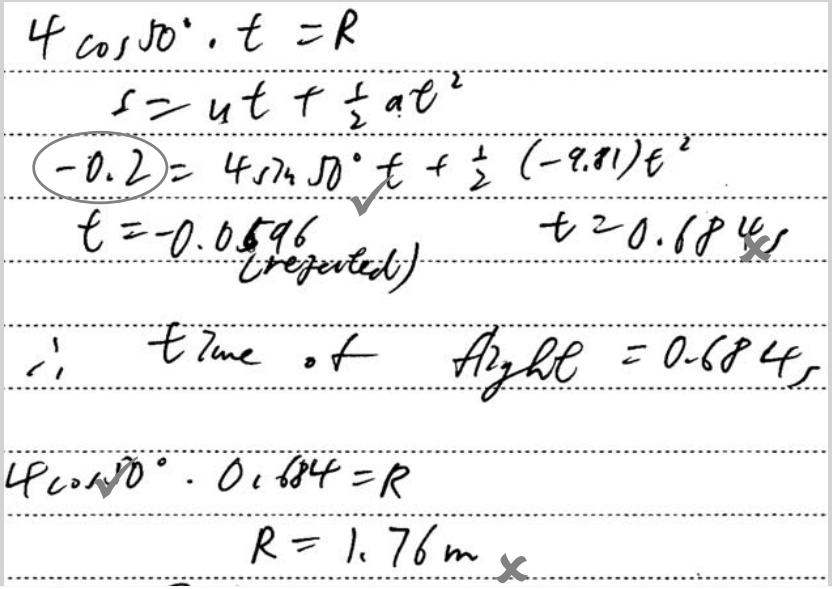
Consider the horizontal components.

$s = ut$

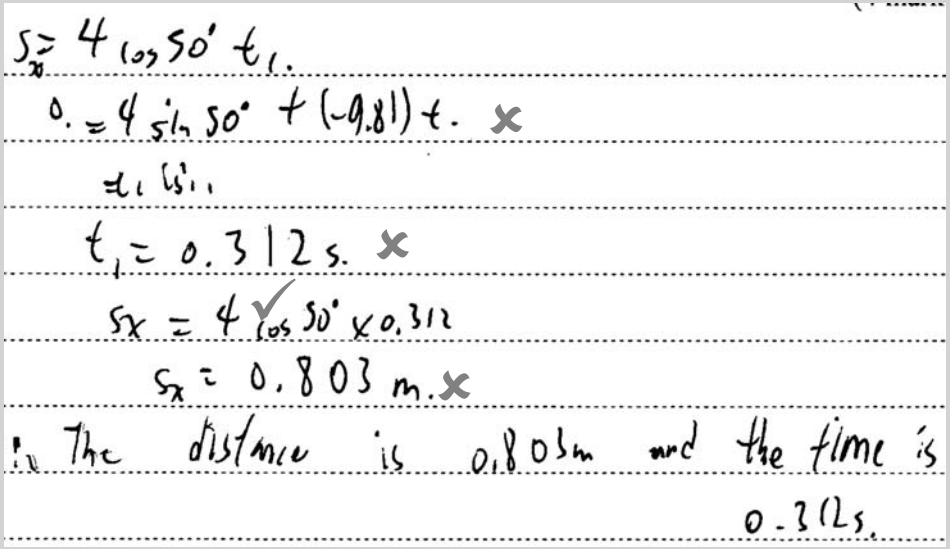
$R = (4\cos 50°)(0.625)$ ✓

$= 1.61$ m ✓

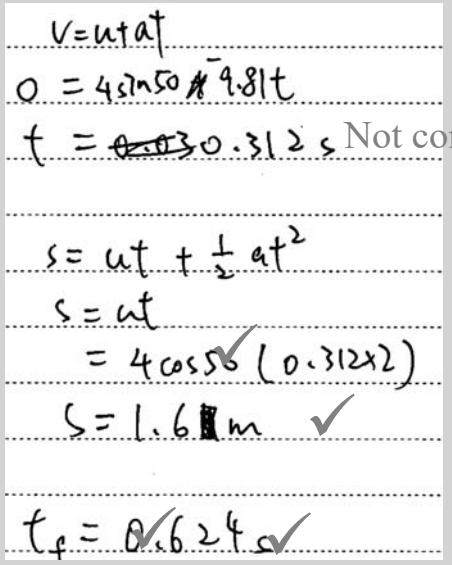
Students' Response



Students' Response



Students' Response



Not complete

*(c) If the projection angle is increased to slightly greater than 50° while the initial speed remains unchanged at 4 m s^{-1}, explain, **without any calculation**, whether there is any change in t_f. (2 marks)

Suggested Solutions

t_f *increases*
since the initial vertical velocity / component is greater.

Marking guideline

0 mark : Correct conclusion (t increases) without correct explanation (initial vertical velocity increases)
1 mark only : time changes since the initial vertical velocity changes.
1 mark only : correct conclusion (t increases) with incomplete explanation (vertical height increases, etc)

Students' Response

Yes As the motion of vertical plane and horizontal plane are independent, the downward acceleration is still $9.8 ms^{-2}$. However, the vertical velocity increases in this way. A larger time is needed to reach the original horizontal plane, thus larger t_f.

The t_f will increase. When $\theta > 50°$, vertical component (speed · sinθ) of ball's speed increases, thus it takes longer to fall back onto the ground

Students' Response

Yes, because the horizontal speed is independence on vertical speed. the time of flight depends on vertical height, due to the angle is larger, $4 \sin\theta$ is larger, height is higher, time of flight is longer.

Yes, there is changes in t_f. As 45° is the perfect angle for an object to be projected, the increase in angle could result in shorter t_f.

The time of the flight will increase because it takes longer to land on sy. 0

+ Part (a)(i) was *well answered*.

+ In (a)(ii), only the *more able candidates understood that as the spring gun was fixed*, external force(s) acted on the system and thus momentum was not conserved. Moreover, some candidates *only mentioned in their answers* that momentum was not the same before and after the process, *without giving any explanation*.

+ Part (b) was *well answered*. However, a few candidates had *difficulties in resolving the initial velocity* of the cannon ball correctly into its vertical and horizontal components.

+ In (c), only the *more able ones reasoned* without any numerical calculation that t_f would increase as the initial vertical velocity $v\sin\theta$ increased.

6. (a) You are given a ray box with a single slit (producing a fine light beam), a cylindrical concave lens, a plastic ruler, a pencil and a piece of paper as shown in Figure 6.1.

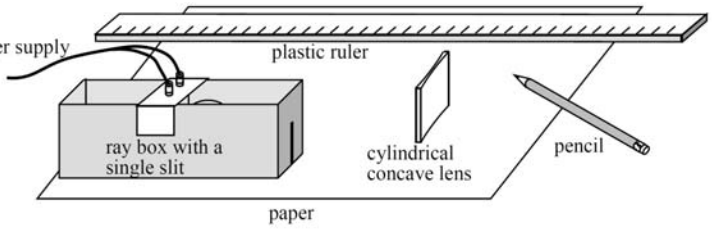


Figure 6.1

Describe how you would use the above apparatus to find the focal length of the lens and state **ONE** possible source of error in the experiment. (5 marks)

Suggested Solutions

Place the (cylindrical) lens on the piece of paper and trace its outline, *use ray tracing method* e.g.
- direct and trace a light ray towards the lens.
- direct and trace a light ray along / parallel to the principal axis

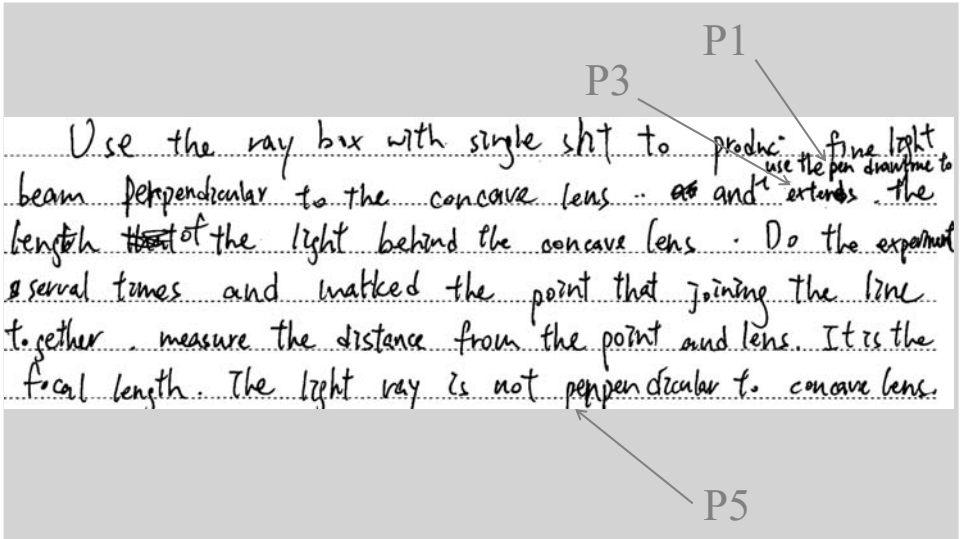
Direct another light ray parallel to the first one / principal axis (by shifting the ray box) and trace the path(s) of the (emerging) ray(s) on the paper.

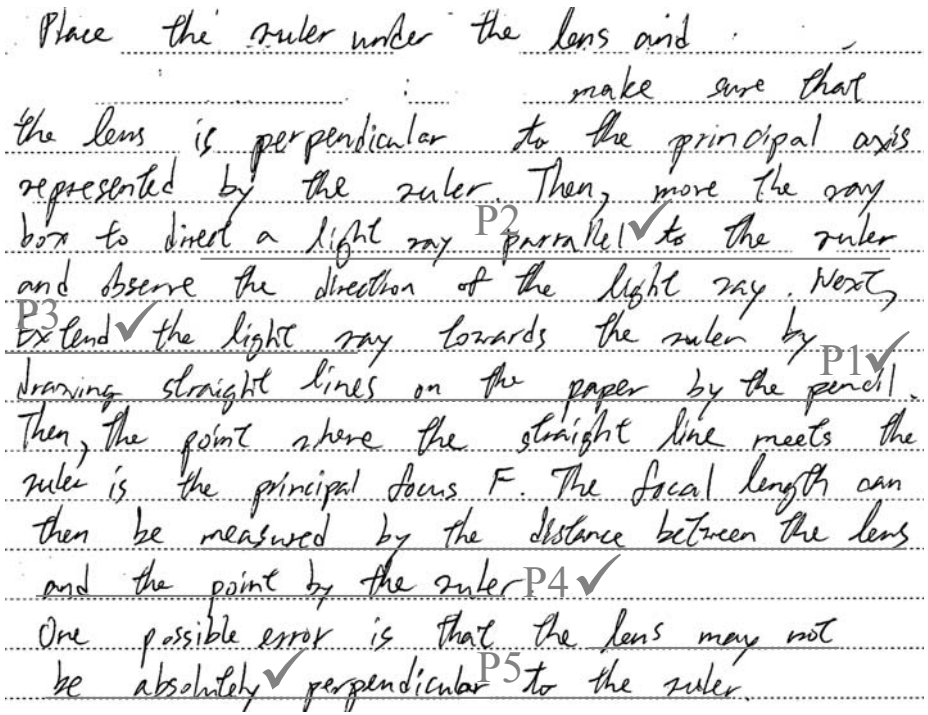
Extend (the path of) the emerging rays backward and locate the intersection point (on the focal plane containing *F*).

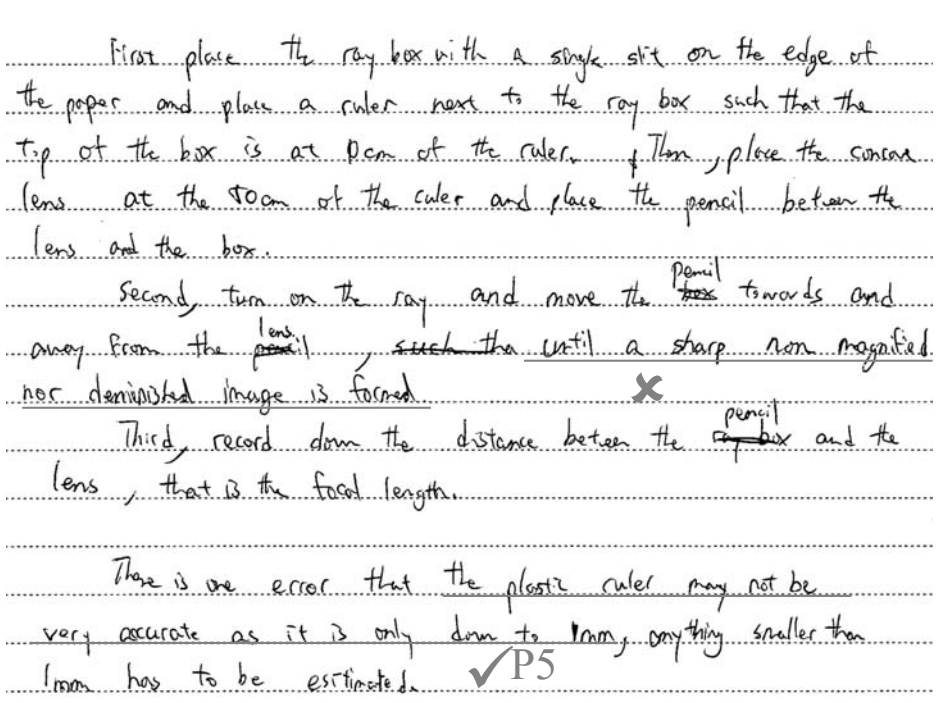
Measure the distance from the intersection point (or F) to the centre of the lens which gives the focal length of the lens.

Source of error: (Any **ONE**)
Scale uncertainty of the plastic ruler (read to nearest mm).
OR Unable to mark the path correctly because of the thickness of the beam of light from the ray box
OR The ray(s) is/are not parallel (to the principal axis)
OR Any reasonable answer (e.g. light rays not ⊥ lens for using rays // principal axis)

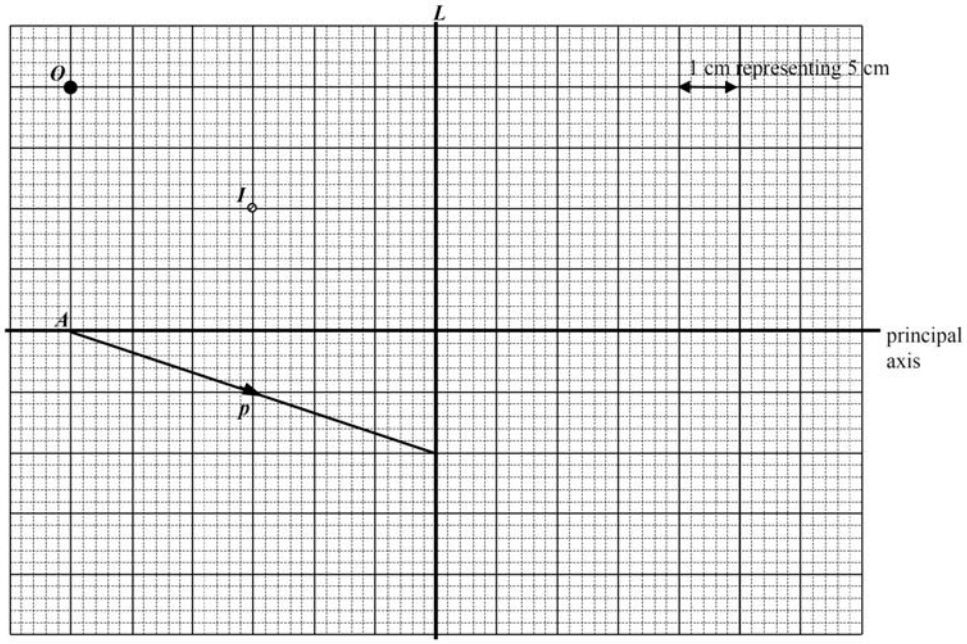
Students' Response







(b) In the figure below, L represents another cylindrical lens. A vertical pin used as the object is placed at O, the image is formed at I by the lens. The horizontal scale is 1 cm to 5 cm.



(i) What kind of lens is used ? Explain. (2 marks)

(ii) Draw a suitable light ray to locate the principal focus F of lens L. Find its focal length.
Focal length = ……. (2 marks)

(iii) Complete the path for the ray p from point A. (1 mark)

Suggested Solutions

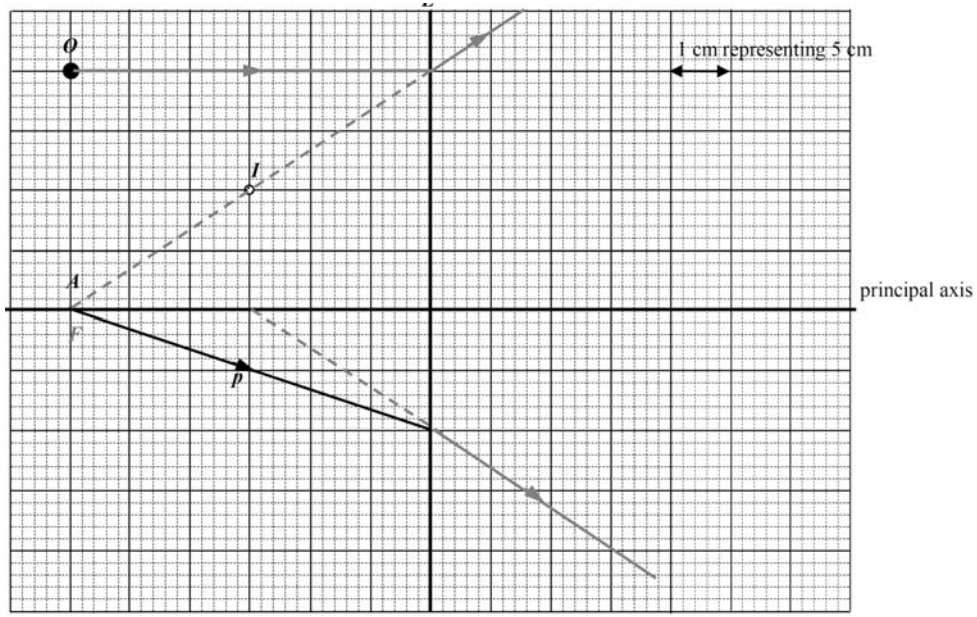
(i) L is diverging/concave. (1A)
only a diverging lens can produce a (virtual) image between the object and the lens (1A)

(ii) Focal length = 30 cm (1A)
Correct ray to find F (1A)

(iii) Correct ray p (1A)

Marking guideline

(i) Accept: only concave lens can produce a image between the object and lens



(i) What kind of lens is used ? Explain. (2 marks)

Students' Response

Concave lens. Since the image is virtual and diminished.

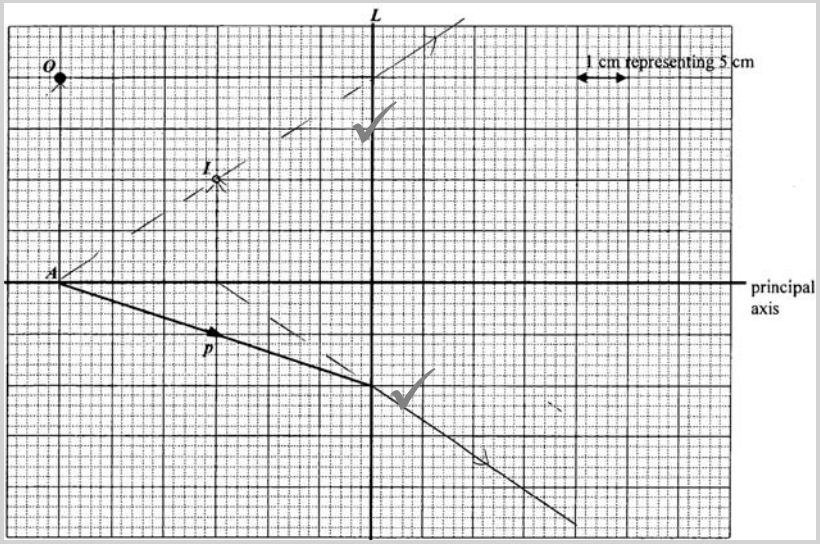
A concave lens is used. Only a concave lens would form an image between the object and the lens.

Since the image is erect and diminished, the lens must be a concave lens

Concave lens, the image ~~is form~~ is Vertual and form in the ~~left~~ same side with the object.

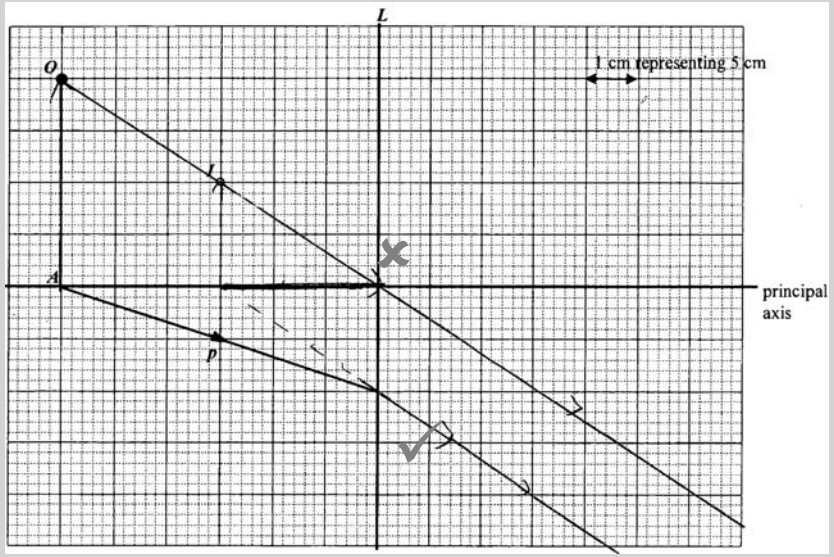
Concave lens, only concave lens can form virtual and erect image.

Students' Response



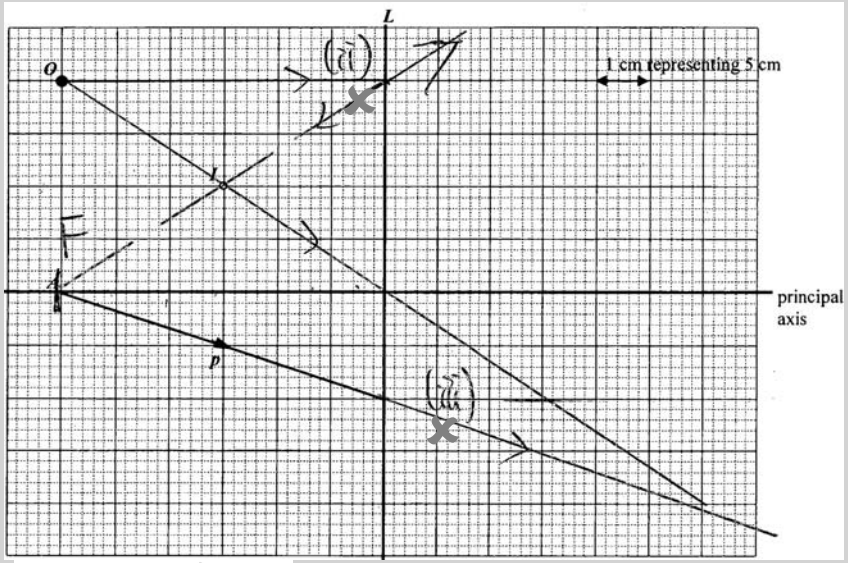
Focal length = ... 30 cm ✓

Students' Response



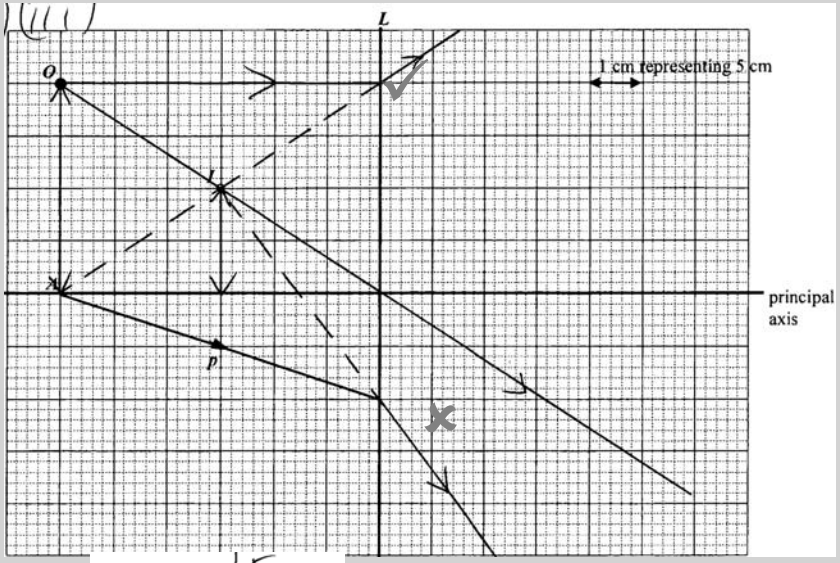
Focal length = ... 30 cm. ✓

Students' Response



Focal length = ... 30 cm ✓

Students' Response



Focal length = ... 15 cm ✗

- Candidates' performance in (a) was *poor*. Not many of them correctly suggested various methods, using one ray (with the lens position and principal axis correctly marked on the piece of paper) or two parallel rays from the ray box to find the focal length of the concave lens. Weaker candidates, however, wrongly tried to obtain an image formed by the concave lens using just a single light ray from the ray box.

- Part (b) was in general *well answered*. Most were able to draw a suitable light ray to find the focal length of the lens in (b)(ii). In (b)(iii), however, some candidates failed to indicate the correct path of ray *p*.

THANKS

2018 HKDSE - PHYSICS

1B-2

QUESTIONS 7, 8 &9

7 (a)(i) For the same set of apparatus, suggest a way to increase the average separation between the bright dots on the screen.

(a)(ii) The double slit is now replaced by a diffraction grating with 400 lines per mm. Briefly explain why the accuracy of the experiment can be improved.

Solution	Marks	Remarks
7. (a) (i) Increase the separation between the double slit and the screen, *D*.	1A	Well answered
	1	
(ii) The separation of the bright dots on the screen becomes larger, thus the percentage error in its measurement is smaller.	1A	NOT accept : - The dots are brighter - The separation of slits is smaller.
	1	

Not as well answered as expected

7 (a)(iii) Only five bright dots are observed on the screen such that the separation between the 1st and 5th dots is 1.56 m. find λ.

(iii) The angular position of the 2nd order bright dot

$\theta = \tan^{-1}\left(\dfrac{1.56/2}{1.40}\right) = 29.124053^\circ$ — 1M

Grating spacing $d = \dfrac{10^{-3}}{400} = 2.5 \times 10^{-6}$ m — 1M

1M is awarded for $\dfrac{1.56}{2}$ and $n = 2$

Applying $d \sin\theta = n\lambda$,

Wavelength $\lambda = \dfrac{2.5\times10^{-6} \times \sin 29.12^\circ}{2}$

$= 6.08378 \times 10^{-7}$ m

$\approx 6.08\times10^{-7}$ m (= 608 nm) — 1A

3

Common errors:
Applying $\Delta y = \dfrac{\lambda D}{a}$ to find the wavelength
OR
mistaking the order of diffraction as n = 1 or 5

7 (b)(i) With reference to the above settings, use the fringe separation equation $\Delta y = \lambda D/a$ in the double-slit interference to find the wavelength of sound is not accurate. Explain briefly.

(b) (i) The equation can only be applied for

- $\lambda << a$ (i.e. wavelength << separation of the two sources), OR λ is much smaller than a
- $a << D$ (i.e. separation of the two sources << separation of the sources and detector), OR a is much smaller than D

Any ONE

OR

Using the fringe separation equation to find the wavelength of sound is not accurate for

- λ is comparable to/ NOT much smaller than a
- a is NOT much smaller than D

Any ONE

1A

1

Note : the order of magnitude of the wavelength of sound is about 10^{-1} m

Common errors:
Poor verbal reasoning

7 (b)(ii) The distance between O and P is found to be 1 m when the signal generator is set at 750 Hz. By considering the path difference $PB - PA$, use the results of the experiment to find the speed of sound in air.

(ii) For the 1st order maximum,

wavelength λ = path difference $PB - PA$ — 1M

1M for λ = path difference

$= \sqrt{(1+0.5)^2 + 2^2} - \sqrt{(1-0.5)^2 + 2^2}$ — 1M

1M for calculation of path difference

$= 2.5 - 2.06155281 = 0.43844719$ m ≈ 0.438 m

speed of sound:

$v = f\lambda = 750 \times 0.4384$

$= 328.835$ m s^{-1}

≈ 329 m s^{-1} — 1A

3

8 (a)(i) To which pairs of terminals, X, Y or Z, should the switch connect to when the heater is in 'heating' mode ?

(a)(ii) Calculate the current drawn from the 220 V mains supply when the heater is in 'heating' mode.

Solution	Marks	Remarks
8. (a) (i) To terminals X	1A	
	1	Not as well answered as expected
(ii) $P = IV$		
800 W = I (220 V)	1M	Correct sub.
$I = 3.636364$ A		
≈ 3.64 A	1A	
	2	Well answered

8 (a)(iii) Find the power consumed by the heater in the mode of 'keeping warm'.

(iii) $800 = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$ $P_{keepingwarm} = \frac{V^2}{4R}$ $= 800(\frac{1}{5}) = 160\,W$	1M 1M 1A	1M for the expression of eq. resistance in heating mode 1M for calculating power with 4R 1A for corr. ans.
Alternative (I) $800 = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$ $R = 75.625\,\Omega$ $P_{keepingwarm} = \frac{V^2}{4R}$ $= \frac{220^2}{4(75.625)}$ $= 160\,W$	1 M 1M 1A	1M for finding the value of R 1M for calculating power with 4R 1A for corr. ans.

8 (a)(iii)

Alternative (II) Power ∝ 1/resistance OR $\frac{P_{warm}}{P_{heating}} = \frac{R_{eq}}{4R}$ $P_{warm} = P_{heating}\left(\left(\frac{1}{R} + \frac{1}{4R}\right)^{-1} / 4R\right)$ $P_{warm} = 160\,W$	1M 1M 1A 3	1M for inverse proportion relationship 1M for finding the ratio of resistances 1A for corr. ans.

Many candidates achieved the correct answer to this question by various routes.
Many incorrect answers seemed to follow a fairly random method.

8 (a)(iii) - ecf

8. (a) (iii) Accept using wrong answer in part (i), error carried forward in this part. ***For candidates selected terminal Y in part (i)**** $800 = \frac{V^2}{4R}$ $P_{keeping\ warm} = \frac{V^2}{R_{eq}} = \frac{V^2}{\frac{4}{5}R}$ $= 800 \times 5 = 4000\,W$	1M 1M 0A	Provided that the answer to (a)(i) is wrongly selected as "terminalsY".
Alternative (I) $800 = \frac{V^2}{4R}$ $R = 15.125\Omega$ $P_{keeping\ warm} = \frac{V^2}{R_{eq}} = \frac{V^2}{\frac{4}{5}R}$ $= 220^2/12.1$ $= 4000\,W$	1M 1M 0A	

8 (a)(iii) - ecf

Alternative (II) Power ∝ 1/resistance OR $\frac{P_{keeping\ warm}}{P_{heating}} = \frac{4R}{R_{eq}}$ $P_{keeping\ warm} = P_{heating}\left(4R / \left(\frac{1}{R} + \frac{1}{4R}\right)^{-1}\right)$ $P_{keeping\ warm} = 4000\,W$	1M 1M 0A	

8 (b)(i) What physical quantity does the meter *M* record ?

(b)(ii) An RCCB is a kind of safety device that cuts off the supply automatically whenever there is a small difference between the currents in the live (L) and neutral (N) wires. State, in each of the following situations, which device(s) will respond (i.e. the fuse blows and/or the RCCB cuts off the supply).

(1) A short circuit occurs between points *X* and *Y*.

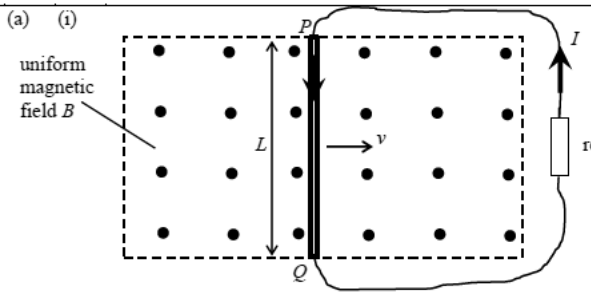
(2) A short circuit occurs between point *Y* and the metal case of the appliance.

(b) (i)	Electrical energy (consumed)	1A	Accept: 'Energy', 'Energy in kW h' or Energy (kW h)', 'Electricity consumed (kW h)', '用電量 (kW h)' NOT accept: 'Electricity consumed', '用電量' or 'k Wh'
		1	
(ii)	(1) only the fuse blows	1A	
	(2) only the RCCB cuts off the supply	1A	
		2	

Not as well answered as expected

Well answered

9 (a)(i) Indicate the direction of *I* in Figure 9.1.

Solution	Marks	Remarks
9. (a) (i) 	1A 1	Accept: Anticlockwise or from *P* to *Q* through the metal rod Not accept: From *P* to *Q*

Well answered

9 (a)(ii) Explain why an external force *F* is required to maintain the uniform motion of rod *PQ*. Find *F* in terms of the physical quantities given.

(a)(iii) This set-up works as a generator. By considering the mechanical power input by external force *F* to the set-up, show that $\xi = BLv$.

(ii)	By Lenz's law, a magnetic force F_B acts on the rod that opposes its motion, an external force *F* is needed to balance F_B so as to maintain uniform motion (or constant *v*)	1A 1A	Accept : Work done by an external force is needed to transfer mechanical energy into electrical energy.
	$\therefore F = F_B = ILB$ (in magnitude)	1A	*Accept :* $F = \xi I/v$
		3	
(iii)	mechanical power input = Fv $= (ILB)\,v$	1M	NOT accept : Proof by considering the rate of flux cutting.
	power input = power output (electrical) $ILB\,v = I\,\xi$ $\xi = BLv$	1M	
		2	

9 (b)(i) Explain why it is **only the horizontal component** of the earth's magnetic field that is cut by the mast which gives rise to this induced e.m.f.

(b)(ii) Referring to (a)(iii), calculate the e.m.f. induced across XY and state whether the distribution of free electrons along the mast is more at end *X*, more at end *Y* or uniform along *XY*.

(b) (i)	Horizontal (component) is perpendicular to the mast / direction of motion. OR Vertical (component) is parallel to the mast	1A	
		1	
(ii)	$\xi = (B\cos 30°)\,L\,v$ $= (50 \times 10^{-6} \cos 30°)\,(20)\,(6)$ $= 5.196152 \times 10^{-3}$ V ≈ 5.20 mV	1M 1A	by (a)(iii) using the horizontal component of *B* e.g. $B\cos\theta$ / $B\cos 30°$ / $B\sin 60°$
	more electrons at end *X*	1A	
		3	

Well answered

9 (b)(iii) Suppose X and Y are connected by a cable running side-by-side with the mast so that they form a complete circuit. explain whether there will be a current passing through it.

(iii)	No current. Both the cable and the mast cut the field lines in the same way, the e.m.f.'s produced are equal and thus oppose each other.	1A 1A 2	The 1st 1A mark is awarded only for correct explanation. Accept : No change in magnetic flux through the loop of the circuit.

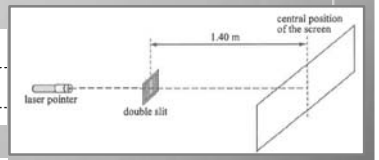
Poorly answered.
Common errors:
Poor verbal reasoning
Explain with induced current rather than induced e.m.f.

Thanks!

Q7(a)(i)

move the screen away from the slit. √

Increase the slit-screen separation by putting the slit closer to the laser pointer. √



Move the double slit more towards to laser pointer. √

Benefit of doubt !

~~place the~~ place the laser pointer more near to the double slit X

Increase the wavelength of the light. X

Q7(a)(ii)

因为所形成的亮点会比较亮X肉眼比较容易观察。

所散出的~~光~~亮点之间的距离误差减小，因此改善实验的准确度。 X

The slit separation of a diffraction grating is much smaller than that of a double slit. X

Q7(a)(iii)

$d\sin\theta = n\lambda$

$\frac{1\times10^{-3}}{400}\sqrt{} \times \left(\frac{1.56}{\sqrt{1.4^2+(\frac{1.56}{2})^2}}\right) = 2\lambda\sqrt{}$

$\lambda = 6.08\times10^{-7}\,m\sqrt{}$

1 M
1 M
1 A

$\tan\theta = \frac{1.56}{1.40}$ X

$\theta = 48.1°$

$d = \frac{1\times10^{-3}}{400}\sqrt{}$

$= 2.5\times10^{-6}\,m$

$d\sin\theta = n\lambda$

$2.5\times10^{-6}\times\sin48.1° = 5\lambda$

$\lambda = 3.72\times10^{-7}\,m$ X

0 M
1 M
0 A

$\Delta y = \frac{D\lambda}{a}$ X

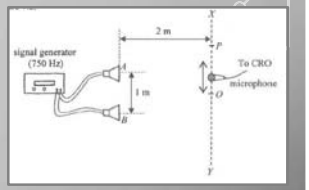
$\frac{1.56}{\frac{a}{2}} = \frac{1.4\times\lambda}{1\times10^{-3}\div400}\sqrt{}$

$\lambda = 6.96\times10^{-7}\,m$ X

0 M
1 M
0 A

Q7(b)(i)

因为 A与B之间的距离太大，所以 a 并不准确 X



The perpendicular distance of the wave source and the CRO is comparable to the seperation between the 2 speaker. X

Because sound waves are longitudinal waves while light waves are transverse waves, they are not the same kind of wave so $\Delta y = \frac{D\lambda}{a}$ can't be used. X

Q7(b)(ii)

$PB = \sqrt{3^2+2^2} = \sqrt{13} = 3.61\,m$ X

$PA = \sqrt{2^2+1^2} = \sqrt{5} = 2.24\,m$

Path difference $= PB - PA = 3.61 - 2.24 = 1.37\,m$

∵ As P is the second maximum

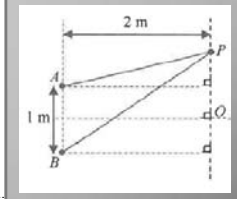
$\therefore \frac{1.37}{\lambda} = 2$ X

$\lambda = 0.685\,m$

$v = f\lambda$

$v = 750\times0.685 = 514\,ms^{-1}$ X

0 M
0 M
0 A



∵ $PO = AB = 1\,m$ X

∴ $PB - PA = \frac{1}{2}\,m$

∵ Central maximum is at O and next one is at P

∴ $\lambda = \frac{1}{2}\,m\sqrt{}$

∵ Speed $= 750(\frac{1}{2})$

$= 375\,ms^{-1}$ X

0 M
1 M
0 A

$\Delta y = \frac{D\lambda}{a}$ X

$1 = \frac{2\lambda}{1}$

$\lambda = 0.5\,m$ X

$v = f\lambda$

$v = 0.5\times750$

$v = 375\,ms^{-1}$ X

0 M
0 M
0 A

Q8(a)(ii)

Current drawn : $P = IV$

$800 = I(220)\sqrt{}$

$I = 3.36\,A$ X

1 M
0 A

$P = I^2R$

$800 = I^2(\frac{1}{4}+\frac{1}{1})$ X

$I = 31.6\,A$ X

0 M
0 A

Find R.

$800 = \frac{220^2}{4R}$

$R = 15.125\,\Omega$

∴ The current

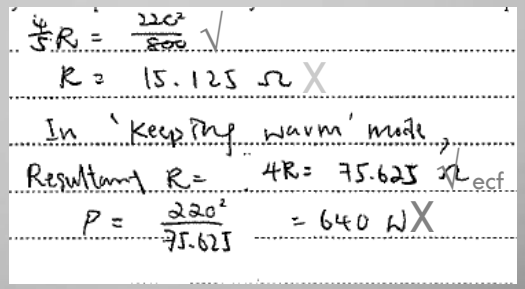
$= \frac{220}{15.125}$ X

$= 14.5\,A$

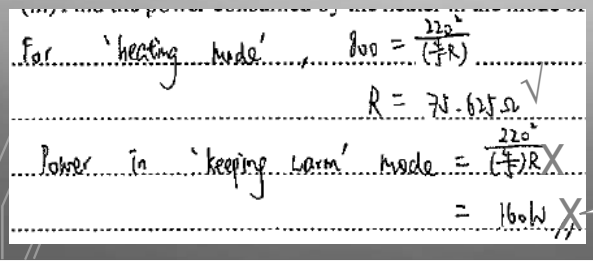
(14.545) X

0 M
0 A

Q8(a)(iii)



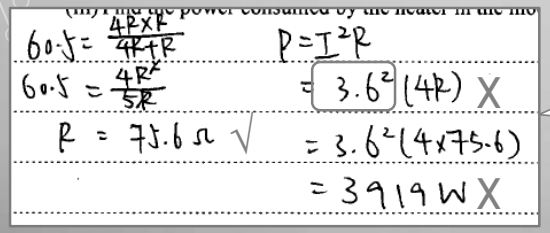
1 M
1 M
0 A



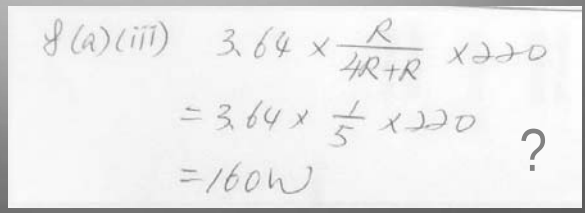
1 M
0 M

0 A (From incorrect method)

Q8(a)(iii)

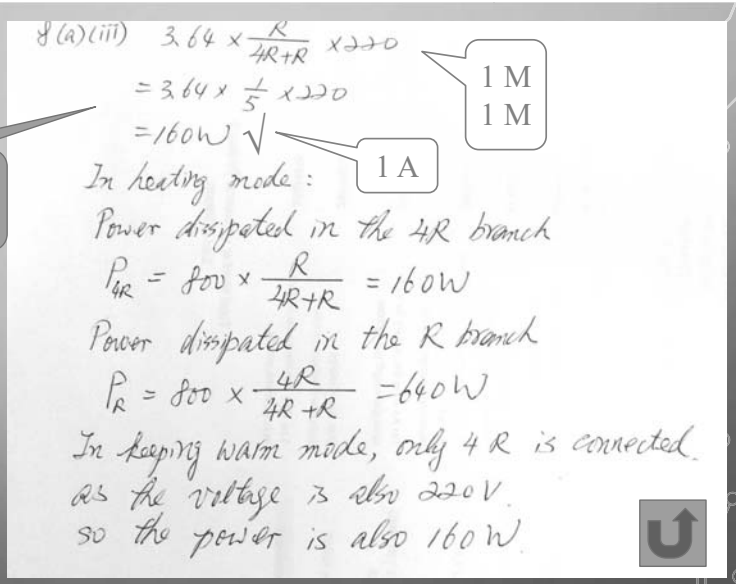


1 M
0 M
0 A



Q8(a)(iii)

Benefit of doubt !

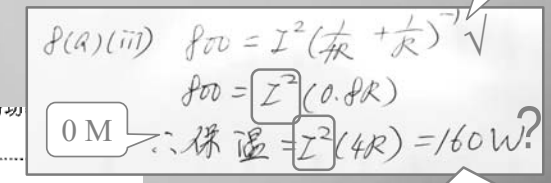


1 M
1 M

1 A

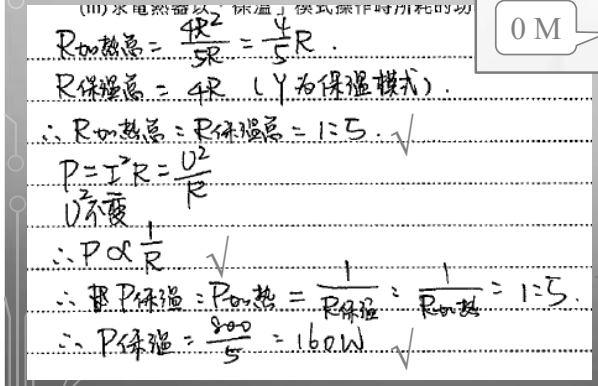
Q8(a)(iii)

1 M



0 M

0 A (From incorrect method)



1M
1M
1 A

Q8(a)(iii)-ecf

(i) 當電熱器以「加熱」模式操作，開關應接於 X、Y 或 Z 哪一對端鈕？

Y X

0 A

$P = \frac{V^2}{R}$ 「保溫」模式即是 $= (\text{兩}+\text{兩})^{-1}$

$800 = \frac{220^2}{R}$ $= \frac{1}{2}R$

$R = 15.125\,\Omega$ √ $= \frac{1}{2} \times 15.125$

$= 12.1\,\Omega$

$P = \frac{V^2}{R}$

$= \frac{220^2}{12.1}$ √

$= 4000\,W$ X

1 M
1 M
0 A

Q8(b)(i)

General term

用电量 (KW·h) √

Condoned

耗电量（能量） √

Voltage X

Current X

The power X in circuit.

Physical Quantity

kilowatt - hour X

Watt X

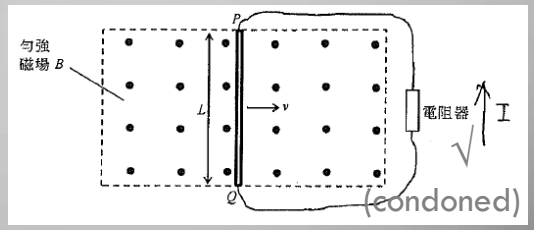
Unit

fuse X

Voltmeter X

Device

Q9(a)(i)



(condoned)

i). the I goes downwards X

terms of the physical

(i) From P to Q X

Q9(a)(ii)

1 A
1 A
1A

when current is conducted, a magnetic force to the left will push the rod, external Force needed to compensate the magnetic force √

$F = BIL$ N. (to the right) √

Unit of force

ii) 通电导线在磁场中运动会受安培力。假设F可平衡安培力

确保 PQ 棒匀速运动. √ √

$F_{安} = BIL$.

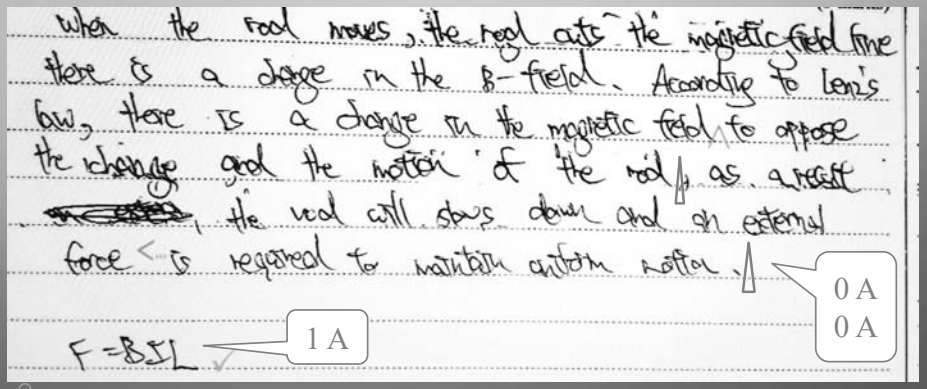
I = 电量.

$v = BLv$

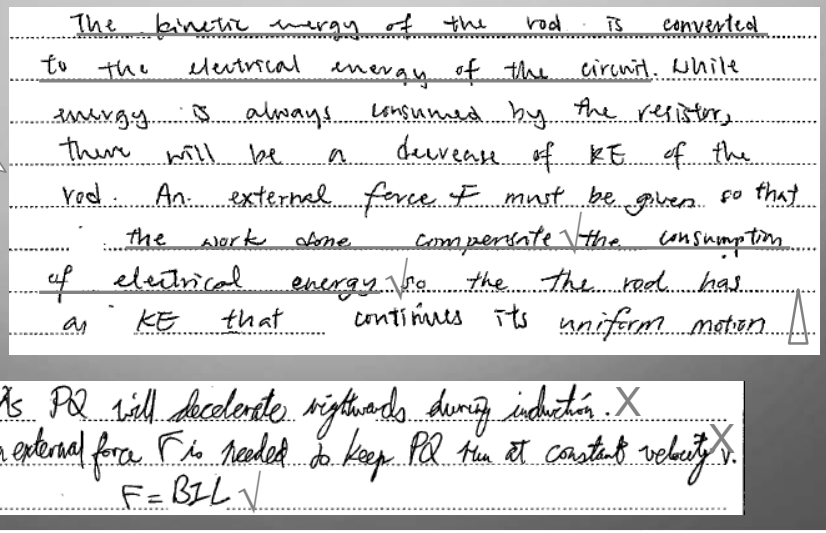
$\therefore F = F_{安} = BIL$ √

1 A
1 A
1A

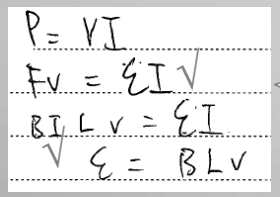
9(a)(ii)

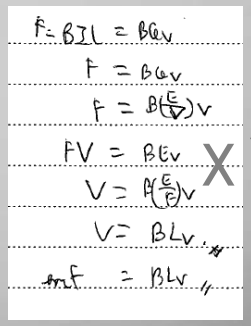


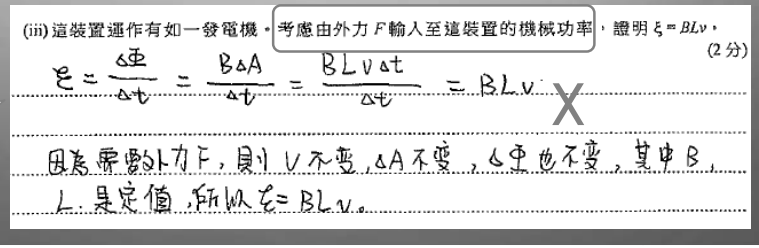
Q9(a)(ii)



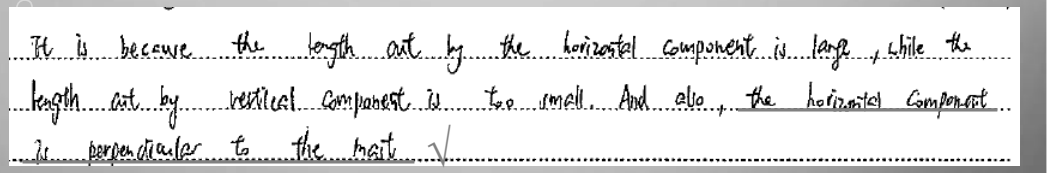
Q9(a)(iii)

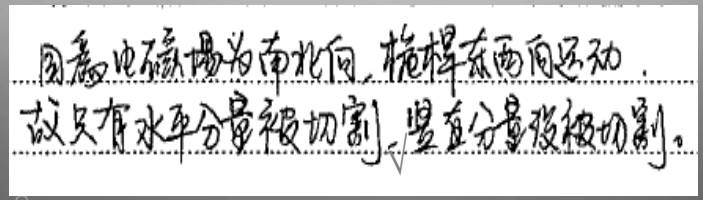






Q9(b)(i)





Q9(b)(ii)

較多在端 Y 還是均勻分佈於 XY。

感生電動勢 = $20(6)(50\times10^{-6})\sin 30°$ X

= 3×10^{-3} V X

自由電荷端 X 受洛倫茲力 √

0 M
0 A
1 A

$\varepsilon = BLv$

$\varepsilon = (50\times10^{-6})(20)(6)$ √

$\varepsilon = 5.20\times10^{-3}$ $\cos 30°$ $T\,m^2\,s^{-1}$ √

A

1M
1 A
0A

Q9(b)(iii)

No, there will NOT be a current passing through it. √

This is because the number of enclosed field lines in the circuit does not change when the ship moves, so that there is no change in magnetic flux, and there will not be any induced emf nor induced current. √

1 A
1 A

yes X there will be current, as it forms a coil, there will be induced emf by the mast, and it forms a complete circuit, so current will pass through it. X

0 A
0 A

Q9(b)(iii)

0 A (for incorrect explanation)

No, it is because the cable would also cut the field when the boat move. Hence, same current with same direction is induced and cancel with the current induced in mast XY. X

0 A

0 A (for incorrect explanation)

不会。X 因为该电路中，船的速度是匀速，因此磁通量的变化率为零，因此不会产生感生电流，所以不会有电流流通电路。X

0 A

2018 DSE PHYSICS/ COMBINED SCIENCE (PHYSICS)

QUESTION 2(a)

*2. Two vessels, A and B, of volumes $3V$ and $2V$ respectively are connected by a narrow tube with a tap as shown in Figure 2.1. Initially the tap is closed and both vessels are at the same temperature. Vessel A contains helium gas at a pressure p while vessel B contains 0.8 mol helium gas at a pressure $2p$. Assume that helium gas can be taken as an ideal gas.

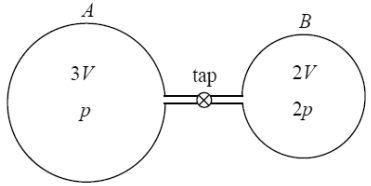


Figure 2.1

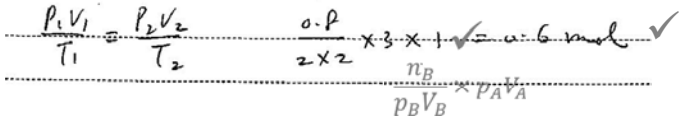
(a) Deduce the amount of helium gas (in mol) in vessel A. (2 marks)

QUESTION 2(a)

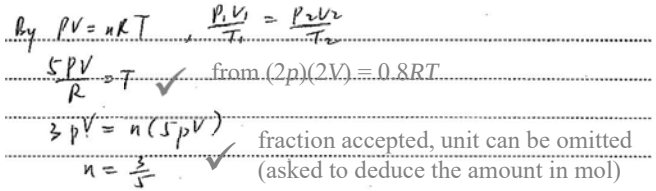
Marking Scheme	Performance/ Common Errors
$n = \frac{pV}{RT} \propto pV$ (for constant T) 1M $\frac{n_A}{n_B} = \frac{(p)(3V)}{(2p)(2V)}$ $n_A = 0.75 \times 0.8$ mol $= 0.6$ (mol) 1A $(2p)(2V) = 0.8RT$ 1M $pV = 0.2RT$ $p(3V) = nRT$ $n = 3 \times 0.2 = 0.6$(mol) 1A	Most candidates were able to find the amount of helium gas in vessel A. However, some of them just used 3 and 1 instead of $3p$ and V in their working.

QUESTION 2(a) (SAMPLES)

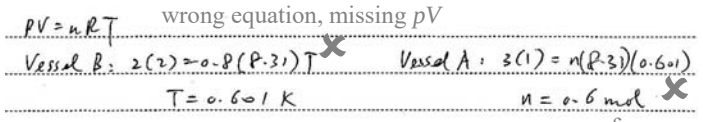
(a) Deduce the amount of helium gas (in mol) in vessel A. (2 marks)



1M 1A



1M 1A



0M 0A

answer from wrong equation

QUESTION 2(b)(i)

(b) Now the tap is open and a steady state is reached. Assume that the temperature remains unchanged.

(i) Find the gas pressure inside the vessels in terms of p. (2 marks)

Marking Scheme	Performance/ Common Errors
$n = n_A + n_B$ $p'(3V + 2V) = p(3V) + (2p)(2V)$ 1M $p' = 1.4p$ 1A $p'(3V + 2V) = (0.6 + 0.8)RT$ 1M $p'(5V) = 1.4RT$ $p' = 1.4p$ 1A	Not many started with conservation of number of gas molecules. Weaker ones tried to employ $\frac{p_AV_A}{n_AR} = \frac{p_BV_B}{n_BR}$ to find the answer.

QUESTION 2(b)(i) (SAMPLES)

(b) Now the tap is open and a steady state is reached. Assume that the temperature remains unchanged.

(i) Find the gas pressure inside the vessels in terms of p. (2 marks)

pressure = $\frac{3p+4p}{}$ ✓ from $p'(3V+2V) = p(3V) + (2p)(2V)$

$= 1.4p$ ✓ 1M 1A

From part (a), in vessel A $n = 1.2$

$n = 0.8 + 1.2 = 2$ mol $V = 3 + 2 = 5V$

$5pV = 2RT$ ✓ $3pV = 1.2RT$ 1M 0A

$p = \frac{2RT}{5V}$ from $p'(3V+2V) = (0.8+1.2)RT$ $p = \frac{1.2RT}{3V}$

pressure = p ✗

$pV = nRT$

$5pV = 1.4RT$ ✓ from $p'(3V+2V) = (0.8+0.6)RT$

$p = 1.4\frac{RT}{5V}$ ✗ 1M 0A

QUESTION 2(b)(ii)

(ii) Account for the pressure change of the gas in vessel A using kinetic theory. (2 marks)

Marking Scheme	Performance/ Common Errors
When the tap is open, no. of gas molecules in vessel A increases due to the (net) flow of molecules from B to A, 1A the frequency of collision of gas molecules with the vessel's wall increases, pressure increases. 1A	This part was well answered though some candidates considered the whole system which led to the conclusion that the volume of the gas increases. Candidates were able to use the terms in kinetic theory. Weaker ones held a misconception that pressure was due to collisions among gas molecules.

QUESTION 2(b)(ii) (SAMPLES)

(ii) Account for the pressure change of the gas in vessel A using kinetic theory. (2 marks)

From kinetic theory, $pV = \frac{1}{3}nN_A m\bar{c}^2$ vessel A understood

Since the number of molecules increases ✓, the pressure increases ✗ explanation in terms of collisions with vessel wall required 1A 0A

Since the no. of gas molecules in A increases ✓, the gas molecules collide with the wall more frequently and more vigorously ✗ the pressure increases more vigorously/violently is not accepted since temperature (average KE of molecules) remains unchanged. 1A 0A

As the volume increases, the no. of gas molecules increases ✗ So the collisions of gas molecules increases ✗ and the pressure increases ✗ with vessel wall 0A 0A

QUESTION 5(a)(i)

5. Figure 5.1 shows the use of a beam balance to measure the mass of a load. Without the load and the counter-weight, the beam with a scale pan at its left end is balanced and remains horizontal. ($g = 9.81$ m s^{-2})

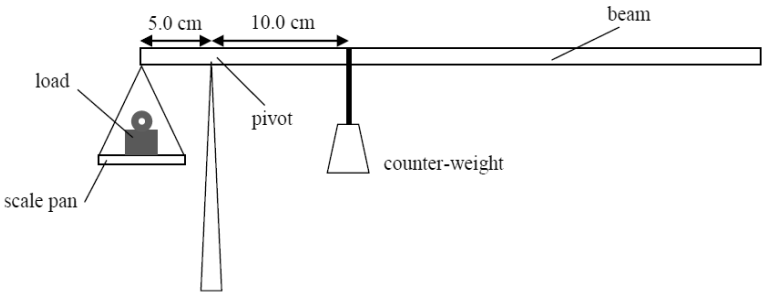


Figure 5.1

(a) A load is placed on the pan which is 5.0 cm from the pivot. The set-up is in equilibrium when the counter-weight of mass 50 g is 10.0 cm away from the pivot as shown.

(i) Find the mass of the load. (2 marks)

QUESTION 5(a)(i)

(a) A load is placed on the pan which is 5.0 cm from the pivot. The set-up is in equilibrium when the counter-weight of mass 50 g is 10.0 cm away from the pivot as shown.

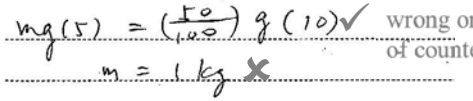
(i) Find the mass of the load. (2 marks)

Marking Scheme	Performance/ Common Errors
$m \times g \times 0.05 = 0.05 \times g \times 0.10$ 1M $m = 0.1$ kg or 100 g 1A	Most candidates correctly considered the balance of moments. A few of them made mistakes in the conversion of units.

QUESTION 5(a)(i) (SAMPLES)

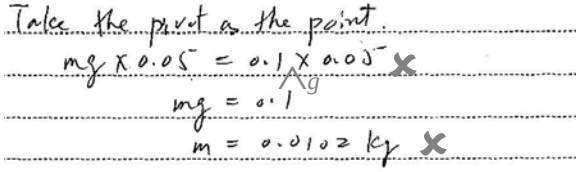
(a) A load is placed on the pan which is 5.0 cm from the pivot. The set-up is in equilibrium when the counter-weight of mass 50 g is 10.0 cm away from the pivot as shown.

(i) Find the mass of the load. (2 marks)



wrong order of magnitude of counter-weight accepted

1M 0A



0M 0A

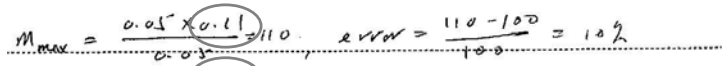
QUESTION 5(a)(ii)

(ii) If the reading of the counter-weight's position on the beam carries an uncertainty of ±0.1 cm, find the maximum error that corresponds to the result found in (a)(i). (2 marks)

Marking Scheme	Performance/ Common Errors
Counter-weight position : 10.0 cm ± 0.1 cm Percentage error = $100\% \times (\frac{0.1}{10.0}) = 1\%$ 1M $\therefore$ m = 101 g to 99 g i.e. maximum error = ± 1 g 1A	New to most candidates. Many considered the max and min values and found their difference instead of using percentage error. Some candidates overlooked that only the error associated with the counter-weight's position was considered or used 0.05 cm in their calculations.

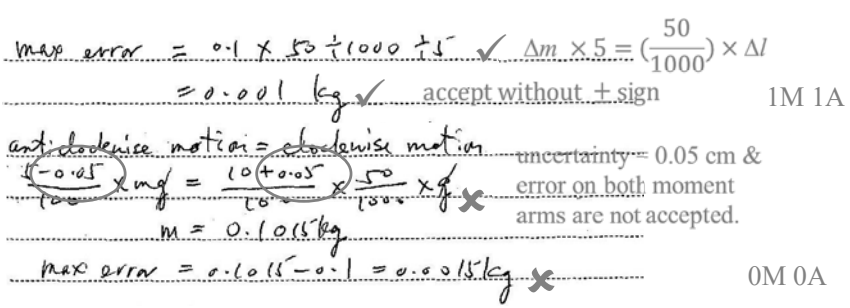
QUESTION 5(a)(ii) (SAMPLES)

(ii) If the reading of the counter-weight's position on the beam carries an uncertainty of ±0.1 cm, find the maximum error that corresponds to the result found in (a)(i). (2 marks)



1M 0A

wrong order of magnitude of uncertainty accepted



1M 1A

uncertainty = 0.05 cm & error on both moment arms are not accepted.

0M 0A

QUESTION 5(b)

(b) The weight of an identical load is now measured by a spring balance calibrated in newtons. What is the balance's reading ? (1 mark)

Marking Scheme	Performance/ Common Errors
Spring balance reading = mg = (0.1 kg) (9.81 N kg^{-1}) = 0.981 N ≈ 1.0 N 1M/ 1A	Most candidates were able to use $W = mg$ to find the correct value.

QUESTION 5(b) (SAMPLES)

(b) The weight of an identical load is now measured by a spring balance calibrated in newtons. What is the balance's reading ? (1 mark)

0.1 kg ✗ should be in N. 0A

From (a)(i) m = 100 g
F = ma = (100)(9.81) 1M
= 981 N ✗/✓ ?

QUESTION 5(c)(i)

(c) The beam balance set-up in Figure 5.1 and the spring balance with the load in (b) are both brought into a lift.

(i) The measurements are then repeated inside the lift which accelerates upwards uniformly. State the change, if any, in the measurements respectively. (2 marks)

Marking Scheme	Performance/ Common Errors
counter-weight position on beam balance: the same 1A; spring balance reading: reading increases 1A	Only some candidates were able to correctly state the counter-weight position on the beam balance. Most were able to indicate that there was an increase of spring balance reading.

QUESTION 5(c)(i) (SAMPLES)

(c) The beam balance set-up in Figure 5.1 and the spring balance with the load in (b) are both brought into a lift.

(i) The measurements are then repeated inside the lift which accelerates upwards uniformly. State the change, if any, in the measurements respectively. (2 marks)

counter-weight position on beam balance	spring balance reading
no change ✓	m(g+a) ✓

1A 1A

counter-weight position on beam balance	spring balance reading
further from the pivot ✗	increases ✓

0A 1A

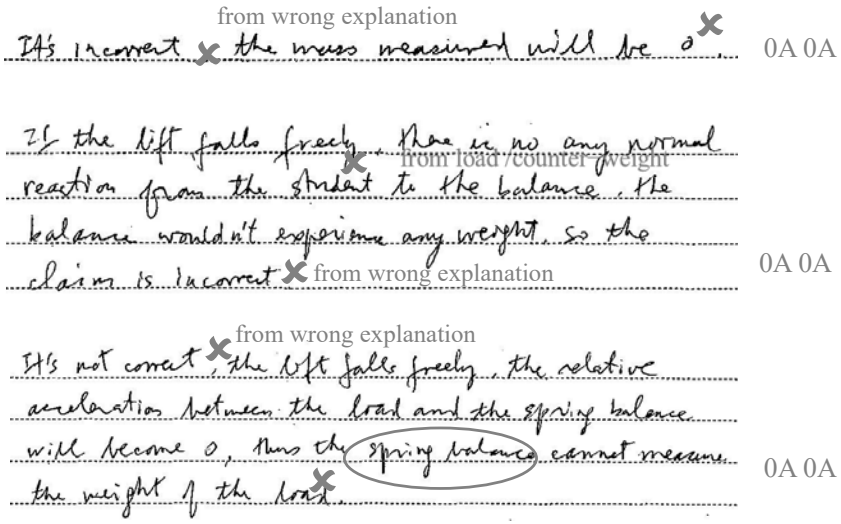
QUESTION 5(c)(ii)

(ii) A student claims that if the lift falls freely, the beam balance can still be used to measure the mass of the load. Explain whether the claim is correct or not. (2 marks)

Marking Scheme		Performance/ Common Errors
The beam balance would fail to work / to measure the mass of the load, as the apparent weight is zero, the counter-weight can take any position.	1A 1A	Very few candidates were able to precisely explain why the beam balance failed to work in a free falling lift. Some of them wrongly thought that the beam balance reading would decrease.

QUESTION 5(c)(ii) (SAMPLES)

(ii) A student claims that if the lift falls freely, the beam balance can still be used to measure the mass of the load. Explain whether the claim is correct or not. (2 marks)



QUESTION 10(a)(i)

(a) Part of the decay series of radium-226 (Ra-226) is shown below. Ra-226 decays to radon (Rn) by emitting an α particle with half-life 1600 years. The end product in the series is lead (Pb), which is stable.

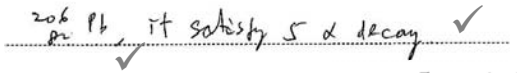
$$^{226}_{88}\text{Ra} \xrightarrow{\alpha} \text{Rn} \longrightarrow \cdots \rightarrow \text{Pb}$$

(i) $^{206}_{82}\text{Pb}$, $^{207}_{82}\text{Pb}$ and $^{208}_{82}\text{Pb}$ are three stable isotopes of lead. State, with a reason, which isotope can be the end product in this series. (2 marks)

Marking Scheme		Performance/ Common Errors
$226 - 206 = 20$ (multiple of 4 for α) $\therefore {}^{206}_{82}\text{Pb}$ is the end product	1M 1A	Well answered.

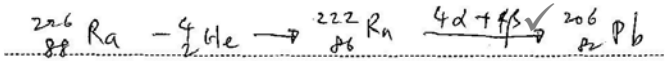
QUESTION 10(a)(i) (SAMPLES)

(i) $^{206}_{82}\text{Pb}$, $^{207}_{82}\text{Pb}$ and $^{208}_{82}\text{Pb}$ are three stable isotopes of lead. State, with a reason, which isotope can be the end product in this series. (2 marks)



accept 5α emissions from Ra – 226

1M 1A



accept 4α emissions from Rn – 222

1M 1A

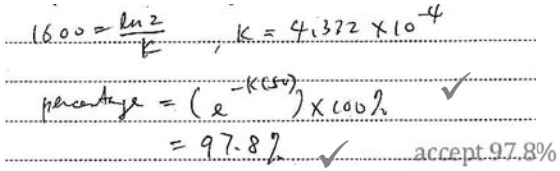
QUESTION 10(a)(ii)

*(ii) In a certain laboratory, a Ra-226 source has been used for 50 years. Estimate the percentage of undecayed Ra-226 left after this period. (2 marks)

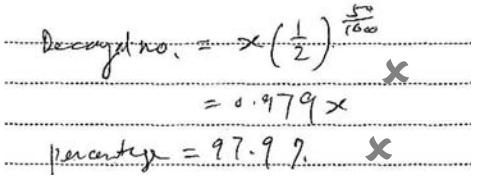
Marking Scheme	Performance/ Common Errors
% undecayed Ra-226 left $= \frac{N}{N_o}$ $= e^{-\frac{\ell n 2}{1600} \times 50}$ 1M $= 97.857\ \%$ $\approx 97.9\ \%$ 1A % undecayed Ra-226 left $= \left(\frac{1}{2}\right)^{\frac{50}{1600}}$ 1M $= 97.857\ \%$ $\approx 97.9\ \%$ 1A	Well answered.

QUESTION 10(a)(ii) (SAMPLES)

*(ii) In a certain laboratory, a Ra-226 source has been used for 50 years. Estimate the percentage of undecayed Ra-226 left after this period. (2 marks)



1M 1A

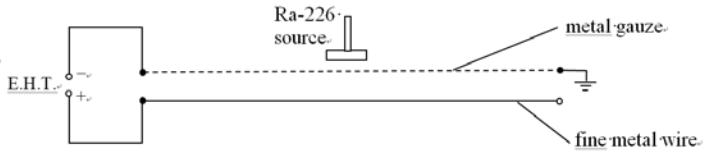


0M 0A

QUESTION 10(b)(i)

(b) Spark counters can show the ionizing power of radiations. Figure 10.1 indicates the main features of a type of spark counters in school laboratories.

Figure 10.1



A spark counter consists of a fine metal wire mounted a few mm beneath an earthed metal gauze. The wire is connected to the positive terminal of an E.H.T. (Extra High Tension) supply so that a very intense electric field is set up between the wire and the metal gauze. When a Ra-226 source is brought near the gauze, sparks giving out flashes of light and crackling sound are produced at irregular intervals.

(i) Explain why the sparks occur at **irregular** intervals. (1 mark)

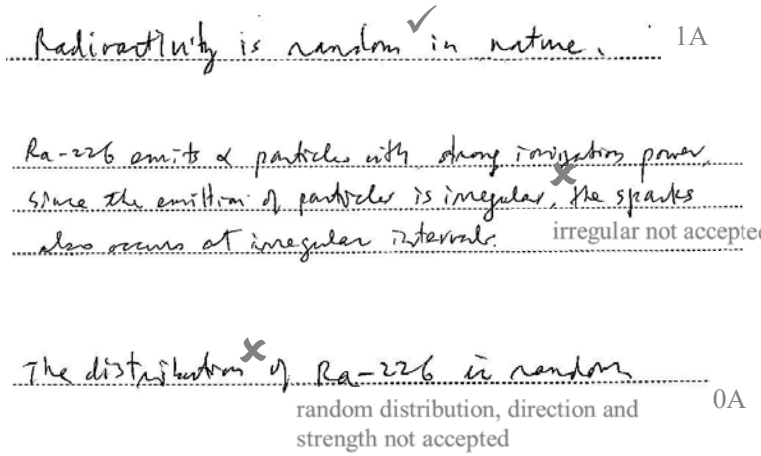
QUESTION 10(b)(i)

(i) Explain why the sparks occur at **irregular** intervals. (1 mark)

Marking Scheme	Performance/ Common Errors
Radioactive decay of Ra-226 is a random process. 1A	Some answers were not precise, e.g. the ionizing power is random or the type of radiation emitted is random.

QUESTION 10(b)(i) (SAMPLES)

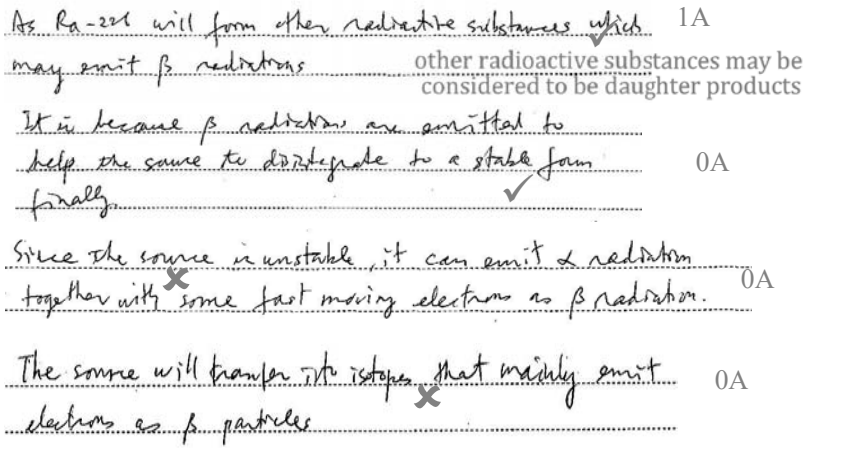
(i) Explain why the sparks occur at **irregular** intervals. (1 mark)



QUESTION 10(b)(ii) (SAMPLES)

A Ra-226 source used in school laboratories is usually said to emit α, β as well as γ radiations.

(ii) Explain why β radiation is also emitted even though the source is primarily an α-emitter. (1 mark)



QUESTION 10(b)(ii)

A Ra-226 source used in school laboratories is usually said to emit α, β as well as γ radiations.

(ii) Explain why β radiation is also emitted even though the source is primarily an α-emitter. (1 mark)

Marking Scheme	Performance/ Common Errors
Some of the daughter products of Ra-226 are also radioactive and may emit β particles. 1A	Many candidates thought that the Ra-226 source was not pure and thus emitted all three kinds of radiation. It seems that candidates did not fully understand the mechanism of a decay series.

QUESTION 10(b)(iii)

(iii) Why is the sparking mainly caused by α radiation rather than β or γ radiation ? Suggest a simple way to verify this. (2 marks)

Marking Scheme	Performance/ Common Errors
Reason: weaker ionizing power of β & γ radiations 1A - raise the source to a distance greater than the range of α (a few cm) will cease to have sparks. - insert a paper between the source and the gauze, sparks will cease to produce. Any **ONE** 1A	Quite a number of candidates pointed out that the sparks were related to the strong ionizing power of α radiation, but many just using cloud chamber to distinguish different types of radiations emitted instead of describing a way to verify the sparks were caused by the α radiation.

QUESTION 10(b)(iii) (SAMPLES)

(iii) Why is the sparking mainly caused by α radiation rather than β or γ radiation ? Suggest a simple way to verify this. (2 marks)

Because α particles are heavier and only be blocked by metal ✗

Use a diffusion chamber, α is greater, β and γ is smaller ✗ 0A 0A

α particles have the greatest ionizing power. ✓

α particles can be stopped by a piece of paper ✗ while β & γ radiations cannot. 1A 0A

The property of α particles only, not the way to verify.

Paper 2

Section A: Astronomy and Space Science

Thank You!

Q.1 Multiple-choice questions

	A	B	C	D
1.1	26.8	37.6*	24.8	8.7
1.2	36.9*	19.5	17.8	22.5
1.3	12.3	10.2	49.9*	25.1
1.4	50.9*	23.2	16.7	7.0
1.5	15.3	44.5*	22.7	14.5
1.6	4.5	17.9	60.8*	14.3
1.7	8.3	17.5	12.5	59.1*
1.8	25.5	29.9	17.4	23.7*

*** : key** ; Red colour : most favourable distractor

MCQ. 1.1

An unpowered spacecraft is travelling in an elliptical orbit around the Earth. Which of the following descriptions is/are correct ?

(1) The acceleration of the spacecraft is always pointing towards the centre of the elliptical orbit.
(2) The magnitude of the acceleration of the spacecraft is greatest when it is moving fastest.
(3) The gravitational potential energy of the spacecraft remains unchanged in the orbit.

A.	(1) only	26.82%	favourable distractor
B.	(2) only*	37.24%	
C.	(1) and (2) only	24.76%	***More than 50% candidates selected (1)***
D.	(2) and (3) only		

F=ma, direction of acceleration same as resultant force

MCQ. 1.2

The escape velocity at the Earth's surface is 11.2 km s^{-1}. A space probe launched from the Earth's surface attains a speed of 6 km s^{-1} when it is very far away from the Earth. Find the launching speed of the space probe. Assume that the flight is unpowered except during launching and neglect the effects of other celestial bodies.

A.	12.7km s^{-1} *	36.90%	
B.	15.6kms^{-1}		
C.	16.4kms^{-1}		
D.	17.2kms^{-1}	22.48%	favourable distractor

$$required\ min.K.E. + final\ K.E. = initial\ K.E.$$

MCQ. 1.5

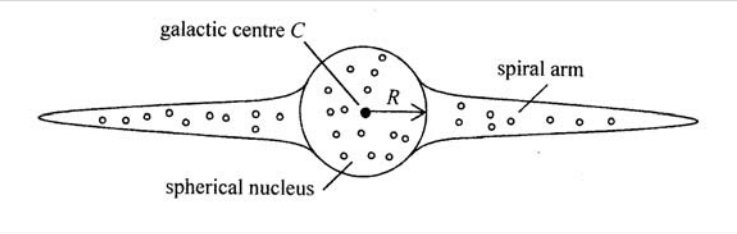
A star of radius *R* has a parallax of θ when observed from the Earth. Which of the following gives the angular size of the star with respect to an observer on the Earth ?

A.	$\frac{4R\theta}{1AU}$		
B.	$\frac{2R\theta}{1AU}$ *	44.45%	
C.	$\frac{R\theta}{1AU}$	22.69%	favourable distractor
D.	$\frac{R\theta}{2AU}$		

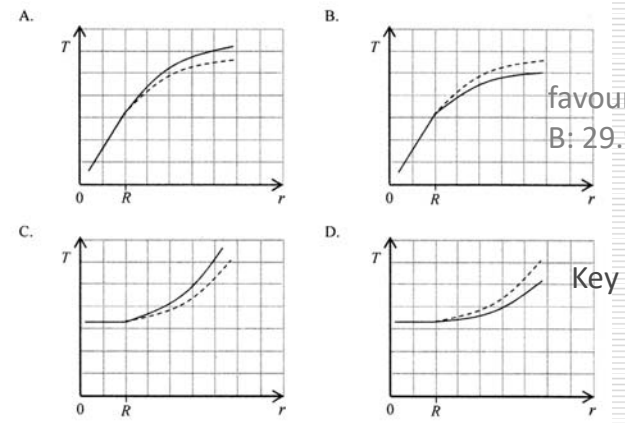
$d=\frac{1}{\theta}$, $angular\ size = 2R/d$

MCQ. 1.8

The figure shows the side view of a typical galaxy with a spherical nucleus of radius *R* and several spiral arms. Observations show that the stars in the nucleus are rotating about the galactic centre *C* as if the nucleus is a solid body. It is expected that the rotation of the stars in the spiral arms about *C* will obey Kepler's third law but instead the stars are observed to rotate with nearly the same constant speed.



Which graph best shows the variation of the rotational period *T* of the stars with their distance *r* from *C* ? (The solid curve represents the observed result whereas the dotted curve represents the expected result.)

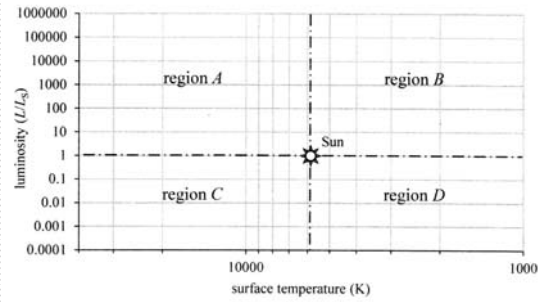


favourable distractor
B: 29.9%

Key D: 23.7%

1. $as\ dark\ matter\ exists\ \Rightarrow v \uparrow \rightarrow T \downarrow$
2. $T^2 \propto r^3$

(a)(ii) The information of star *X* is given below:
surface temperature = 2900 K
radius = 0.14 R_S where R_S is the radius of the Sun
Given the surface temperature of the Sun T_S = 5800 K, deduce the luminosity of star *X* in terms of the luminosity of the Sun, L_S. Hence, or otherwise, state in which region, *A*, *B*, *C* or *D*, on the Hertzsprung-Russell (H-R) diagram *X* is located. (3 marks)



Q.1 Structured question

(a) *X* is a distant star and it has a parallax of 0.08 when observed from the Earth.

(i) Find the distance of star *X* from the Earth in ly. (2 marks)

Distance from the Earth = $\frac{1}{0.08}$ pc = 12.5 pc = 12.5 x 3.26 ly 1M
= 40.75 (ly) 1A

(a)(i), most candidates knew how to deduce the distance of a star using parallax though a few of them made mistakes in units conversion.

Q.1 Structured question

- $L = 4\pi R^2 \sigma T^4$
- $L \propto R^2 T^4$ *or* $\frac{L}{L_S} = \left(\frac{R}{R_S}\right)^2 \left(\frac{T}{T_S}\right)^4$ 1M
- *L= 0.00123* 1A
- *Region D* 1A

(a)(ii) was well answered.
Only some drew incorrect conclusion from their results.

Q. 1 Structured question

- (b) Star *X* has an Earth-sized planet *Y* orbiting around it.
  (i) Why is it difficult to observe *Y* directly using optical telescopes other than it is very small and extremely far away from the Earth ? (1 mark)

Planet does not emit light / only reflects light, so easily overshadowed (黯然失色) by the parent star's flare.

Accept :	**NOT accept:**
The planet is an extremely faint source,	**The planet is too small,**
Compared to the parent star, the planet is too dark/dim,	**The planet is dark/dim**
亮度比較，行星不夠亮/不夠光亮	**Compared to the luminosity/ 光度, 母星遮(掩)蓋行星**

Some candidates did not fully understand the concept of luminosity and brightness, and thus performed poorly in (b)(i)

(iii) It has been postulated that a favourable condition for life to exist on a certain planet is that the power per unit area coming from the parent star onto that planet I_Y is within 0.5 to 2 times that coming from the Sun onto the Earth I_E. Deduce whether this condition is satisfied for planet *Y* using the result in (a)(ii). Given that the distance between *X* and *Y* is 0.04 AU. (Note: the power per unit area coming from a parent star onto its planet is given by $I = \frac{L}{4\pi d^2}$ where *L* is the luminosity of the parent star and *d* is the distance of the planet from its parent star.) (2 marks)

(ii) Astronomers are able to deduce the orbital period *T* of *Y* around its parent star *X* indirectly since the interaction between them causes *X* to wobble (i.e. small degree of rotation about their centre of mass) with the same period. Name the kind of interaction and state what physical quantity of *X* should be measured in order to find *T*. (2 marks)

Gravitation / gravitational (force of) attraction / gravity.
By monitoring the Doppler shift of a particular spectral line (from *X*) caused by the variation of the star's radial velocity, period *T* can be found.

Accept :
Measure Doppler shift
The change of wavelength/frequency by Doppler effect
NOT accept:
only red or blue shift.; radial velocity

Not many were able to state the physical quantity of *X* that should be measured in order to find the period *T* in (b)(ii). Weaker ones did not understand Doppler shift or simply did not know what the question asked for.

Q.1 Structured question

- $I = \frac{L}{4\pi d^2}$
- $I \propto \frac{L}{d^2}$ or $\frac{I_Y}{I_E} = (\frac{L_X}{L_S})(\frac{d_E}{d_Y})^2$ 1M
- $\frac{I_Y}{I_E} = 0.766$
- The planet satisfied the condition for the existence of life. 1A

Candidates' performance was fair in (b)(iii).

Thank You

Q.2 Multiple-choice questions

	A	B	C	D
2.1	13.2	31.3	**46.1***	8.9
2.2	13.9	11.5	22.9	**51.2***
2.3	12.6	11.3	28.2	**47.7***
2.4	**15.0***	64.8	11.1	8.6
2.5	7.2	24.8	**56.8***	10.8
2.6	18.6	**61.5***	9.8	9.4
2.7	9.3	8.9	**61.6***	19.7
2.8	31.3	**25.7***	22.6	20.0

* : KEY ; Underlined : most favourable distractor

Paper 2

Section B : Atomic World

Q.2 Multiple-choice questions

2.1 In Rutherford's scattering experiment, the distance of closest approach of an α particle to a gold atom can be deduced. This distance is a good estimate of the upper limit of

A. the radius of an α particle. (13.19%)

favourable distractor

B. the radius of a gold atom. (31.31%)

C. the radius of a gold nucleus. **(46.10%)***

D. the thickness of the gold foil. (8.88%)

Q.2 Multiple-choice questions

2.4 According to the Bohr model of an atom when the electron of a hydrogen atom undergoes transition from an inner orbit to an orbit of larger radius, the hydrogen atom may have

A. absorbed a photon, and the electron's kinetic energy decreases. **(15.02%)***

B. absorbed a photon, and the electron's kinetic energy increases. favourable distractor (64.82%)

C. emitted a photon, and the electron's kinetic energy decreases. (11.11%)

D. emitted a photon, and the electron's kinetic energy increases. (8.59%)

Q.2 Multiple-choice questions

2.8 Which statement below is **INCORRECT** ?

favourable distractor

A. Nano particles of silver show a colour different from the colour of silver in bulk form. (31.33)

B. Diamond is a *poor thermal conductor* and a poor electrical conductor as it does not have free electrons. **(25.66%)***

C. A carbon nanotube is much stronger than steel of the same size. (22.58%)

D. Carbon buckyballs such as C_{60} are formed by carbon atoms arranged in hollow cages. (19.96%)

Q.2 Structured question

The set-up shown in Figure 2.1 can be used to measure the maximum kinetic energy of photoelectrons emitted from sodium metal when electromagnetic radiations of the same intensity but having different frequencies are incident on a sodium-coated cathode.

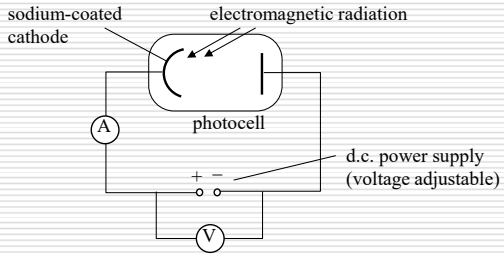


Figure 2.1

(a) Briefly describe how the maximum kinetic energy of photoelectrons can be measured using this set-up for a certain frequency (above the threshold value) of radiation. (2 marks)

Q.2 Structured question

(a) Briefly describe how the maximum kinetic energy of photoelectrons can be measured using this set-up for a certain frequency (above the threshold value) of radiation. (2 marks)

Increase/adjust the voltage just until there is no current passing through the circuit (no photoelectrons to complete the circuit),

1A

record the voltage V_s which gives the maximum kinetic energy of the photoelectrons = eV_s

1A

Q.2 Structured question

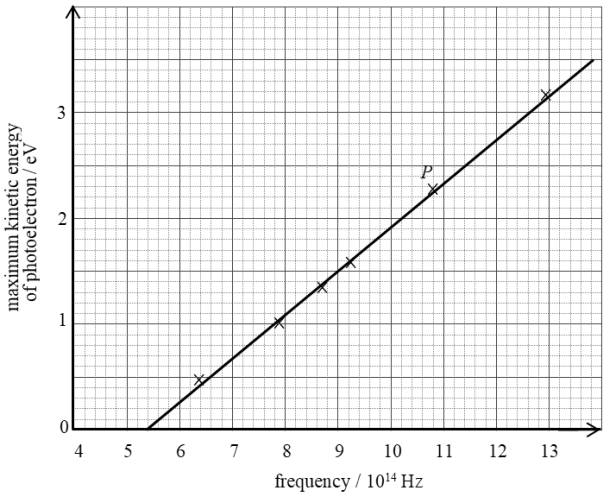
2a) For a certain frequency of radiation, ~~we~~ can measure the electric potential needed (stopping potential V_s) to make the photo electric current to become 0. ×

The maximum kinetic energy of photoelectrons $= eV_s$, where e is the charge of an electron. ✓

Q.2 Structured question

(b) The graph in Figure 2.2 shows the results of the experiment.

Figure 2.2



Q.2 Structured question

(i) State the part of the electromagnetic spectrum from which radiation was used in obtaining data point *P*. (1 mark)

Ultra-violet (UV) radiation (light) (~278 nm) 1A
accept : UV / (紫外輻射 / 紫外光 / 紫外線)

Q.2 Structured question

(b) (ii) Find the slope of the graph and deduce its physical meaning. (3 marks)

slope of the graph $= \dfrac{3.3 - 0}{(13.4 - 5.4) \times 10^{14}}$ 1M

$= 4.125 \times 10^{-15}$ eV s ($= 6.6 \times 10^{-34}$ J s) 1A

NOT accept without steps!

The slope gives the Planck constant *h*. 1A

Q.2 Structured question

(ii) Slope of the graph = $\frac{3.5-0}{13.8-5.4} = \frac{5}{12}$ ✓ ✗

Common mistakes
- incorrect/no units
- forgot to include 10^{14} for the frequency in their calculation.
- chose one point from the graph together with (0, 0) to find the slope.

Q.2 Structured question

(b) (iii) Calculate the work function of sodium in eV. (2 marks)

Threshold frequency $f_0 = 5.4. \times 10^{14}$ Hz
Work function of sodium
$= hf_0$ 1M
$= (6.6 \times 10^{-34}) \times (5.4 \times 10^{14})$
$= 3.564 \times 10^{-19}$ J
$= 2.2275$ (eV) 1A
$\approx$ 2.20 – 2.40 (eV) (Accept)

Many different approaches found from the scripts.
If the threshold frequency is read incorrectly,
- f used must be defined as the threshold frequency.

Q.2 Structured question

(c) State the change, if any, in the graph obtained if the experiment is repeated with electromagnetic radiations of lower intensity. Explain. (2 marks)

Unchanged, i.e. the same graph. 1A

The (max.) kinetic energy of photoelectrons depends on the energy of each photon, which is proportional to the frequency of radiation.

1A

Q.2 Structured question

(c) With lower intensity, there will be no change to the graph. ✓
Since the intensity don't affect the work function of the element. ✗

c) "Intensity of incident light ray is independent to its frequency and hence K.E. of photoelectrons, as well as freshold frequency of the metal. ✗
∴ The graph remains unchanged. ✓

Paper 2

Section C : Energy and Use of Energy

Q.3 Multiple-choice questions

	A	B	C	D
3.1	**51.8***	6.9	29.6	11.6
3.2	11.5	**57.9***	9.9	20.6
3.3	28.4	24.2	**37.3***	9.9
3.4	15.0	37.2	10.3	**37.4***
3.5	**79.2***	7.7	10.9	2.0
3.6	3.4	11.5	32.6	**52.4***
3.7	5.7	22.5	**60.2***	11.3
3.8	12.5	**62.2***	15.5	9.4

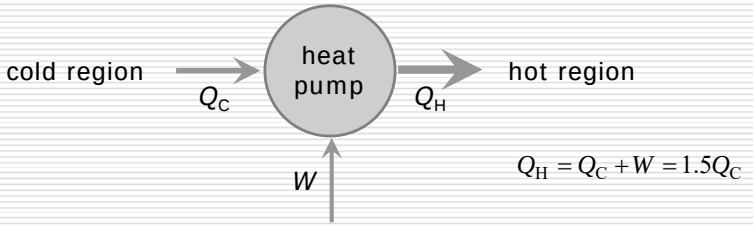
*** : key** ; Red colour : most favourable distractor

MCQ 3.3

3.3 An air-conditioner with $\frac{\text{cooling capacity}}{\text{electrical power input}} = 2$ has a cooling capacity of 746 W. Estimate the rate at which thermal energy is being released to the environment outside.

A.	373 W	favourable distractor	28.35%
B.	746 W		
* C.	1119 W		37.33%
D.	1492 W		

A B C D



Candidates were not familiar to the concept of Heat Pump.

MCQ 3.4

3.4 Which of the following contribute(s) to cooking with a microwave oven ?

(1) The energy of microwave is only absorbed by the food's surface and then transferred to its interior by conduction.
(2) Water molecules are polar due to non-uniform charge distribution within each molecule.
(3) The electric field of microwave is continuously changing.

A.	(1) only		
B.	(2) only	favourable distractor	37.16%
C.	(1) and (3) only		
* D.	(2) and (3) only		37.37%

A B C D

Candidates did not know that the changing E-field of microwave forces the water molecules to vibrate.

Q.3 Structured question

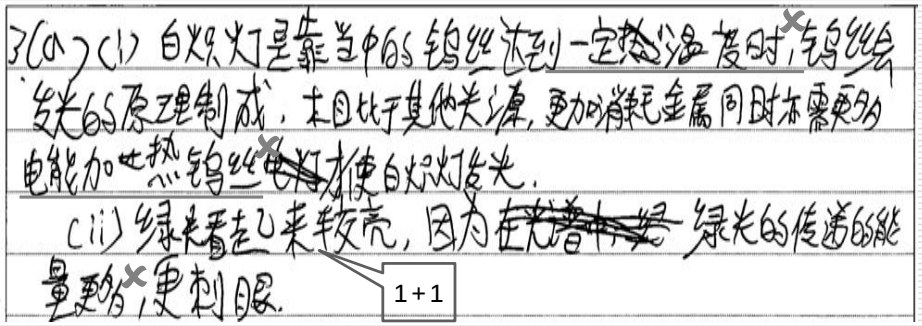
(a) (i) Incandescent lamps are far less energy efficient than other light sources like fluorescent lamps or light emitting diodes (LEDs). Explain why this is so in terms of how incandescent lamps produce light. (2 marks)

Incandescent lamps: by heating a (tungsten) filament to a high temperature / red hot via joule heating (of a current), 1A

most of the energy becomes thermal energy / heat or only a small portion is converted to light output. 1A

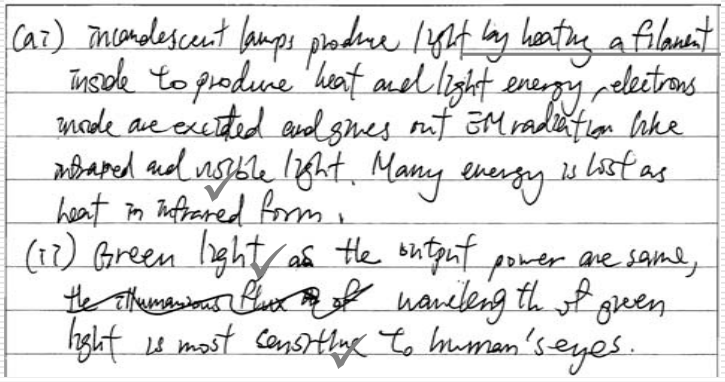
1A for high temperature / red hot
1A for more thermal energy / less light energy / more IR / less visible light

In (a)(i), candidates in general knew that most of the energy became thermal energy in incandescent lamps, but many of them failed to state that these lamps produced light by joule heating of a tungsten filament at a high temperature.


3(a)(i) 白炽灯是靠当中的钨丝达到一定热温度时，钨丝会发光的原理制成，主因比于其他光源，更加消耗金属同时本需要多电能加热钨丝才使白炽灯发光。

(ii) 绿光看起来较亮，因为在光谱中绿光的传递的能量更多，更刺眼。

1+1


(a)(i) Incandescent lamps produce light by heating a filament inside to produce heat and light energy, electrons inside are excited and gives out EM radiation like infrared and visible light. Many energy is lost as heat in infrared form.

(ii) Green light as the output power are same, the ~~illuminous flux of~~ wavelength of green light is most sensitive to human's eyes.

Q.3 Structured question

(ii) Two light sources of identical size and shape emit white light and green light respectively. If the light output power of them is the same, briefly explain which light source looks brighter. (2 marks)

As the eye is most sensitive to green light, 1A
a green light source (having the same light output power) would appear brighter compared to a white one (comprises of different colours). 1A

1+1

Accept:
- most / more sensitive to green light
- higher luminous flux for green light + luminous flux depends on human eye sensitivity

Candidates' performance in (a)(ii) was satisfactory though quite a number of them did not realise that luminous flux depends on the sensitivity of the human eye to light of different wavelengths.

Q.3 Structured question

(b) Figure 3.1 illustrates the simplified lighting arrangement within a tunnel in which two lamps each of luminous flux 10000 lumens are installed on the ceiling.

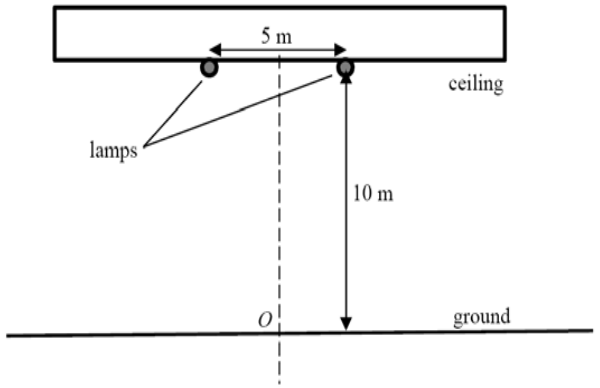
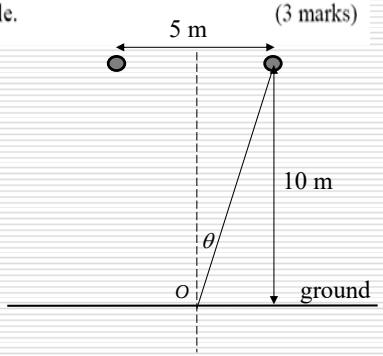


Figure 3.1

Q.3 Structured question

(i) Calculate the illuminance around point O on the ground mid-way between the two lamps. Take the lamps as point light sources and reflection is assumed negligible. (3 marks)



$\tan\theta = \frac{2.5}{10}$ / $\cos\theta = \frac{10}{\sqrt{10^2+2.5^2}}$ 1M

$\theta = 14.036243° \approx 14.0°$

$I = \frac{E\times\cos^3\theta\times 2}{4\pi d^2}$ or $\frac{E\times\cos\theta\times 2}{4\pi r^2}$ 1M

= 14.532045 lux

≈ 14.5 lux or lx 1A

1M for finding θ
1M for correct expression or correct substitution of I
1A for 14.5 lx

In (b)(i), most candidates were able to calculate the angle θ correctly, but some of them failed to apply the correct expression to find the illuminance.

Q.3 Structured question

(ii) The specification of two kinds of lamps A and B are given below. In terms of efficacy, recommend which one the tunnel company should choose. (1 mark)

lamp	rated power	luminous flux
A	150 W	11000 lumens
B	135 W	10000 lumens

Efficacy (A) = $\frac{11000}{150}$ = 73.333333 lm W^{-1}

Efficacy (B) = $\frac{10000}{135}$ = 74.074074 lm W^{-1}

Lamp B is recommended. 1A

Part (b)(ii) was well answered.

Calculation is necessary.

Q.3 Structured question

(iii) Figures 3.2(a) and 3.2(b) illustrate two arrangements of tunnel lights. In Figure 3.2(a), more lamps each with relatively lower luminous flux are used. In Figure 3.2(b), less lamps each with relatively higher luminous flux are used. The resultant average illuminance on the ground is the same in both cases.

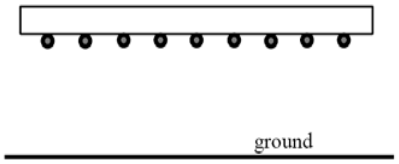


Figure 3.2(a)

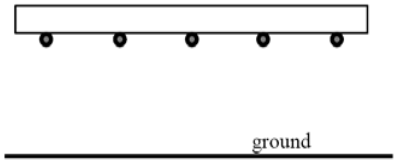


Figure 3.2(b)

Q.3 Structured question

State one advantage and one disadvantage of the arrangement in Figure 3.2(a) over that in Figure 3.2(b). (2 marks)

Advantages:
- Variation of illuminance smaller
- Effect of individual lamp failure smaller
- Less glare 1A

Disadvantages:
- More frequent change/replacement of lamps
- More expensive as installation cost increases
- More wiring involved
- More installation cost/time 1A

In (b)(iii), not many candidates were able to state explicitly the advantage and the disadvantage of the two arrangements of tunnel lights.

(iii) The advantage is that even one lamp is not working, the tunnel can still maintain a reasonable high illuminance, not causing a huge decrease in the brightness for drivers to see. A disadvantage is that the cost of buying more lamps will be higher.

iii) The advantage is the light inensity is more even
The disadvantage is lower efficacy when compared to 3.2(b)

(iii) Advantage: The light and brightness in the tunnel is more even
Disadvantage: A larger electricity is consumed so it is less and the cost of maintainence will be higher.

adv: iii. 3.2的安排的能源效益較低,
disadv: 3.2的安排的光度較平均

(iii) 能源效益較(3.2(b))低
但的燈較多,每一个地方都能照得到。

Paper 2

Section D: Medical Physics

HKDSE 2018

Multiple Choice

Qn.	1	2	3	4	5	6	7	8
A	16.9%	11.7%	*46.2%	14.2%	18.8%	*66.7%	13.8%	*56.7%
B	5.5%	27.7%	33.2%	20.3%	*53.9%	11.4%	*57.1%	14.1%
C	12.2%	15.6%	13.6%	*41.6%	16.2%	11.0%	19.3%	17.4%
D	*63.7%	*43.3%	6.6%	23.2%	10.7%	10.7%	9.5%	11.9%

Qn. 4.2

4.2 John's vision has a near-point distance of 20 cm and a far-point distance of 250 cm. If he wears spectacles that correct his far point to infinity, what should the type of spectacles be and what is his near-point distance after wearing the spectacles ?

	type of spectacles	near-point distance (with spectacles)	A	B	C	D
A.	convex lens	18.5 cm				
B.	concave lens	18.5 cm favourable distractor	○	○	○	○
C.	convex lens	21.7 cm				
*D.	concave lens	21.7 cm				

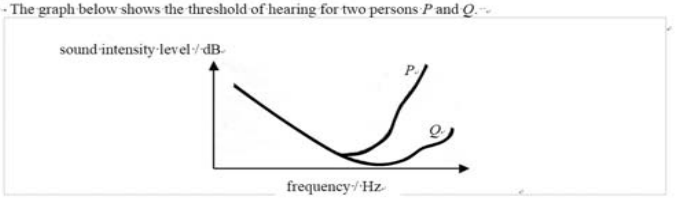
Answer : D (43.3%)

Best distractor: B (27.7%)

Most candidates knew that this situation is short sight and concave lens is needed. However, some candidates cannot apply the lens formula correctly. They have wrong sign for *u* and *f*.

Qn. 4.3

4.3 The graph below shows the threshold of hearing for two persons *P* and *Q*.



Which statements below **MUST BE** correct ?

(1) *P* and *Q* have the same hearing sensitivity for sound of very low frequencies.
(2) *P* does not usually hear sound of high frequencies unless the sound wave is large in amplitude.
(3) *Q* suffers from a hearing loss.

		A	B	C	D
* A.	(1) and (2) only				
B.	(1) and (3) only favourable distractor	○	○	○	○
C.	(2) and (3) only				
D.	(1), (2) and (3)				

Answer : A (46.2%)

Best distractor: B (33.2%)

Confuse the meaning of high SIL in the graph (lower sensitivity)

Qn. 4.4

4.4 A small loudspeaker emits a sound. The sound intensity level measured at 5 m away from it is 40 dB. The power output of the loudspeaker is then reduced to half and the sound intensity level is measured again at 10 m away. By what percentage has the sound intensity level changed ?

		A	B	C	D
A.	12.5%				
B.	15.1%				
* C.	22.6%	○	○	○	○
D.	25.0% favourable distractor				

Answer : C (41.6%)

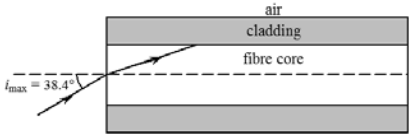
Best distractors: B, D (20.3%, 23.2%)

Do not know the relationship between intensity and distance.

Do not know how to find dB change from a ratio.

Qn. 4.5

4.5 As shown below the optical fibre used for an endoscope is cladded with material of refractive index different from that of the fibre core to avoid light leakage. The maximum angle of incidence i_{max} is 38.4° for no leakage of light. Find the refractive index of the cladding material.
Given: refractive index of the fibre core = 1.55



		A	B	C	D
A.	1.69 favourable distractor				
*B.	1.42	○	○	○	○
C.	1.33				
D.	1.16				

Answer : B (53.9%)

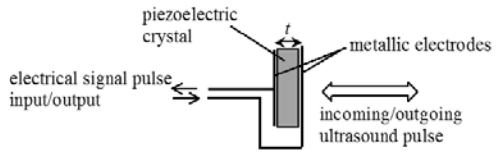
Best distractor: A (18.8%)

Confuse the refractive indices of the two media. Reverse n_1 and n_2.

Q.4 Structural question

(a) Piezoelectric transducers can generate as well as detect ultrasound. Figure 4.1 shows the basic construction of a piezoelectric transducer in which the thickness of the piezoelectric crystal is t.

Figure 4.1



(i) The crystal has a maximum response for a certain frequency f of the electrical signal applied such that t is about half of the wavelength of the ultrasound in the crystal. The speed of ultrasound in the crystal is 4000 m s^{-1}. Estimate f if t = 0.4 mm. (1 mark)

(ii) An ultrasound pulse produced by the piezoelectric transducer is reflected back from an interface as an echo. Explain how the transducer detects this echo. (2 marks)

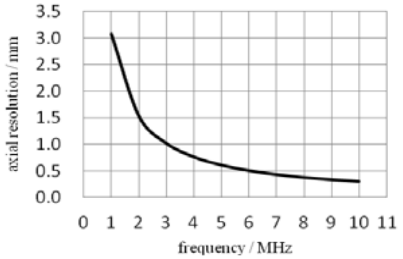
Q.4 Structural question

4.	(a)	(i)	The frequency f is $f = \frac{c}{\lambda} = \frac{4000\,\text{m s}^{-1}}{2\times0.4\times10^{-3}\,\text{m}} = 5\ \text{MHz}$	1A 1
		(ii)	The piezoelectric crystal is forced to vibrate/change shape when the ultrasound echoes hit the crystal. When the piezoelectric crystal is compressed or extended (deform/change shape/change size/pressure variation), it produces a potential difference/voltage across its ends.	1A 1A

Candidates' performance in (a)(i) was fair. A few did not realise that the wavelength was twice the crystal's thickness (even though this is given). Many candidates failed to give concise explanations in (a)(ii). Few pointed out explicitly that the vibration of the crystal generates a 'voltage'. Some candidates tried to explain how the ultrasound is reflected, which is not asked here.

Q.4 Structural question

(b) For medical imaging using an ultrasound beam, the resolution (in mm) along the beam direction (axial direction) in soft tissue varies with the frequency (in MHz) of the ultrasound used as shown below.



(i) Explain the importance of axial resolution in ultrasound imaging. (2 marks)

(ii) In fact the axial resolution is inversely proportional to the frequency of ultrasound used. Make use of one or two points of the graph to deduce the axial resolution of imaging when using 12 MHz ultrasound. (2 marks)

Q.4 Structural question

(b)	(i)	With better resolution, the ability to detect, as separate, two objects / points at different distances along the path of the beam (axial direction) is higher / points at a closer distance can be distinguished as two separate points. Resolution is a measure of the smallest detail (structure) that can be detected in an image / the image can have more details (is finer / has smaller pixels / is formed by smaller points).	1A 1A

Many candidates did not understand what (b)(i) asked for, particularly the meaning of 'axial resolution'. Most candidates just answered how the frequency affected resolution and penetration or used generic terms such as 'clear' to describe the effects of a higher resolution.

Q.4 Structural question

(ii) Given the relationship (inversely proportional):
axial resolution × frequency = constant
i.e. 1.5 mm × 2 MHz = 3 mm MHz (using one data point) — 1M

Thus, at 12 MHz the axial resolution = $\frac{3}{12}$ = 0.25 mm — 1A

In (b)(ii), some candidates were not able to manipulate the calculation of inverse proportion. Even though the relation

axial resolution × *frequency* = *constant*

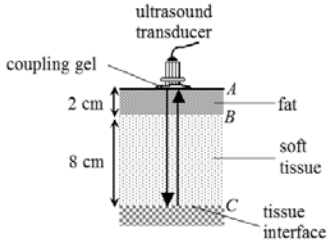
is given in the question, they still did it as a direct proportion

(*axial resolution* ÷ *frequency* = *constant*).

Q.4 Structural Question

(c) Figure 4.2 shows the set-up for studying a tissue interface underneath a 2 cm thick fat layer and a 8 cm thick soft tissue layer. The speed of ultrasound in the fat layer is 1450 m s^{-1} while that in the soft tissue layer is 1540 m s^{-1}.

Figure 4.2



(i) Calculate the echo time *T* for the ultrasound pulse going to and from the tissue interface at *C*. (2 marks)

(ii) The depth of the tissue interface is computed using a device which takes the whole echo time *T* as being spent on propagating to and fro in soft tissue only (i.e. calibrated at a speed of 1540 m s^{-1}). Determine by how much this **computed depth** differs from the **actual depth** of the tissue interface. (1 mark)

Q.4 Structural question

(c) (i) The round-trip travel time of the ultrasound pulse through the 2 cm of fatand 8 cm of softtissue are respectively,

$t_1 = \frac{2 \times 2\text{ cm}}{1.45 \times 10^5\text{ cm s}^{-1}} = 27.5862069\ \mu\text{s} \approx 27.6\ \mu\text{s}$ — 1M

$t_2 = \frac{2 \times 8\text{ cm}}{1.54 \times 10^5\text{ cm s}^{-1}} = 103.896104\ \mu\text{s} \approx 103.9\ \mu\text{s}$

Echo time T = (27.59+103.90) μs
= 131.482311μs≈ 131μs — 1A

(c)(i) was well answered though a few candidates omitted the factor '2' for a round trip.

Q.4 Structural Question

(ii) The computed depth is

$\frac{1.54 \times 10^5\text{ cm s}^{-1} \times 131.48\ \mu\text{s}}{2} = 10.124138\text{ cm} \approx 10.12\text{ cm}$

i.e. the depth of tissue interface is computed 1.2 mm deeper than its actual position. — 1M/1A

Candidates' performance in (c)(ii) was fair as they did not realise that the true depth was 10 cm. Weaker candidates simply did not understand the relationship between the *computed depth* and the *calibration speed*.

The End