Tasmanian Secondary Assessment Board

PH866 Physics (865, 866)

Report on 1997 External Examination

OVERALL COMMENTS FROM THE CHIEF EXAMINER

A team of 10 markers completed the task, with markers divided into 3 teams corresponding to Criteria 7, 9 and 10. In addition to marking a particular question, each marker awarded a score for Criterion 2. All these scores were tallied to arrive at an overall award for this criterion.

Each team decided on exact point values for each part of each question. These values are indicated in the comments and solutions which accompany this document. Based on the standards for the subject, marking teams decided on point totals necessary for 'A', 'B', 'C' and 'D' ratings on each criterion.

Point totals for each section agreed upon were as follows:

	Sect A	Sect B	Sect C
'D'	0-9	0-22	0-26
'C'	10-17	23-32	27-41
'B'	18-21	33-39	42-53
'A'	22+	40+	54+

Comments from the markers were mostly favourable with regard to the exam itself. A few questions remain. Should the format of the exam remain static or are there changes that could improve its discrimination? Also, as students seem perpetually rushed to complete the exam, could some adjustments be made to shorten it to allow them to complete the paper with sufficient time. These and other issues can be discussed next year via the moderation process.

Thanks go to all markers who professionally completed the task on time.

Examiners Comments

SECTION A - *(assessing criteria 2 and 7)*

Question 1

Criterion 7

This question was very well done by the majority of students with many gaining full marks.

(b) (ii) The most common errors included using data prior to 26 s rather than after 26 s as instructed, to calculate acceleration. A few students failed to specify the acceleration was negative, either by a minus sign or in words.

(b) (iii) Some students, because of the poor choice of scales, found difficulty in reading accurately from their graphs the speed of the car at 36.2 s. (See comments under criterion 2.) Others assumed the photograph would be taken at maximum speed. The general comment here would be to again advise students to read the question carefully.

Criterion 2

Again, graph drawing was a little disappointing, with a significant number of students not following convention or erring in the following areas:

- poor choice of scales resulting in graphs occupying only a minuscule part of the page;
- points not being joined by appropriate lines;
- straight lines not being ruled;
- inaccurate plotting of data;
- axes not labelled.

Question 2

Overall, most students attempted all parts (a), (b), (c) and (d).

(a) Was answered well when students used the given formulae. Many plotted $\ell \sim \frac{1}{f}$; many plotted $\ell \sim \frac{1}{4f}$; many plotted $\frac{1}{\ell} \sim f$; some plotted $\frac{1}{4\ell} \sim f$. (All 4 alternatives were equally acceptable.)

Students should not round off values for $\frac{1}{f}, \frac{1}{\ell}$ etc., to 2 significant figures; this led to inaccuracies in plotting points in part (b).

Students who used log graphs made mistakes unless they took the log of both variables. Graph of log $\ell \sim$ log f gave correct solution; graph of log $f \sim \ell$ and log $\ell \sim f$ were totally unacceptable.

THE USE OF LOG GRAPHS IN PHYSICS C IS NOT RECOMMENDED.

Most students were able to state why they chose to use $\frac{1}{f}, \frac{1}{\ell}$ etc., to ENABLE THEM TO PLOT A STRAIGHT LINE GRAPH.

(b) Answers were generally well done. Most students plotted points accurately. A large proportion of students drew 2 straight lines. Students who drew only 1 line were penalised 1 or 2 marks. Students who drew a line from the point (1.95, 0.625) to the origin were penalised 1 mark out of 5. Students generally pointed out that the point (1.95, 0.625) belonged to another overtone: it belonged to the 5th Harmonic.

(c) Answers were varied. Many used the slope of the straight line graph for either the 1st Harmonic or the 3rd Harmonic and then determined $c = 320\text{ms}^{-1}$. However, some only substituted for 1 point in the formula $\left(\ell = \frac{c}{4f}\right.$ or $\left.\ell = \frac{3}{4}\frac{c}{f}\right)$; these students received 1 mark out of 3.

(d) Answers were generally not well done. Many could not interpret the increase in slope for sketch graph (ii); many could not envisage that graph (iii) cut the ℓ axis at +D and is parallel to graph (i).

SECTION B - ***(assessing criteria 2 and 9)***

Question 3

Generally, most students were able to score better than 8/16 on the question. Most had difficulty with question 3 (d) (ii) possibly by failing to understand the question fully.

(a) Reasonably done. If students got correct part (i) they generally got part (ii) correct. Conversely if (i) was wrong, (ii) was wrong. One point for each part.

(b) (i) Well done.

(ii) Many good attempts at the conversion. Two points for each part.

(c) (i) (ii) Most were able, with the help of a diagram, to get this correct. Some merely quoted frequency as $\frac{V}{\lambda}$. Part (i) worth 2 points, (ii) one point.

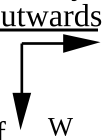
(iii) Most got the diagram correct though some thought the division line to be the normal. The effect of transferring from one to the other on frequency not well done with many clearly guessing. Part (iii), 3 points.

(d) (i) Most were able to provide a reasonable definition of an electric field though some extended to electric field strength.

(ii) Very few recognised the CURRENT origins of B Fields, they tried to talk in terms of N & S poles always being together.

Question 4

(a) (i) Main source of force? - ‘centripetal force’ given no credit. Many failed to specifically state main source. Most students had problems drawing the forces. Some showed Newton III pairs (forces acting <u>on</u> car asked for). Many confused force with other quantities e.g. mass, acceleration, velocity, inertia, momentum ‘vectors’ were often drawn! An incredible number had friction acting <u>outwards</u>! Some could not conceive of friction acting in direction other than opposite the motion.

If 

Friction then 1/2 mark. Any outward force (or non-force!) meant 0 marks.

(a) (ii) Marked in conjunction with (i), however if outward force remained generally 0 marks. Description of motion - 1 mark. Explanation - 2 marks. Many students had the car spiralling inwards!

(a) (iii) Many misread the question and drew in gravitational field lines - no credit. 1 mark for correctly showing <u>direction</u> of force on each object. 1 mark for correctly showing that magnitudes are equal.

Overall question 4 (a) was answered very badly.

(b) (i) Needed to have correct forces labelled and obviously adding to 0 for both marks or appropriate labelling.

(b) (ii) 2 marks only if showed net force = 0. Showing uneven forces or net unbalanced force, no credit.

(b) (iii) Many students could not forget their notes and interpret data given. Mention of 1.6×10^{-19}C as being the fundamental change was not viewed favourably. Some students insisted on describing Millikan's expt. rather than the conclusions that could be drawn from the data.

Overall question 4 (b) not well answered.

Question 4 (c) generally done to pass or better standard. Answers tended to be too verbose, requiring more space than was given. No extra marks were given to long answers, in fact it annoyed the marker.

(c) (i) Few students combined $T^2 \alpha\, r^3$ with the actual questions, giving formulae answers (from formulae sheet). Often if a student did mention $T^2 \alpha\, r^3$ they did not constrain this with the 24 hours for the Geo.sat. Many students did not mention 24 hour period of Geo.sat.

(c) (ii) Most implied that Geo.sat. are over equator, but did not confine the L.E.O.sat. to orbits around the centre of the earth. Some looked only at the distance travelled.

(c) (iii) Few students attacked this part comprehensively. Most gave the more obvious reasons (i.e. not continuous). Many saw the question only in terms of one satellite and not a system.

Some gems:

'geostationary satellites have a period of 1 year'
'All satellites orbit the earth once every 24 hours'

24 different spellings of 'satellite'

1. sattalight
2. sattelite
3. satalite
4. saltelite
5. satelite
6. statellite
7. satellits
8. satellities
9. satelitte
10. satetites
11. satillite
12. sattelitie
13. sattalite
14. sallelite
15. satelit
16. satterlight
17. satallite
18. satelletes
19. satarlights
20. satelights
21. salelite
22. satilights
23. sattilights
24. satilite

Question 4 (d) done to a pass standard by most students.

(d) (i) Many students did not mention the critical angle, stating that it occurs only when the 'angle of reflection' (?) is 90°. Students placed a large degree of importance on the interface being a dense medium with a less dense medium.

The ray diagram rarely showed partial reflections (perhaps students have never actually seen this!). Refraction towards the normal was a common mistake.

(d) (ii) Often well done. Some students forgot that the angle of incidence must equal the angle of reflection. Basic geometry let students down. A number of students did not understand the principle of a safety reflector.

(e) (i) Very well answered.

(e) (ii) While most students did well, a number of students were unable to consistently use the proportionality relationships implied by $E = hf$ and $\lambda = c/f$. Many students assumed that the outgoing photon *velocity* would be reduced.

(e) (iii) Again generally well answered, though many students simply wrote down everything they could think of involving X rays - and still did not answer the question. Many students stated that the experiment indicates that photons have *mass*. While this is correct in one sense, it often suggested confusion between *rest mass* and the relativistic mass equivalent of the photon energy. It is safer to simply emphasise that photons have *momentum*.

(f) (i) The many mistakes in this question seemed to indicate a fundamental lack of understanding of refraction.

(f) (ii) Answers given were disappointing, and in the end full marks were to any students who showed that they understood that photons would be emitted with a number of different discrete wavelengths.

(f) (iii) Most students had a reasonable understanding of the concept of energy levels. However, there was still considerable confusion. Common errors included having *one* spectral line to correspond with the one hydrogen electron, confusing absorption and emission spectra, attempting to represent the spectrum as electronic energy diagram and others. Students who answered in terms of using spectral lines to identify elements were not given full marks.

Question 5

This question was attempted by all, except one, student. There were slightly more students choosing the 2nd alternative. A few students caused extra work by attempting both parts. Both parts were well done on the whole with most candidates gaining at least half marks.

Either

(a) Some students did not show maximum of the resultant pattern equal to the sum of the separate waves.

(b) Many people were unable to explain how nodes and antinodes were formed, or how they related to the resultant pattern. Many did not seem to understand the meaning of the words ‘resultant pattern’. Many students did not draw a diagram.

(c) Well done.

(d) Some students confined themselves to saying which part of the string should be plucked.

Or

(a) Many students thought a force was exerted to the right by the g and E fields.

(b) (i) Many students ignored this part.

(b) (ii) Well done.

(c) (i) Many vague answers.

(c) (ii) Few complete answers - should explain experiment and method of finding g. Many students calculated acceleration for falling object, but thought g was something different.

(c) (iii) Idea of g as a force not force per unit mass was suggested by many. Many people suggested rate of change of acceleration.

SECTION C - ***(assessing criteria 2 and 10)***

Question 6

(a) (i) Generally well done.

(a) (ii) Generally well done.

(a) (iii) Generally well done, although many believed that g = 0 outside the atmosphere. The decrease in g due to height has to be considered negligible.

(a) (iv) Many good answers. Common mistakes were:

(a) not realising that the air resistance is in the opposite direction to the plane's motion;
(b) making the downwards force = 70 x 3.52 rather than 70 x 9.8;
(c) The upwards air resistance is in fact negligible immediately after jumping.

(a) (v) Generally well done by those starting with correct information. Direction frequently ignored in answer.

(b) (i) Generally well done.

(b) (ii) Not many answers clearly explained the direction of the force.

Question 7

About one in ten students left this question out altogether, with most remaining students attempting at least some of the parts. Very few full marks were awarded. The most common error was to use an incorrect formula or to use incorrect values for variables.

(a) (i) This part of the question was very well done by most attempting it.

(a) (ii) This part of the question was done reasonably well by those attempting it. Most used Newton's Second Law to find the acceleration from the force given (50 Newton) and then use an equation of motion to show that v = 50 m/s. Some equated the work done by the 50 N force over 1.25 m with the gain in Kinetic Energy to solve for v. Quite a few students had difficulty with this type of question and did not use a good technique to show that v = 50 m/s.

(b) (i) This part of the question was well done by most attempting it with a common problem being incorrect units. Also, using l = 1.25 m and not converting 10 cm into 0.1 m were common errors.

(b) (ii) This part of the question was reasonably well done by most attempting it with a common problem of not converting 20 gram into kg, not converting 10 cm into 0.1 m and allowing θ to confuse the issue.

Question 8

(a) In most cases either very well done or very poorly done. A clear understanding was required to gain good marks.

(b) Generally well done, although some students made little progress.

Question 9

This question was very well answered with many students gaining full marks. There was still some confusion between mass and weight in (a) (ii) and often incorrect values of mass (and weight!) were carried over and used in (iii).

Part (b) was better answered than part (a). Errors were mostly careless (not squaring r, using the wrong k) and mathematical. Some students were worried by the answer for the acceleration in part (i) thinking that as the number was greater than the speed of light it was not possible. One problem with the question was that an incorrect answer to part (i) meant that part (ii) was impossible to show. If this was the case correct working was accepted. Some students used incorrect working and then put "$= 2.2 \times 10^6 ms^{-1}$" at the end! This was not accepted.

Criterion 2 - many students failed to give directions when required. The setting out of the momentum question was very poor. Units and significant figures were mostly used well.

Question 10

About one in twenty students left this question out altogether, with most remaining students attempting at least some of the parts. Very few full marks were awarded. The most common difficulty students had was dealing with conversion of units into SI and with the mathematics associated with expotentials.

(a) (i) This part of the question was very well done by most attempting it. Converting years to seconds was a problem for some.

(a) (ii) This part of the question was done reasonably well by those attempting it.

(a) (iii) This part of the question caused many students difficulty. Many knew the correct formula and were given credit for quoting the correct values into the expression. The evaluation of t caused many students a problem. Obviously log calculations is an area requiring further practice.

(b) (i) This part of the question was reasonably well done by most attempting it. The lack of a Periodic Table or extract thereof seemed to throw many students. However, this was not needed as the question stated that Caesium decays into a stable isotope of Barium by β^- emission. It should be known that the Mass Number does not change by this process (i.e. 137) and that Z will increase by one (i.e. from 55 to 56).

(b) (ii) This part of the question was reasonably well done by most attempting it with a common problem being that students did not simply use the conversion factor of 1 u = 931 MeV.

(b) (iii) This part of the question was very poorly done. The wording of the question in (a) was not familiar to students although not being an unreasonable way to express this situation. From that information, students were required to show that 4×10^{13} decays per second occurred with each decay yielding 1.17 MeV or 1.88×10^{-13} Joule to obtain an answer of 7.49 Joules per second or 7.49 Watts. Comments as to whether this amount was significant or not were not given credit unless accompanied by a calculated value on which to base the opinion, i.e. no marks for simply 'yes' or 'no'.

Statistical Summary

Award Summary

Outstanding Achievement	(OA)	158
High Achievement	(HA)	193
Satisfactory Achievement	(SA)	132
Reassessed into neighbour		50
Total		534

Gender Breakdown

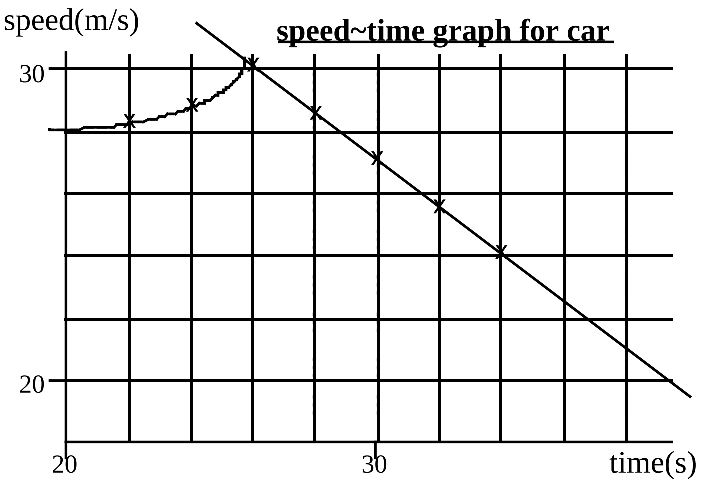
Males	365
Females	169

Summary of external ratings	A	B	C	D
Criterion 2	289	119	105	3
Criterion 7	218	121	102	71
Criterion 9	163	123	165	65
Criterion 10	168	110	146	91

Physics C Nov 1997

Section A

1(a)



(b)i. At about 26 seconds the car stopped speeding up and began slowing down.

(2 points)

(b)ii. From the graph:

$a = \frac{24 - 30}{34 - 26} = -0.75$

The acceleration of the car was $-0.75ms^{-2}$ after 26s

(3 points)

(b)iii. At time of photo(36.2) the speed of the car **could** be $22.35ms^{-1}$. (read from graph)

CHECK (optional):

$a = -0.75\ ms^{-2}$

$u = 30\ ms^{-1}$

$t = 10.2\ s$

$v = u + at = 22.35\ ms^{-1}$.

Range 22.3 - 22.4 ms^{-1} was acceptable.

(2 points)

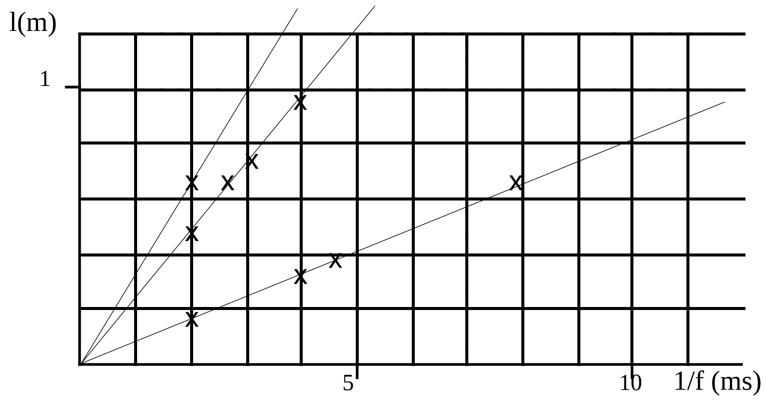
(b)iv. $22.35ms^{-1} = 22.35 \times 3.6\ kmh^{-1} = 80.46kmh^{-1}$. Since 80.46 is greater than 60 (the speed limit), the owner of the vehicle has the potential to be fined.

2a) The relationships between l and *f* are of the form $\ell = \frac{2n-1}{4} \cdot \frac{1}{f}$ *(6 points)*

and so, if l is plotted against f^{-1}, the points should fall into linear groupings that extrapolate through the origin. The gradient of any of these lines should be an odd-multiple of c/4. The corresponding values of f^{-1} are given on the table:

l (m)	0.625	0.364	0.313	0.156	0.938	0.469	0.625	0.625	0.727
f (Hz)	128	220	256	512	256	512	512	384	33
1/f x 10^{-3} sec	7.81	4.55	3.91	1.95	3.91	1.95	1.95	2.60	3.03

b) *(5 points)*

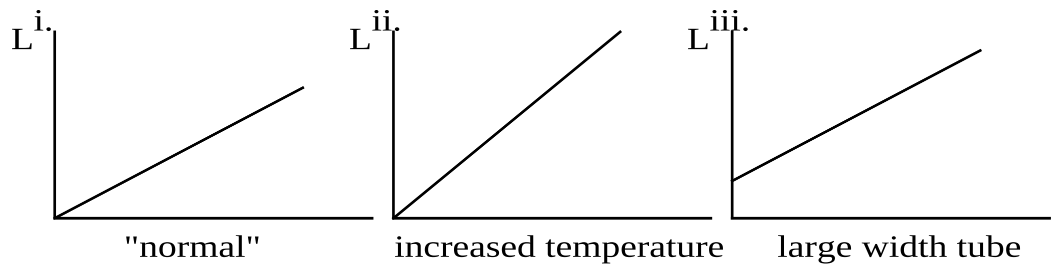


The single point (1.95ms,0.625m) does not fit on a "line" in this set.
It belongs to the 5th harmonic.

c) The two lines (through 4 points each) have gradients $80.0ms^{-1}$ and $240.0ms^{-1}$. These are the gradients corresponding to the constants c/4 and 3c/4 respectively. Using either gradient, the speed of sound in air is $320ms^{-1}$.

(3 points)

d)



Section B

Question 3

(a)i. The law of conservation of mass-energy is always true.

(a)ii. The other two laws are not true when mass and energy are interconverting, such as in nuclear processes (radioactivity and nuclear reactions) or when particles approach the speed of light.

(b)i. Weight is the force that gravity exerts on a person, and as such should be measured in newtons. The unit kilogram (kg) is a measure of mass. A 70kg mass **will** have a force of gravity acting on it if it is in a gravitational field and this force can be called "70kilogram-weight" inferring that it is the weight of 70kg, that is, the force on 70kg. It is an incorrect use of units to say that a person has a weight of 70kg. The error does not cause any major problems because personal experience is generally a force of 9.8 newtons per kilogram of mass, and so the ratio of masses is the same as the ratio of forces for any two objects.

(b)ii Bathroom scales measure the **force** of gravity because of the spring in the balance. Lower gravity causes less compression of the spring, and so registers a smaller force.
Possible solutions are:

- Recalibrate the scale by multiplying by 9.8 to measure in newtons.
- Recalibrate the scale by multiplying by 9.8/1.6 to measure in kilogram weight.
- Change the spring to one which is 1/6 as strong.

(c)i. Wavelength of a (continuous) wave is the distance (in metres) that the waveform moves in one cycle.

(c)ii. Frequency of a wave is the number of waveforms that pass a single fixed point in unit time (one second).

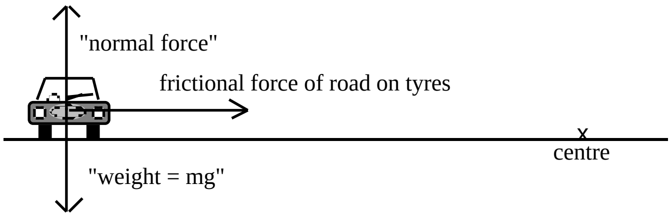
(c)iii. The wave's direction will bend towards the normal. Its frequency will not change. Its wavelength will shorten (decrease).

(d)i. An electric field is a region where a charged object will experience a force *due to the charge* (i.e. object alone - no force, chargs on object - a force).

(d)ii. All matter is usually considered to be electrically neutral, and becomes charged when electrons are added or removed. This separation of charge creates an electric field with field lines moving from positive charges(sources) to negative charges(sinks). Magnetic fields **can** be thought of as being created by electric currents. The field lines under this assumption form continuous loops around the conductor that carries the current.

Question 4 part (a)

(a)i. Turning the front wheels into a corner causes a sideways frictional force to be exerted on the four wheels. The sum of these four forces points directly to the centre of the turn. Other forces ("weight" and "normal" force) still add to zero.

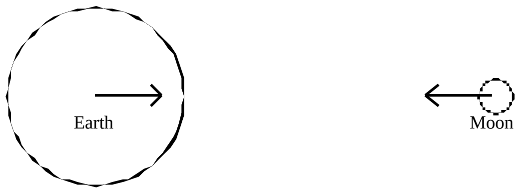


(1 mark)

(a)ii. If the road was covered in ice, the frictional force from road to tyres would have a smaller maximum value than if the road was dry. Consequently, if the force in the above diagram is "maximal" then a shorter arrow would be used to represent the maximal frictional force on an icy road. If the car is travelling at a relatively high speed so that the centripetal force (mv^2/r) is close to the maximal frictional force for dry roads, and the driver encounters an icy corner, then the radius of the turn will be such that mv^2/r = "icy max.frictional force"
This radius may be greater than the radius of the corner being negotiated and the car will consequently leave the road with its wheels skidding "outwards" on the ice.

(3 marks)

(a)iii.



Note: the forces are the same in each case.

(2 marks)

Question 4 part (b)

(b)i (

(b)iii Charges can be positive or negative - two different signs given.
Because the smallest charge is _2 x 10^{-19}C, all charges are integer multiples of _2 x 10^{-19}C and all charges differ by a whole number multiple of _2 x 10^{-19}C, electric charge is quantised, charges are discrete and come in positive and negative types.

(4 marks)

Question 4 part (c)

(c)i Geostationary satellites have an orbital period of 24 hours *(_ mark)* By Kepler's Law, T^2 proportional to r^3 *(1 mark)* geostationary satellite will have a longer period than the low earth orbit satellite. *(_ mark)*

(3 marks)

(c)ii. Geostationary satellites orbit in a circular path above the equator. *(1 mark)* Relative to the Earth they do not move. Low orbit satellites also move in circular paths centred on the earths centre (*1 marks)*, but relative to the Earth they move either in a circular path if above the equator, or in a series of parallel oblique crossings if not above the equator.

(2 marks)

(c)iii Geostationary satellites

- need more than one
- need strong signals and sensitive receivers
- problem in covering extreme north and south regions
- time delay on transmitting signals
- cost of launch.

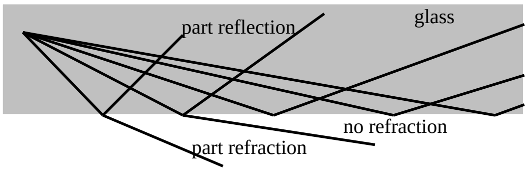
Lower Earth orbit satellite system

- Need more satellites
- Cheap to launch
- Expensive to keep on track
- Requires less powerful signal
- Requires complex interconnection
- Excellent whole globe coverage. *(3 marks)*

Question 4 part (d)

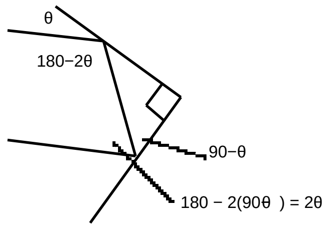
(d)i. When light is incident on the interface between a more dense to a less dense medium, if the incident angle exceeds the critical angle, then all the light is reflected and none is transmitted (refracted). The light is said to be **totally internally reflected**.

(2 marks)



(3 marks)

(d)ii. The incoming and outgoing rays will be parallel (antiparallel) to one another, provided that the angle in the retro-reflector is 90°. The angle of incidence does **not** affect this relationship.

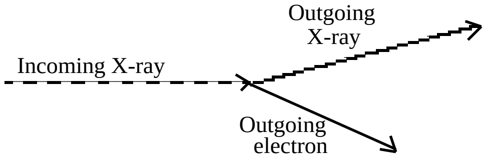


The angles (180 - 2_) and 180 - 2(90-_) are supplementary angles and so form the **co-interior angles** of the **transversal** crossing parallel lines. The incoming and outgoing rays are therefore antiparallel.

(1 mark diagram, 1 mark for parallel, 1 mark for "no")

Question 4 part (e)

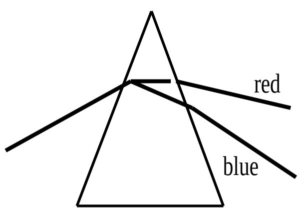
(e)i



(e)ii. Conservation of energy implies that
energy of *incoming* photon = energy of *outgoing* photon + KE of electron: $hf_o = hf_1 + KE$
Hence, comparing the outgoing photon with the incoming photon:
- the *energy* of the incoming photon is *less*
- the *frequency* of the outgoing photon is *less* (frequency is proportional to energy)
- the *wavelength* of the outgoing photon is *greater* (wavelength in inversely proportional to frequency)

(e)iii. The experiment indicates that in collisions with electrons X rays behave both as
- particles called photons having momentum and energy
- waves with wavelength and frequency.

Question 4 part (f)
(f)i.



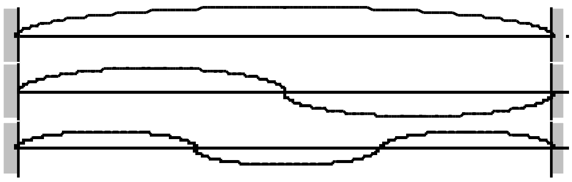
ii. Acceptable answer (for this examination): The light emitted by exceited hydrogen atoms contains a number of components having distinct wavelengths characteristic of hydrogen. Because these are viewed as differently coloured lines in spectrometers, they are referred to as spectral lines.

iii. A mathematical analysis of the wavelengths of these spectral lines showed that the *energies* of the photons corresponding to these lines could be obtained if electrons existed in discrete energy levels or "orbits" within the hydrogen atom. Hence, the spectral lines lead to the development of the modern theory of the electronic structure of atoms.

Question 5
"Éither" part

(a)

(b) The wave pattern is a typical standing wave. The wave-form does not move to the left or to the right. The points on the string oscillate with different amplitudes but the same frequency. Some points do not vibrate (nodes), others vibrate with greatest amplitude (antinodes) and others vibrate with a value in between. Nodes alternate with antinones along the string, separated by one quarter wavelength.

b) 

ii. In the string the waves produces by the pluck travel in opposite directions and then reflect off the fixed ends. They interfere with each other and produce the standing wave pattern shown and as demonstrated by superposition in the earlier question.

5a) motion	g-field	e-field	m-field
stationary	down	down	-
moving	down	down	up
b) question	g-field	e-field	m-field
shape	parabolic	parabolic	circular
kinetic energy	increase	increase	constant

c) i. Gravitational field strength is a measure of how strong a gravitational field is. That is, how strongly will it pull on a standard (fixed) mass. The direction of the field is also considered and is nominated to be the same as that of the force.

ii. With a small mass, measure the force required to prevent it falling. This force is approximately the same as the force of "gravity" on the mass. Field strength can then be calculated using $g = F/m$.

iii. Nkg^{-1}- tells us the number of newtons of force that act on each kilogram of a body's mass.
ms^{-2} - tells us the acceleration that the body would experience if no other force acted.

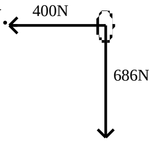
Section C

6 a)

i. $a_{av} = (62.6 - 0)/17.8 = 3.52ms^{-2}$.

ii. Because air resistance reduces the acceleration from 9.8 ms^{-2}.

iii. $t = (v-u)/a = (62.6 - 0)/9.8 = 6.39$seconds

iv. 

v. Resultant force (by Pythagoras) is 794N in a direction towards the west at 30.2° (using tan_) below the horizontal. The skydiver's acceleration is therefore $11.3ms^{-2}$ in the same direction as the resultant force.

b)

i. speed = $\_(a_c r) = 470ms^{-1}$.

ii. Sample is rotating practically in a horizontal plane, and so the centripetal force will be almost entirely due to the tube pushing centrally on the sample. The sample, of course pushes equally but outwards on the tube with a force of mv^2/r = mac = 1g x 150000g
The force is 1470N away from the centre.

7. a)i. Magnetic force = Bil Sin_ (where = 0.5 x 1000 x 0.10 = 50N

ii. $v = \_(u^2 + 2as) = \_(2Fs/m) = \_(2 \times 50 \times 1.25 / 0.05) = 50ms^{-1}$.

b) i. _ = vlB = 50 x 0.10 x 0.5 = 2.5V (down the page)

ii. F = Bil = 0.5 x 12.5 x 0.1 = 0.625N
_ a = F/m = 0.625 / 0.02 = $31.25ms^{-2}$. (slowing down)

8. a) i. E = hf = hc/_ = 5.68×10^{-19}J = 3.55eV

ii. Smallest energy:- is the work function 2.9eV = 4.64×10^{-19}J

iii. Maximum kinetic energy of the photoelectrons is 3.55 - 2.9eV
i.e. 0.65eV

iv. The minimum kinetic energy of a photoelectron will be 0ev assuming that the metal has, within its electron energy levels, a value of 3.55eV

b) i. The electron has lost 4.09×10^{-19}J of energy.

ii. _ = c/f =ch/E_n = 4.86×10^{-7}m = 486nm (green/blue)

iii. energy required is 2.42×10^{-19}J

9.a) i. $g = GM/d^2 = 6.67 \times 10^{-11} \times 6.42 \times 10^{23}/(3.38 \times 10^6)^2$
$= 3.75Nkg^{-1}$.

ii. W = mg = 10 x 3.75 = 37.5N

iii. $P_{before} = 10 \times .02 = P_{after} = 10.5v$. _ $v = 0.019ms^{-1} = 1.9cms^{-1}$.

b) i. $F = kQq/d^2 = 9x10^9 \times (1.6 \times 10^{-19})^2/(5.3 \times 10^{-11})^2$.
$= 8.2 \times 10^{-8}ms^{-2}$.
$a = F/m = 9.0 \times 10^{22}ms^{-2}$.

ii. v =_($a_c r$) = 2.19×10^{6} = 2.2×10^{6} ms^{-1}.

10. a) i. _ = ln2/T = 0.0231y^{-1}.

ii. N = A/_ = 4x 10^{13} / 0.0231/(365.5x24x3600)

= 5.47×10^{22} atoms (=5.46×10^{22}?)

iii. Using A = A_0e^{-}_^{t}, e^{-}_^{t} = 1x 10^{10}/(4 x 10^{13}) = 2.5×10^{-4}.

_ t = -ln(2.5×10^{-4})/_. = 359 years

b) i. ${}^{137}_{55}Cs$ ♦ ${}^{137}_{56}Ba$ + ${}^{0}_{-1}e$ + energy

ii. _m = 1.26×10^{-3}u _ 1.26×10^{-3} x 931MeV = 1.17eV

iii. Power = energy /time = 1.17 x 1.6 x 10^{-19} x A = 7.5W