MARKING KEY

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PHYSICS
SECTION ONE: SHORT ANSWER

Question 1(a)
Wave period

Description	Mark
Period = 12 s.	1

Question 1(b)
Wave frequency

Description	Mark
$\text{frequency} = \dfrac{1}{\text{period}}$	1
$= \dfrac{1}{12}\ \text{s}^{-1} = 0.083\ \text{Hz}$.	1

Question 1(c)
Number of waves

Description	Mark
$\text{period} = 12\ \text{s}$ $5.0\ \text{min} = 300\ \text{s}$	1
$\therefore \text{n}^{\text{o}}\ \text{waves} = \dfrac{300}{12} = 25$.	1

Question 2
Light bulb

Description	Mark
$P = VI$	1
$I = \dfrac{P}{V} = \dfrac{60}{250}$	1
$= 0.24\ \text{A}$.	1

Question 3
Standing waves

Description	Mark
The lines represent the maximum amplitude, at any point, of the air molecules in the tube.	1

Question 4(a)
Alternating current

Description	Mark
The emf alternates OR the current direction alternates.	1

Question 4(b)
AC home delivery

Description	Mark
High voltages are more efficient for long distance power transmission.	1
Low voltages are safer for domestic use.	1
AC allows transformers to step current up and down.	1

Question 5
Seesaw

Description	Mark
Assume: child has mass 25 kg (allow 5-50 kg)	1
Assume: child is 2 m from the fulcrum (allow 1-4 m)	1
$\tau = rF$	1
$= (2)(25)(9.8)\text{ m N} = 490\text{ m N}$. (allow 49-1960 m N)	1

Question 6
Magnetic field

Description	Mark
False.	1
Moving charges create magnetic fields.	1

Question 7(a)
Electric field

Description	Mark
$E = \frac{V}{d} = \frac{18}{0.04} = 450\text{ V m}^{-1}$	1

Question 7(b)
Electric field

Description	Mark
$E = \frac{V}{d} = \frac{18}{0.04} = 450\text{ V m}^{-1}$	1

Question 8(a)
Transformer

Description	Mark
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	1
$V_s = \frac{N_s \text{ x } V_p}{N_p} = \frac{600 \text{ x } 120}{200}$	1
$V_s = 360\text{ V}$	1

Question 8(b)
Current in transformer

Description	Mark
In an ideal transformer, $P_{in} = P_{out}$	1
so $V_{in}I_{in} = V_{out}I_{out}$	1
$\frac{I_{out}}{I_{in}} = \frac{V_{in}}{V_{out}}$, so $\frac{I_{out}}{I_{in}} = \frac{120}{360} = 1:3$	1

Question 9
Big bang

Description	Mark
The Universe is expanding.	1
The rate of recession for galaxies etc increases with distance.	1

Question 10
Force between moons

Description	Mark
Minimum force is when they are furthest apart. Distance = $(4.22 \times 10^8 + 1.07 \times 10^9)$m = 1.492×10^9 m apart	1
$F_g = G\frac{m_I m_G}{d^2}$	1
$F_g = 6.67 \times 10^{-11} \times \frac{8.93 \times 10^{22} \times 1.48 \times 10^{23}}{(1.492 \times 10^9)^2} = 3.96 \times 10^{17}$ N	1

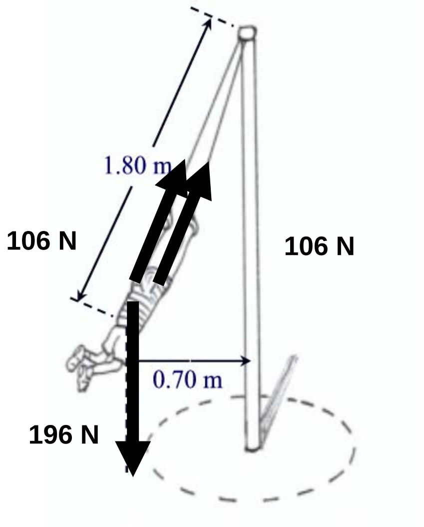
Question 11
Quasars

Description	Mark
Red shift is a Doppler effect showing that the emitter is moving away from us.	1
Large red shift means high recession rate.	1
Recession rates increase with distance.	1

Question 12
Lenz's law

Description	Mark
Aluminium is a good conductor.	1
The falling magnet's magnetic field induces eddy currents in the tube.	1
These eddy currents oppose the change that created them (Lenz's law) and slow down the falling magnet.	1
Plastic is not a conductor so no eddy currents are created in it.	1

Question 13
Circular motion free body diagram

Description	Mark
$\text{weight force} = mg = 20 \times 9.8 = 196\ \text{N}$	1
Angle between pole and chains: $\sin\theta = \frac{0.7}{1.8}$ $\theta = 22.89^\circ$	1
Tension in each chain has vertical component = half the child's weight $T_v = \frac{T\cos\theta}{2}$	1
$T = \frac{T_v}{2\cos\theta} = \frac{196}{2\cos 22.89^\circ} = 106\ \text{N}$.	1
	2

SECTION TWO: PROBLEM-SOLVING

Question 14(a)
Standing wave formation

Description	Mark
The quiet places are displacement nodes (or pressure antinodes) in a standing wave.	1
The two speakers had the same frequency, and in air both have the same wavelength and speed.	1
A standing wave forms from interference between two such waves, travelling in opposite directions.	1

Question 14(b)(i)
Error reduction

Description	Mark
B: Measure the distance between several quiet spots	1

Question 14(b)(ii)
Explaining error reduction

Description	Mark
Measuring a greater distance involves the same absolute error.	1
Sam should divide the distance by the number of internodal distances to determine the value for one internodal distance.	1
This reduces the relative error in distance measurement.	1

Question 14(c)
Speed of sound

Description	Mark
$\text{internodal distance} = \frac{1}{2}\lambda$ $\text{so } \lambda = 2 \times 0.39 = 0.78 \text{ m}$	1
$v = f\lambda = (440)(0.78)$	1
$v = 3.4 \times 10^2 \text{ m s}^{-1}$.	1

Question 15(a)(i)
Frequency of AC

Description	Mark
83.3 Hz.	1

Question 15(a)(ii)
Power to lamp

Description	Mark
$P = \frac{V^2}{R}$	1
$P = \frac{4.4^2}{1.1} = 18 \text{ W}$.	1

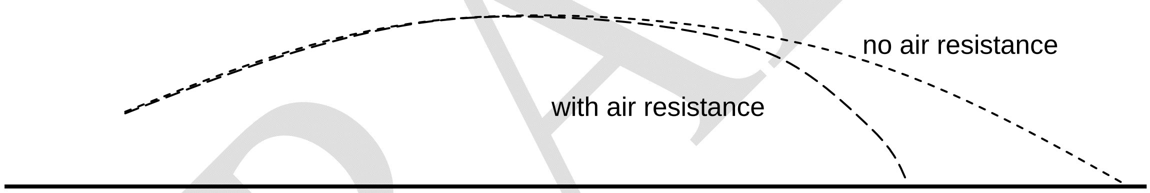
Question 15(b)
Magnetic field strength

Description	Mark
$\therefore \Delta t = \frac{1}{4}T = \frac{1}{4}(\frac{1}{83.3}) = 0.00300\ s$	1
$emf = -N\frac{\Delta\Phi}{\Delta t}$	1
$\Delta\Phi = \frac{(emf)(\Delta t)}{N} = \frac{(4.4)(0.003)}{400} = 3.3 \times 10^{-5}\ Wb$	1
In ¼ turn, $\Delta\Phi = \Phi - 0 = \Phi$	1
$B = \frac{\Phi}{A}$	1
$B = \frac{3.3 \times 10^{-5}}{140 \times 10^{-6}} = 0.24\ T$.	1

Question 15(c)
Commutator used to change to DC

Description	Mark
Required commutator is a split ring.	1
This reverses the induced current in phase with the reversal of the field through the coil.	1
In effect this keeps current direction constant.	1

Question 16(a)(i)
Trajectory



Description	Mark
Parabolic shape.	1
Starts above ground, ends on the ground.	1

Question 16(a)(ii)
Effect of air resistance

Description	Mark
Starts along the same path, becomes more strongly curved.	1

Question 16(a)(iii)
Explaining effect of air resistance

Description	Mark
Air resistance decreases the forward component of velocity.	1
So the ball does not travel as far forward in the time of flight.	1

Question 16(a)(iv)
Acceleration of ball

Description	Mark
No.	1
The ball is continually subject to the acceleration due to gravity.	1

Question 16(b)(i)
Flight time

Description	Mark
Vertical component of initial velocity $= u \sin\theta = (55)(\sin 1.5°) = 1.44 \text{ m s}^{-1}$	1
Vertical motion $s = ut + \frac{1}{2}gt^2$; let up be positive.	1
$t = \sqrt{\frac{2\,s}{g}} = \sqrt{\frac{2\,(-0.35)}{-9.8}} = 0.267 \text{ s}$.	1

Question 16(b)(ii)
Range

Description	Mark
Horizontal component of initial velocity $= u \cos\theta = (55)(\cos 1.5°) = 54.98 \text{ m s}^{-1}$	1
Horizontal motion $s = vt$.	1
$s = (54.98)(0.267) = 14.7 \text{ m}$	1

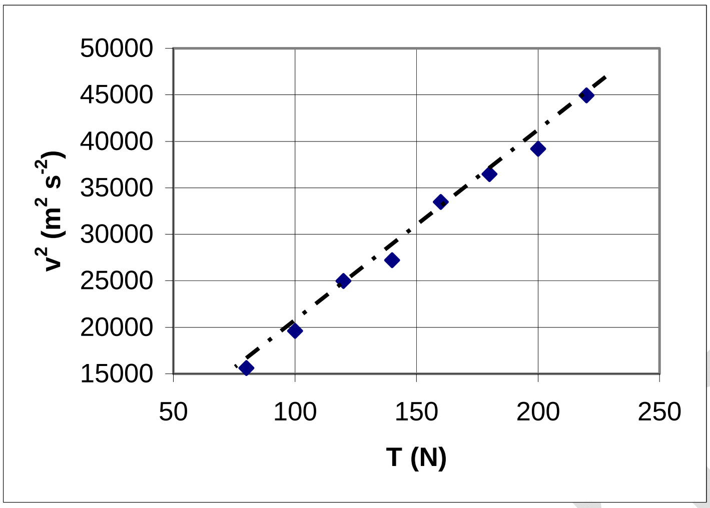
Question 17(a)(i)
Plotting v^2 vs T

Description	Mark
v^2 *vs* T gives a straight line, v *vs* T does not **OR** v *vs* T does not map the function.	1
A straight line allows gradient to be calculated more easily and accurately.	1

Question 17(a)(ii)
Units of μ

Description	Mark
$\mu = \frac{T}{v^2} = \frac{\text{force}}{\text{velocity}^2}$	1
units of $\mu = \frac{\text{kg m s}^{-2}}{\text{m}^2\ \text{s}^{-2}}$. So the units of μ are kg m^{-1} (accept N s^2 m^{-2}).	1

Question 17(b)
Experimental value for μ

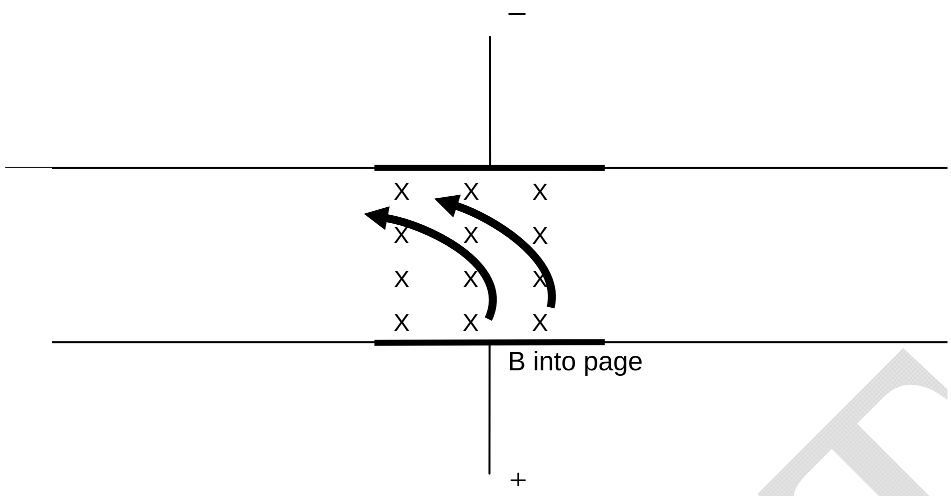


Description	Mark
Draw line of best fit by eye.	1
$\text{gradient} = \dfrac{\text{rise}}{\text{run}}$	1
$\text{gradient} = \dfrac{(45000 - 15000)\,m^2\,s^{-2}}{(210 - 75)\,N}$ $\text{gradient} = 222\,m\,kg^{-1}$	1
$\text{since } v^2 = \dfrac{1}{\mu}T$, thus $\text{gradient} = \dfrac{1}{\mu}$	1
$\mu = \dfrac{1}{\text{gradient}} = \dfrac{1}{222.222}\,kg\,m^{-1}$ $\mu = 0.00450\,kg\,m^{-1}$ (or $4.50\,g\,m^{-1}$).	1

Question 17(c)
Fundamental mode when stretched

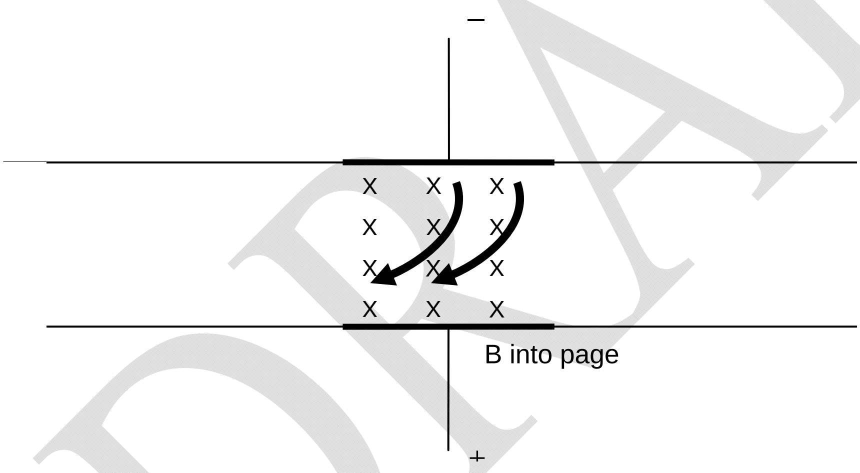
Description	Mark
The wave velocity is $v = \sqrt{\dfrac{T}{\mu}} = \sqrt{\dfrac{125}{4.5 \times 10^{-3}}}$ =166.7 m s^{-1}	1
The wavelength is (2 × 0.76) m	1
so we can find the frequency $f = \dfrac{v}{\lambda}$ = 110 Hz.	1

Question 18(a)
Motion of positive ions



Description	Mark
Path is curved	1
To the left.	1

Question 18(b)
Motion of negative ions



Description	Mark
Path is curved.	1
To the left.	1

Question 18(c)
How the pump works

Description	Mark
The electric field accelerates both positively and negatively charged particles so they move across the tube.	1
Charged particles moving across magnetic field lines experience a magnetic force at right angles to both the movement and the magnetic field.	1
This pushes the charged particles to the left whether their charge is positive or negative.	1
The charged particles drag the solution with them as they move, so the pump moves the entire solution.	1
As particles leave the pump to the left, more arrive from the right and the process repeats.	1

Question 18(d)
Energy transfer in pump

Description	Mark
The electric field transfers energy to the charged particles.	1
The charged particles transfer energy to the liquid.	1
The magnetic field does not transfer energy to the charges.	1

Question 19(a)(i)
Ionisation energy

Description	Mark
Minimum energy = 5.3 eV	1

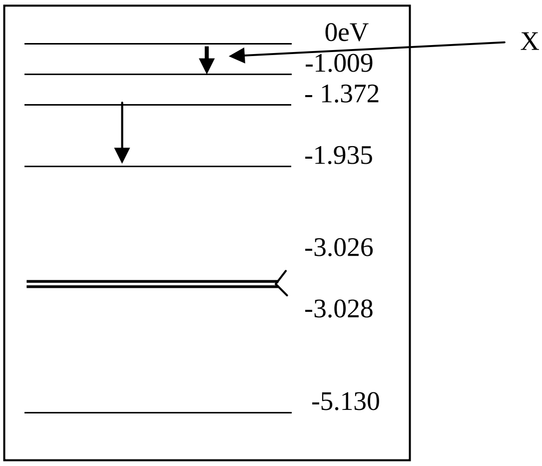
Question 19(a)(ii)
Process

Description	Mark
The arrow represents an electron falling to a lower energy level.	1
The result is the emission of a photon.	1
Whose energy is equal to the energy difference between the levels.	1

Question 19(b)(i)
Two yellow lines

Description	Mark
Two energy levels are very close together. Electron transitions from these energy levels to the ground state produce almost equal wavelengths.	1
$\lambda = \frac{hc}{E}$	1
$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{2.103 \times 1.6 \times 10^{-19}}$ m $\lambda = 5.91 \times 10^{-7}$ m (591 nm) (allow 590-592 nm)	1

Question 19(b)(ii)
Electron transition

Description	Mark
 On diagram: Any transition with a lower energy level difference, e.g. the transition labelled X above.	1
Explanation: Lower energies correspond to longer wavelengths.	1

Question 19(c)
Using the spectrum

Description	Mark
Each line in the spectrum represents a transition between energy levels.	1
These transitions are unique to each element and so can be used to identify specific elements.	1

SECTION THREE: COMPREHENSION

Question 20(a)(i)
Producing X-rays

Description	Mark
X-rays are produced when high energy electrons are rapidly decelerated—as when striking the molybdenum target.	1
The peaks result when electrons are lost ('knocked out') from the lowest energy levels (shells) of a molybdenum atom.	1
When electrons from higher levels drop into the vacant spaces, X-rays of a specific energy are produced. Note: K_α results from electron transition from L shell to K shell K_β results from electron transition from M shell to K shell	1

Question 20(a)(ii)
Electron energy

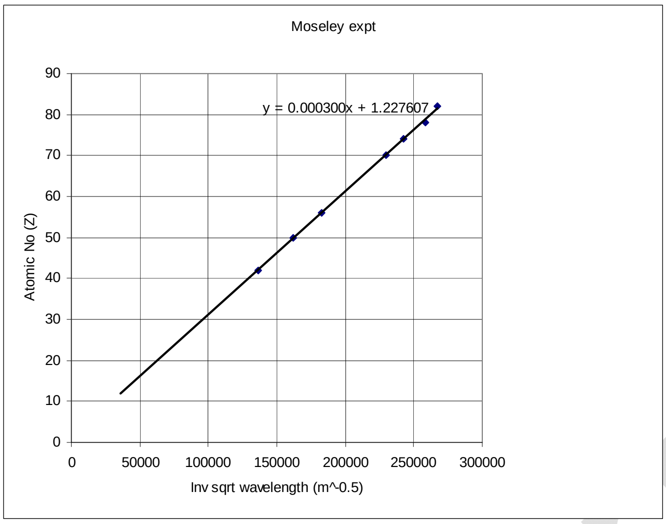
Description	Mark
35 kV	1
Max energy of incoming electrons corresponds to shortest wavelength X-ray = 0.035nm (estimate)	1
$W = Vq = hf = \frac{hc}{\lambda}$ $\therefore \quad V = \frac{hc}{q\lambda} = \frac{6.63x10^{-34}(3x10^{8})}{1.60x10^{-19}(0.035x10^{-9})} = 3.6x10^{4}\,V = 36kV$ [possible range that might be calculated = 35-41 kV]	1

Question 20(b)(i)
Table

Element	Wavelength (m)	$\frac{1}{\sqrt{\lambda}}$ ($m^{-½}$)
Molybdenum	5.4×10^{-11}	1.4×10^{5}
Tin	3.8×10^{-11}	1.6×10^{5}
Barium	3.0×10^{-11}	1.8×10^{5}
Ytterbium	1.9×10^{-11}	2.3×10^{5}
Tungsten	1.7×10^{-11}	2.4×10^{5}
Platinum	1.5×10^{-11}	2.6×10^{5}
Lead	1.4×10^{-11}	2.7×10^{5}

Description	Mark
Wavelengths all correctly calculated ***OR*** mostly correct (1 mark)	2
$\frac{1}{\sqrt{\lambda}}$ all correctly calculated ***OR*** mostly correct (1 mark)	2

Question 20(b)(ii)
Graph



Description	Mark
Axes marked.	1
Points plotted.	1
Line of best fit.	1

Question 20(c)(i)
Gradient

Description	Mark
$\text{gradient} = \frac{\text{rise}}{\text{run}} = \frac{\text{change in y - values}}{\text{change in x - values}}$	1
$\text{gradient} = \frac{85 - 50}{2.80 - 1.64} = 3.0\text{x}10^{-4}\text{m}^{0.5}$	1

Question 20(c)(ii)
Gradient

Description	Mark
two significant figures	1
since both Z and λ are given to 2 SF (and gradient is the ratio of these two)	1

Question 20(d)
Gradient

Description	Mark
$\text{gradient} = 3.0\text{x}10^{-4} = 6.60\text{x}10^{8}\sqrt{hc}$	1
$\therefore \quad hc = \left(\frac{3.0\text{x}10^{-4}}{6.60\text{x}10^{8}}\right)^2$	1
$h = \frac{2.1\text{x}10^{-25}}{3\text{x}10^{8}} = 6.9\text{x}10^{-34}\text{ Js}$ reasonable range = 6.4 – 7.3 ($\text{x}10^{-34}$) If using $2.5\text{x}10^{-4}$, $h = 4.8\text{x}10^{-34}$Js	1

Question 21(a)
Magnetic field direction

Description	Mark
Into the page.	1

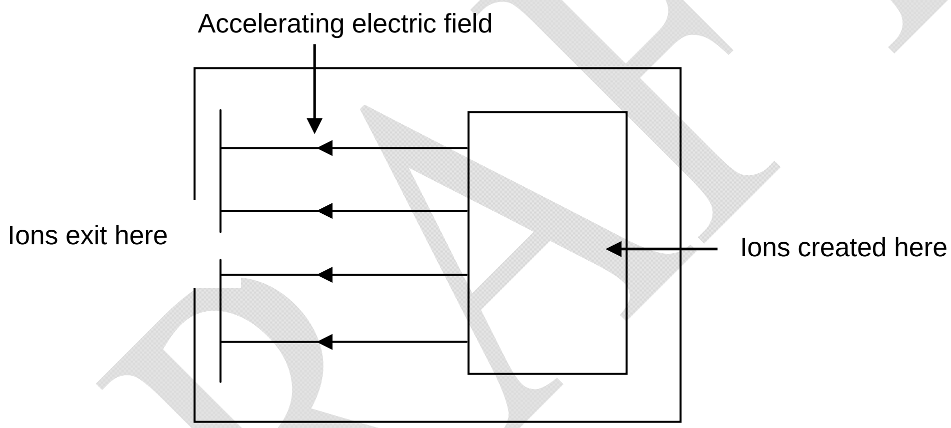
Question 21(b)
Identify ion

Description	Mark
Ion 1.	1
It has a greater mass.	1
From the equation, it must also have a greater path radius.	1

Question 21(c)
Ionising atoms with an electrons beam

Description	Mark
Electrons in the beam have large kinetic energies and can remove an electron from the target atoms i.e. ionise the atom positively.	1

Question 21(d)(i)
Accelerating electric field



Description	Mark
Straight lines, orientation to left.	1

Question 21(d)(ii)
Kinetic energy of ion

Description	Mark
$\Delta E_k = Vq$	1
$E_k = (25000)(1.6x10^{-19}) = 4x10^{-15}$ J **OR** 25 keV (2 marks)	1

Question 21(d)(iii)
Radius of ion path

Description	Mark
$r = \frac{mv}{Bq}$	1
$r = \frac{(2.656x10^{-26})(5.49x10^{5})}{(8)(1.6x10^{-19})} m$	1
$r = 0.114m$.	1

Question 21(e)
Isotope ratios

Description	Mark
The ice core will have a ratio of ${}^{18}_{8}O$ to ${}^{16}_{8}O$ that reflects the conditions at the time because the ice forms from rainfall.	1
The cave sample will have a different ${}^{18}_{8}O$ to ${}^{16}_{8}O$ ratio because of the effect of calcium carbonate deposition….	1
….added to the effect of rainfall.	1
The final ratio of the cave sample will depend on which effect is greater.	1

Physics Stage 3 exam

	3A				3B		
	Working in physics	Motion and forces in a gravitational field	Electricity and magnetism		Working in physics	Particles, waves and quanta	Motion and forces in electric and magnetic fields
SECT A							
1						X	
2			X				
3						X	
4			X				
5			X				
6							X
7							X
8			X				
9						X	
10		X					
11						X	
12			X				
13		X					
SECT B							
14					X	X	
15			X				
16		X					
17					X	X	
18							X
19						X	
SECT C							
20					X	X	
21							X