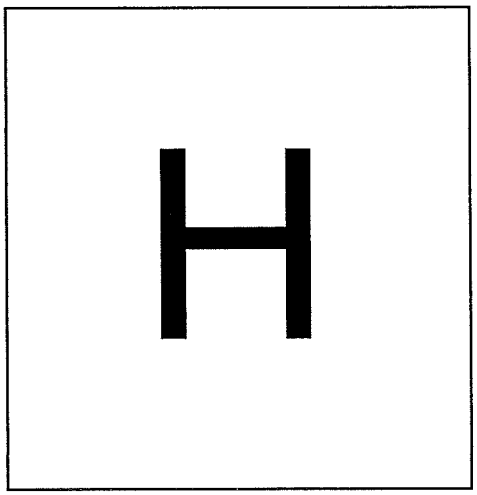
St Maurice's High School	Physics Department

Higher Physics

Unit 1

Our Dynamic Universe



Homework

Higher Physics Homework 1 Equations and Graphs of Motion

(1) A car accelerates from rest and reaches 23ms^{-1} in a time of 3.7s. Calculate its acceleration. (6.2ms^{-2})

(2) A motorboat accelerates at 3.8ms^{-2} from rest until it reaches 25ms^{-1}. How far did it travel during the acceleration. (82.2m)

(3) A plane flying at 100ms^{-1} accelerates at 18ms^{-2}. How far will it travel in 6s. (924m)

(4) A train enters a station with a speed of 15ms^{-1}. If it decelerates to rest while covering 146m calculate its acceleration. (- 0.77ms-2)

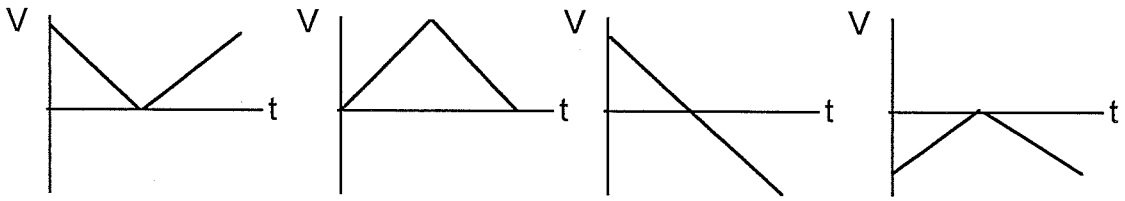
(5) A ball is thrown vertically upwards at 24ms^{-1}. Calculate its maximum height. (29.4m)

(6) A stone falls down a well which is 84m deep.

(a) How long did it take to hit the bottom of the well? (4.1s)
(b) What was its velocity when it hits the bottom? (-40.2ms^{-1})

(7) A helicopter is travelling vertically upwards with a velocity of 8ms^{-1}. A spanner falls out of the helicopter and hits the ground 6s later. How high above the ground was the helicopter when the spanner fell out? (128.4m)

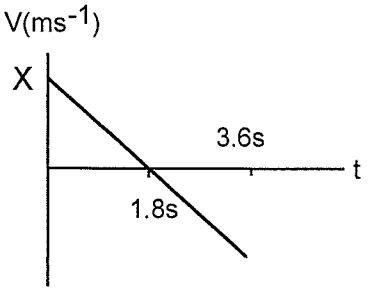
(8) Which velocity - time graph shows a ball thrown vertically upwards?



A B C D

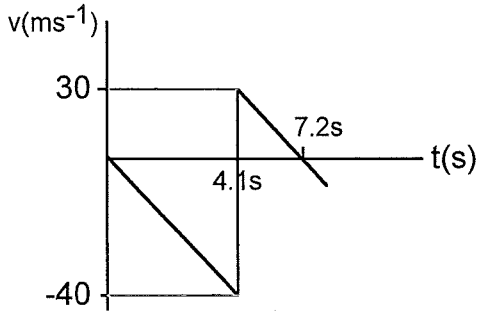
(9) A girl throws a ball vertically upwards and a velocity time graph of the motion is drawn.

(a) At what X velocity did it leave her hand?
(b) What was the maximum height of ball.
(c) Sketch the acceleration time graph for the motion. Values of are required on both axis.



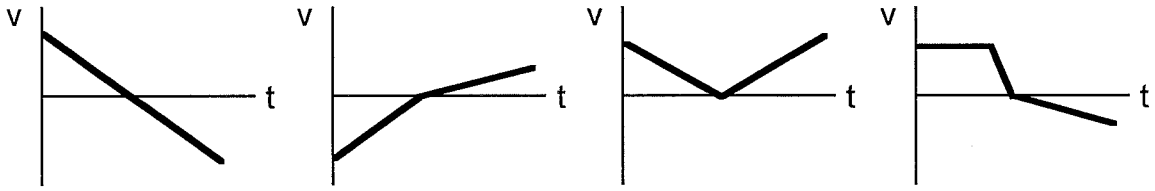
(a) 17.6ms^{-1} (b)15.8m

(10) A ball is dropped and bounces. The velocity time graph is shown.

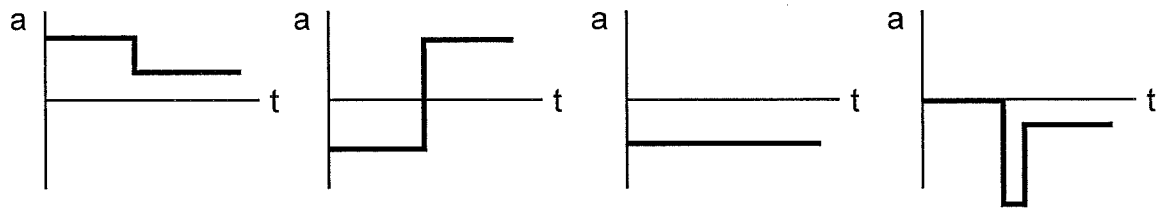


(a) What was its velocity when it hit the ground?
(b) From what height was it dropped? (82m)
(c) What happens <u>after</u> 4.1s?
(d) How high did the ball rise after it bounced? (46.5m)
(e) Describe the ball's motion after 7.2s.
(f) Sketch the acceleration time graph for the motion. Values of are required on both axis.

(11) Look at these velocity time graphs.



(a) Match up each graph with its acceleration time graph



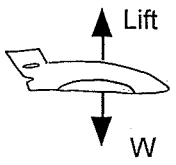
(12) In an experiment a boy measured the following times for an event:

2.56s 2.58s 2.46s 2.43s 2.71s

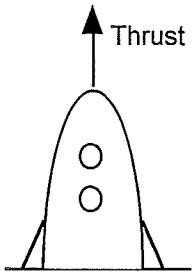
(a) Calculate the mean time. (2.55s)
(b) Calculate the random uncertainty in the mean (0.06s)
(c) Write the final answer as mean ± % uncertainty 2.55s ± 2.4%

Higher Physics Homework 2 Vertical Motion & Resolving Vectors

(1) A plane flies at a constant height. If its mass is 8000kg what is the lift force? (78,400N)

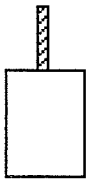


(2) A rocket of mass 4500kg takes off from Cape Carnival with a constant acceleration of $8.2ms^{-2}$.



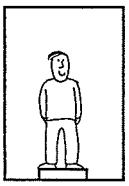
(a) Calculate the weight of the rocket. (44,100N)
(b) Calculate the unbalanced force. (36,900N)
(c) Therefore calculate the upward thrust. (81,000N)
(d) How long will it take to reach a velocity of $280ms^{-1}$ if it continues at this constant acceleration. (34.1s)
(e) What height will it reach after 5s. (102.5m)

(3) A lift of mass 800kg accelerates upwards from rest. The Tension in the cable is 8160N.

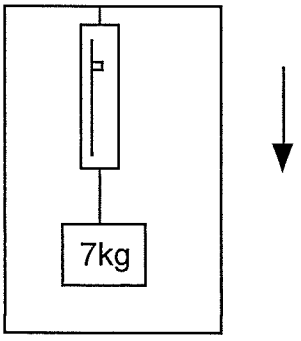


(a) Draw a free body diagram showing the forces acting on the lift.
(b) Calculate the unbalanced force on the lift. (320N)
(c) Calculate the acceleration of the lift. ($0.4ms^{-2}$)
(d) What is the lifts velocity after 4s? ($1.6ms^{-1}$)
(e) How high did the lift rise while accelerating for the 4s? (3.2m)

(4) A boy of mass 54kg stands on set of bathroom scales in a lift. He accelerates downwards from the top floor at $0.8ms^{-2}$. What is the reading on the scales during this acceleration? (486N)

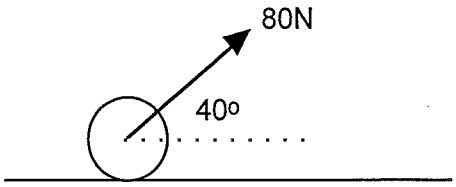


(5) A 7kg mass is hung from a balance in a lift as shown. At one point the lift is decelerating downwards at $0.5ms^{-2}$ as it approaches the ground floor.



Calculate the reading on the balance.
(72.1N)

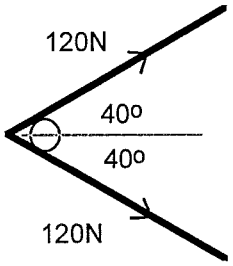
(6) A groundsman at a cricket ground pulls a 40kg roller with a force of 80N at the angle shown.



(a) What is the horizontal component of the force? (61.3N)

(b) If the roller friction amounts to 58N calculate its acceleration ($0.08ms^{-2}$)

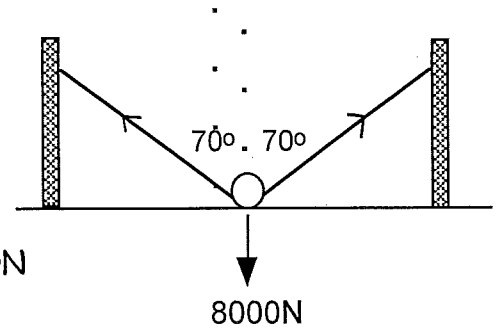
(7) A catapult is used to fire a small ball as shown. The Tension in each elastic band is shown.



(a) Calculate the resultant force on the ball. (183.9N)

(b) If its mass is 20g calculate its initial acceleration. ($9193ms^{-2}$)

(8) A 400kg pod at a fun fair is held in place by a magnet as shown. When the magnet is switched off the pod shoots up in the air, propelled by two elastic cables as shown. The pods weight and magnetic force amount to a downwards force of 8000N



(a) Calculate the tension in each cable just before the magnet is switched off. (11,695N)

(b) What is the initial acceleration of the pod when magnets are switched off? ($20ms^{-2}$)

(9) A boy measures the distance he sprints as 15± 0.3m. He measures his time as 2.1± 0.1s

(a) Calculate his average speed. ($7.1ms^{-1}$)

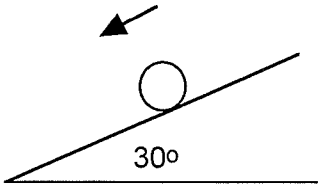
(b) Work out the percentage uncertainty in each value (2%, 4.8%)

(c) What would be an appropriate % error in the final answer. (4.8%)

(c) Write the final answer as speed ± absolute uncertainty ($7.1\pm 0.3ms^{-1}$)

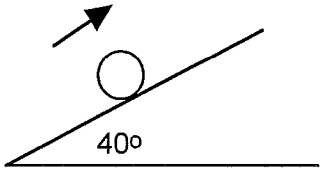
Higher Physics Homework 3 Inclined Planes & Multiple Mass Systems

(1) A 0.2kg ball rolls down a slope as shown.



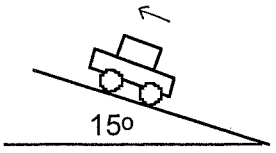
(a) Calculate the component of its weight acting down the slope. (0.98N)
(b) If it rolls at a constant speed state the frictional force. (0.98N)

(2) A 0.4kg ball is kicked up a slope as shown. If frictional forces of 0.8N acts on the ball calculate



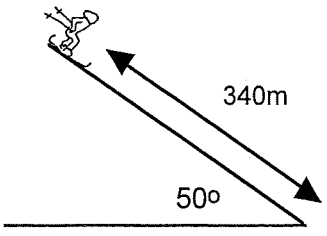
(a) The unbalanced force acting on the ball.
(b) The acceleration of the ball.
(c) If the ball's velocity at the bottom of the slope is $5ms^{-1}$ how far up the slope will it roll?

(3) A 700kg car accelerates **up** a road inclined at 15° at $1.6ms^{-2}$. Frictional forces amount to 500N.



(a) Calculate the component of the car's weight acting down the slope.
(b) Calculate the unbalanced force on the car.
(c) Calculate the forward engine force of the car.

(4) A 60kg skier starts a straight run on a 340m long slope as shown. Frictional forces are a constant size of 200N.



(a) Calculate his velocity at the bottom of the slope if he starts from rest.

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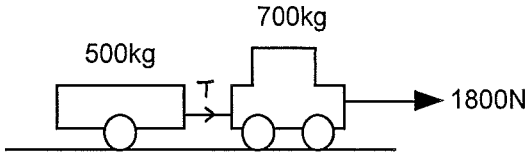
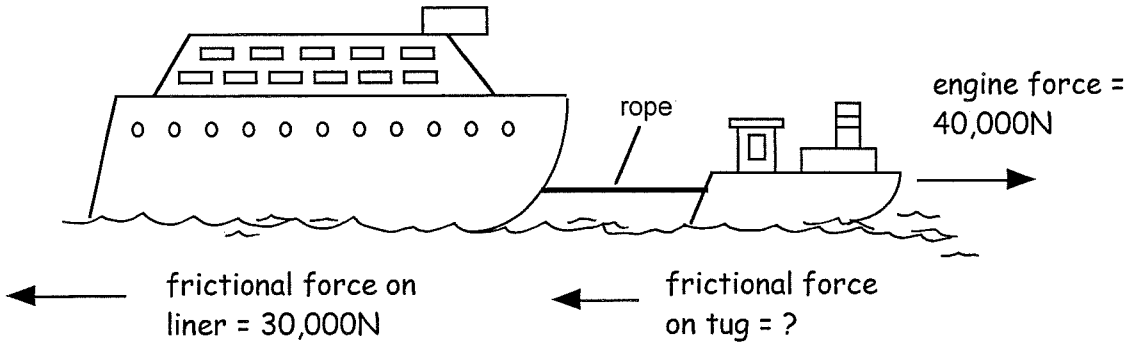
(1)(a) 0.98N (b) 0.98N (2)(a) 3.3N (b) $8.3ms^{-1}$ (c) 1.5m (3) 1776N (b) 1120N (c) 3396N (4)(a) $53.4ms^{-1}$

(5) The diagram shows a car pulling a trailer on a friction less surface



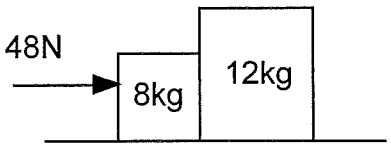
(a) Calculate the acceleration of the system
(b) Calculate the tension in the cable.

(6) A tug pulls a liner at a **constant speed** as shown using a rope.
The forces on the system are shown.



(a) What is the size of the frictional force on the tug?
(b) What is the tension in the rope.

(7) A force of 48N is applied to this friction less system as shown.



(a) Calculate the force the 8kg box apples to the 12kg block. (28.8N)

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(5)(a) 1.5ms^{-1} (b) 750N (6)(a) 10,000N (b) 30,000N (7)(a) 28.8N

Higher Physics Homework 4 Momentum and Impulse

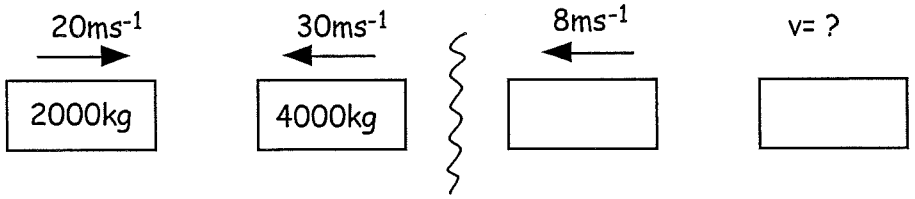
(1) Calculate the momentum of a 4kg ball travelling at 5ms-1

(2) An 80kg runner has momentum of 560kgms-1. Calculate its velocity

(3) A 600kg car has 20,000J of kinetic energy. Calculate its momentum.

(4) A 5kg trolley travelling at 3.2ms^{-1} collides with a stationary trolley of mass 2kg. If the trolleys stick together calculate the velocity of the combined trolleys.

(5) Two spacecrafts collide in space as shown. Space craft A rebounds at 20ms-1. Calculate the velocity of space craft B.



(a) calculate the velocity of space craft B after the collision.
(b) Show whether the collision is elastic or inelastic

(6) A 75kg astronaut is drifting away from the space capsule at 0.14ms^{-1}. He remembering his school physics he throws a 2kg spanner he is carrying away from him. At what velocity would he have to throw the spanner to alter his velocity to 0.1ms^{-1} back towards the station.

(7) A golfer hits a 20g ball by applying a force of 52N over a time of 7ms Calculate the velocity the ball leaves the club head.

(8) A pitcher catches a 50g ball travelling at 40ms^{-1}. He brings it to rest in a time of 0.24s. (take direction of ball as positive direction)

(a) Calculate the force he has to apply.
(b) Why would the force be greater if the ball hits him in the back of the head.

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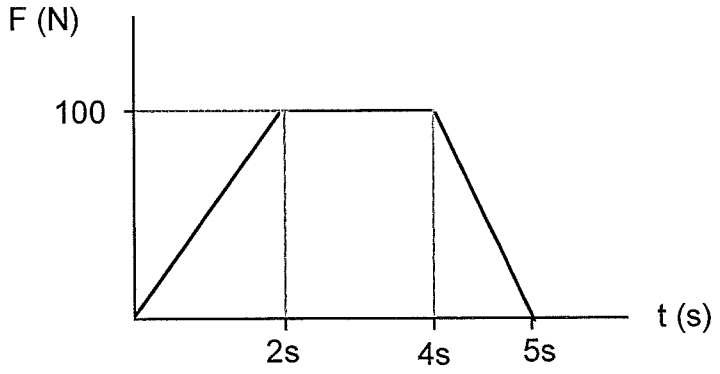
(1) 20kgms^{-1} (2) 7ms^{-1} (3) 4902kgms^{-1} (4) 2.3ms^{-1} (5) -16ms^{-1} (6) 80,000J Ek lost therefore inelastic (7) 9.1ms^{-1} (8)(a) -8.3N (b) t is less F is therefore greater

(9) A 4kg ball it dropped from a height of 6m.

(a) Calculate the velocity it hits the ground

(b) The ball rebounds upwards at 7.2ms^{-1}. If the ball is in contact with the ground for 0.15s calculate the force the ground applies to the ball.

(10) The following force is applied to a 20kg trolley which is originally at rest.



(a) Calculate the change of momentum of the car

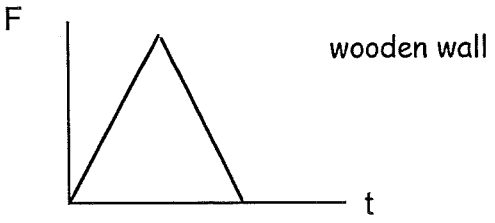
(b) Therefore what is the impulse of the force.

(c) Calculate the final velocity of the trolley after 5s

(d) What is the average force on the trolley?

(11) Describe how a air bag reduces the injuries to a driver involved in a car crash.

(12) A sprinter finishes a race and is stopped by a wooden wall The force time graph showing how the stopping force is applied to the sprinter



(a) The same sprinter hits a new padded wall at the same speed. Draw the above graph and overlay on it the force time graph for the padded wall.

(b) How do the areas of the two triangles compare? Explain.

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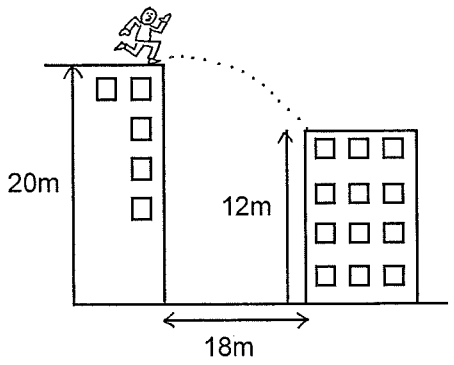
(9) (a) 10.8ms^{-1} (b) 480N (10)(a) 350kgms^{-1} (b) 350Ns (c) 17.5ms-1 (d) 70N

Higher Physics Homework 5 Projectile motion & Gravitation

(1) A ball is kicked of the edge of a 50m high cliff with a horizontal velocity of $12ms^{-1}$.

(a) Calculate the time it is in the air
(b) Calculate the horizontal distance travelled.
(c) Calculate the final vertical velocity of the ball
(d) Calculate the resultant velocity of the ball when it lands.

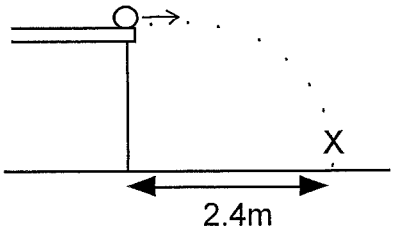
(2) A stunt man has to jump from one roof to another as shown in a scene from a film



(a) Calculate the minimum horizontal speed he requires to complete the jump

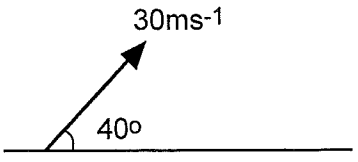
(3) A pupil rolls a ball off a table as shown. It lands 0.35s later

(a) Calculate the height of the table.
(b) If the ball hits point X calculate the horizontal velocity of the ball.
(c) Why would repeating the experiment using a taller table give a more accurate measurement of the time.



(4) A golfer hits a ball as shown in the diagram

(a) Calculate the horizontal component of its velocity
(b) Calculate the initial vertical component of its velocity.
(c) What was maximum height reached?
(d) How long is the ball in the air
(d) What was maximum range of the shot.



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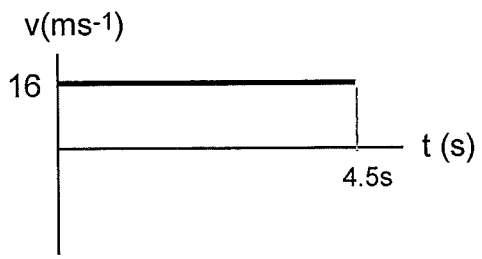
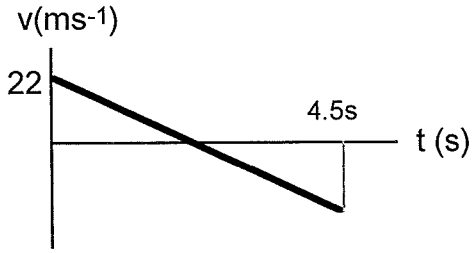
(1)(a) 3.2s (b) 38.4m (c $31.4ms^{-1}$ (d) $33.6ms^{-1}$ (69^o below horz) (2) $14ms^{-1}$
(3)(a) 0.6m (b) $4ms^{-1}$ (4)(a) $23ms^{-1}$ (b) $19.3ms^{-1}$ (c) 19m (d) 3.9s (e) 89.7m

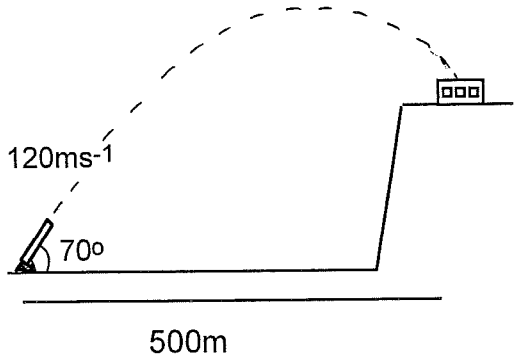
(5) A sports trainer is analysing a javelin throwers performance.
He sketches two graphs showing the horizontal and vertical velocities of the javelin as it travels through the air.





(a) What is the horizontal velocity of the javelin?
(b) What is the initial vertical velocity of the javelin?
(c) Calculate the actual velocity and angle at which the javelin left the throwers hand. $27ms^{-1}$ (54^o above the horizontal)
(d) Calculate the maximum height of the javelin. (24.7m)
(e) Calculate the horizontal range of the javelin. (72m)

(6) A charity fires an aid package up to a hillside hospital from a valley.



(a) Calculate the time it takes to reach the hospital. (12.2s)
(b) What is the vertical height of the hospital above the valley? (647m)

(7) Calculate the gravitational force between the Sun and Jupiter. $G = 6.67 \times 10^{-11}$
msun = 2×10^{30}kg mjupiter = 1.9×10^{27}kg dist to sun = 8.2×10^{12}m

Calculate the gravitational attraction between the Sun and Jupiter

(8) Bob has a mass of 50kg and Sue has a mass of 40kg. The gravitational force between bob and Sue is 3.3×10^{-8}N . How far apart are they standing.

(9) A 200kg satellite orbits a height of 40km above the surface of the Earth.
(a) Calculate the gravitational force between the Earth and satellite
(b) Calculate the gravitational field strength at this point.

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(7) 3.8×10^{21}N (8) 2m (9)(a) 1930N (b) $9.7 Nkg^{-1}$

Higher Physics Homework 6 Special Relativity & Red Shift

(1) Newton's physics was depended on space and time being constant everywhere in the universe.

(a) What did Einstein say was the only constant in the universe?

(b) If this is a constant what affect does this have on space and time?

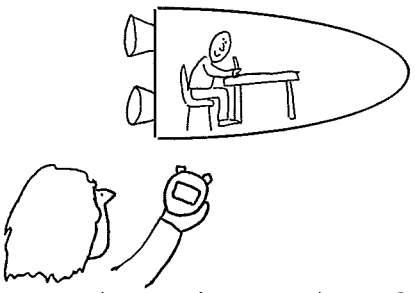
(2) A scientist moving past Mars on a fast moving space craft measures the speed of light in an experiment on the craft as $3x10^8 ms^{-1}$.
A person on Mars views this experiment. Does he measure the speed of light as greater, smaller or the same as the scientist on the space craft?

(3) Scientist A and B are sitting at a table. Scientist C walks by the table.

(a) Which scientists are in the same frame of reference

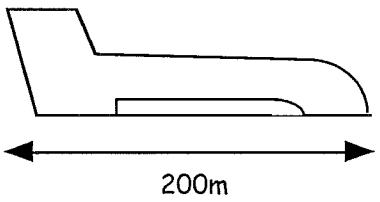
(b) If Scientist A and B get in a car and travel at a constant speed down the road are they still in the same frame of reference?

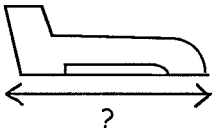
(4) Bob is on a space craft moving relative to the earth at a velocity of $2.5x108ms^{-1}$.
He measures the time for him to write a note as 2mins. Emily on Earth measures the time for Bob to write the note. What time does she record?



(5) A muon is created when cosmic rays hit the outer atmosphere. The muon lasts for 1.2ms. However a scientist on Earth measures the time it exists for as 2.4ms. What speed is the muon travelling relative to the scientist?

(6) A spacecraft has a length of 200m as measured by a Jane on Earth. Jane observes the spacecraft moving by her at a velocity of 0.7c





(a) What length will she measures it when it passes Earth at this velocity?

(6) A metre stick is measured on earth as 1m long. At what speed would the metre stick require to move relative to a stationary observer for its length to be measured as 0.4m.

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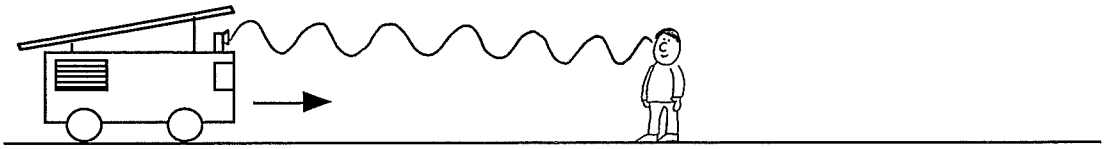
(1)(a) speed of light (b) they must vary (2) same (4) 3.6mins (5) $2.6x10^8 ms^{-1}$ (6) 143m
(6) $2.7x10^8 ms^{-1}$

(7) A fire engine approaches an observer with its siren on.



Explain why the frequency of the sound heard by an observer is different than the frequency of the sound he would hear if the fire engine was stationary

(8) A police car emits sound of frequency 1200Hz. The car passes an observer. What frequency does the observer hear as the car travels away from her at 24ms-1?

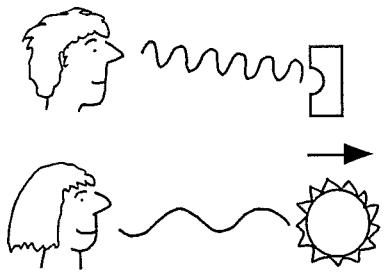
(9) A fighter plane approaches a crowd at an airport with a speed of 260ms^{-1}. The drone of the engine is 500Hz. What frequency do the people at the airport hear?

(10) A bat produces a sound of frequency 260kHz. When it flies towards a scientist he measures the frequency as 268Hz. Calculate the speed of the bat.

(11) A line in the line spectra of gas X has a frequency of 6×10^{14}Hz. When the line spectra for this gas is observed from a distant star the frequency of the line is measured as 5.6×10^{14}Hz. Explain why. (Hint - make link between f and λ)

(12) Most of the stars in the universe show a red shift in their spectra. What does this tell you about the universe?

(13) The wavelength of a violet photon from the line spectra of hydrogen when measured in a classroom is 410nm. When this photon is viewed being emitted by a distant star its wavelength is measured as 425nm.



(a) Calculate the red shift
(b) Calculate the recessional velocity of the star.

(14) A star travels away from earth at a velocity of 4×10^{6}ms^{-1}. A wave viewed from this star has a wavelength of 486nm. What would be the wavelength of this photon if the star was stationary relative to the observer?

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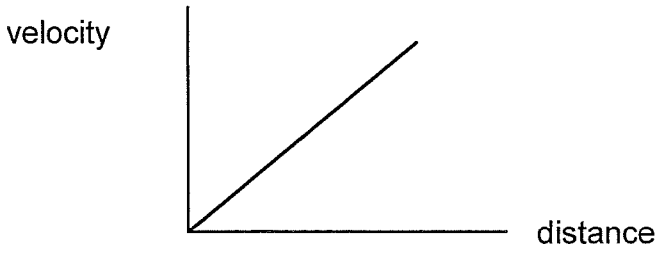
(8) 1121Hz (9) 2125H (10) 10.1ms^{-1} (13) (a) 0.037 (b) 1.1×10^{7}ms^{-1}
(14) 479.8nm

Higher Physics Homework 7 Hubble and the Big Bang

Hubble's constant = $2.3 \times 10^{-18}\ s^{-1}$

(1) Convert 16 light years to m

(2) Hubble plotted a graph of a stars distance from



(a) What value do you get if you calculate the gradient of the line?
(b) What does Hubble's law tell you about the expansion of the universe?

(3) A star is a distance of 6×10^{24}m from Earth. What is its recessional velocity?

(4) A star is travelling away from earth at a velocity of 0.08c. Calculate the distance this star is from Earth.

(5) Light from a distant galaxy is found to contain the spectral lines of sodium. One of these lines has a wavelength of 602nm when measured using a telescope on Earth. When this same line is measured on Earth its wavelength is 589nm.

(a) Calculate the red shift z.
(b) Calculate its recessional velocity
(c) Therefore calculate the distance this galaxy is from Earth.

(6) (a) How can Hubble's law be used to approximate the age of the universe?
(b) What is the approximate age of the universe as accepted today?

(7) Approximately 13.7 billion years ago all the universe - energy and matter - was concentrated in a space of __A__ volume called a ____B____. Then it start to ___C___ extremely quickly in a hot dense explosion. This initial expansion is called the ___D___ ____E____. As the universe cooled and expanded further some of the energy turned to ___F_____.

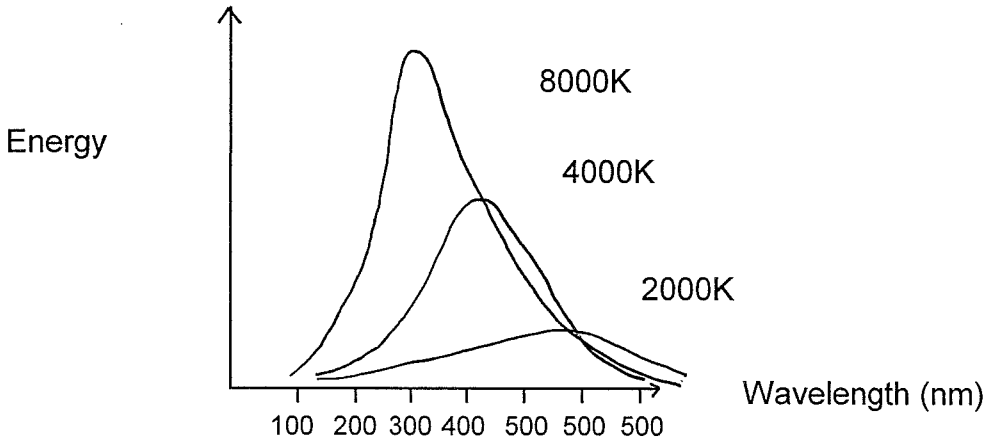
(a) State the missing words A to F.

(8) At the Big Bang there was only a swirl of extremely dense hot energy in the form of high frequency waves. eg Gamma Rays.

(a) As the universe cooled and expanded what happened to the wavelength of these waves?
(b) Scientists calculated that using Hubble's law after 13.7 billion years of expansion the wavelength of this Big Bang radiation should be in what part of the electromagnetic spectrum.
(c) When did physicists detect this radiation coming from all points of the universe?
(d) What do we call this radiation?

(9) Why is the amount of helium in the universe evidence of the big bang?

(10) This graph shows how the energy given off by different stars depends on their temperatures



(a) Does the majority of radiation given off by the 8000K star come from the Infra red or Ultraviolet part of the spectrum?
(b) What can you tell about the total energy a star emits as its temperature increases.
(c) The 8000K star and the 2000K star emit the same number of photons. Why would a star of temp 8000K emit more energy than one of temperature 2000K.
(d) A bluey white star is very hot because it gives off most of its radiation at the **long/short** wavelength, **high/low** frequency end of the electromagnetic spectrum. It is a very **long/short** lived star as it uses up its fuel very **slowly/quickly**. Choose the correct terms.

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(1) 1.5×10^{17}m (2) Hubble constant (b) accelerating (3) 1.38×10^{7}ms^{-1} (4) 1×10^{25}m
(5)(a) 0.022 (b) 6.6×10^{6}ms^{-1} (c) 2.87×10^{24}m