HKDSE Physics Practice Papers Briefing Session

(20 & 24 February 2012)

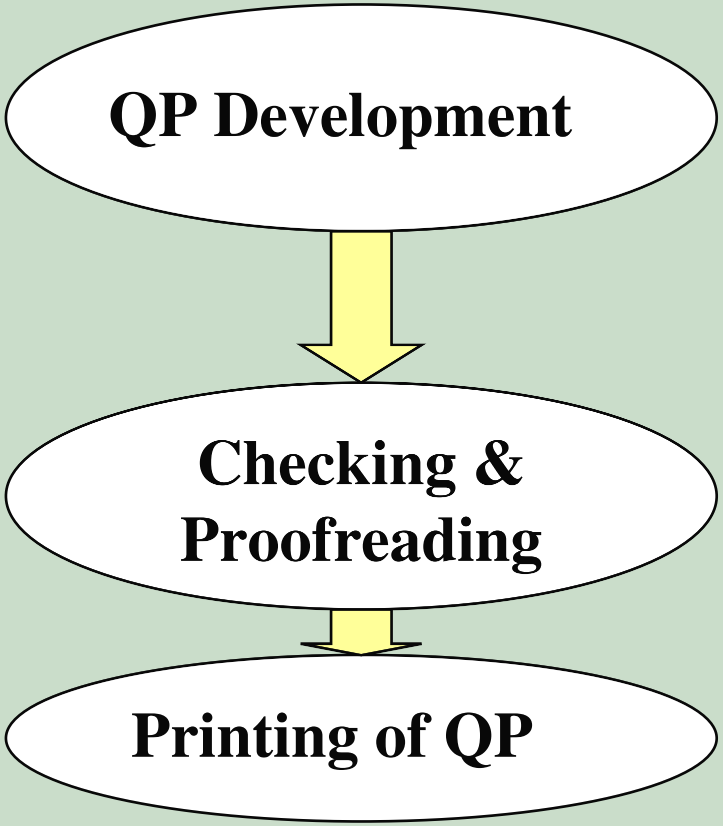
HKDSE Physics Practice Papers Briefing Session
Programme Rundown

2:00 – 2:10	Registration
2:10 – 2:30	Question paper requirements of the DSE Physics Examination
2:30 – 2:45	Students' performance on multiple-choice questions (Paper 1A)
2:45 – 3:15	Marking scheme interpretation (Paper 2) and students' performance
3:15 – 3:30	Break
3:30 – 4:30	Marking scheme interpretation (Paper 1B) and students' performance
4:30 – 5:00	Q&A

Acknowledgements

- Members of the Moderation Committee for the Practice Papers
- Schools participated in the piloting (7 schools and more than 160 students involved)
- CDI-HKEAA Committee on NSS Physics Education
- All those who has contributed to the successful implementation of HKDSE Physics and Combined Science (Physics)

Development of Examination Papers (Pre-exam Work)



Moderation Committee
- Chief Examiner(s)
- Moderators
- Setter(s)
- MC Contributor(s)

- Assessors
- Proofreaders

GLD Printing Unit

Marking and Grading (Post-exam Work)

Marking of scripts

- **Examiners' Meeting**
- **Markers' Meeting**
- **Checkmarking of scripts**

Standards-referenced Grading

Appeal of examination results

- **Rechecking and Remarking**

Structure of DSE Physics Examination

Paper	Section	Weight	Other information
1	A	21%	36 MCQs
	B	39%	84 marks
2		20%	For each elective: 8 MCQs + 10 marks
SBA		20%	

Structure of DSE Combined Science (Physics) Examination

Written paper	A	14%	24 MCQs
	B	26%	56 marks
SBA		10%	

What the practice papers can do?

It illustrates:

- Level of difficulty
- Balance in curriculum content
- Question types
- Relationship between Physics and Combined Science (Physics part)

Balance in curriculum content

- Paper 1A
  36 MCQ = 26 (core) + 10 (extension)
- Paper 1B
  84 marks = 60 (core) + 24 (extension)

- Balance
  ~70% core + ~30% extension

Question types

- Paper 1A
  - Single response type
  - Multiple-completion type
- Paper 1B
  - Comprehension question (integrated into a question ?)
  - Short essay (on a proof ?)
  - Graph plotting ?

Relationship between Physics and Combined Science (Physics part)

- Section A
  24 MCQ = 22 (common with Physics)
  + 2
- Section B
  56 marks = 47 (common with Physics)
  + 9

- $\geq$ 70% common with Physics papers

Practice papers piloting exercise

- 7 schools (167 students) participated
- Exam using Physics practice papers on 12th Jan (no CS(Phy))
- 2 "Examiners' meetings"

  Updated the Marking Schemes

  Selected Samples of Student Performance

  Completed the Report on Students Performance

Students' performance on multiple-choice questions (Paper 1A)

Students' Performance in Piloting (Paper 1 Section A)

- **Number of records = 164**
- **Mean = 19 (52%)**
- **S.D. = 6 (16%)**

Question best attempted: Q.3 (percentage correct = 87%)

3. Peter adds 50 g of milk at 20°C to 350 g of tea at 80°C, what is the final temperature of the mixture ?

Given : Specific heat capacity of milk = 3800 J kg^{-1} $°C^{-1}$
Specific heat capacity of tea = 4200 J kg^{-1} $°C^{-1}$

A. 50.0°C
B. 72.5°C
C. 73.1°C
D. 77.4°C

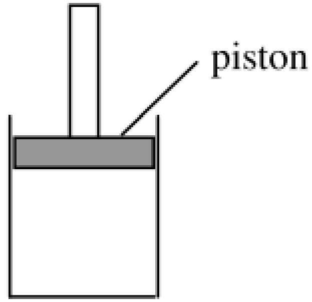
Question most poorly attempted: Q.26 (percentage correct = 19%)

Q26 Two metal rods, *X* and *Y*, of uniform cross-sectional area are made of the same material and have the same volume. The length and resistance of *X* are *l* and *R* respectively. What is the resistance of *Y* if it has a length of 2*l* ?

A.	*R*/4	(4%)
B.	*R*/2	(13%)
C.	2*R*	(64%)
D.*	4*R*	(19%)

64% of the students wrongly chose option C; they had probably overlooked the difference in the cross-sectional areas between wires *X* and *Y*.

*Q5 A fixed mass of an ideal gas is contained in a cylinder fitted with a frictionless piston as shown in the figure below. If the gas is cooled under constant pressure,

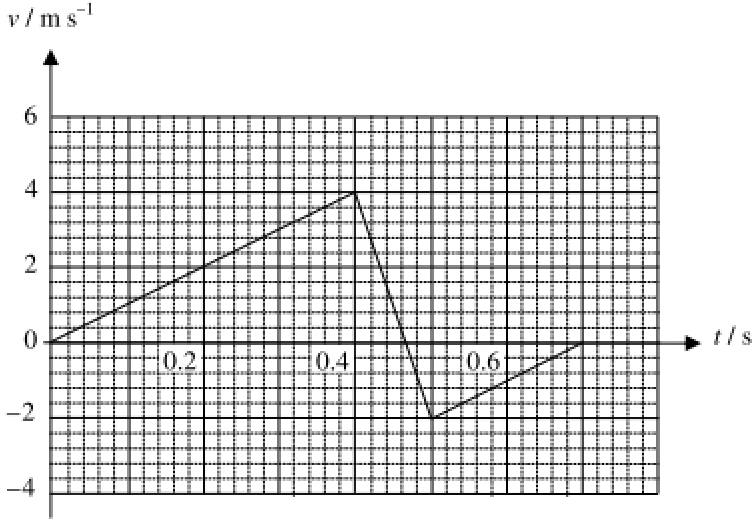


(1) the average separation of the gas molecules will decrease.
(2) the r.m.s. speed of the gas molecules will decrease.
(3) the number of collisions per second of the gas molecules on the piston will decrease.

A.* (1) and (2) only (29%)
B. (1) and (3) only (5%)
C. (2) and (3) only (33%)
D. (1), (2) and (3) (33%)

More than 60% of students wrongly thought that the number of collisions per second of the gas molecules on the piston will decrease when a gas is cooled under constant pressure, and wrongly chose options C or D.

Q13



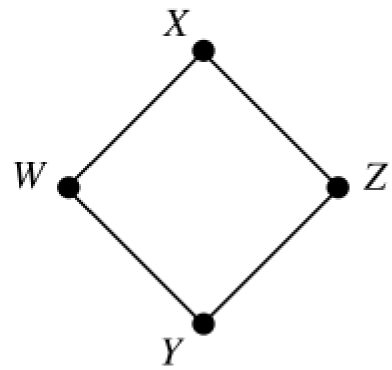
A ball of mass 0.2 kg is released from rest. It hits the ground and rebounds. The velocity-time graph of the ball is shown above. Which of the following statements are correct ?

(1) The magnitude of the change in momentum of the ball during the collision is 1.2 kg m s^{-1}.
(2) The magnitude of the average force acting on the ball by the ground during the collision is 12 N.
(3) There is mechanical energy loss during the collision.

A.	(1) and (2) only	(15%)
B.*	(1) and (3) only	(21%)
C.	(2) and (3) only	(27%)
D.	(1), (2) and (3)	(37%)

When considering the force acting on the ball by the ground during the collision, only 20% of the students considered the weight of the ball and correctly ruled out statement (2).

*Q25



The figure above shows four points *W*, *X*, *Y* and *Z* in a uniform electric field. *WXZY* is a square. The electric potential at *W*, *X* and *Y* are 1 V, 5 V and 5 V respectively. What is the electric potential at *Z* ?

A.	1 V	(46%)
B.	6 V	(15%)
C.*	9 V	(29%)
D.	11 V	(10%)

46% of the students wrongly thought that the electric potential at *Z* is the same as that at *W*, and wrongly chose option A.

*Q32 A Hall probe is placed in a uniform magnetic field. The slice of semiconductor inside the Hall probe is 1.3×10^{-3} m thick and has 10^{25} charge carriers per cubic metre. When a steady current of 0.4 A passes through the slice, a Hall voltage of 2×10^{-5} V is set up. What is the magnetic field strength detected by the probe ? Assume that the magnitude of the charge of each charge carrier is 1.6×10^{-19} C.

A.*	0.104 T	(51%)
B.	0.962 T	(15%)
C.	1.04 T	(26%)
D.	9.62 T	(8%)

26% of the students wrongly obtained an answer 10 times bigger than it should have been, probably because of wrong entry of 10^{25} charge carriers per cubic metre into the calculator.

- Due to the small number of students attempting each section, statistical analysis of the performance in multiple-choice questions in paper 2 is not compiled.

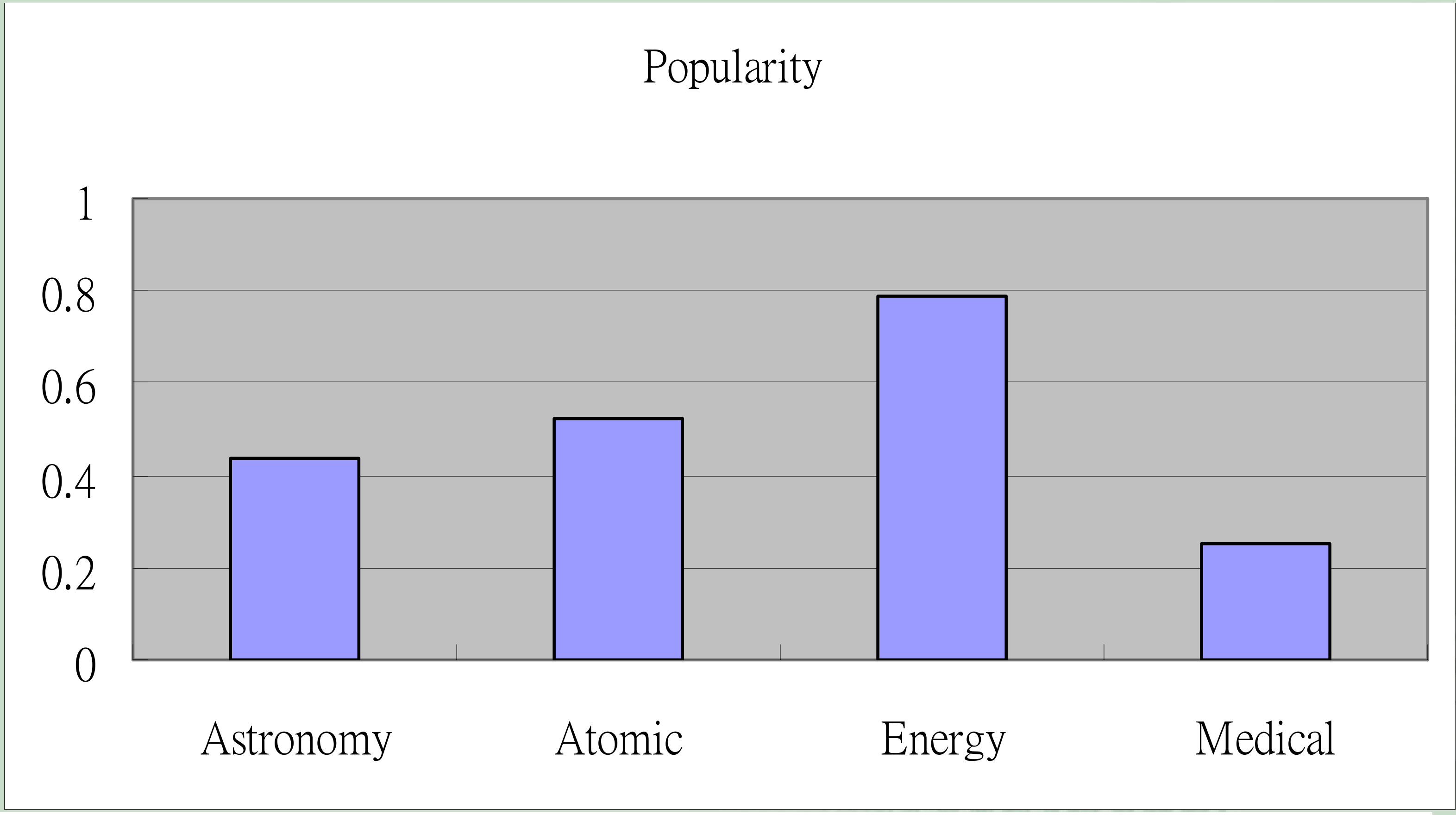
Marking scheme interpretation (Paper 2) and students' performance

Marking scheme interpretation and students' performance

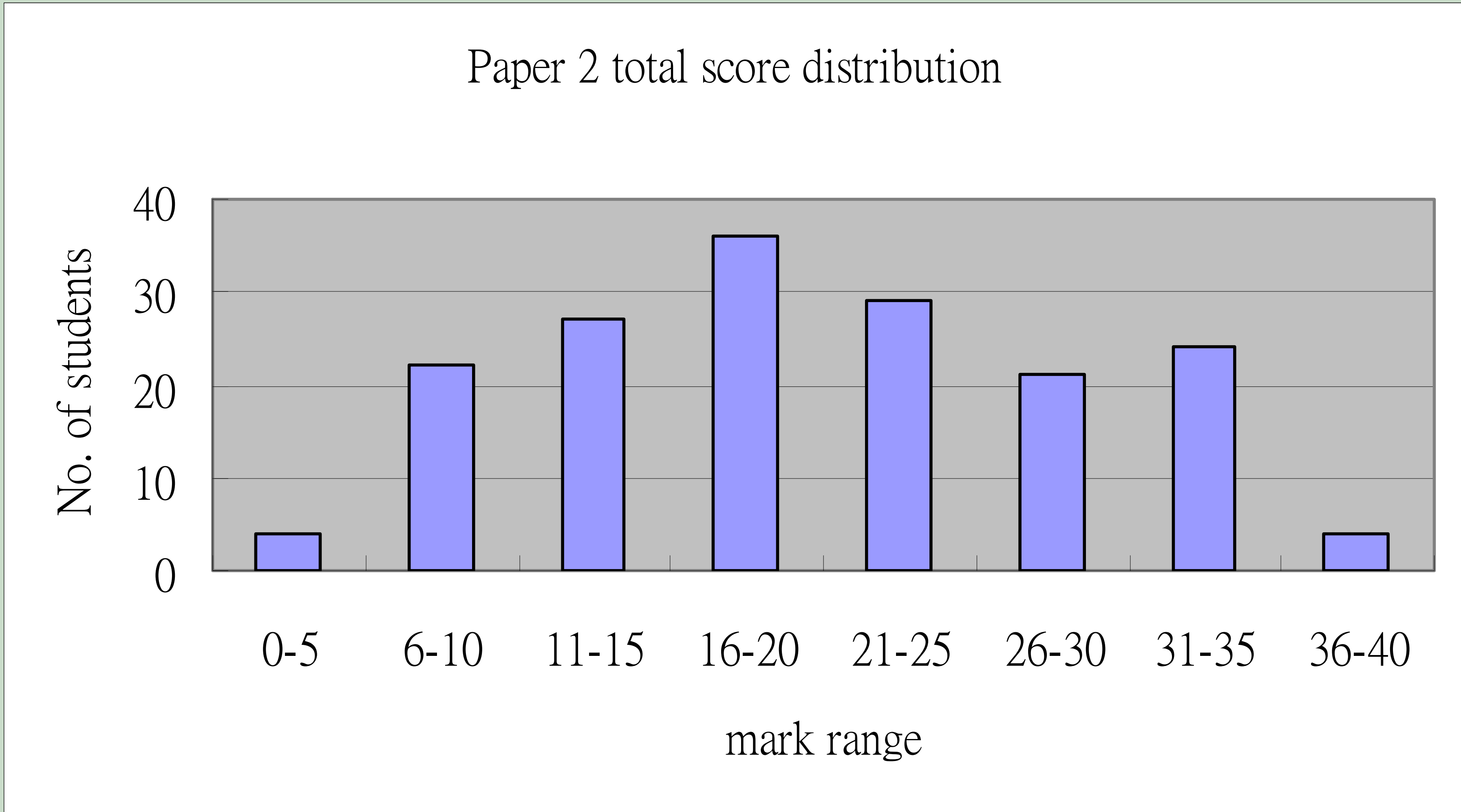
- **Preliminary and "final" marking schemes**
- **Suggested answers cannot be exhaustive (professional judgment)**
- **Marking criteria not indicative for future examinations**

Students' Performance in Piloting (Paper 2)

- **Number of records = 167**



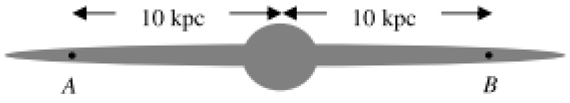
Mean = 20.9 (52%), Stdev = 8.2 (21%)



Q.1

Q.1: Structured question

(a) We observe a galaxy X as shown in Figure 1.1. X has negligible velocity relative to the Earth. Points A and B are both 10 kpc from the centre. The wavelengths of the H-alpha lines from the hydrogen gas at points A and B are 656.83 nm and 655.73 nm respectively. The wavelength of the H-alpha line measured in the laboratory is 656.28 nm.



edge-on view of galaxy X

Figure 1.1

(i) Determine the speed of the hydrogen gas at point A along the line of sight of an observer on the Earth.

(1 mark)

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(ii) Briefly explain at which point, A or B, the hydrogen gas is moving towards the Earth.

(2 marks)

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(iii) Assuming that the hydrogen gas at points A and B are moving in a circular path around the centre of X, and that the mass of X is concentrated at its centre, estimate the mass of X.

(2 marks)

....

Q.1

(b) Observations were made on another galaxy Y, as shown in Figure 1.2.

Figure 1.2

(i) The angular separation between points C and E is 1.6°. Given that Y is 950 kpc from the Earth, express the separation between C and E in kpc.

(2 marks)

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(ii) Further observations show that the velocities of hydrogen gas at points D and E along the line of sight of an observer on the Earth are about the same. What could be inferred about the mass distribution of Y ? Assume that the hydrogen gas at points D and E are moving in circular paths around the centre of Y.

(1 mark)

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(c) Briefly explain how we can estimate the surface temperature of a star by analyzing its radiation.

(2 marks)

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Q.1 Astronomy and Space Science

(a)	(i)	$\frac{\Delta\lambda}{\lambda}=\frac{v}{c}$ $v_A=\frac{(656.83-656.28)}{656.28}\times 3\times 10^8 = 2.51\times 10^5$ m s^{-1}	1A
	(ii)	The H-alpha line of hydrogen gas at point *B* shows a blue shift,	1A
		thus hydrogen gas at point *B* is moving towards the Earth.	1A
	(iii)	$\frac{mv_r^2}{r}=\frac{GMm}{r^2}$	1M
		$M=\frac{v_r^2 r}{G}=\frac{(2.51\times 10^5)^2(10\times 10^3\times 3.08\times 10^{16})}{6.67\times 10^{-11}}$ $=2.92\times 10^{41}$ kg	1A
			5

1A + 1A

(b)	(i)	By small angle approximation, $\frac{x}{d} = \theta$	1M
		Separation of CE, $x = d\theta$ $= 950 \times 1.6 \times \frac{\pi}{180}$ $= 26.5$ kpc	1A
	(ii)	The mass of Y may have an extended distribution/not concentrated at the center.	1A
			3
(c)		The radiation from a star can be approximated by a black body radiation curve.	1A
		And the radiation spectrum of a black body is related to its temperature.	1A
			2

Q.1

- In (a)(i), some Ss used the wavelengths at points *A* and *B* in their calculations, instead of comparing λ_A to the laboratory value.
- In (a)(iii), some Ss missed "*kilo-*" in kpc.
- In (b)(i), some Ss used the arc length formulae without converting the angle to radian measure.
- In (c), some Ss failed to mention that the radiation of a star can be related to that of a black body.

Q.2

Q.2: Structured question

(a) In studying the photoelectrons emitted from sodium, it was found that no photoelectrons were emitted when the wavelength of the incident light was longer than 5.27×10^{-7} m.

(i) Explain why the wave model of light **cannot** account for this phenomenon.

(2 marks)

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(ii) Determine the work function for sodium. Express your answer in electron-volts.

(3 marks)

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(iii) What is the physical meaning of work function ?

(1 mark)

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Q.2

(b) Figure 2.1 shows a photoelectric smoke detector Peter made for a science project competition. It consists of a light source *S*, a photocell *C* and an alarm circuit. When smoke enters the detector, light from *S* is scattered by the smoke particles and enters *C* as shown in Figure 2.2. Photoelectrons are produced in *C* when light is incident on its sodium surface. The alarm is triggered when the photoelectric current is larger than 1×10^{-8} A.

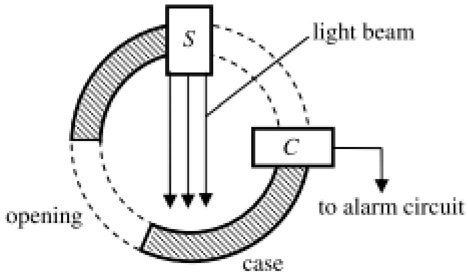

Figure 2.1

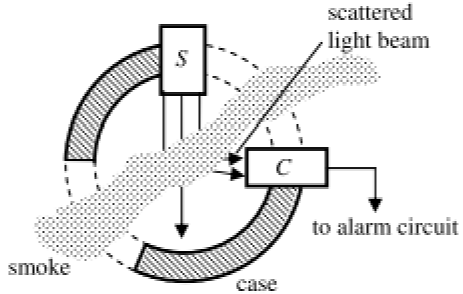

Figure 2.2

(i) If 5% of the photons incident on the sodium surface of *C* emit photoelectrons, what is the minimum number of photons incident on the sodium surface of *C* in 1 s when the alarm is triggered ?

(2 marks)

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(ii) Peter claimed that the detector will become more sensitive if a light source of the same type as *S* but of higher intensity is used. Comment on his suggestion.

(2 marks)

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Q.2 Atomic World

(a)	(i)	According to wave theory, energy of light depends on the intensity / amplitude.	1A
		No matter what the frequency is, photoelectrons should be emitted when the incident light is intense enough / when the time of exposure is long enough / when enough energy is stored after a certain time.	1A
	(ii)	According to the photoelectric equation,	
		$\frac{1}{2} m_e v_{max}{}^2 = hf - \phi$	
		Take K.E. = 0,	1M
		$0 = hf_o - \phi$	
		$\phi = h\dfrac{c}{\lambda_o}$	
		$\phi = h\dfrac{c}{\lambda_o}$	
		$= 6.63 \times 10^{-34} \times \dfrac{3\times10^8}{5.27\times10^{-7}}$	1M
		$= 3.77 \times 10^{-19}$ J	
		$\phi = \dfrac{3.77\times10^{-19}}{1.6\times10^{-19}} = 2.36$ eV	1A

Q.2

	(iii)	It is the minimum energy required to release an electron from a metal surface against the attractive electric force of the metal.	1A
			6
(b)	(i)	Number of photoelectrons $= \frac{I}{e} = \frac{1\times10^{-8}}{1.6\times10^{-19}}$	1M
		$= 6.25 \times 10^{10}$	
		Number of photons $= 6.25 \times 10^{10} \div 5\% = 1.25 \times 10^{12}$	1A
	(ii)	With a more intense light source of the same type, more photons are emitted.	1A
		Sufficient photons will be scattered by a smaller amount of smoke.	1A
		Hence Peter's claim is correct.	
			4

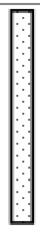
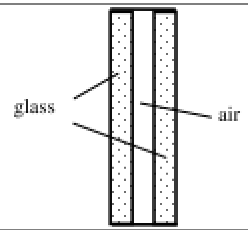
Q.2

- In (a)(i), few Ss could explain why the wave theory fails to account for the photoelectric effect.
- In (a)(iii), some Ss failed to mention that the work function is the *minimum* amount of energy required.
- In (b)(ii), some Ss did not realize that more photons are emitted from a light source of higher intensity. Some Ss did not understand that a more sensitive detector means it will be triggered by less smoke.

Q.3

Q.3: Structured question

(a) The heat transfer through a window can be reduced by using double-glazed glass. The table below shows some information of two types of windows, both made from the same type of glass.

		
Type	Single layer	Double-glazed
Thickness	0.01 m	0.03 m (0.01 m for each layer)
Thermal transmittance U-value	5.7 W m^{-2} K^{-1}	2.8 W m^{-2} K^{-1}

(i) Suggest **two** reasons why the thermal transmittance of the double-glazed window is smaller than that of the single layer window.

(2 marks)

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(ii) On a hot sunny afternoon, the temperatures outside and inside a room are 36°C and 24°C respectively.

(1) If the double-glazed window is used in the room and the area of the window is 2 m^2, estimate the rate of heat transfer due to conduction through this window.

(1 mark)

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(2) Briefly explain whether the actual rate of heat transfer will be higher or lower than your answer in part (1).

(2 marks)

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Q.3

(a) (iii) Other than using double-glazed windows, suggest one method to reduce the heat flow through windows.

(1 mark)

(b) An air-conditioner is installed in a room to keep the room cool.

(i) Briefly explain how the refrigerant in an air-conditioner absorbs heat from the room.

(2 marks)

(ii) The energy label of the air-conditioner is shown in Figure 3.1.

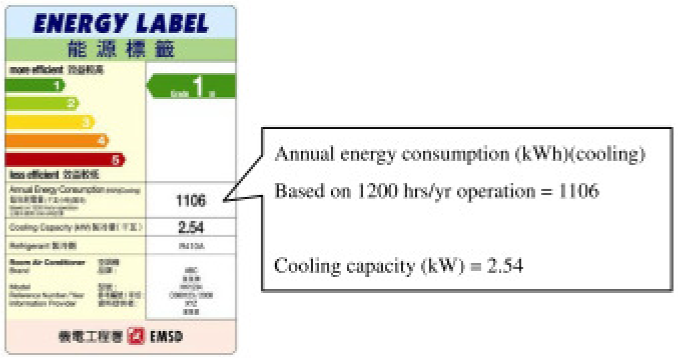

Figure 3.1

Estimate the amount of heat that can be removed from the room by the air-conditioner in 5 minutes.

(2 marks)

Q.3 Energy and Use of Energy

(a)	(i)	The air in the double-glazed glass has a much lower thermal transmittance than glass / is a poor conductor / is a good insulator.	1A
		The double glazed glass is thicker than the single layer window.	1A
	(ii)	(1) $\frac{Q}{t} = UA(T_{hot} - T_{cold})$ $= 2.8 \times 2 \times (36 - 24)$ $= 67.2$ W	1A
		(2) As heat is also transferred through other means, e.g. radiation,	1A
		the actual rate of heat transfer will be higher.	1A
	(iii)	Use solar control window film / drawing blinds (accept other reasonable answers)	1A
			6

Should give an example, e.g. radiation / sunlight…

Withhold if no reason given

(b)	(i)	The refrigerant evaporates	1A	
		and absorbs the latent heat of vaporization from the room.	1A	
	(ii)	Heat removed from the room = Pt		
		$= 2.54 \times 10^3 \times 5 \times 60$	1M	
		$= 7.62 \times 10^5$ J	1A	
				4

Q.3

- In (a)(i), few Ss stated that a doubled glazed glass is thicker.
- In (a)(ii)(1), some Ss mixed up U and κ. They included the thickness of the glass in the calculation.
- In (a)(ii)(2), some Ss wrongly suggested that the rate of heat transfer will be smaller as “heat loss to surroundings”.
- In (b)(i), some Ss described the complete cooling cycle of the refrigerant instead of focusing on the heat absorption part.
- (b)(ii) revealed that many Ss mixed up the quantities shown in the energy label and included unrelated quantities in the calculation.

Q.4

Q.4: Structured question

The table below shows the linear attenuation coefficient, μ, of X-rays for different tissues.

Tissue	bone	liver	muscle	lung	air
Linear attenuation coefficient/cm^{-1}	4.00	0.85	0.84	0.20	0.10

(a) Suggest one reason to explain why the linear attenuation coefficient of the lung is smaller than that of the liver.

(1 mark)

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....

(b) Show that the half-value thickness = $\frac{\ln 2}{\mu}$.

(2 marks)

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(c) The intensity of a beam of X-ray drops to 1/8 of its initial value after passing through a lung. Estimate the thickness of the lung.

(2 marks)

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Q.4

(d) Figure 4.1 shows an X-ray radiographic image of a patient's chest. Explain why the bones appear white in colour.

(2 marks)

Figure 4.1

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(e) Artificial contrast medium is sometimes used to highlight an organ in X-ray radiographic imaging. Suggest **two** properties that an artificial contrast medium should have.

(2 marks)

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(f) Suggest one advantage of X-ray radiographic imaging over CT scan.

(1 mark)

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Q.4 Medical Physics

(a)	The lung is filled with air / has a low density.	1A
		1
(b)	$I = I_0 e^{-\mu x}$ $\frac{I_0}{2} = I_0 e^{-\mu x_{1/2}}$ $\frac{1}{2} = e^{-\mu x_{1/2}}$	1M
	$e^{\mu x_{1/2}} = 2$ $\mu x_{1/2} = \ln 2$ $x_{1/2} = \frac{\ln 2}{\mu}$	1M
		2

Q.4

(c)	By $I = I_o e^{-\mu x}$	
	$\frac{1}{8} = e^{-(0.20)x}$	1M
	$x = 10.4$ cm	1A
	OR: Intensity drops to 1/8 after passing through 3 half thicknesses.	1M
	Thickness of lung $= 3 \times \frac{\ln 2}{\mu} = 3 \times \frac{\ln 2}{0.20}$	
	$= 10.4$ cm	1A
		2
(d)	Bone has a high linear attenuation coefficient.	1A
	Only very little X-ray can pass through to blacken the film.	1A
	The film appears white after being developed.	
		2

Accept "have significantly different linear attenuation coefficient compared to the body tissues"

(e)	An artificial contrast medium should be non toxic / can be excreted from the body / should not cause adverse reactions.	1A	
	An artificial contrast medium should have a high linear attenuation coefficient	1A	
			2
(f)	The patient is exposed to less radiation in X-ray radiographic imaging. X-ray radiographic imaging is fast / cheap / widely available. (any 1)	1A	
			1

Q.4

- In (a), some Ss wrongly thought that there was water in the lungs.
- In (c), some Ss used the number of half thickness method, but wrongly calculated that there were 8/2 = 4 half thicknesses.
- In (d), most Ss realized that the bone absorbs more X-ray, a few wrongly stated that bone reflects X-ray. Very few Ss could state that X-ray would blacken the film.
- In (e), some Ss mixed up artificial contrast medium and tracer.

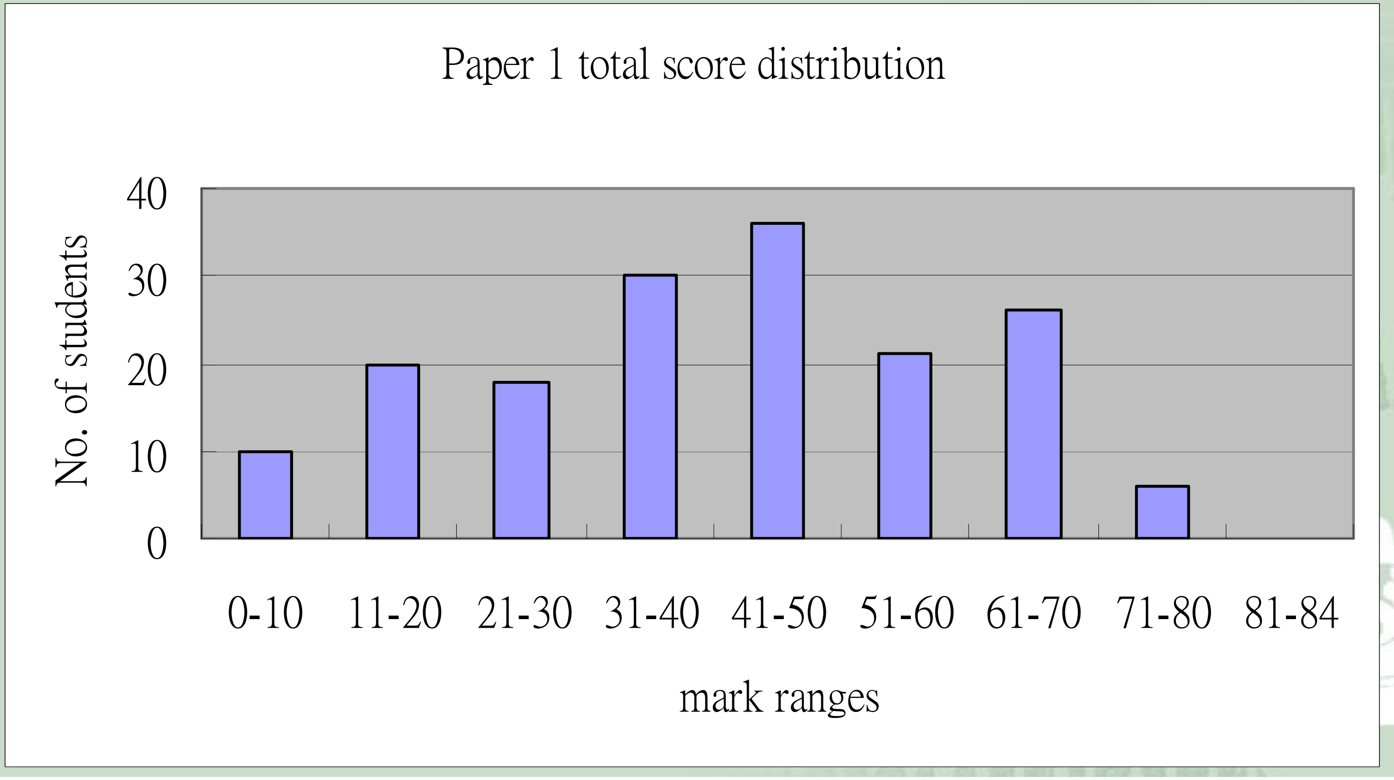
Marking scheme interpretation (Paper 1B) and students' performance

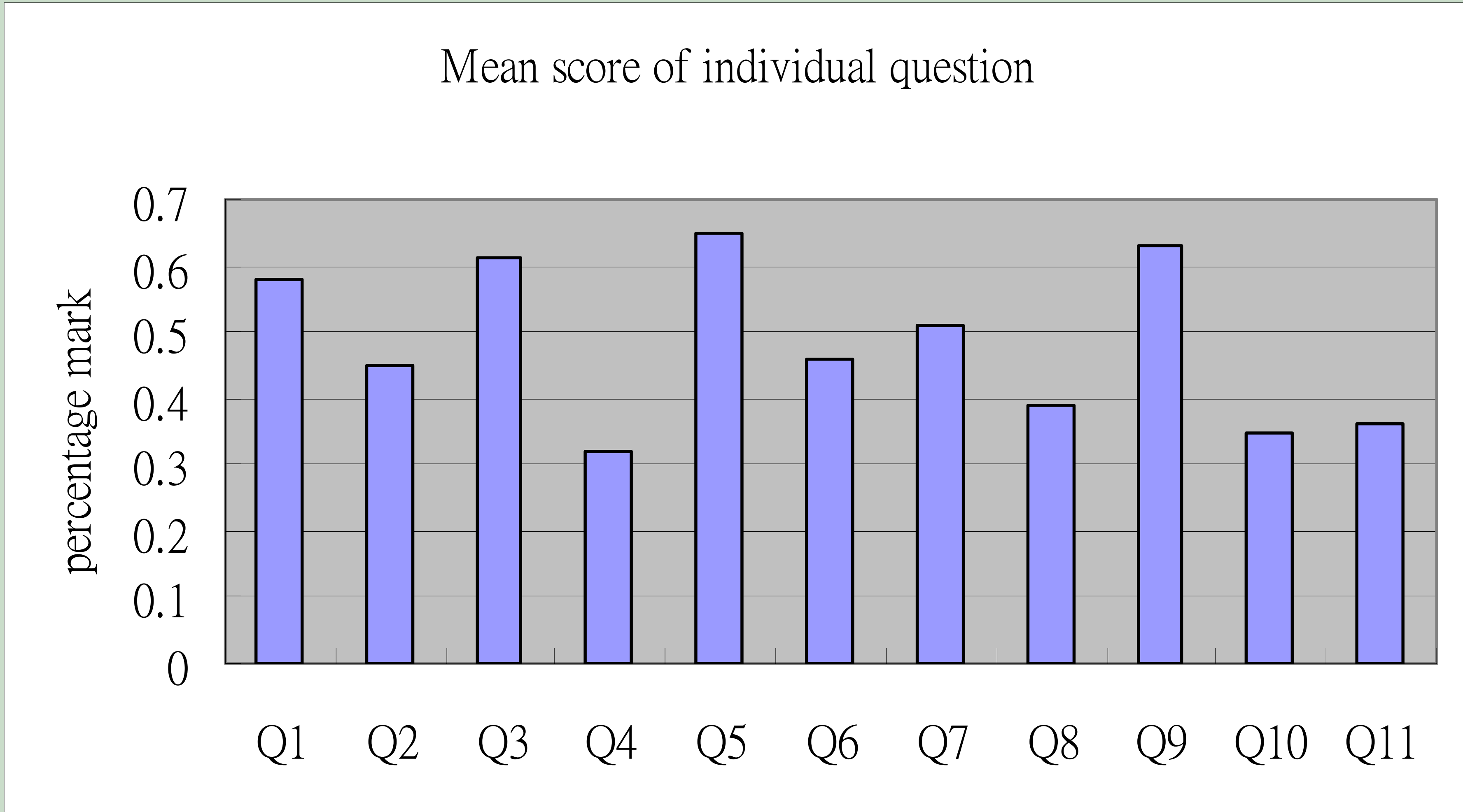
Marking scheme interpretation and students' performance

- **Preliminary and "final" marking schemes**
- **Suggested answers cannot be exhaustive (professional judgment)**
- **Marking criteria not indicative for future examinations**

Students' Performance in Piloting (Paper 1B)

- Number of records = 167
- Mean = 41 (49%), Stdev = 18 (22%)





Mean score of individual question
percentage mark
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11

Q.1

1.

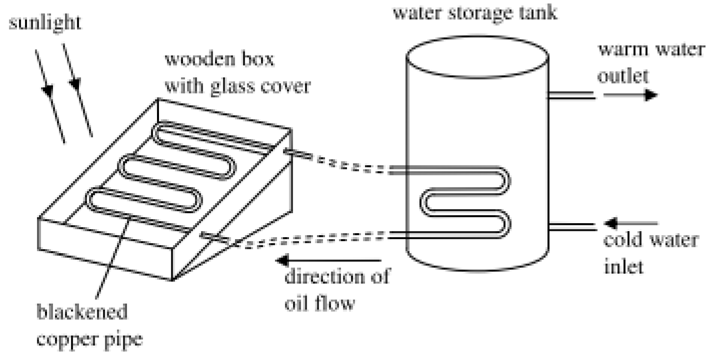


Figure 1.1

Figure 1.1 shows a solar water heating system. The heater is made from a glass-covered wooden box and the copper pipe inside is painted black. The heater is put on an inclined surface. Oil circulates between the heater and the water storage tank via the copper pipe.

(a) (i) Explain why the copper pipe inside the box is painted black.

(1 mark)

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(ii) Explain why the wooden box is covered by a sheet of glass.

(1 mark)

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(iii) Explain why the oil circulates in the system in the direction as indicated in Figure 1.1.

(2 marks)

....

Q.1

(b) When the oil flows through the pipe in the heater at a rate of 0.3 kg per minute, the temperature of the oil rises from 25°C to 37°C. Determine the power absorbed by the oil.

Given : specific heat capacity of oil = 2500 J kg^{-1} $°C^{-1}$

(3 marks)

*(c) If the wooden box is sealed and made air-tight, how would the air pressure inside change when temperature increases ? Explain briefly in terms of kinetic theory. No mathematical derivation is required.

(3 marks)

Q.1

Should show a comparison

(a) (i) A black surface is a good absorber of radiation.	1A	
(ii) A cover reduces heat loss due to convection of air.	1A	
(iii) The oil in the copper pipe inside the box is heated and rises.	1A	
Cooler and denser oil from the pipe in the storage tank will move downward and replace the heated oil.	1A	
OR: The oil in the copper pipe inside the box is heated and becomes less dense,	1A	
they rise due to convection.	1A	
		4
(b) In 1 minute,		
$E = mc\Delta T$,		
$= 0.3 \times 2500 \times (37 - 25)$	1M	
$= 9000$ J		
$P = E / t$		
$= 9000 / 60$	1M	
$= 150$ W	1A	
		3
(c) The pressure increases with temperature.	1A	
As temperature increases, the average kinetic energy / speed of the air particles increases.	1A	
The air particles will hit the wall of the box more violently / more frequently.	1A	

Q.1

- Mean = 58% (paper mean = 49%)
- Generally well answered.
- In (a)(ii), some Ss just answered “reduce heat loss to the surroundings” without stating the means of heat transfer.
- In (a)(iii), some Ss tried to explain how the direction of oil circulation helps to heat the water.

Q.2

2.

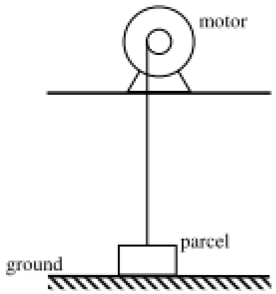

Figure 2.1

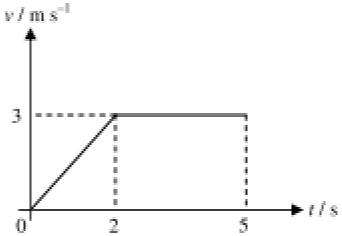

Figure 2.2

A parcel of mass 4 kg is being raised from the ground by a light string connected to a motor at the rooftop of a building as shown in Figure 2.1. The speed-time graph of the parcel for the first 5 s is shown in Figure 2.2. Neglect air resistance.

(a) Find the tension in the string at time $t = 1$ s.

(3 marks)

(b) Calculate the output power of the motor between $t = 2$ s and 5 s.

(2 marks)

(c) At $t = 5$ s, the string suddenly breaks. Describe the subsequent motion of the parcel.

(2 marks)

Q.2

(a) $a = 3/2 = 1.5 \text{ m s}^{-2}$	1A
By $T - mg = ma$	1M
$T - 4 \times 9.81 = 4 \times 1.5$	
$T = 45.24 \text{ N} \; [46 \text{ N}]$	1A
	3
(b) Power $= Fv$	
$= 4 \times 9.81 \times 3$	1M
$= 117.72 \text{ W} \; [120 \text{ W}]$	1A
	2
(c) The parcel first rises and comes to rest momentarily.	1A
It then falls freely under gravity.	1A
	2

Q.2

- Mean = 45% (paper mean = 49%)
- Many Ss forgot to include the weight of the parcel in the calculations in (a).
- (b) was generally well answered.
- In (c), many Ss did not mention the parcel rises first after the string breaks.

Q.3

3. A smooth curved rail *PQR* is fixed on a horizontal bench as shown in Figure 3.1. *P* is at a height *h* above the bench surface. A small metal ball *X* of mass 0.03 kg is released from rest at *P*.

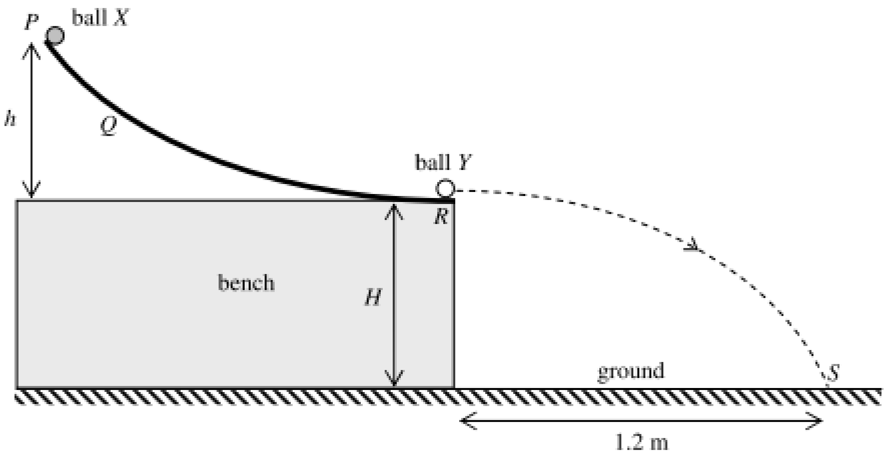

Figure 3.1

When ball *X* reaches *R*, it moves horizontally and collides head-on with another metal ball *Y* of mass 0.04 kg which is initially at rest on the rail. Immediately after the collision, ball *X* comes to rest while ball *Y* moves off the bench horizontally with a speed of 3 m s^{-1}. Neglect air resistance.

(a) What is the speed of ball *X* just before it collides with ball *Y* ?

(1 mark)

....

....

....

(b) Find the value of *h*.

(2 marks)

....

Q.3

*(c) Ball Y lands on the ground at S which is at a horizontal distance of 1.2 m from the bench. Find the height H of the bench.

(3 marks)

*(d) Ball X is now released at Q such that ball Y moves off the bench horizontally with a smaller speed after collision. Would the time of flight of ball Y change ? Explain briefly.

(2 marks)

Q.3

(a) By the conservation of momentum, $0.03\ v = 0.04 \times 3$ $v = 4\ \text{m s}^{-1}$	1A	
		1
(b) By P.E. lost = K.E. gain	1M	
$mgh = \frac{1}{2} mv^2$ $0.03 \times 9.81 \times h = 0.5 \times 0.03 \times 4^2$ $h = 0.815$ m [0.8 m]	1A	
		2
(c) Time of flight = 1.2 / 3 = 0.4 s	1M	
Vertical distance ball Y travelled before hitting the ground, $S = \frac{1}{2} at^2$ $= 0.5 \times 9.81 \times 0.4^2$	1M	
$= 0.7848$ m [0.8 m]	1A	
The height H of the bench is 0.7848 m [0.8 m].		
		3
(d) The time of flight remains unchanged	1A	
as the vertical displacement and the initial vertical speed remains unchanged.	1A	
OR : as it is independent of the horizontal speed of the projectile.	1A	
		2

Q.3

- Mean = 61% (paper mean = 49%)
- In (a), some Ss tried to find the speed of ball *X* by using the conservation of energy.
- In (c), some Ss mistook the horizontal speed of ball *Y* to be the initial speed in vertical motion.
- In (d), many Ss could not explain why the time of flight of ball *Y* remains unchanged.

Q.4

4. A communications satellite moves in a circular orbit around the Earth with a period of 24 hours and remains above a certain place on the equator.

Given : radius of the Earth r_E = 6400 km

*(a) (i) Find the orbital radius of the communications satellite.

(3 marks)

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....

....

*(ii) Determine the orbital speed of the communications satellite.

(2 marks)

....

Q.4

(b) In Figure 4.1, X is a point in space and O is the centre of the Earth.

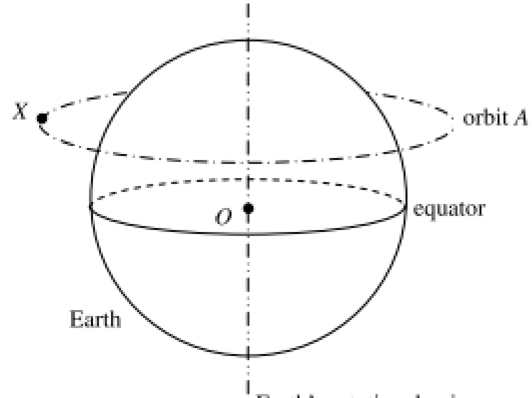


Figure 4.1

*(i) A satellite is at X. In Figure 4.1, draw the gravitational force acting on the satellite due to the Earth.

(1 mark)

*(ii) Briefly explain why the satellite cannot move in a circular orbit A as shown in Figure 4.1 under the influence of the Earth's gravitational force only.

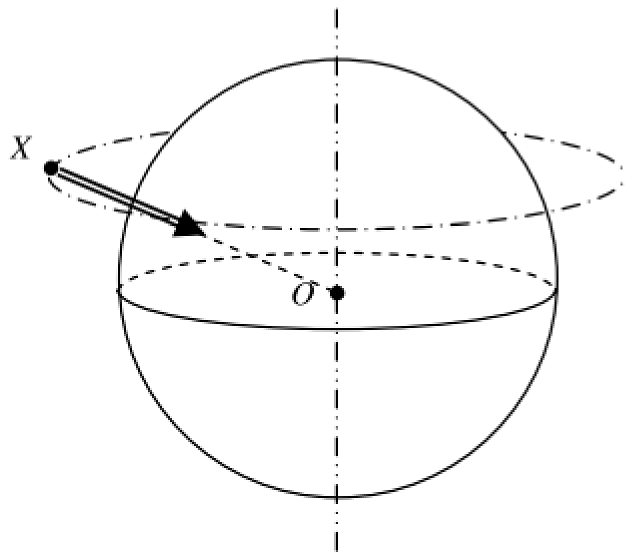
(1 mark)

Q.4

(a) (i) $\dfrac{GMm}{r^2} = m\omega^2 r$	1M
$r^3 = \dfrac{GM}{\omega^2}$	
On earth's surface,	
$\dfrac{GMm}{r_E^2} = mg$	1M
$GM = gr_E^2$	
Hence,	
$r^3 = \dfrac{GM}{\omega^2} = \dfrac{gr_E^2}{\omega^2} = \dfrac{gr_E^2 T^2}{4\pi^2}$	
$r = 4.24 \times 10^7$ m [4.26×10^7 m]	1A
(ii) By $v = \dfrac{2\pi r}{T}$	1M
$= \dfrac{2\pi(4.24\times10^7)}{86400}$ =3080 m s^{-1} [3100 m s^{-1}]	1A
	5

Q.4

(b) (i)



1A

(ii) The direction of the required centripetal force is different from the direction of the gravitational force acting on the satellite. / The vertical component of the gravitational force will pull the satellite towards the equator.
The plane of orbit of a satellite must pass through the centre of the earth. / The gravitational force provides the centripetal force required. (Accept drawing the correct orbit in great circle.)

1A

Q.4

- Mean = 32% (paper mean = 49%)
- In (a)(i), not many Ss expressed *GM* in terms of r_E.
- In (b)(i), and in general, Ss should be reminded to draw straight lines using ruler.
- Quite a number of Ss just left this question unanswered.

Q.5

5. (a) Two rectangular barriers are put into a ripple tank. A vibrator vibrating at 25 Hz produces water waves with straight wavefronts. The wavelength of the water waves is 0.8 cm. Circular wavefronts are observed after the water waves pass through the opening between the two barriers. Figure 5.1 shows the top view of the set-up.

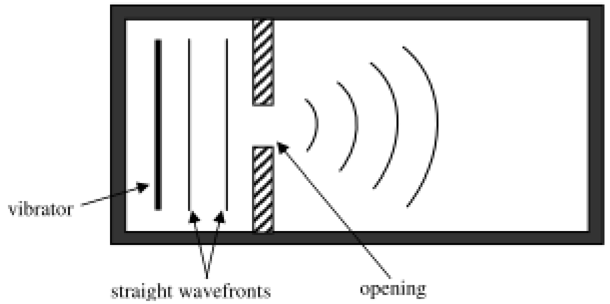


Figure 5.1

(i) Name the wave phenomenon that takes place when the water waves pass through the opening.

(1 mark)

....

....

....

(ii) Calculate the speed of the water waves in the ripple tank.

(2 marks)

....

....

....

....

....

(iii) If the experiment is repeated using a higher vibrator frequency, describe the changes, if any, in the wave pattern shown in Figure 5.1.

(2 marks)

....

Q.5

(b) Figure 5.2 shows three points, *P*, *Q* and *R*, in a ripple tank such that *PR* = 8 cm and *QR* = 10 cm. A dipper is put at *P* to produce circular water waves of wavelength 0.8 cm.

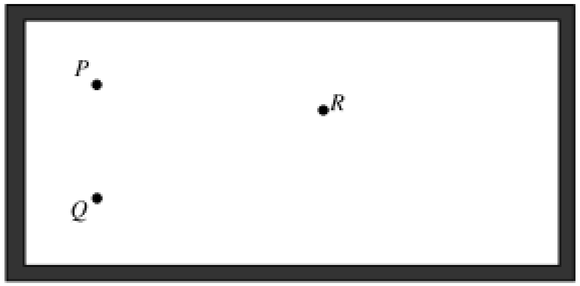


Figure 5.2

Another identical dipper, vibrating in phase with the one at *P*, is later put at *Q*. Explain the change, if any, in the amplitude of the water wave at *R*.

(3 marks)

Q.5

Correct spelling

(a) (i) Diffraction	1A
(ii) $v = f\lambda$	1M
$= (25)(0.8)$	
$= 20 \text{ cm s}^{-1}$	1A
(iii) The wavelength of the water wave decreases.	1A
The degree of diffraction decreases.	1A
	5

For 2.5 λ or "destructive interference"
No mark if only "destructive interference" is stated.

(b)	Path difference at $R = QR - PR$	1M
	$= 2.5\ \lambda$	
	$\therefore$ Destructive interference at R.	1A
	Amplitude of the water wave at R decreases when another dipper is placed at Q.	1A
		3

Consider this mark only when 2nd 1 A awarded.

Q.5

- Mean = 65% (paper mean = 49%)
- This question was generally well answered.
- In (a)(ii), some Ss made mistake in the unit.
- In (a)(iii), while most Ss pointed out that the wavelength will decrease, many did not mention the change in the degree of diffraction.
- In (b), some Ss failed to calculate the path difference in terms of wavelength.

Q.6

6. Figure 6.1 shows the following apparatus:

A low voltage power supply, a ray box with a single slit, a full circle protractor and a semi-circular glass block.

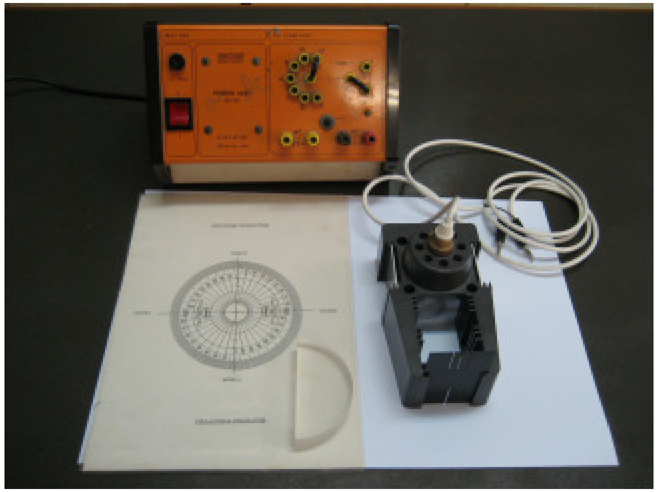


Figure 6.1

Describe how to use the above apparatus to measure the critical angle of the semi-circular glass block.
(5 marks)

Q.6

Connect the ray box to the power supply and switch it on.	1A
Put the semi-circular glass block onto the protractor.	1A
Direct a light ray into the glass block through the curved side towards its centre.	1A
Vary the incident angle in the glass block until the refracted ray is parallel to the straight edge of the glass block.	1A
Make sure that the centre of the semi-circular glass block coincides with the centre of the paper protractor. Read the incident angle from the protractor and the critical angle of the glass block can be obtained.	1A
	5

Accept using labelled diagram for 1st to 3rd 1A.

4th and 5th 1A require description of the action.

Q.6

- Mean = 46% (paper mean = 49%)
- Ss used many different ways to describe the situation at critical angle. This shows a good understanding of the phenomenon.
- While most Ss described the major steps of the experiment, they skipped important details. Only few mentioned that the centres of the glass block and the protractor should coincide, and how the light ray should be directed (towards the centre through the curved side).

Q.7

7. A drop of liquid is placed on a thin glass slide above a plastic ruler. The side view of the set-up is shown in Figure 7.1. Looking through the liquid drop, a magnified image of the number '9' on the ruler is seen as shown in Figure 7.2.

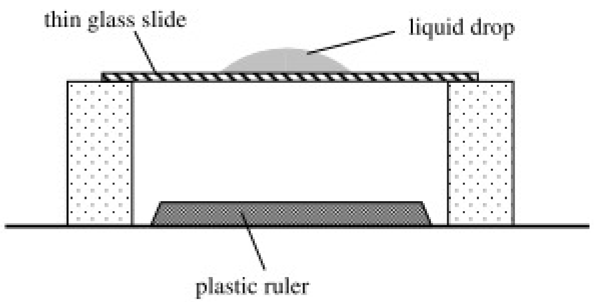


Figure 7.1

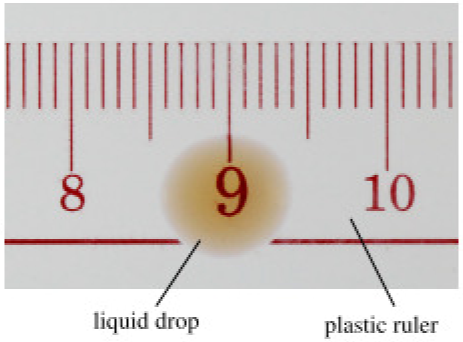


Figure 7.2

(a) A lens can be used to produce an image with the same nature as that produced by the liquid drop. State the type of lens and explain your answer.

(2 marks)

....

Q.7

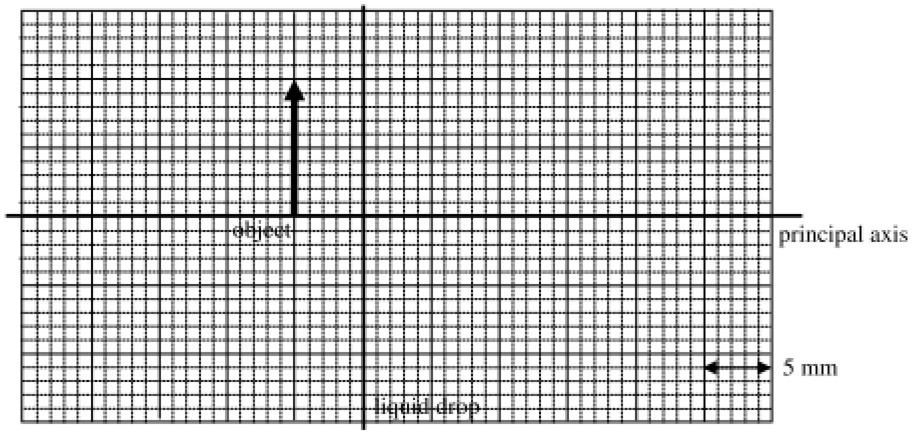
(b) The linear magnification of the number '9' is 1.4. Take the number '9' as the object, use the graph paper below to

(i) draw the image of the object, and

(ii) draw **one** light ray to find the focal length of the liquid drop.

You may neglect the effect due to the thin glass slide.

(3 marks)



Focal length of the liquid drop = ______ mm

(c) If the refractive index of the liquid becomes smaller, explain the change, if any, in the focal length of the liquid drop.

(2 marks)

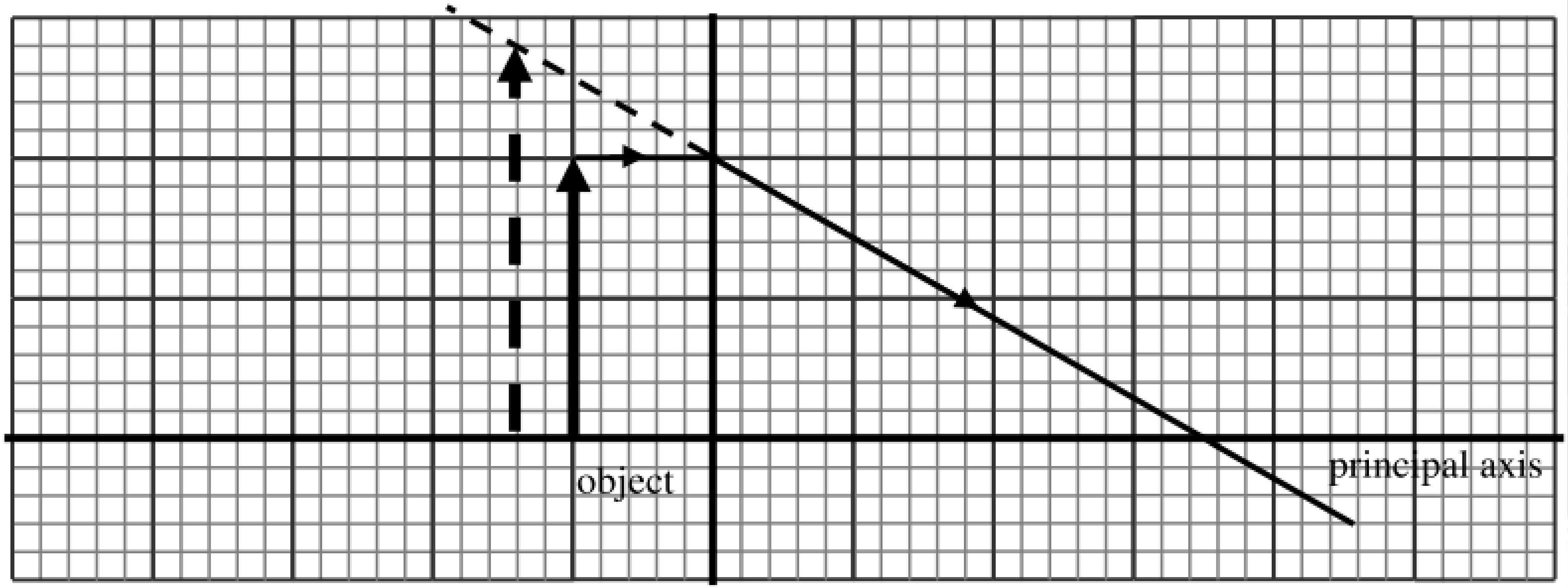
Q.7

Correct spelling

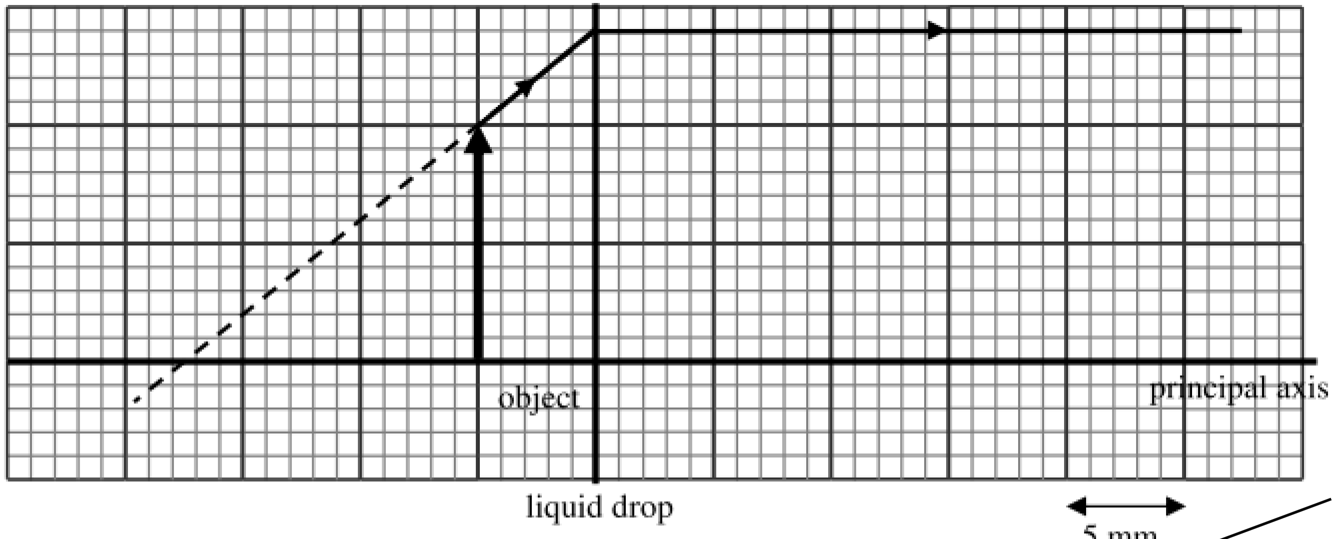
(a) Convex lens.
A convex lens can produce magnified images.

(a) Convex lens.	1A
A convex lens can produce magnified images.	1A
	2

(b) (i)(ii)



OR: for (ii)



No mark for no arrow

Image position and height correct	1A
Construction ray correct	1M
Focal length = 17.5 mm	1A
	3
(c) The focal length of the liquid drop will increase.	1A
An incident ray parallel to the principal axis of the liquid will bend towards the principal axis less after passing through the liquid.	1A
	2

Q.7

- Mean = 51% (paper mean = 49%)
- (a) and (b) were generally well answered. Most Ss adhered to the conventions in drawing ray diagrams.
- In (c), many Ss failed to explain why the focal length becomes longer when the refractive index of the liquid decreases.

Q.8

8. As shown in Figure 8.1, two large vertical parallel metal plates, each in a slotted base, are placed on a polystyrene tile. The plates are connected to the positive and negative terminals of an EHT supply respectively. The plates' separation d = 10 cm.

.

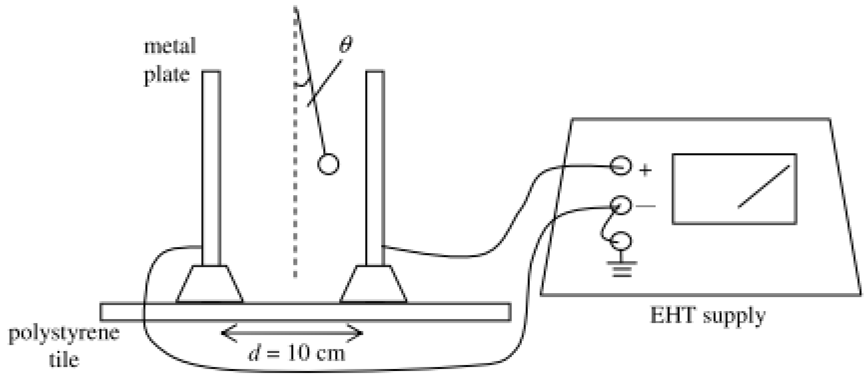


Figure 8.1

A small charged ball is suspended by a nylon thread and is placed midway between the plates. The thread makes an angle θ to the vertical when the ball is in equilibrium.

(a) Draw a free-body diagram to show the forces acting on the charged ball. Also indicate in your diagram the direction of the electric field between the plates.

(3 marks)

Q.8

(b) (i) Express tan θ in terms of the electric force F acting on the ball and the weight W of the ball.

(1 mark)

....

....

....

*(ii) Given that the mass of the ball is 0.07 g. When the voltage between the plates is 4000 V, $\theta = 2°$. Estimate the magnitude of the charge carried by the ball. Assume that the electric field between the plates is uniform.

(3 marks)

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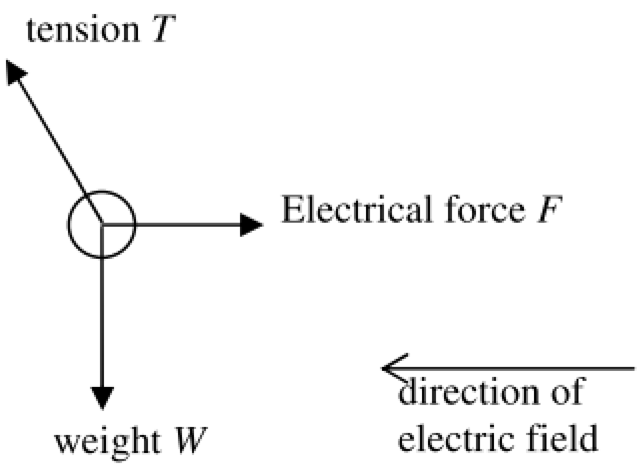
(c) Using the setup in Figure 8.1, suggest a simple method to test whether the electric field between the plates is uniform.

(3 marks)

....

Q.8

(a)



any two forces correct	1A
all correct in the free body diagram	1A
direction of electric field correct	1A
	3
(b) (i) $\tan\theta = \dfrac{F}{W}$	1A

(b) (i) $\tan\theta = \dfrac{F}{W}$	1A
(ii) Electric force $F = qE$ For parallel plates, $E = \dfrac{V}{d}$	1A
From (i), $\tan\theta = \dfrac{F}{W} = \dfrac{qE}{mg} = \dfrac{qV}{mgd}$ $\therefore q = \dfrac{mgd\tan\theta}{V}$	1M
$= \dfrac{(0.07\times10^{-3})(9.81)(0.1)\tan 2^{\circ}}{4000}$ $= 6.00 \times 10^{-10}$ C [6.11×10^{-10} C]	1A
	4
(c) Move the polystyrene tile / the point of support of the nylon thread,	1A
so that the ball is placed in different positions in the space between the plates.	1A
Angle θ should remain the same if the electric field between the plates is uniform.	1A
	3

Q.8

- Mean = 39% (paper mean = 49%)
- General performances of (a) and (b) were fair, though Ss did not read the question carefully: Ss just added forces in Figure 8.1 instead of drawing a free body diagram as required. And in (b)(ii), some Ss used 0.07 kg, instead of 0.07 g, in their calculations.
- (c) revealed some of the misconceptions of the Ss about a parallel-plate system. Some Ss suggested angle θ would remain the same when the plates' separation was adjusted, and some suggested the ball would swing if the electric field was non-uniform.

Q.9

9.

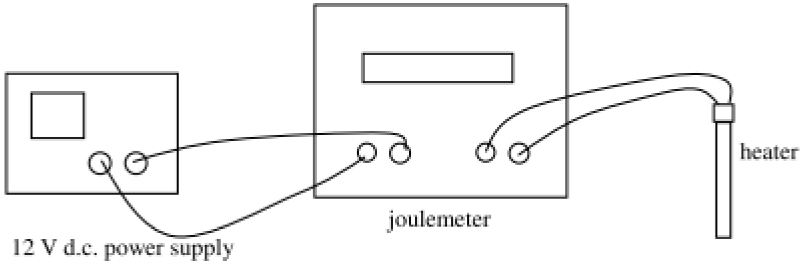


Figure 9.1

(a) A 12 V heater is operated under a steady d.c. voltage of 12 V. The energy consumed by the heater in 2 minutes is measured by a joulemeter as shown in Figure 9.1. The initial and final readings of the joulemeter are 126 J and 2526 J respectively.

(i) Estimate the electrical power of the heater.

(2 marks)

....

....

....

....

....

(ii) Hence, find the current through the heater.

(2 marks)

....

Q.9

(a) (iii) A 5 A fuse is installed in the power supply. Explain whether the fuse will blow if another identical heater is connected in parallel with the original heater.

(2 marks)

....

....

....

....

....

*(b) The heater is now connected to a sinusoidal a.c. power supply. The peak value of the voltage of the a.c. power supply is 15 V. How would the output power of the heater change ?

(2 marks)

....

Q.9

(a) (i) $P = \frac{E}{t}$	
$= \frac{(2526 - 126)}{2 \times 60}$	1M
$= 20$ W	1A
(ii) $P = VI$	
$20 = 12 \times I$	1M
$I = 1.67$ A	1A
(iii) Total current $= 1.67 \times 2$	1M
$= 3.34$ A	
The fuse will not blow as the total current is less than 5 A.	1A
	6
(b) The r.m.s. voltage of the a.c. supply	
$= \frac{15}{\sqrt{2}} = 10.6$ V	1M
which is smaller than 12 V,	
hence the power output of the heater decreases.	1A
	2

Consider this mark only when V_{rms} = 10.6 V

Q.9

- Mean = 63% (paper mean = 49%)
- (a)(i) and (a)(ii) were generally well answered.
- In (a)(iii), many Ss failed to see that the current would double when one more identical parallel branch was connected, and they produced lengthy calculations to find the new current.
- In (b), some Ss showed no understanding of the concept of r.m.s. value of an alternating current.

Q.10

10. Read the following passage about ignition coils and answer the questions that follow.

Ignition coil

An ignition coil is used to produce sparks from the battery of a car to ignite the fuel in the engine. It is used to produce high-voltage pulses from a low-voltage d.c. supply.

An ignition coil consists of two coils of insulated copper wire that are wound around a common iron core. One coil, called the primary coil, is made from relatively few (tens or hundreds) turns of thick copper wire. The other coil, called the secondary coil, typically consists of many (thousands) turns of thin copper wire.

When an electric current is passed through the primary coil, a magnetic field is created. The iron core guides most of the primary coil's magnetic field to the secondary coil. When the current in the primary coil is suddenly interrupted, a high voltage pulse of many thousand volts is developed across the secondary coil. This voltage is often sufficient to cause an electrical discharge to produce a spark.

(a) Explain why a voltage is developed across the secondary coil when the current in the primary coil is suddenly interrupted.

(2 marks)

(b) Suggest **two** reasons why the voltage developed across the secondary coil is very large.

(2 marks)

(c) Explain why thick wire should be used to construct the primary coil.

(3 marks)

Q.10

(a) When the primary current is suddenly interrupted,	
the magnetic field through the secondary coil changes,	1A
and an e.m.f. is induced across the secondary coil.	1A
	2
(b) The number of turns of the secondary coil is much larger than that	
of the primary coil.	1A
The rate of change of magnetic flux is very large / the magnetic	
flux collapses in a very short time.	1A
	2
(c) The resistance of thick wire is smaller,	1A
so that the primary current will be larger	1A
and the magnetic field produced will be stronger.	1A
OR:	
By energy conservation, input power should be equal to the	
output power,	1A
$V_pI_p \approx V_sI_s$.	
To produce a large secondary voltage, the primary current should	1A
be large.	
Therefore thicker wire of smaller resistance should be used.	1A

Should show a comparison

Q.10

- Mean = 35% (paper mean = 49%)
- In (a), many Ss did not relate their answers to electromagnetic induction at all. Few Ss could explain the induced e.m.f. by a *change* of magnetic field.
- In (b), most Ss pointed out that the secondary coil has a large number of turns, but failed to compare it to the primary coil.
  And very few Ss mentioned the high rate of change caused by the sudden interruption of current.
- In (c), while many Ss knew that the resistance of a thick wire is small, they failed to point out why this is important for the primary coil.

Q.11

11. The decay of radioactive isotope protactinium-238 (^{238}Pa) has a half-life of approximately 136 s. A sample of ^{238}Pa is put in front of a GM tube and the initial count rate is 1000 counts per minute. The background count rate is 50 counts per minute.

(a) It is known that the decay of ^{238}Pa does not emit γ radiation. Suggest a simple test to verify the radiation from ^{238}Pa is β radiation but not α radiation.

(3 marks)

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....

*(b) Estimate the decay constant of ^{238}Pa.

(1 mark)

....

....

....

*(c) Hence, or otherwise, estimate the time taken for the count rate to drop to 250 counts per minute.

(3 marks)

....

Q.11

(a)	Put the GM tube close to a ^{238}Pa sample, note the count rate.	1A
	Insert a piece of paper between the sample and the GM tube / Put the GM tube more than 5 cm from the sample,	1A
	the count rate will show no significant difference.	1A
	This shows that no α radiation is emitted.	
		3
(b)	$k = \frac{\ln 2}{t_{½}}$	
	$k = \frac{\ln 2}{136}$	
	$k = 5.10 \times 10^{-3}\ s^{-1}$	1A
		1
(c)	Corrected initial count rate = 1000 – 50 = 950 min^{-1}	1M
	Corrected final count rate = 250 – 50 = 200 min^{-1}	
	By $C = C_o e^{-kt}$	
	$200 = 950\ e^{-(\ln 2 / 136)t}$	1M
	$(\frac{\ln 2}{136})t = \ln\frac{950}{200}$	
	$t = 306$ s	1A
	OR : By $C = C_o\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$	1M
	$t = 306$ s	1A

Accept using 950 / 200 directly in calculations

Q.11

- Mean = 36% (paper mean = 49%)
- In (a), very few mentioned that the GM tube should be very close to the source in the first place. Some Ss tried to use the method of electric / magnetic deflection but failed to give a full account.
- In (b), most Ss failed to give the correct unit.
- In (c), some Ss did not use the corrected count rates in their calculations.

Standards Setting in 2012

Cut scores for Physics

The panel of judges will set cut scores based on:

- Level descriptors
- Selected marked live scripts
- Statistical data - Group Ability Index (GAI) to reflect overall performance (ability) in the core subjects for all candidates taking a subject (group)
- Markers' feedbacks on the level of difficulty
- Students samples from SRR Information Package
- HKAL 2011 and HKCE 2010 library scripts

Cut scores for Combined Science

- Cut scores of each half-elective to be determined with reference to the cut scores of the corresponding full-elective subjects using a statistical method that serves to equate the standard between the two
- Cut scores of the two half-elective subjects to be added up to form the cut score of Combined Science
- Overall subject level and levels for the two chosen components will be reported

Levels 5* and 5**

- Level 5** will be awarded to the highest-achieving 10% (approximately) of Level 5 candidates
- Level 5* will be awarded to the next highest-achieving 30% (approximately) of Level 5 candidates

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Thank you