3	1	3	0	5	3	7	3

Student Number

Sydney Girls High School

[redacted]

2019

TRIAL
HSC
EXAMINATION

Booklet A

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A data sheet, formulae sheet and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations

Total Marks: 100

Section I – 20 marks (pages 2-12)

- Attempt Questions 1-20
- Allow about 35 minutes for this section

Section II – 80 marks (pages 13-30)

- Attempt Questions 21-35
- Allow about 2 hours and 25 minutes for this section

Total: 83/100
Raw: 8/40

Section I

20 marks
Attempt Questions 1 - 20
Allow about 35 minutes for this part.

Use the multiple-choice answer sheet for Questions 1–20.

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1 How does the penetration power and ionising ability of alpha and beta particles compare?

A. Alpha particles are less ionising and less penetrating.

B. Alpha particles are more ionising, but less penetrating.

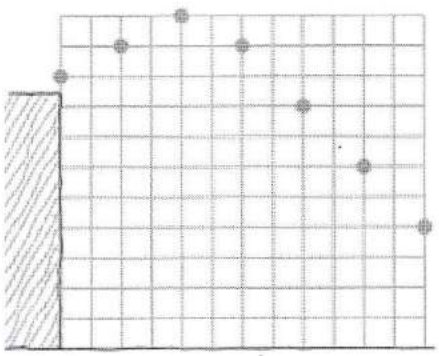
C. Alpha particles are less ionising, but more penetrating.

D. Alpha particles are more ionising and more penetrating.

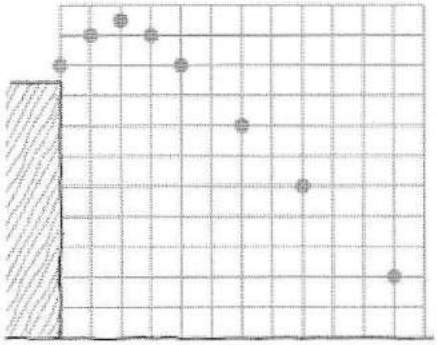
2 A projectile is thrown from a cliff.

Assuming negligible air resistance, which graph correctly shows the motion of the projectile?

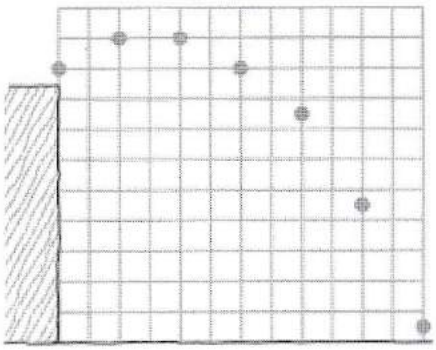
A.



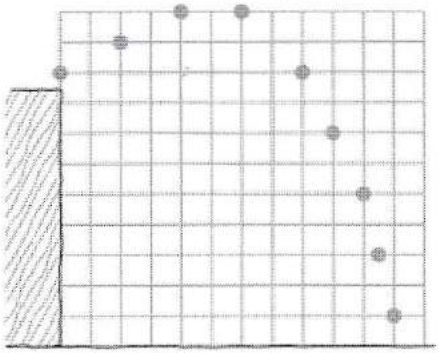
B



C.



D



3 A TV remote control emits near infra-red light with a frequency of 3.2×10^{14} Hz.

What is the energy of each photon?

A. 2.1×10^{-19} J

B. 9.4×10^{-7} J

C. 2.1×10^{21} J

D. 4.8×10^{47} J

4 An ideal transformer has a primary coil of 50 turns. The current in the primary coil is 10 A, while the current in the secondary coil is 2 A.

What type of transformer is this, and how many turns are there in the secondary coil?

	Transformer type	*No. turns in secondary*
A.	Step up	10
B.	Step up	250
C.	Step down	10
D.	Step down	250

5 Which change might help to change an uncontrolled fission reaction into a controlled reaction?

A. Divide the fuel in two

B. Speed up the neutrons

C. Increase neutron reflection

D. Decrease neutron absorption

6 The masses of the proton and neutron are 1.007277 u and 1.008665 u respectively.

If the mass of hydrogen-2 is 2.01473 u, what is its binding energy per nucleon?

A. 0.564 MeV

B. 0.664 MeV

C. 1.128 MeV

D. 1.692 MeV

7 A star's spectrum has a peak wavelength of 620 nm.

What is its temperature?

A. 1800 K

B. 2139 K

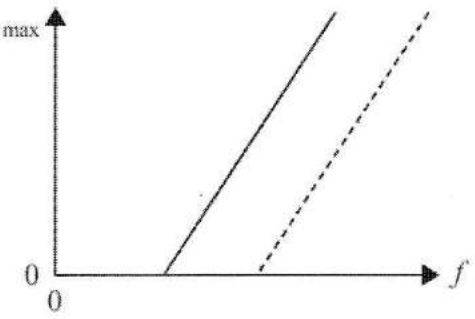
C. 4400 K

D. 4700 K

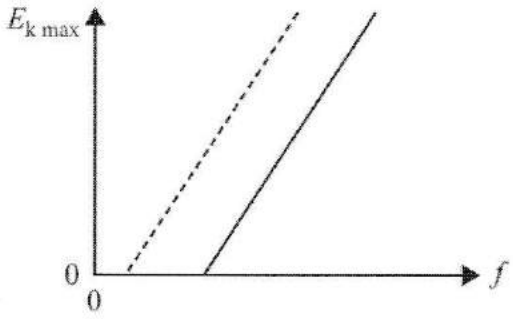
8 The results of a photoelectric experiment are displayed in the graphs below, shown with a solid line. The experiment is then repeated with a metal with a smaller work function and shown with a dashed line.

Which one of the following graphs shows the results from the two experiments?

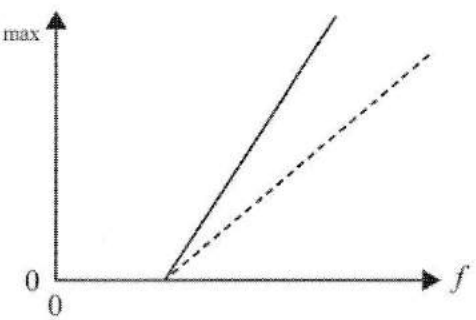
A.



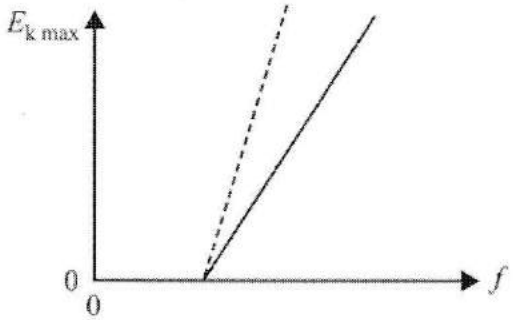
B.



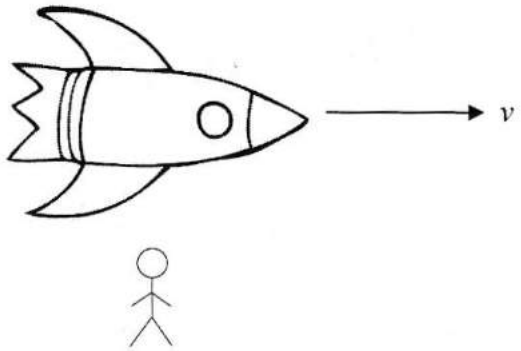
C.



D.



9 An observer watches as a relativistic spacecraft passes by at 0.60 c, perpendicular to her line of sight.



The astronauts inside the spacecraft have measured it to be 45 m long.

How long is it according to the observer?

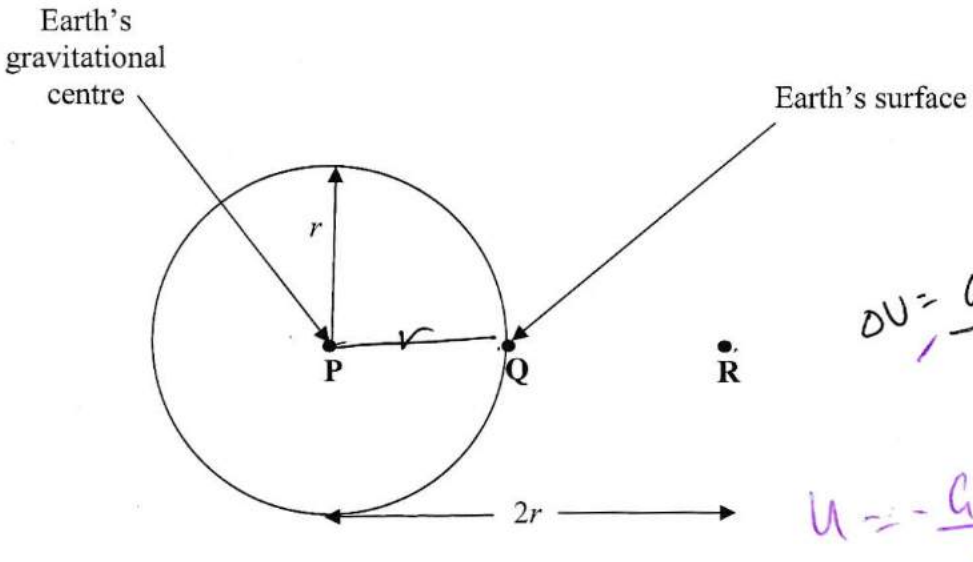
A. 28 m

B. 36 m

C. 45 m

D. 71 m

10 The following diagram represents 3 points P, Q, and R in the gravitational field of the Earth.



$\Delta U = \frac{GM}{r}$ $\frac{GM}{2r}$

$U = -\frac{GMm}{r}$

What is the relationship between the potential energy at Q and the potential energy at R?

A. Potential energy at Q is twice that at R

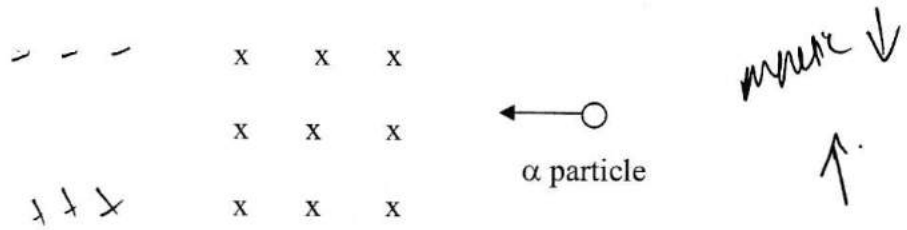
B. Potential energy at Q is half that at R

C. Potential energy at Q is four times that at R

D. Potential energy at Q is one quarter that at R

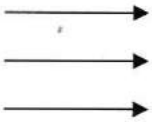
potential energy is negative

11 An α particle (positive charge) enters a region containing a magnetic and an electric field. The diagram below shows the path of the particle and the direction of the magnetic field. The electric field is not shown. The particle moves in a straight line through the two fields.

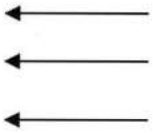


Which of the following diagrams best represents the electric field.

A. 

B. 

C 

D. 

12 What electric field strength is required to balance the gravitational force acting on an electron, at the surface of the Earth?

A. 1.4×10^{-48} N C^{-1}

B. 5.6×10^{-11} N C^{-1}

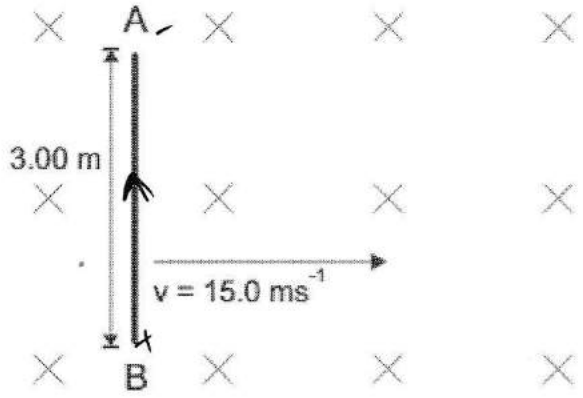
C. 5.8×10^{-13} N C^{-1}

D. 6.1×10^{-19} N C^{-1}

$F = mg = Eq$

$E = \frac{mg}{q}$

13 A length of wire is pulled with constant velocity through a magnetic field, as shown in the diagram below.



What is the emf developed and at which end do the electrons accumulate?

	emf (V)	*End with electrons*
A.	0.90	A
B.	0.90	B
C.	9.00	A
D.	9.00	B

14 An extrasolar planet is found with a mass the same as that of Earth, but twice the radius.

How big is the escape velocity from its surface compared to that of Earth, v_e?

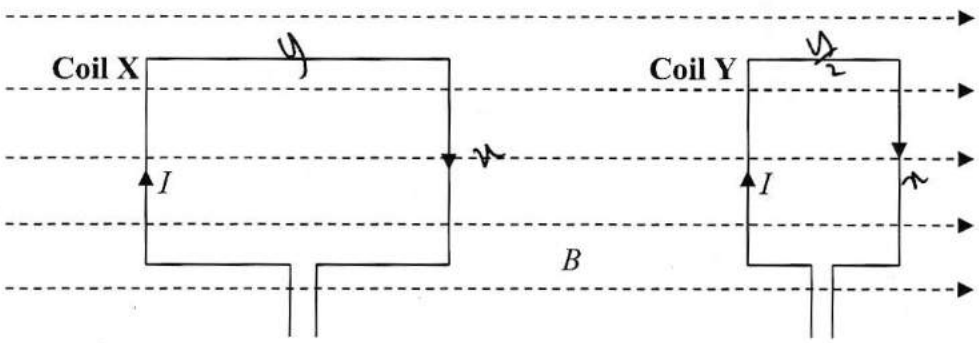
A. $\frac{v_e}{2}$

B. $2\,v_e$

C. $\sqrt{2}\,v_e$

D. $\frac{v_e}{\sqrt{2}}$

15 Coil X is replaced with Coil Y in a motor. The two coils are identical except that Coil Y has half the width of Coil X, as shown in the diagram.



What effect will this change have on the force and torque on the coil (coil Y)?

	Force	*Torque*
A.	Half	Same
B.	Same	Half
C.	Half	Half
D.	Same	Same

16 The thorium radioactive decay series begins with the Th-232 nucleus which emits, in succession, one alpha particle, two beta(-) particles, four alpha particles, one beta(-) particle, one alpha particle and one beta(-) particle.

What is the final nucleus?

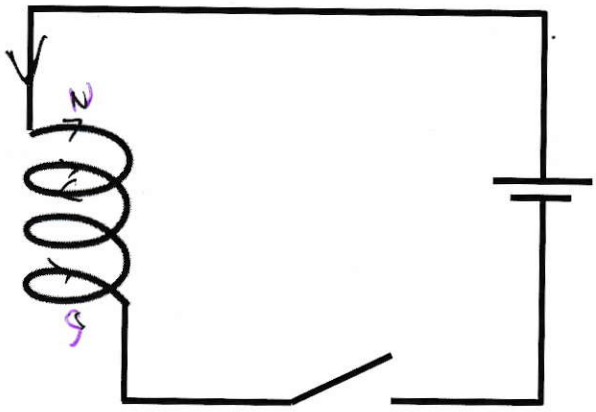
A. Lead-208

B. Lead-220

C. Osmium-208

D. Osmium-220

17 A loose spring is connected to a power supply using flexible connection wires.



What will happen to the spring after the switch is closed?

A. The spring will extend its length.

B. The spring will contract in length.

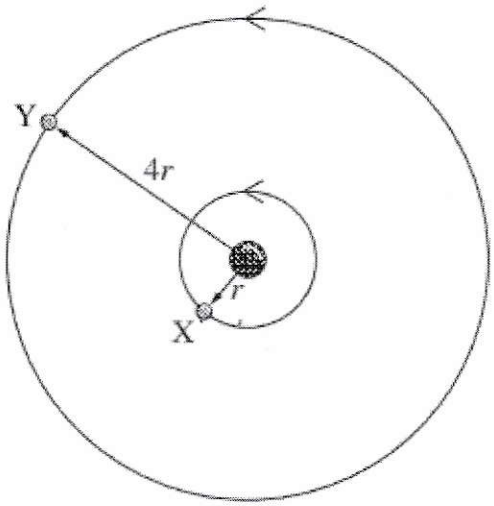
C. The spring will maintain its shape and size.

D. The spring will repeatedly extend & contract.

creates north & south poles
∴ they attract

18 Two planets, X and Y, travel around a star in the same direction, in circular orbits.

Planet X completes one revolution about the star in time T. The radii of the orbits are in the ratio 1 : 4.



How many revolutions does planet Y make about the star in the same time T?

A. 1/ 8 revolution

B. 1/2 revolution

C. 2 revolutions

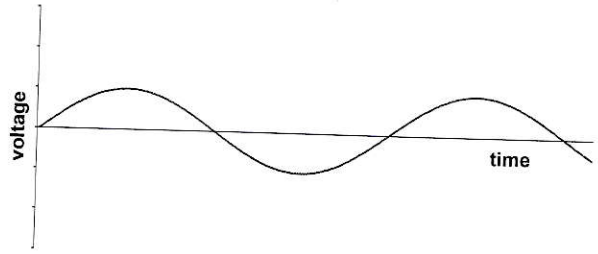
D. 8 revolutions

$$\frac{V^3}{T^2} = \frac{V_2^3}{T_2^2}$$

$$\frac{V^3}{T^2} = \frac{(4V)^3}{T_2^2} \quad 64V^3$$

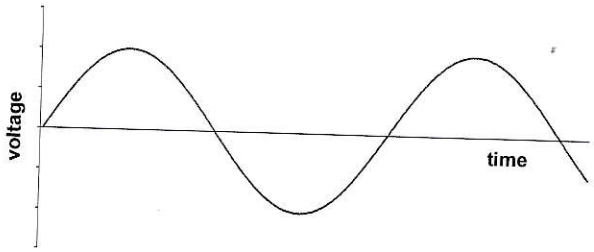
$$T_2^2 = \frac{T^2 \times 64V^3}{T^2}$$

19 The graph shows the output of an AC generator.

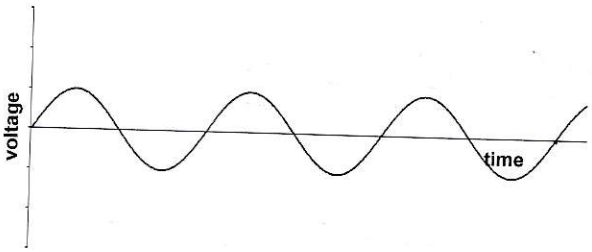


What would the output be if the generator turned at twice the speed?

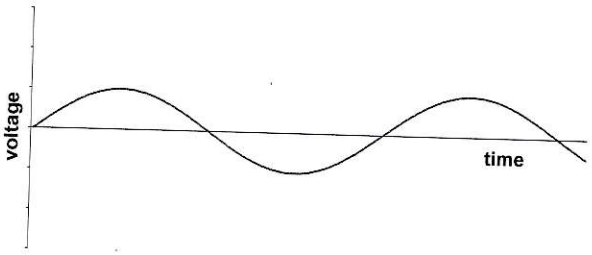
A.



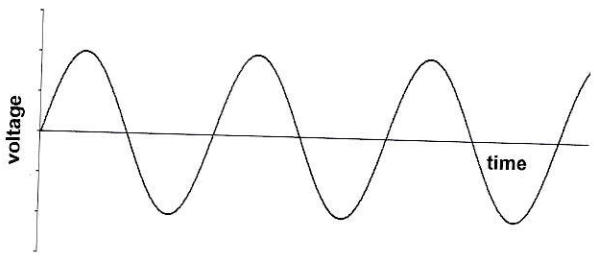
B.



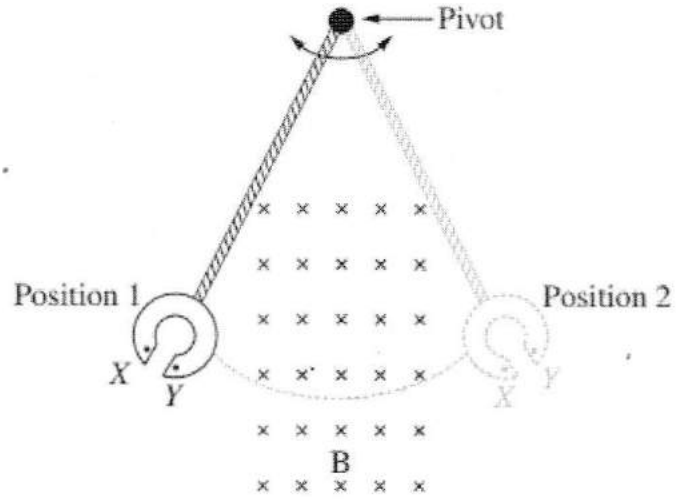
C.



D.

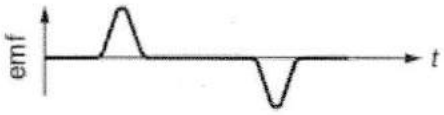


20 A heavy copper split ring is attached by a light insulating rod to a pivot to form a pendulum. A region of uniform magnetic field B is present as shown. As the pendulum swings from Position 1 to Position 2, the induced emf in the ring is measured between points X and Y.



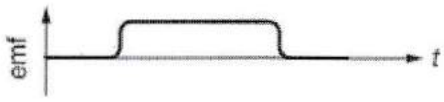
Which graph best represents the measured emf during the time that the pendulum swings from Position 1 to Position 2?

A.



B.

C.



D.

Question 21 (7 marks)

Fluorine-18 is an important radioisotope used in medicine.

The activity from a sample of F-18 was monitored over the course of 10 hours, and the following data was obtained. (Activity is the number of decays per second.)

Time (h)	*Activity (s^{-1})*
0	6520
2	3056
4	1432
6	671
8	315
10	147

(a) Complete the graph below. 3A

(b) Use your graph to generate a reliable estimate for the half-life of F-18. 2A

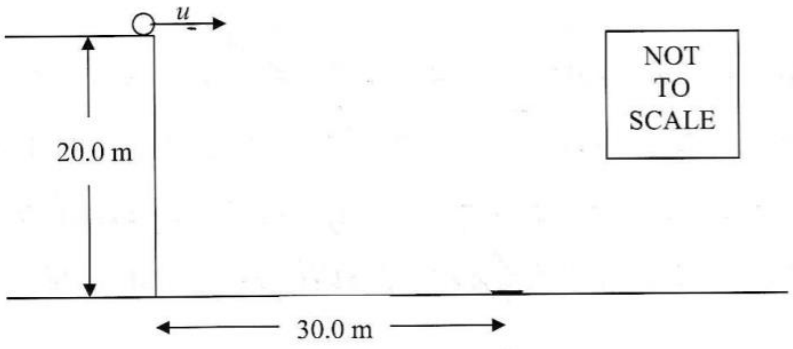
(c) Fluorine-18 decays by positron emission. Predict the daughter nucleus by writing the relevant nuclear equation. 2A

Question 22 (4 marks)

Compare the appearance and cause of the spectra of an incandescent filament lamp and a sodium vapour discharge tube. 4K

Question 23 (6 marks)

A projectile is to be launched horizontally into a container 30 m from the base of a 20 m cliff.



(a) Calculate the required initial velocity. 2A

(b) Calculate the final velocity of the projectile.

Question 24 (5 marks)

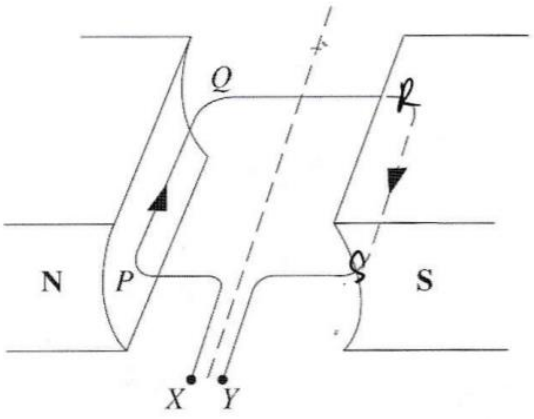
Until 1960 the metre was defined as the length of one particular platinum-iridium bar kept in France.

(a) Outline the current definition of the metre. 2K

(b) Evaluate the usefulness of this new definition. 3A

Question 25 (6 marks)

The diagram shows the coil of a generator at a particular instant in time. The coil is attached to a handle at XY, which is being turned. The arrows show the direction of an induced current.

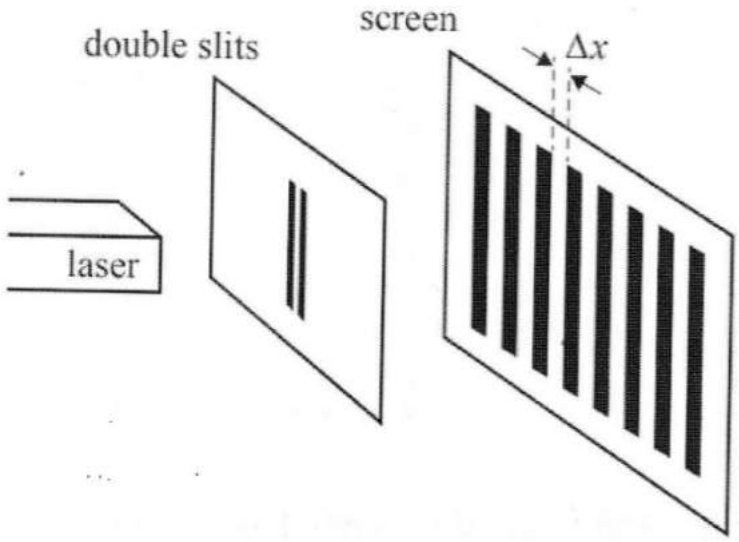


(a) Explain how the current is induced, with reference to flux and emf. 3K

(b) The handle can be moved much more easily if the magnets are removed. Explain why this occurs. 3K

Question 26 (5 marks)

The apparatus and results for the double slit experiment are shown below.



(d) Identify TWO changes that you could make that would increase the spacing maxima (Δx). 2K

(e) This experiment is considered to be a key piece of evidence for one of the models of the nature of light. Identify the model and justify the experiment's role as evidence. 3K

Question 27 (7 marks)

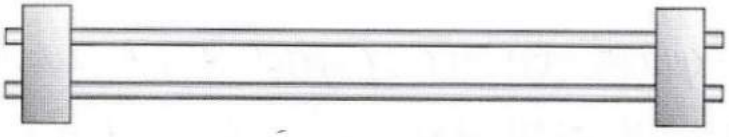
> The electrical current that's needed to operate most [mobile] phones is lower than the current that's buzzing on the electrical grid. And since we don't want to fry our phone with an amount of current it cannot handle, we have to convert the current properties somewhere along the way — that's where our AC Adapter comes into action. The little (often) black box creates a magnetic field that's blocking some of the current from reaching the end device. Yes, a plugged-in transformer establishes a magnetic field around it!
>
> http://www.naturalbuy.com/dont-sleep-next-to-your-phone-charger/

Discuss the accuracy of this passage. 7K

Question 28 (3 marks)

Two conductors, each with mass = 0.200 kg and length = 0.500 m, are held in a bracket as shown. The upper conductor is free to move up or down. The lower conductor carries a current of 215 A.

Front view



Side view

Calculate the current that must flow in the upper conductor to support it 1.00 mm above the lower conductor. 3A

Question 29 (3 marks)

Cosmic rays hitting the upper atmosphere results in the production of muons, travelling at 0.98 *c*. Since they normally decay after about 2.2 μs they should not have time to make it all the way to the surface of the Earth. However, many muons can be detected at the surface.

Explain how this observation supports Einstein's Theory of Special Relativity. ~~3K~~

Question 30 (5 marks)

A student shone a laser emitting orange light of wavelength 610 nm at a photocell.

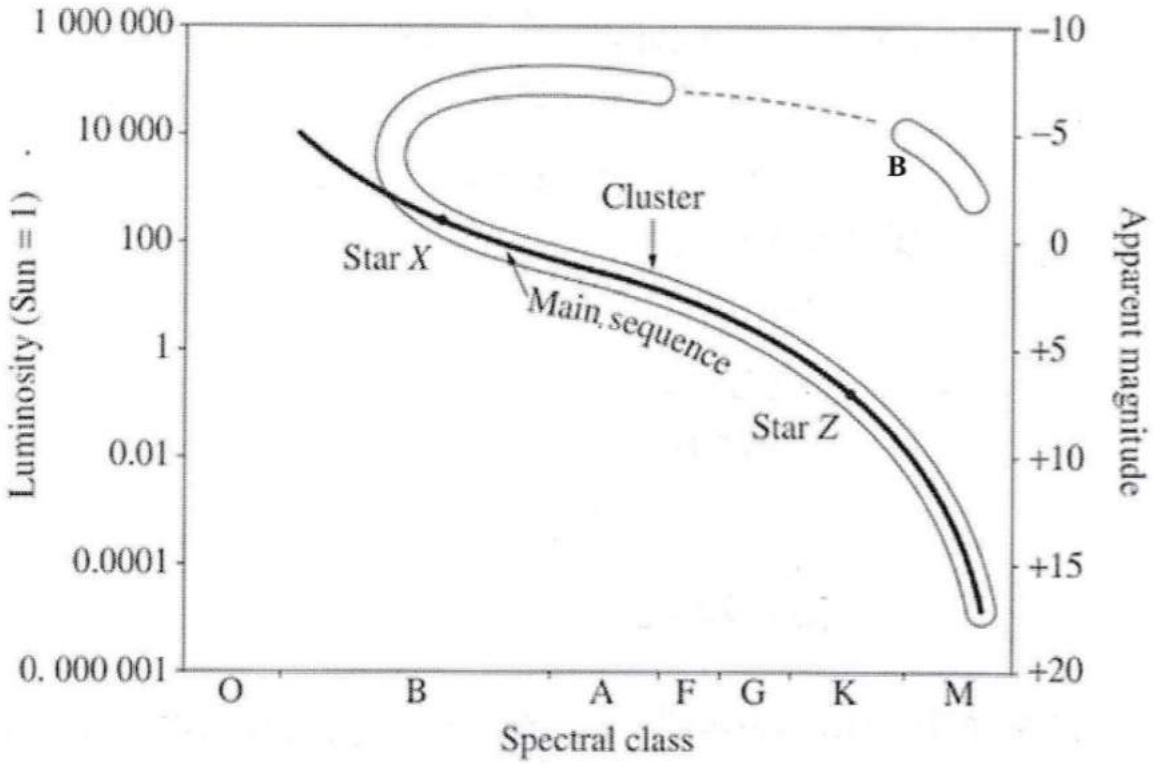
(a) Calculate the energy of one photon from this laser in electron-volts. 3A

(b) No current was produced by the photocell, so the student used a different laser that was twice as bright, with a wavelength of 540 nm. This time a current was produced.

Explain why. 2K

Question 31 (5 marks)

The diagram shows the positions on a Hertzsprung Russell diagram of the stars in a cluster. The stars in the cluster all formed at about the same time but vary widely in their mass.

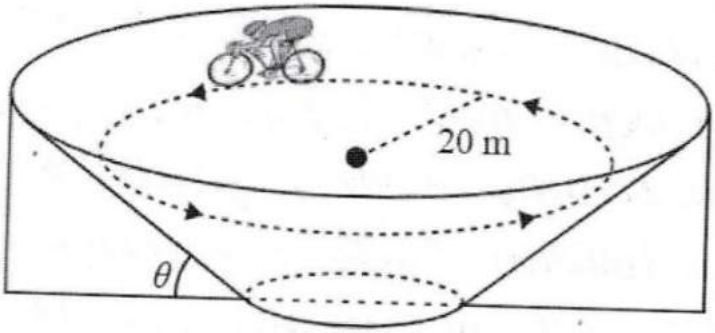


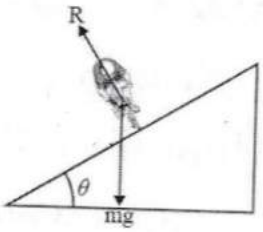
(f) Describe the characteristics of the stars found in the region labelled **B**. 2K

(g) Describe the nuclear processes providing energy in Stars X and Z. 3K

Question 32 (5 marks)

The bicycle travels at a constant speed of 15 m/s. The bike and rider have a combined mass of 300 kg. Ignore friction.



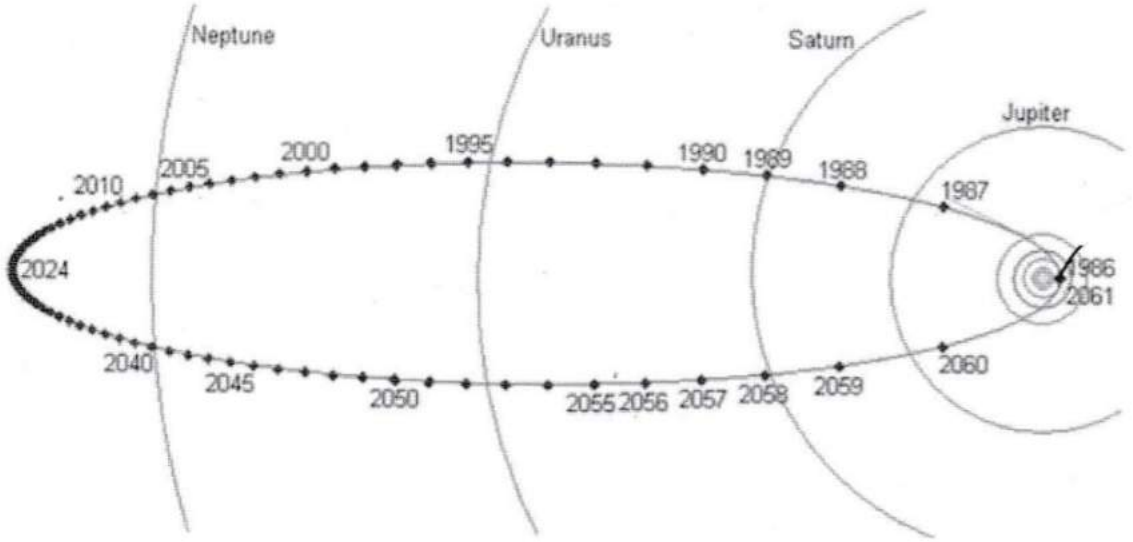


(a) Calculate the magnitude and direction of the net force on the bike and rider. 3A

(b) Determine the angle, θ, of the banked track. 2A

Question 33 (6 marks)

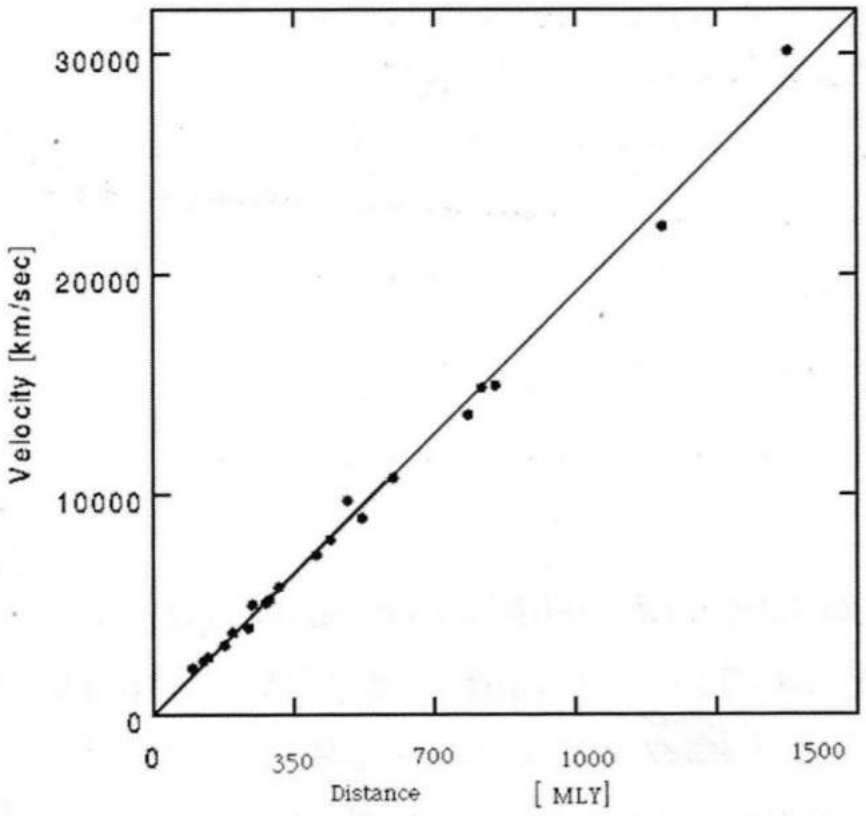
The diagram below shows the orbit of Halley's comet, which last passed near Earth in 1986.



Analyse this orbit in terms of Kepler's Laws and energy changes. 6K

Question 34 (4 marks)

Explain how the following graph supports the hypothesis that the universe is expanding. 4K



Question 35 (9 marks)

Assess the role of prediction in validating and invalidating hypotheses in physics, with reference to examples from different areas of physics. (More weight will be given to examples not otherwise assessed in the paper.)

Question 21 (7 marks)

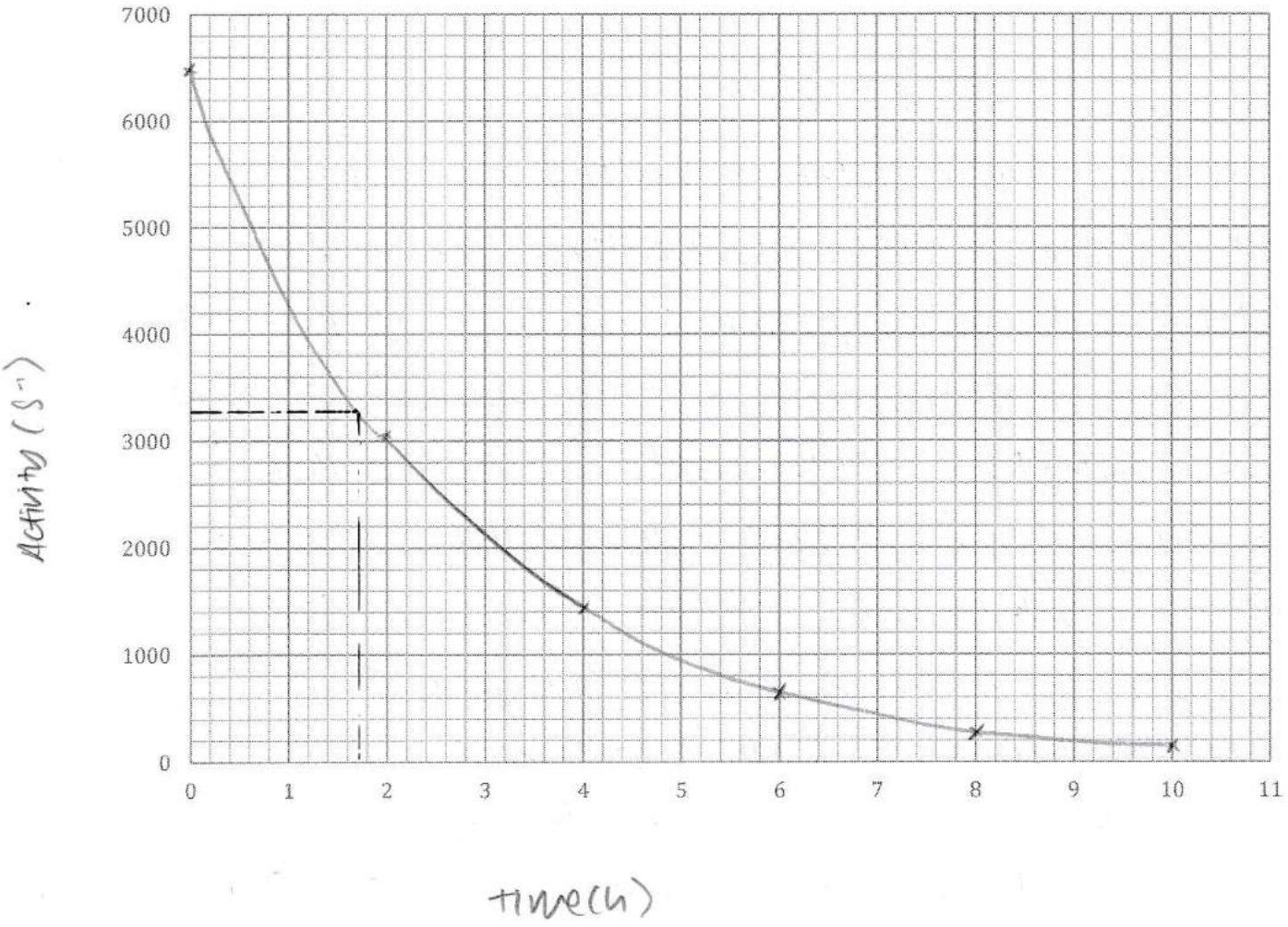
Fluorine-18 is an important radioisotope used in medicine.

The activity from a sample of F-18 was monitored over the course of 10 hours, and the following data was obtained. (Activity is the number of decays per second.)

Time (h)	*Activity (s^{-1})*
0	6520
2	3056
4	1432
6	671
8	315
10	147

(a) Complete the graph below. decay of Fluorine-18

3A



do it more than once

(b) Use your graph to generate a reliable estimate for the half-life of F-18. 3260 2A

by intravenous, mean activity = $\frac{6520}{2}$; (1)

time = 1.7 hrs.

(c) Fluorine-18 decays by positron emission. Predict the daughter nucleus by writing the relevant nuclear equation. 2A

~~$^{18}_{9}F \rightarrow {}^{0}_{+1}e + {}^{18}_{8}O$~~ (1)

$^{18}_{9}F \rightarrow {}^{0}_{+1}e + {}^{18}_{8}O$ + ✓

∴ oxygen-18

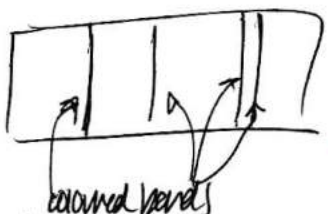
Question 22 (4 marks)

Compare the appearance and cause of the spectra of an incandescent filament lamp and a sodium vapour discharge tube. 4K (3)

Incandescent lamps are produced by heating a piece of metal inside a tube to very low temperatures. The spectrum observed is continuous spectrum. A continuous spectrum contains all the colors of the spectrum at their respective wavelengths and frequencies. No dark bands, all colors visible. ?

A sodium vapor discharge tube operates in a tube containing (Ne) gas and 2 electrodes. When the vapour is passed through the tube, the ion gas produces an emission spectrum. An emission spectrum is black in appearance, with colored bands representing the colors of light that have emitted.

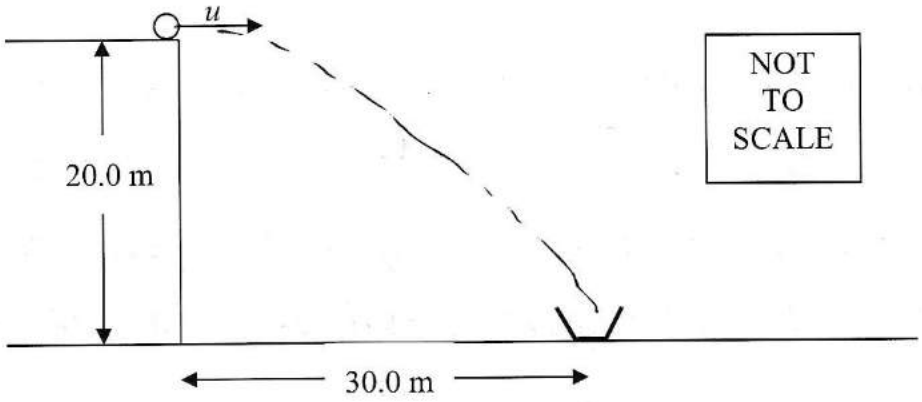
The colors produced can be explained by the release of a photon when electrons change orbital levels (dropping from excited state to ground state).



why were they up?

Question 23 (6 marks)

A projectile is to be launched horizontally into a container 30 m from the base of a 20 m cliff.



(a) Calculate the required initial velocity.

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

$Ux t = 30$

$Ux = \frac{30}{t}$

$= \frac{30}{2.02}$

$= 14.85$ m/s

$-20 = 0 - \frac{9.8}{2}t^2$

$4.9t^2 = 20$

$t^2 = \frac{20}{4.9}$

$t = 2.02$ s (3 sig figs)

= 14.9 m/s (3 sig figs) to the right

2A

(b) Calculate the final velocity of the projectile.

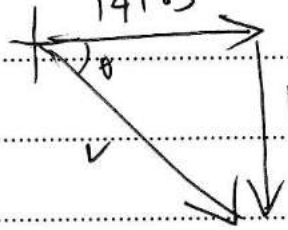
$Ux = Vx$ (constant horizontal velocity)

$v = u + at$

$V_y = 0 - 9.8 \times 2.02$

$= -19.796$

$= -19.8$ m/s



$V^2 = 14.85^2 + 19.8^2$

$V = 24.75 = 24.8$ m/s (3 sig figs)

$\tan\theta = \frac{19.8}{14.85}$

$\theta = 53.13$ ✓

bearing $= 90 + \theta$

$= 143.13^\circ$

?? $= 143^\circ$ (3 sig figs)

3 4A

BE CAREFUL your decimal (1) looks like a 1!!

NO!!

$s = \frac{d}{t}$

Question 24 (5 marks)

Until 1960 the metre was defined as the length of one particular platinum-iridium bar kept in France.

(a) Outline the current definition of the metre. 2K

1 metre is the distance travelled by the speed of light in $\frac{1}{299792458}$ seconds. It is derived from the definition of time, being the time period to transition between 2 hyperfine levels of ground state caesium.

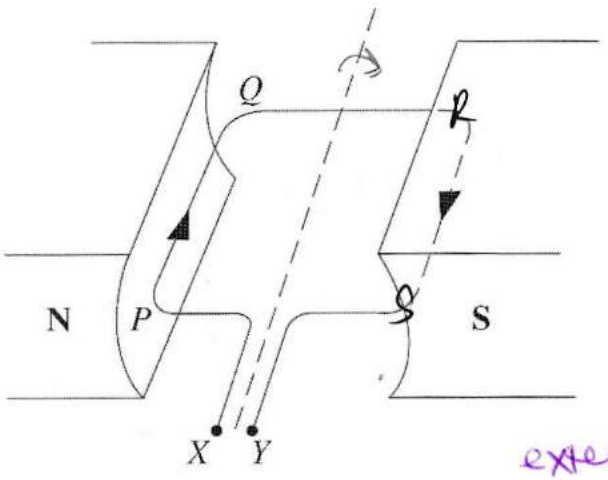
(b) Evaluate the usefulness of this new definition. ~~3A~~ 2

The new definition of a meter, is able to be calculated from anyplace on earth without needing to have measurements off of a single object in France. This increases the accuracy of measurements and also makes it more convenient. As a result, it is one of the fundamental units used and extensively varied.

speed of light independent of inertial frame of reference

Question 25 (6 marks)

The diagram shows the coil of a generator at a particular instant in time. The coil is attached to a handle at XY, which is being turned. The arrows show the direction of an induced current.



external circuit

(a) Explain how the current is induced, with reference to flux and emf. ~~3K~~ (2)

when the handle is rotated, the coil PQRS begins to rotate. since the direction of the induced current is from P to Q, the initial force exerted by the electrons must have caused PQ to be pushed upwards ∴ coil turns clockwise. this movement changes the flux through the coil, thus generating an emf (faraday's law $emf = -N\frac{\Delta\Phi}{\Delta t}$). this induced emf then makes a current through the coil.

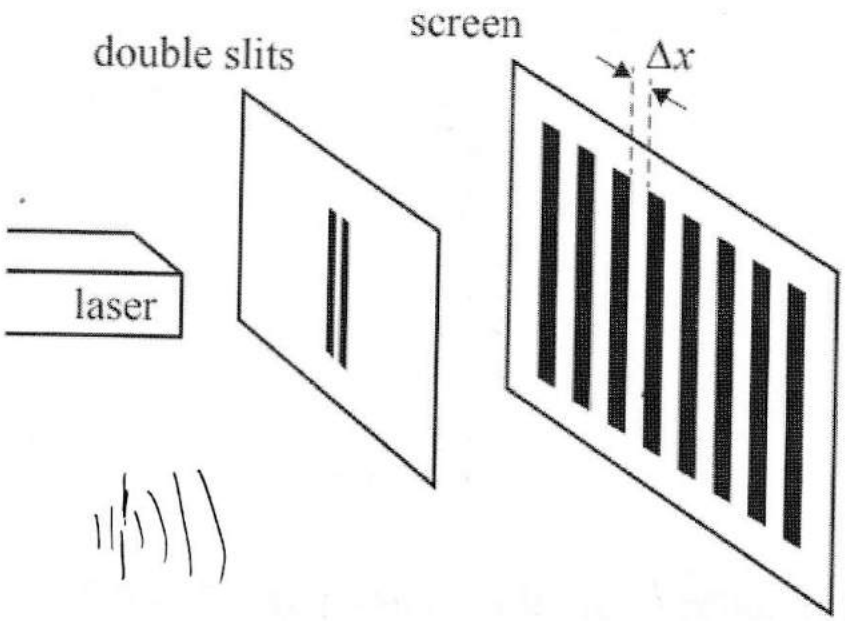
lenz's law to conserve energy

(b) The handle can be moved much more easily if the magnets are removed. Explain why this occurs. **3K**

the permanent magnets provide a magnetic field which induces a current. this current creates a force that opposes the initial force acting on the coil, thus making it harder to turn the coil (lenz's law). if the magnets are removed, there would not be an induced current and force, thus the coil is able to rotate without any opposition ∴ handle moved much more easily.

Question 26 (5 marks)

The apparatus and results for the double slit experiment are shown below.



(d) Identify TWO changes that you could make that would increase the spacing maxima (Δx). 2K

Increasing the distance between the slits and screen

decreasing the distance between the slits (more diffraction)

(e) This experiment is considered to be a key piece of evidence for one of the models of the nature of light. Identify the model and justify the experiment's role as evidence. 3K

wave model of light. Youngs double slit experiment showed a new property of light (diffraction) that the previous particle theory of light could not explain. When light split out after the double slit, the original wavefronts superimposed with each other creating a new set of wavefronts. It also resulted in areas of dark bands (nodes) and light bands (antinodes), splitting according to the equation $m\lambda = d\sin\theta$. Thus the experiment is evidence for the ability of light to diffract.

interference!!

Question 27 (7 marks)

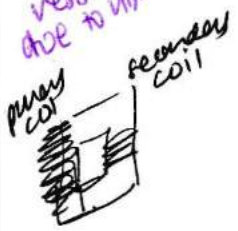
↑ I
V=IR

$P_{loss} = I^2R$

time due to resistance of wire & ohm's law creating heating due to high current

The electrical current that's needed to operate most [mobile] phones is lower than the current that's buzzing on the electrical grid. And since we don't want to fry our phone with an amount of current it cannot handle, we have to convert the current properties somewhere along the way — that's where our AC Adapter comes into action. The little (often) black box creates a magnetic field that's blocking some of the current from reaching the end device. Yes, a plugged-in transformer establishes a magnetic field around it!

http://www.naturalbuy.com/dont-sleep-next-to-your-phone-charger/



Discuss the accuracy of this passage. 7K

5

the beginning of the passage is inaccurate saying that the current in transmission wires is high. Transformers step up voltages to reduce the current in the transmission (ie in transmission lines) of power, reducing power loss ($P_{loss} = I^2R$). When these voltages reach households, they are stepped down, thus current increases, to allow for use in mobile phones. Additionally the claim that AC adapter blocks current from reaching the end device is inaccurate. A transformer operates on the principle of mutual inductance. A supply voltage would cause a change in flux with the primary coil, which then transfers to the secondary coil. The functioning of a step up / down always pairs depends on the number of coils in each coil. Instead of 'blocking the current and establishing a magnetic field', the step down transformer uses smaller amounts of voltages to be produced for safe use in mobile phones. This is what drops the amount of current needed. The transformer does not establish a magnetic field.

$V_P I_P = V_S I_S$

Question 27 (7 marks)

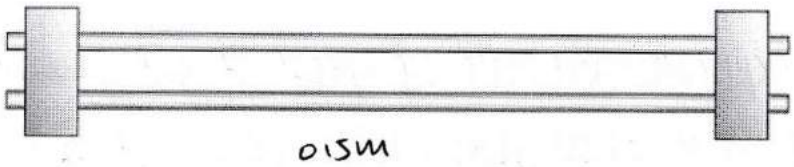
> The electrical current that's needed to operate most [mobile] phones is lower than the current that's buzzing on the electrical grid. And since we don't want to fry our phone with an amount of current it cannot handle, we have to convert the current properties somewhere along the way — that's where our AC Adapter comes into action. The little (often) black box creates a magnetic field that's blocking some of the current from reaching the end device. Yes, a plugged-in transformer establishes a magnetic field around it!
>
> http://www.naturalbuy.com/dont-sleep-next-to-your-phone-charger/

Discuss the accuracy of this passage. 7K

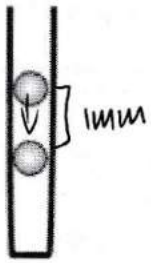
Question 28 (3 marks)

Two conductors, each with mass = 0.200 kg and length = 0.500 m, are held in a bracket as shown. The upper conductor is free to move up or down. The lower conductor carries a current of 215 A.

Front view



Side view



$\frac{F}{0.5} = \frac{KI_1I_2}{r}$ 1mm = .011m

Calculate the current that must flow in the upper conductor to support it 1.00 mm above the lower conductor.

3A

F_W = F between conductors

$0.2 \times 9.8 = \frac{2\times10^{-7} \times 215 \times I_2 \times 0.5}{0.11\times10^{-2}}$

$\frac{0.2\times9.8\times0.11\times10^{-2}}{2\times10^{-7}\times215\times0.5} = I_2$

$I_2 = 91.163\ A$

$= 91.2\ A$ (3 sig figs)

3A

$s = \frac{d}{t}$

Question 29 (3 marks)

Cosmic rays hitting the upper atmosphere results in the production of muons, travelling at 0.98 *c*. Since they normally decay after about 2.2 μs they should not have time to make it all the way to the surface of the Earth. However, many muons can be detected at the surface.

Explain how this observation supports Einstein's Theory of Special Relativity. ~~3K~~ 2K

special relativity explains that since the speed of light is constant, time will dilate as a result when objects are travelling at high speeds. Muons are produced ≈ 10km in the atmosphere, and given $t = \frac{d}{s}$, the time needed to travel this distance is much longer than the half life of the muon 2.2μs. As a result, they would decay before reaching the surface of the earth. However, according to Einstein special theory of relativity, time would dilate and run slower given by $t = \frac{t_0}{\sqrt{(1 - \frac{v^2}{c^2})}}$ where t_0 is the half life of the muon as measured in the laboratory. The half life would now be $\frac{2.2\,\mu s}{\sqrt{1 - 0.98^2}} = 11.055\,\mu s$, thus many muons are able to make it to the surface of earth. This evidence supports Einstein's theory.

earth sees ~~time~~ time dilated
muon sees length contracted.

2K

Question 30 (5 marks)

A student shone a laser emitting orange light of wavelength 610 nm at a photocell.

(a) Calculate the energy of one photon from this laser in electron-volts. 3A

$E = hf \quad v = f\lambda$

$E = \frac{hv}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{610 \times 10^{-9}}$

$= 3.2587 \times 10^{-19}\ J$

$= \frac{3.2587 \times 10^{-19}}{1.602 \times 10^{-19}}\ eV$

$= 2.03\ eV$
(3 sig figs)

(b) No current was produced by the photocell, so the student used a different laser that was twice as bright, with a wavelength of 540 nm. This time a current was produced.

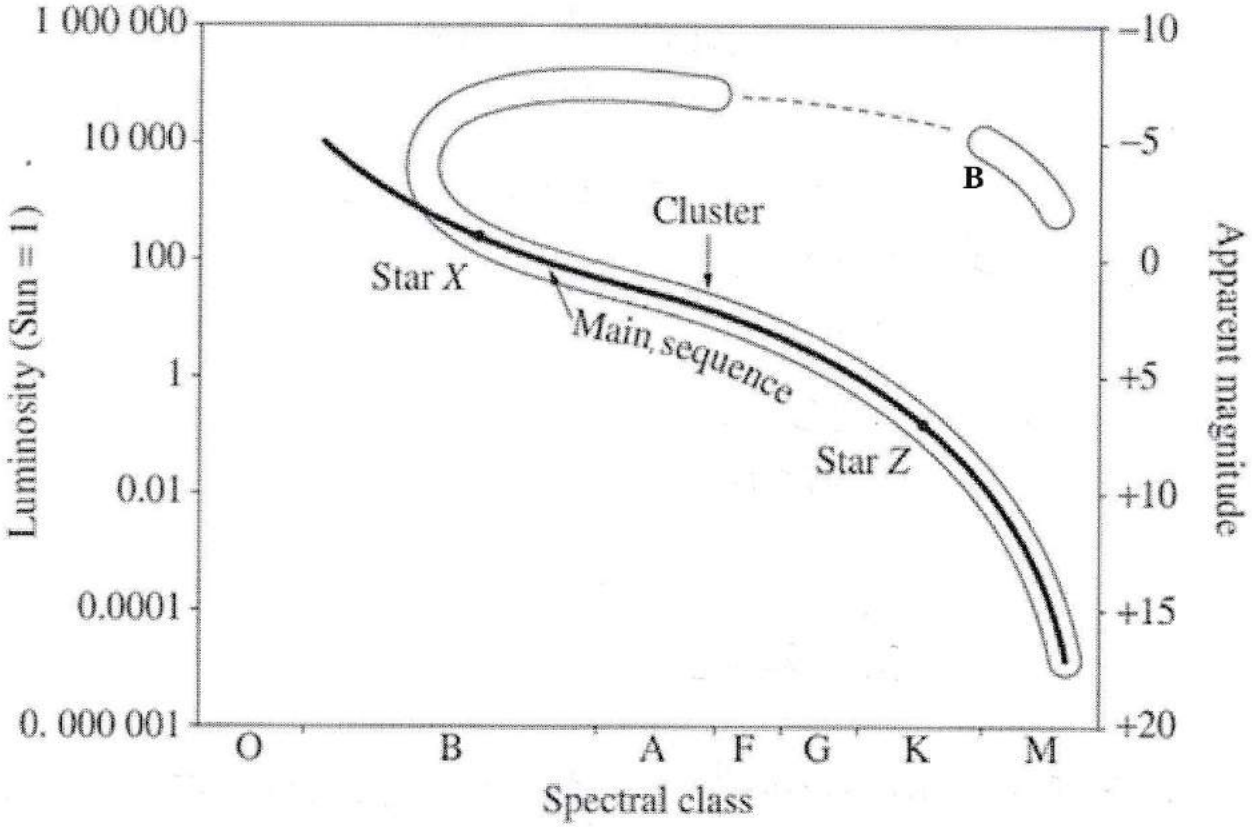
Explain why. $K_{max} = hf - \Phi$ 2K

the first laser released 2.03eV of energy per photon, however this was not enough to overcome the work function (minimum energy required to release an electron from the metal). Thus, no current was produced. ~~Increasing~~ Decreasing the wavelength increases frequency ($v = f\lambda$) thus the 540nm light releases more energy of 2.3eV, which would have been enough to overcome the required energy & work function. Increasing the brightness of the laser increases the intensity, which would increase the photocurrent, but only after the required energy is overcome.

3A 2K

Question 31 (5 marks)

The diagram shows the positions on a Hertzsprung Russell diagram of the stars in a cluster. The stars in the cluster all formed at about the same time but vary widely in their mass.



(f) Describe the characteristics of the stars found in the region labelled **B**. 2K

Stars in region B are red giants. They have high luminosities, lower temperatures (K–M class stars), due to the fusion of hydrogen fusion. Red giants expand to very large sizes, thus exhibiting extremely large surface areas. They are in the second stage of their life cycle, right after the initial main sequence.

Question 31 continues on next page

+ doesn't fuse hydrogen into helium in its core

2K

(g) Describe the nuclear processes providing energy in Stars X and Z. 3K

Star Z is a cooler and smaller main sequence star which undergoes proton-proton chain of fusion. Hydrogen nuclei combine to form helium. Overall reaction: $4\left({}^{1}_{1}H\right) \rightarrow {}^{4}_{2}He + 2\beta^{+} + 2\nu$ + energy (2β)

Star X is also in the main sequence, but since it is in spectral class B, it is an extremely hot star temperatures > $(1,8\times10^{9}K)$ thus the CNO cycle dominates. Carbon Nitrogen oxygen cycle involves the fusion of hydrogen to form carbon, nitrogen and oxygen, and

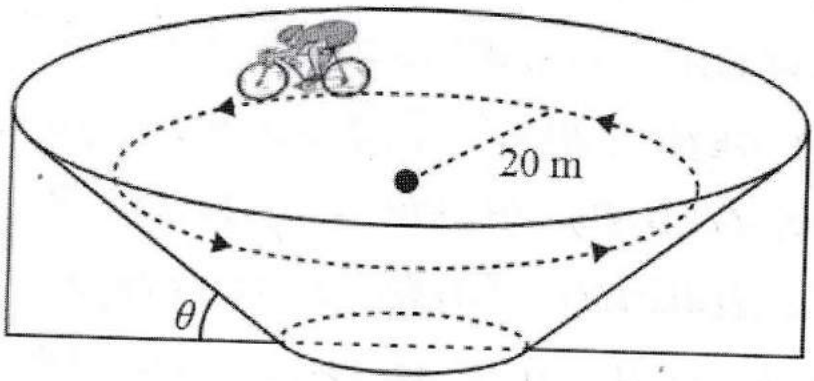
End of Question 31

releases a carbon-12 catalyst. The overall reaction is: $4\left({}^{1}_{1}H\right) \rightarrow {}^{4}_{2}He + 2\beta^{+} + 2\nu + 3\delta$ (energy)

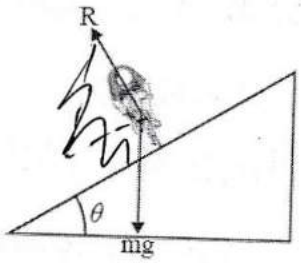
3K

Question 32 (5 marks)

The bicycle travels at a constant speed of 15 m/s. The bike and rider have a combined mass of 300 kg. Ignore friction.



V=15m/s
M= 300kg



(a) Calculate the magnitude and direction of the net force on the bike and rider.

3A

Force keeping the bike and rider on the bend is centripetal ∴ towards the centre.

$F_C = \frac{mv^2}{r} = \frac{300 \times 15^2}{20} = 3375\ N$

F_C provides net force.

2A +1A

(b) Determine the angle, θ, of the banked track.

2A

H: $N\sin\theta = 3375$ ①

V: $N\cos\theta = mg = 300 \times 9.8$ ②

① ÷ ② $\tan\theta = \frac{3375}{300 \times 9.8}$

$\tan\theta = \frac{225}{196}$

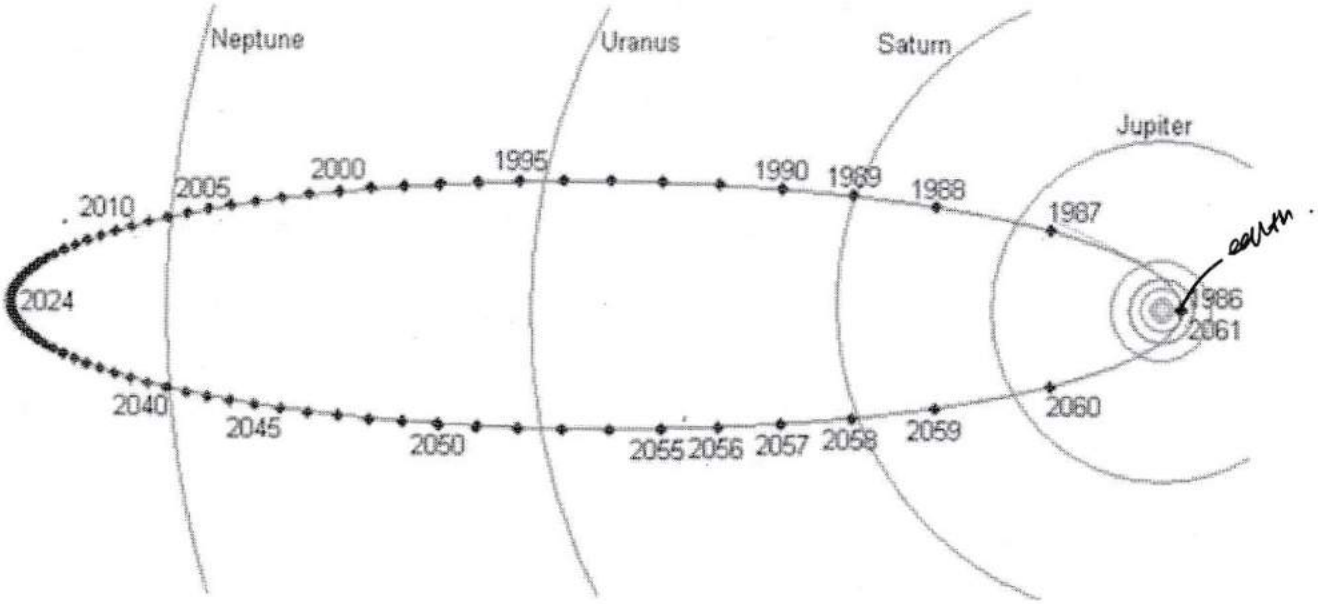
$\theta = 48.94°$

4A

draw on areas!!

Question 33 (6 marks)

The diagram below shows the orbit of Halley's comet, which last passed near Earth in 1986.



Analyse this orbit in terms of Kepler's Laws and energy changes.

6K

4

2

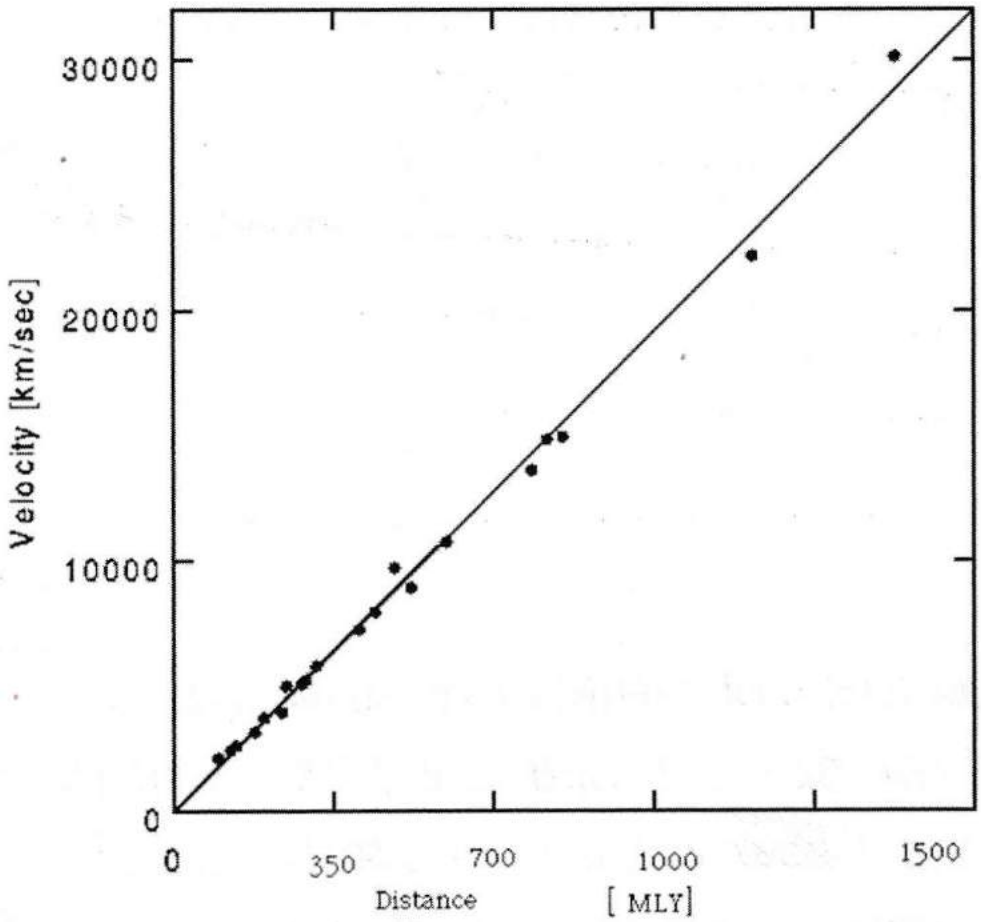
Kepler's second law states that satellites cover equal areas in equal periods of time. Thus for an object which is further away from Earth, it would travel ~~faster~~ slower. This is in line with the law of conservation of energy where (U + K = total energy) is conserved. As the comet travels further from earth, its GPE increases, thus KE decreases. This can be seen by the comet covering approximately the same distance in 5 years (between 2035-2040) when it is far away from earth, compared to 1 year (1987-1988) when it is close to earth. This is also supported by Kepler's third law, given $\frac{V^3}{T^2} = \frac{GM}{4\pi^2}$. Since G, M and $4\pi^2$ are all constants, $V^3 = kT^2$. Thus, as the distance of a comet from the centre of earth increases, the period to complete an orbit would also increase. As the comet is on its return path, GPE decreases, thus KE increases. This is shown by the increase in distance travelled between each year.

6K

Question 34 (4 marks)

Explain how the following graph supports the hypothesis that the universe is expanding.

4K



red shift

The graph supports Hubble's hypothesis for the expansion of the universe. By measuring the degree of red shift of cepheid variables, Hubble was able to conclude that our universe was expanding, and started off from a singularity. He found that as the distance of a galaxy from the Milky Way increased, so did its transverse velocity. Hubble's equation $V = H_0 D$ where H_0 is a constant can be shown in the graph, as an increase in distance increases velocity of recession. As the graph passes through (0,0) it can be seen that the universe originated from one point (if time ran backwards, expansion would have needed to start somewhere). By reading the ~~reciprocal of the~~ gradient $\frac{V}{D}$, Hubble's constant can be found. Furthermore, age of universe is $\frac{1}{\text{gradient}}$.

4K

Question 35 (9 marks) reactions Maxwell

Assess the role of prediction in validating and invalidating hypotheses in physics, with reference to examples from different areas of physics. (More weight will be given to examples not otherwise assessed in the paper.)

to validate

Scientists utilise predictions ~~made~~ hypotheses to create new theorys to explain behaviour. 9K

Maxwell's prediction of EMR and the ~~[redacted]~~ speed of light. (1)/1 (2)/4

- Maxwell's prediction that ~~[redacted]~~ needed to be validated through experiments (3)/4

- prediction that light is an EMR wave.

- Hertz experiment proved this. He found that when supplying a voltage, a spark generated will be able to jump the gap and transmit through air and be detected by a receiving coil. This helped prove that light was indeed an EMR wave, where a change in electrical field creates the magnetic field, and so on, thus it is a self propagating wave. This helped also explain observations of light externally reflecting without the need for it to be created.

- As a result, Maxwell unified the fields of previous scientists, and created his four equations (1. Gauss's law for electricity, 2. Gauss's law for magnetism 3. Faraday-Henry law)

- Thus, the theory that light consisted of both magnetic and electric fields was able to be made, after his prediction was validated.

Question 35 continues on next page

6K

- Maxwell also predicted that the speed of light is equal to $\frac{1}{\sqrt{\varepsilon_0 \mu_0}} \approx 3 \times 10^8$ m/s.

- This was also able to be confirmed by Hertz in a later experiment. After producing a spark in the receiver coil, Hertz adjusted the orientation of the coil to measure the difference in distance between the nodes and antinodes produced. As a result, he was able to calculate wavelength. Since $v = f\lambda$ and frequency from the supply was known, he was able to calculate the speed of light. This result applied Maxwell's prediction, thus further validating his hypothesis.

continued on next page

End of Question 35

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Einstein's theory of special relativity

- predicted that speed of light was a constant
- As a result, space and time would dilate and [illegible] would contract. (All inertial frames are equivalent)
- Michelson-Morley experiment. Null result needed which would that there was no change in interference pattern and that the speed of light is constant.
- There needed new and support Einstein's predictions.
- In later years, the experiment was modified flying atomic clocks in 2 aeroplanes around the world to find that it had deviated when compared to atomic clocks on the ground proving Einstein's time dilation.
- Further confirmed by the decay of muons.
- Thus, Einstein's predictions were successfully validated, allowing the full development of his special theory of relativity.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Einsteins quantisation of Energy

- Following on from planck's continuum that energy = hf, where h is planck's constant, Einstein suggested the idea of a photon, being a discrete packet of energy with a quantised value.
- This was tested through the photoelectric effect, the process where the bombardment of photons onto a metal surface would cause the release of electrons.
- The photoelectric effect could explain why there was no time delay for the release of electrons, how intensity influenced the photocurrent and KE influenced the ~~ability~~ ability of the photons energy to overcome the work function.
- Einstein's prediction that photons existed in discrete packets of energy was supported by the idea that all the energy is transferred to an electron, and it is not accumulated until all the electrons in the metal have enough energy (1:1 ratio)
- Einsteins hypothesis was thus validated, and allowed him to put forward the ~~photon~~ model of light.

carried on next page