

NATIONAL SCIENCE Olympiad

Past Examination Questions and Answers: Physics Section

2004

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PAST EXAMINATION QUESTIONS AND ANSWERS 2004: GENERAL KNOWLEDGE AND PHYSICS SECTIONS

SECTION A: GENERAL KNOWLEDGE

1 When did the break up of Gondwanaland start?

- 1 10 000 years ago
- 2 3 million years ago
- 3 50 million years ago
- 4 150 million years ago
- 5 2 billion years ago

Answer 4 (Encyclopaedia Britannica)

Gondwanaland was an ancient supercontinent that incorporated present-day South America, Africa, Arabia, Madagascar, India, Australia, and Antarctica. It was fully assembled by Late Precambrian time, some 600 million years ago, and the first stage of its break-up began in the Early Jurassic Period, about 180 million years ago. The name Gondwanaland was coined by the Austrian geologist Eduard Suess in reference to Upper Paleozoic and Mesozoic formations in the Gondwana region of central India, which are similar to formations of the same age on Southern Hemisphere continents.

- 2 The oceanic crust consists of one of the following rocks. Which one?
 - 1 Granite
 - 2 Basalt
 - 3 Dolerite
 - 4 Limestone
 - 5 Slate

Answer 2 (Encyclopaedia Britannica)

Basalt is the extrusive igneous (volcanic) rock that is low in silica content, dark in colour, and comparatively rich in iron and magnesium. Some basalts are guite glassy (tachylytes), and many are very fine-grained and compact; it is more usual, however, for them to exhibit porphyritic structure, with larger crystals (phenocrysts) of olivine, augite, or feldspar in a finely crystalline matrix (groundmass). Olivine and augite are the most common porphyritic minerals in basalts; porphyritic plagioclase feldspars are also found. Basaltic lavas are frequently spongy or pumiceous; the steam cavities become filled with secondary minerals such as calcite, chlorite, and zeolites.

Granite is a coarse- or medium-grained intrusive igneous rock that is rich in quartz and feldspar; it is the most common plutonic rock of the Earth's crust, forming by the cooling of magma (silicate melt) at depth. Because of its use as paving block and as a building stone, the guarrying of granite was, at one time, a major industrial activity. Except for tombstones, however, for which there is a continuing demand, the present production of granite is geared to the fluctuating market for curbing in highway construction and veneer used in the facing of large industrial and commercial buildings. Dolerite, also called diabase, is a fine- to medium-grained, dark grey to black intrusive igneous rock. It is extremely hard and tough and is commonly guarried for crushed stone, under the name of trap. Although not popular, it makes an excellent monumental

stone and is one of the dark-coloured rocks commercially known as black granite. Diabase is widespread and occurs in dikes (tabular bodies inserted in fissures), sills (tabular bodies inserted while molten between other rocks), and other relatively small, shallow bodies. Chemically and mineralogically, diabase closely resembles the volcanic rock basalt, but it is somewhat coarser and contains glass. With increase in grain size, diabase may pass into gabbro. About one-third to two-thirds of the rock is calcium-rich plagioclase feldspar; the remainder is mostly pyroxene or hornblende. Limestone is sedimentary rock composed mainly of calcium carbonate $(CaCO_3)$, usually in the form of calcite or aragonite. It may contain considerable amounts of magnesium carbonate (dolomite) as well; minor constituents also commonly present include clay, iron carbonate, feldspar, pyrite, and guartz. Most limestones have a granular texture. Their constituent grains range in size from 0.001 mm (0.00004 inch) to visible particles. In many cases, the grains are microscopic fragments of fossil animal shells. Limestone has two origins: (1) biogenic precipitation from seawater, the primary agents being lime-secreting organisms and foraminifera; and (2) mechanical transport and deposition of preexisting limestones, forming clastic deposits. Travertine, tufa, caliche, chalk, sparite, and micrite are all varieties of limestone.

Slate is fine-grained, clayey metamorphic rock that cleaves, or splits, readily into thin slabs having great tensile strength and durability; some other rocks that occur in thin beds are improperly called slate because they can be used for roofing and

similar purposes. True slates do not, as a rule, split along the bedding plane but along planes of cleavage, which may intersect the bedding plane at high angles. Slate was under low-grade formed metamorphic conditions—*i.e.*, under relatively low temperature and pressure. The original material was a fine clay, sometimes with sand or volcanic dust, usually in the form of a sedimentary rock (e.g., a mudstone or shale). The parent rock may be only partially altered so that some of the original mineralogy and sedimentary bedding are preserved; the bedding of the sediment as originally laid down may be indicated by alternating bands, sometimes seen on the cleavage faces. Cleavage is a superinduced structure, the result of pressure acting on the rock at some time when it was deeply buried beneath the Earth's surface. On this account, slates occur chiefly among older rocks, although some occur in regions in which comparatively recent rocks have been folded and compressed as a result of mountain-building movements. The direction of cleavage depends upon the direction of the stresses applied during metamorphism.

Oceanic crust is the part of Earth's lithosphere that surfaces in the ocean basins. It differs from the continental crust in several ways: it is thinner, denser, younger, of different chemical composition, and created in a different plate-tectonic setting. The oceanic crust is formed at spreading centres on the oceanic ridges, whereas continental crust is formed above the subduction zones. The oceanic crust is about six kilometres thick. It is composed of several layers, not including the overlying sediment. The topmost layer, about 500

3

metres thick, includes lavas of basaltic composition (i.e., rock material consisting largely of plagioclase [feldspar] and pyroxene). The lavas are generally of two types: pillow lavas and sheet flows. Pillow lavas appear to be shaped exactly as the name implies—like large overstuffed pillows about one metre in cross section and one to several metres long. They commonly form small hills tens of metres high at the spreading centres. Sheet flows have the appearance of wrinkled bed sheets. They commonly are thin (only about 10 centimetres thick) and cover a broader area than pillow lavas. There is evidence that sheet flows are erupted at hiaher temperatures than those of the pillow variety. Below the lava is a layer composed of feeder, or sheeted, dikes that measures more than one kilometre thick. Dikes are fractures that serve as the plumbing system for transporting magmas (molten rock material) to the seafloor to produce lavas. They are about one metre wide, sub-vertical, and elongate along the trend of the spreading centre where they formed, and they abut one another's sides-hence the term sheeted. These dikes are also of basaltic composition. There are two layers below the dikes totalling about 4.5 kilometres in thickness. Both of these include gabbros, which are essentially basalts with coarser mineral grains. The upper gabbro layer is isotropic (uniform) in structure. In some places, this layer includes pods of plagiogranite, a differentiated rock richer in silica than gabbro. The lower gabbro layer has a stratified structure and evidently represents the floor or sides of the magma chamber. This layered structure is called cumulate, meaning that the layers (which measure up to several metres thick) result from the sedimentation of minerals out of the liquid magma. The layers in the cumulate gabbro have less silica but are richer in iron and magnesium than the upper portions of the crust. Olivine, an ironmagnesium silicate, is a common mineral in the lower gabbro layer. The oceanic crust lies atop the Earth's mantle, as does the continental crust. Mantle rock is composed mostly of peridotite, which consists primarily of the mineral olivine with small amounts of pyroxene and amphibole.

- 3 Which two forces on a satellite must be balanced so that the satellite can stay in its orbit?
 - 1 frictional force and gravitational force
 - 2 Gravitational force of the moon and the gravitational force of the earth
 - 3 Centrifugal force and gravitational force
 - 4 Coriolis force and gravitational force
 - 5 Magnetic force and gravitational force

Answer (NASA and Encyclopaedia Britannica)

A satellite is a natural object (moon) or spacecraft (artificial satellite) orbiting a larger astronomical body. Most known natural satellites orbit planets; the Earth's Moon is the most obvious example. The idea of an artificial satellite in orbital flight was first suggested by Sir Isaac Newton in

his book Philosophiae Naturalis Principia Mathematica (1687). He pointed out that a cannonball shot at a sufficient velocity from atop a mountain in a direction parallel to the horizon would go all the way around the Earth before falling. Although the object would tend to fall toward the Earth's surface because of gravitational force. its momentum would cause it to descend along a curved path. Greater velocity would put it into a stable orbit, like that of the Moon, or direct it away from the Earth altogether. On Oct. 4, 1957, nearly three centuries after Newton had proposed his theory, the Soviet Union launched the first Earth satellite, Sputnik I. The United States orbited its first satellite, Explorer 1, three months later (Jan. 31, 1958). Explorer, though much smaller than Sputnik, was instrumented to detect radiation and discovered the innermost of the two Van Allen radiation belts, a zone of electrically charged solar particles that surrounds the Earth. A satellite remains in orbit because of a balance between the satellite's velocity (speed at which it would travel in a straight line) and the gravitational force between the satellite and Earth. Were it not for the pull of gravity, a satellite's velocity would send it flying away from Earth in a straight line. But were it not for velocity, gravity would pull a satellite back to Earth. To help understand the balance between gravity and velocity, consider what happens when a small weight is attached to a string and swung in a circle. If the string were to break, the weight would fly off in a straight line. However, the string acts like gravity, keeping the weight in its orbit. The weight and string can also show the relationship between a satellite's altitude and its orbital

period. A long string is like a high altitude. The weight takes a relatively long time to complete one circle. A short string is like a low altitude. The weight has a relatively short orbital period. Many types of orbits exist, but most artificial satellites orbiting Earth travel in one of four types: (1) high altitude, geosynchronous; (2) medium altitude, (3) sun-synchronous, polar; and (4) low altitude. Most orbits of these four types are circular. A high altitude, geosynchronous orbit lies above the equator at an altitude of about 22,300 miles (35,900 kilometres). A satellite in this orbit travels around Earth's axis in exactly the same time, and in the same direction, as Earth rotates about its axis. Thus, as seen from Earth, the satellite always appears at the same place in the sky overhead. To boost a satellite into this orbit requires a large, powerful launch vehicle. A medium altitude orbit has an altitude of about 12,400 miles (20,000 kilometres) and an orbital period of 12 hours. The orbit is outside Earth's atmosphere and is thus very stable. Radio signals sent from a satellite at medium altitude can be received over a large area of Earth's surface. The stability and wide coverage of the orbit make it ideal for navigation satellites. A sun-synchronous, polar orbit has a fairly low altitude and passes almost directly over the North and South poles. A slow drift of the orbit's position is coordinated with Earth's movement around the sun in such a way that the satellite always crosses the equator at the same local time on Earth. Because the satellite flies over all latitudes, its instruments can gather information on almost the entire surface of Earth. A low altitude orbit is just above Earth's

atmosphere, where there is almost no air to cause drag on the spacecraft and reduce its speed. Less energy is required to launch a satellite into this type of orbit than into any other orbit. Satellites that point toward deep space and provide scientific information generally operate in this type of orbit. The Hubble Space Telescope, for example, operates at an altitude of about 380 miles (610 kilometres), with an orbital period of 97 minutes.

- 4 Which tropical cyclone caused millions of rands damage to the South African East Coast in 1984?
 - 1 Linda
 - 2 Agatha
 - 3 Odessa
 - 4 Domoina
 - 5 Andrew

Answer 4 (From the South African Weather Service weathersa.co.za)

A tropical cyclone is a relatively small, intensely developed low pressure cell that usually occur over warm oceans. Its diameter can range between 200 and 2 000 km. It is characterized by a warm centre, very steep pressure gradients and strong cvclonic (clockwise in the southern hemisphere) winds near the Earth's surface. Tropical cyclones with a maximum wind speed of less than 60 km/h are called tropical depressions; when the maximum wind speed ranges between 60 and 110 km/h, they are tropical storms, and when the maximum wind speed exceeds 110 km/h, they are called tropical cyclones. (In the North Atlantic and eastern North Pacific regions it is called

"hurricanes", in the western North Pacific "typhoons.")

The tropical cyclone season in our part of the world is from November to April, with the peak frequency in January and February. Only tropical cyclones moving into the Mozambique channel influence South Africa's weather. When this happens, we usually experience dry weather over the interior because of the subsiding air surrounding a tropical cyclone. Only a few move in over or close enough to the land to cause destruction, and then usually north of the 25S latitude. In such cases, the Northern Province, Mpumalanga and KwaZulu-Natal may experience destructive winds and the risk of flooding. Significant tropical cyclones that had such an effect on South Africa was "Domoina" which occurred in January 1984, "Imboa" in February 1984 and more recently Eline in February 2000.

- 5 Where and in which year was one of the only big earth tremors in South Africa noted?
 - 1 Pretoria, 1904
 - 2 Stellenbosch, 1940
 - 3 Tulbach, 1969
 - 4 Welkom, 1940
 - 5 Ventersdorp, 1969

Answer (www.iafrica.com)

JOHANNESBURG: Earth tremor strikes Klerksdorp, Wed, 09 Mar 2005 Miners at Durban Roodepoort Deep (DRD) near Stilfontein were being evacuated early on Wednesday afternoon after an earth tremor measuring a preliminary five on the Richter scale. DRD spokesperson Ilja Graulicj said there had been four

aftershocks. He could not offer further details. Anglo American spokesperson Andries van Zyl said that while the company was aware of the seismic event, it appeared that its operations had not been affected. A number of buildings had to be evacuated in the town of Stilfontein. Emergency services in nearby Klerksdorp, about 200km south west of Johannesburg, rushed to Stilfontein after several reports of damaged buildings were received. Spokesperson Mesh Letanta told Sapa an entire block of flats housing elderly people had to be evacuated after the building was severely damaged. "It is no longer fit for human habitation," he said. Two high schools in the mining town were also evacuated as the walls were damaged. He said by early Wednesday afternoon emergency services had received a report of only one minor injury. The tremor's epicentre was believed to be around Klerksdorp, said lan Saunders, project leader of the SA National Seismograph Network at the Council for Geoscience in Pretoria. He said such a measure was "quite serious" for South Africa, which is an aseismic country (not prone to earthquakes). "It's rather early to say anything," said Saunders. He said the largest earthquake to have hit South Africa — in Ceres in the Western Cape in 1969 had measured 6.1 on the Richter scale. It was not yet known whether the Klerksdorp guake was related to mining or due to natural causes. The tremor was felt as far as Johannesburg. Sapa

6 Which one of the following type of clouds is found closest to the surface of the earth?

- 1 Cirrostratus
- 2 Altostratus
- 3 Cirrus
- 4 Nimbostratus
- 5 Cumulus

Answer 5 (Wikipedia)

A cloud is a visible mass of condensed droplets, frozen crystals suspended in the atmosphere above the surface of the Earth or another planetary body, such as a moon. (Clouds can also occur as masses of material in interstellar space, where they are called interstellar clouds and nebulae.) The branch of meteorology in which clouds are studied is nephology. On Earth the condensing substance is typically water vapour, which forms small droplets or ice crystals, typically 0.01 mm in diameter. When surrounded by billions of other droplets or crystals they become visible as clouds. Dense deep clouds exhibit a high reflectance (70% to 95%) throughout the visible range of wavelengths: they thus appear white, at least from the top. Cloud droplets tend to scatter light efficiently, so that the intensity of the solar radiation decreases with depth into the cloud, hence the grey or even sometimes dark appearance of the clouds at their base. Thin clouds may appear to have acquired the colour of their environment or background, and clouds illuminated by non-white light, such as during sunrise or sunset, may be coloured accordingly. In the near-infrared range, clouds would appear darker because the water that constitutes the cloud droplets strongly absorbs solar radiation at those wavelengths. Clouds are divided into two general categories: layered and convective.

These are named stratus clouds (or stratiform, the Latin *stratus* means "layer") and cumulus clouds (or cumuliform; *cumulus* means "piled up"). These two cloud types are divided into four more groups that distinguish the cloud's altitude. Clouds are classified by the cloud base height, not the cloud top.

Cirrostratus clouds belong to a class characterized by a composition of ice crystals and often by the production of halo phenomena. They appear as whitish and usually somewhat fibrous veils, often covering the whole sky and sometimes so thin as to be hardly discernible. Cirrostratus clouds are signs that precipitation will follow in the next 12-24 hours. These clouds are located above 6,000m (20,000ft).

Altostratus is a cloud belonging to a class characterized by a generally uniform grey sheet or layer, lighter in colour than nimbostratus and darker than cirrostratus. You can usually see the sun shining through them, and frequently cover the whole sky. Altostratus is caused by a large air mass that is lifted then condensed, usually by an incoming frontal system and can be found over wide-spread areas. Altostratus clouds are potentially dangerous, because they can cause ice accretion on aircraft. Their altitude is from 6,500-20,000 feet.

Cirrus clouds are composed of ice crystals and are characterized by thin, wisplike strands, often accompanied by tufts. Sometimes these wispy clouds are so extensive that they are virtually indistinguishable from one another, forming a veil or sheet called "cirrostratus". Sometimes convection at high altitudes produces another form of cirrus called

"cirrocumulus", a pattern of small cloud tufts which include droplets of super-cooled water. Many cirrus clouds produce hair-like filaments made of the heavier ice crystals that precipitate from them. These "fall streaks", a form of virga, often indicate the difference in the motion of air (wind shear) between the upper part of the cirrus cloud and the air below it. Sometimes the top of the cirrus cloud is moving rapidly above a slower layer of air, or the streak is falling into a faster moving lower layer. The directions of these winds can also vary. Cirrus usually form at altitudes above 8000 meters (26,000 feet). The fall streaks may appear straight when wind shear is absent, giving the clouds the appearance of a comma (cirrus uncinus), or tangled, an indication of highlevel turbulence. The falling ice crystals evaporate before reaching the ground.

Nimbo is from the Latin word "nimbus" meaning rain. A Nimbostratus is a cloud of the class characterized by a formless layer that is almost uniformly dark grey; it is a rain cloud of the layer type, of low altitude, usually below 8000 ft (2400 m) and sometimes down to 350 ft (100 m). Nimbostratus block a great amount of sunlight as a result of its characteristic dense structure. Thickness of nimbostratus layer is usually 6500-10000 ft (2000-3000 meters), but can reach up to 15000 ft (4500 m) and down to 3500 ft (1000 m). Nimbostratus in rare cases can be very thin and accompanied by separate layer of altostratus divided by cloudless layer.

Cumulus clouds are clouds that are usually of a puffy, popcorn-like appearance, with noticeable vertical development and clearly defined edges. They can be found singly, or

in lines or cluster at low altitudes (0-2 km). Given enough instability, moisture and temperature gradient, they are precursors of many other types of cloud, for instance, cumulonimbus. One of the unique characteristics of cumulus clouds is their creation of wind. This happens because the first rain to fall from the base of a cumulus cloud evaporates into the air beneath and cools it, often by several degrees. The cooled air descends. The colder the air is relative to the air around it, the faster it will fall. Thus, a ground observer will generally feel a gust of strong, cold wind being pushed ahead of large cumulus clouds -- especially in the case of cumulus clouds being generated from the result of a cold front.

- 7 Which one of the following animals is not a vertebrate animal?
 - 1 Frog
 - 2 Lungfish
 - 3 Lobster
 - 4 Dove
 - 5 Red- bait

Answer 3 (Encyclopaedia Britannica)

Lobsters are numerous marine crustaceans Kingdom: Animalia, Phylum: Arthropoda, Subphylum: Crustacea, Class:

Malacostraca, Order: Decapoda, Infraorder: Astacidea Family: Nephropidae: true lobsters; Palinuridae, spiny lobsters, or sea crayfish; Scyllaridae, slipper, Spanish, or shovel lobsters; and Polychelidae, deep-sea lobsters. All are marine and benthic (bottomdwelling), and most are nocturnal. Lobsters scavenge for dead animals but also eat live fish, small mollusks and other bottomdwelling invertebrates, and seaweed. Some

species, especially of true and spiny lobsters, are commercially important. The lobster has a rigid, segmented body covering (exoskeleton) and five pairs of legs, one or more pairs of which are often modified into pincers (chelae) with the chela on one side usually larger than that on the other. The eyes are on movable stalks, and there are two pairs of long antennae. Several pairs of swimming legs (swimmerets) are on the elongated abdomen. A flipper-like tail is used for swimming; flexure of the tail and abdomen propel the animal backward.

- 8 What is the name of the multi-role fighter that is being purchased to replace the aged fleet of Mirages for the South African Air Force?
 - 1 Gripen
 - 2 Rafael
 - 3 Euro fighter
 - 4 F-16
 - 5 Joint Strike Fighter

Answer 1

The Saab JAS 39 "**Gripen**" (*Griffin* or "Gryphon", see picture below) is a fighter aircraft manufactured by the Swedish aerospace company Saab. The aircraft is in service with the Swedish Air Force, the Czech Republic Air Force and the Hungarian Air Force, and has been ordered by the South African Air Force. In April 2007, Norway signed an agreement on a joint development programme of the aircraft. Gripen International acts as a prime contracting organisation and is responsible for marketing, selling and supporting the Gripen fighter around the world.



Also called Fighting Falcon, the F-16 is a single-seat, single-engine jet fighter built by the General Dynamics Corporation (now part of the Lockheed Martin Corporation) for the United States and more than a dozen other countries. The F-16 originated in an order placed in 1972 for a lightweight, costeffective air-to-air fighter; current models are also all-weather capable, and it is effective for ground attack as well. The U.S. Air Force took first delivery in 1978. The F-16 is 49 feet (15 m) long and has a wingspan of 31 feet (9.45 m). It is powered by a single Pratt & Whitney or General Electric turbofan engine, which, with afterburning, can generate 23,000 to 29,000 pounds (102 to 130 kilonewtons) of thrust, accelerating the aircraft to more than twice the speed of sound. Weaponry includes a 20-millimetre rotary cannon as well as attachments under the wings and fuselage for a wide variety of bombs and missiles. With a typical combat load, the F-16 weighs approximately 23,000 pounds (10,000 kg), which is less than half the weight of the previous-generation F-4 Phantom II. The fuselage of the F-16 flares out at its juncture with the aluminium-alloy wings, giving the aircraft greater lift and stability at steep angles of attack. A computerized "fly-by-wire" stabilizing system issues continuous commands to control

surfaces in the tail and wings, and a "headsup-display" instrumentation system projects flying and combat data onto a transparent screen in front of the pilot. In addition, a highly sophisticated bomb-aiming system, using a laser range-finder and high-speed digital data processing, permits ordinary "dumb" bombs to be dropped with precision accuracy from low altitudes. Such structural and electronic innovations made the F-16 a highly capable and versatile aircraft. It has been built under license in Belgium, The Netherlands, Turkey, and South Korea and is the basis for Japan's FS-X fighter. It has been sold to U.S. allies in the Middle East. where it proved very effective in air-to-air combat and ground attack in the Israeli-Syrian conflict of 1982 and in the Persian Gulf War of 1990-91.



- 9 Who made world news with the discovery of the coelacanth on the coast of South Africa?
 - 1 J.L.B. Smith
 - 2 Charles Darwin
 - 3 Ernest H. Starling
 - 4 Cleveland P. Hickman Jr
 - 5 Allan Larson

Answer 1 (Encyclopaedia Britannica/ Wikipedia)

Coelocanths are the lobe-finned bony fishes of the order Crossopterygii. Members of the

related but extinct suborder Rhipidistia are considered to have been the ancestors of land vertebrates. In some systems of classification, the coelacanths and rhipidistians are considered separate orders, members of the subclass Crossopterygii. Modern coelacanths are deep-sea fishes of the family Latimeriidae. The name refers to their hollow fin spines (Greek: koilos, "hollow"; akantha, "spine"). The modern coelacanths are bigger than most fossil coelacanths and are powerful predators with heavy, mucilaginous bodies and highly mobile, limb-like fins. They average 5 feet (1.5 m) in length and weigh about 100 pounds (45 kg). Coelacanths appeared about 350 million years ago and were abundant over much of the world; the genus Coelacanthus has been found as fossils in rocks from the end of the Permian, 245 million years ago, to the end of the Jurassic, 144 million years ago. Coelacanthus, like other coelacanths, showed a reduction in bone ossification and a general trend toward a marine mode of life away from the earlier freshwater environment. It was lona supposed that coelacanths became extinct about 60 million years ago. However, on December 23, 1938, Hendrik Goosen, the captain of the trawler Nerine returned to the harbour at East London after a trawl around the mouth of the Chalumna River. As he frequently did, he telephoned his friend, Marjorie Courtenay-Latimer, curator at East London's small museum, to see if she wanted to look over the contents of the catch for anything interesting. At the harbour, Latimer noticed a blue fin and took a closer look. There she found what she later described as "the most beautiful fish I

had ever seen, five feet long, and a pale mauve blue with iridescent silver markings." Failing to find a description of the creature in any of her books, she attempted to contact her friend, Professor James Leonard Brierley Smith, but he was away for Christmas. Unable to preserve the fish, she reluctantly sent it to a taxidermist. When Smith returned, he immediately recognized it as a coelacanth, known only from fossils. Smith named the fish Latimeria chalumnae in honour of Marjorie Courtenay-Latimer and the waters in which it was found. The two discoverers received immediate recognition, and the fish became known as a "living fossil." The 1938 coelacanth is still on display in the East London Museum.

10 What is an osteoblast?

- 1 A bony, dermal plate beneath an epidermal scale
- 2 A cell which rebuilds bone
- 3 A cavity in the body encircled by cartilage
- 4 One of the three ear-bones in the middle ears of a mammal
- 5 A channel where blood vessels go through the bone

Answer 2 (Encyclopaedia Britannica)

An osteoblast is large cell responsible for the synthesis of new bone during both initial formation and later remodelling of bone. Osteoblasts form a closely packed sheet on the surface of the bone, from which cellular processes extend through the developing bone. They arise from the differentiation of osteogenic cells in the periosteum, the tissue that covers the outer surface of the

bone, and in the endosteum of the marrow cavity. This cell differentiation requires a regular supply of blood, without which cartilage-forming chondroblasts, rather than osteoblasts, are formed. The osteoblasts produce only the organic, unmineralized component of the bone, called osteoid, which consists of two substances secreted in different regions of the cell: the mucopolysaccharides from Golgi apparatus and collagen fibres from the endoplasmic eticulum. Mucopolysaccharides are the basic component of osteoid, while the collagen strengthens the matrix just as steel rods are used to reinforce concrete. Eventually the osteoblast is engulfed by the growing bone matrix, and as the material calcifies, the cell is trapped and can no longer lay down new bone. Thus entrapped, it becomes an osteocyte or stable bone cell.

11 The gravitational force on Mars is

- 1 half the gravitational force on earth
- 2 a third of the gravitational force on earth
- 3 a quarter of the gravitational force on earth
- 4 the same as the gravitational force on earth
- 5 double the gravitational force on earth

Answer 2 (Encyclopaedia Britannica and the NASA website)

Mars moves around the Sun at a mean distance of 228 million km (140 million miles), or about 1.5 times that of Earth from the Sun. Because of its relatively elongated orbit, the distance between Mars and the

Sun varies from 206.6 million to 249.2 million km (128.4 million to 154.8 million miles). Mars orbits the Sun once in 687 Earth days, which means that its year is nearly twice as long as Earth's. At its closest approach, Mars is less than 56 million km (35 million miles) from Earth, but it recedes to almost 400 million km (250 million miles) when the two planets are on opposite sides of the solar system. Mars is a small planet, larger than only Mercury and slightly more than half the size of Earth. It has an equatorial radius of 3,396 km (2,110 miles) and a mean polar radius of 3,379 km (2,100 miles), both values accurately determined by the Mars Global Surveyor spacecraft, which began its primary mission in orbit around the planet in 1999. The mass of Mars is only one-tenth the terrestrial value, and its gravitational acceleration of 3.72 metres (12.2 feet) per second per second at the surface means that objects on Mars weigh a little more than a third of their weight on Earth's surface.

- 12 Which one of the following is the biggest carnivore on land?
 - 1 Indian elephant
 - 2 Black rhinoceros
 - 3 Siberian tiger
 - 4 Brown bear
 - 5 Kodiak bear

Answer 5 (Encyclopaedia Britannica)

Rhinos and **elephants** are herbivores! **Bears** (Class Mammalia, Order Carnivora, Family Ursidae) of which there are nine species, are large, short-tailed carnivores found in the Americas, Europe, and Asia. The sun bear (*Helarctos malayanus*) is the

smallest, often weighing less than 50 kg (110 pounds), and the largest is a subspecies of Alaskan brown bear called the Kodiak bear (Ursus arctos middendorffi). The polar bear (Ursus maritimus), however, is the largest bear species. The black bear (Ursus americanus) is common in parts of the United States and Canada. Brown bears are native to Europe, Asia, and northwestern North America. More than 80 forms of brown bear have been described: they are treated as several subspecies of Ursus arctos. North American brown bears are traditionally called grizzly bears. Eurasian brown bears are generally solitary animals that are able to run and swim well. They are usually 120-210 cm (48-84 inches) long and weigh 135-250 kg (300-550 pounds); the exceptionally large Siberian brown bear (Ursus arctos beringianus), weighing as much as 360 kg (800 pounds). It approximates the size of the North American grizzly of which a large adult may be about 2.5 metres (8 feet) long and weigh about 410 kg (900 pounds). Brown bears are omnivorous and feed on berries, plant roots and shoots, small mammals, fish, calves of many hoofed animals, and carrion. They often cache food in shallow holes, and they dig readily and strongly in search of rodents. Except in some southern areas, bears retire to dens in winter and therefore accumulate large amounts of fat during late summer and autumn.

The **Kodiak bear** is the largest living land carnivore and may attain a length of more than 3 metres and a weight of 780 kg. It lives only on Kodiak Island in Alaska and neighbouring islands. Because of their bulk and long, straight claws, these bears rarely climb even as cubs.

The Siberian, or Amur, tiger (P. tigris altaica) is the largest member of the cat family, measuring up to 4 metres (13 feet) in total length and weighing up to 300 kg (660 pounds). Its closest rival in strength and ferocity is the lion of which a full-grown male is about 1.8-2.1 metres (6-7 feet) long, excluding the 1-metre tail; he stands about 1.2 metres high at the shoulder and weighs 170-230 kg (370-500 pounds). The female, or lioness, is smaller, with a body length of 1.5 metres, a shoulder height of 0.9-1.1 metres, and a weight of 120-180 kg. The Indian, or Bengal, tiger (*P. tigris tigris*) is the most numerous and accounts for about half of the total tiger population. Males are larger than females and may attain a shoulder height of about 1 metre and a length of about 2.2 metres, excluding a tail of about 1 metre; weight is 160-230 kg (350-500 pounds), and tigers from the south are smaller than those of the north.

- 13 What name can be given to the soil appearing in grasslands in semi-arid and sub-humid areas?
 - 1 Andisols
 - 2 Aridisols
 - 3 Mollsols
 - 4 Alfisols
 - 5 Laterite

Answer 2 (Wikipedia)

Andisols are soils formed in volcanic ash and defined as soils containing high proportions of glass and amorphous colloidal materials, including allophane, imogolite, and ferrihydrite. Because they are

generally guite young, Andisols typically are very fertile except in cases where phosphorus is easily fixed (this sometimes occurs in the tropics). They can usually support intensive cropping, with areas used for wet rice in Java supporting some of the densest populations in the world. Other Andisol areas support crops of fruit, maize, tea, coffee or tobacco. Most Andisols occur around the Pacific Ring of Fire, with the largest areas found in central Chile, Ecuador, Colombia, Mexico, the Pacific Northwest, Japan, Java and New Zealand's North Island. Other areas occur in the Great Rift Valley, Italy, Iceland and Hawaii. Aridisols (from the Latin aridus, for "dry") form in an arid or semi-arid climate. Aridisols dominate the deserts and xeric shrublands which occupy about one third of the Earth's land surface. Aridisols have a very poor concentration of organic matter (In this case decomposed material, humus). Water deficiency is the major definina characteristic of Aridisols. Also required is sufficient age to exhibit sub-soil weathering and development. Imperfect leaching in Aridisols often results in one or more subsurface soil horizons in which suspended or dissolved minerals have been deposited: silicate clays, sodium, calcium carbonate, gypsum or soluble salts.

Alfisols form in semiarid to humid areas, typically under a hardwood forest cover. They have a clay and nutrient-enriched subsoil. "Alf" refers to aluminium (Al) and iron (Fe). Because of their productivity and abundance, the Alfisols represent one of the more important soil orders. They are widely used both in agriculture and forestry and are generally easier to keep fertile than other humid-climate soils, though those in Australia and Africa are still very deficient in nitrogen and available phosphorus. Those in monsoonal tropical regions, however, have a tendency to acidify when heavily cultivated, especially when nitrogenous fertilisers are used.

Laterite is a surface formation in hot and wet tropical areas which is enriched in iron and aluminium and develops by intensive and long lasting weathering of the underlying parent rock. Nearly all kinds of rocks can be deeply decomposed by the action of high rainfall and elevated temperatures. The percolating rain water causes dissolution of primary rock minerals and decrease of easily soluble elements as sodium, potassium, calcium, magnesium and silicon. This gives rise to a residual concentration of more insoluble elements predominantly iron and aluminium. Laterites consist mainly of the minerals kaolinite, goethite, hematite and gibbsite which form in the course of weathering. Moreover, many laterites contain guartz as relatively stable relic mineral from the parent rock. The iron oxides goethite and hematite cause the redbrown colour of laterites.

14 What is the map scale of the current topographic series of South Africa?

1	1:1000
2	1:10 000
3	1:40 000

- 4 1:50 000
- 5 1:100 000

Answer 4

This information was obtained from the website of Eastview Cartographic,' (http://www.cartographic.com), a leading provider of South Africa 1:50K Topographic Maps and other global geospatial data. The map was Published by: Chief Directorate: Surveys and Mapping (CDSM) in 1970 - 2003

15 During August 2003 Mars was the closest to earth that it will be in 60 000 years. The distance from the earth (in millions of kilometres) was

1	6
2	16
3	26
4	56
5	86

Answer 4 (Wikipedia)

Mars made its closest approach to Earth in nearly 60,000 years: 55,758,006 km on August 27, 2003, at 9:51:13 UT. This occurred when Mars was one day from opposition and about three days from its perihelion, making Mars particularly easy to see from Earth. The last time it came so close is estimated to have been on September 12, 57,617 BC., the next time being in 2287. However, this record approach was only very slightly closer than other recent close approaches. The orbital changes of Earth and Mars are making the approaches nearer: the 2003 record will be bettered 22 times by the year 4000. 16 Why is it sometimes possible to see a star that lies directly behind the sun?

- 1 Light is bent by the presence of mass
- 2 Space is bent by gravitation
- 3 Light changes direction every time it enters a new medium
- 4 Light changes direction ` during temperature changes
- 5 Reflection against other planets

Answer 5

A star is a massive, luminous ball of plasma. Stars group together to form galaxies, and they dominate the visible universe. The nearest star to Earth is the Sun, which is the source of most of the energy on Earth, including daylight. Other stars are visible in the night sky, when they are not outshone by the Sun. A star shines because nuclear fusion in its core releases energy which traverses the star's interior and then radiates into outer space. Almost all elements heavier than hydrogen and helium were created inside the cores of stars. The energy produced by stars, as a by-product of nuclear fusion, radiates into space as both electromagnetic radiation and particle radiation. The particle radiation emitted by a star is manifested as the stellar wind (which exists as a steady stream of electrically charged particles, such as free protons, alpha particles, and beta particles, emanating from the star's outer layers) and as a steady stream of neutrinos emanating from the star's core. The production of

energy at the core is the reason why stars shine so brightly: every time two or more atomic nuclei of one element fuse together to form an atomic nucleus of a new heavier element, gamma ray photons are released from the nuclear fusion reaction. This energy is converted to other forms of electromagnetic energy, including visible light, by the time it reaches the star's outer layers. The colour of a star, as determined by the peak frequency of the visible light, depends on the temperature of the star's outer layers, including its photosphere. Besides visible light, stars also emit forms of electromagnetic radiation that are invisible to the human eye. In fact. stellar electromagnetic radiation spans the entire electromagnetic spectrum, from the longest wavelengths of radio waves and infrared to the shortest wavelengths of ultraviolet,

X-rays and gamma rays. All components of stellar electromagnetic radiation, both visible and invisible, are typically significant.

- 17 Which of the following mineral is the most expensive per weight?
 - 1 Gold
 - 2 Palladium
 - 3 Platinum
 - 4 Iron ore
 - 5 Chrome

Answer 3

The following table comes from the Business Report of the Independent OnLine. The last column shows the metal prices in dollars, as on October 9, 2007.

Precious Metals	% Move	Last move
Gold	-0.61 💌	728.40
Palladium	-0.14 💌	358.00
Platinum	-0.26 💌	1355.00
Silver	-0.56 🔻	13.18
Don't miss our <u>Mining</u> <u>Report</u> which includes news on <u>Mining</u> , <u>Gold</u> , <u>Platinum</u> and <u>Commodition</u>	Gold Price	747 735 724 712 700

Please note that Gold, Platinum, Palladium, Rhodium, Ruthenium, Osmium and Iridium are rare and precious metals used in jewellery and industry as catalysts and are thus expensive. We take daily interest in their prices (as economic indicators) because South Africa is the main producer of these.

- 18 Which one of the following organic compounds is not aromatic?
 - 1 Benzene
 - 2 Acetic acid
 - 3 Toluene
 - 4 Pyridine
 - 5 Benzoic acid

Answer 2 (Wikipedia)

These are the structures of the mentioned compounds;



Aromaticity is a chemical property in which a conjugated ring of unsaturated bonds, lone pairs, or empty orbitals exhibit a stabilization stronger than would be expected by the stabilization of conjugation alone. It can also be considered a manifestation of cyclic delocalization and of resonance. This is usually considered to be because electrons free to cycle around circular are arrangements of atoms, which are alternately single- and double-bonded to one another. These bonds may be seen as a hybrid of a single bond and a double bond, each bond in the ring identical to every other. An aromatic compound contains a set of covalently-bound atoms with specific characteristics:(1) A delocalized conjugated π system, most commonly an arrangement of alternating single and double bonds (2) Coplanar structure, with all the contributing atoms in the same plane (3) Contributing atoms arranged in one or more rings (4) A number of π delocalized electrons that is even, but not a multiple of 4. This is known as Hückel's rule. Permissible numbers of π electrons include 2, 6, 10, 14, and so on. (5) Special reactivity in organic reactions such as electrophilic aromatic substitution and nucleophilic aromatic substitution.

- 19 Which characteristic is used to classify mammals?
 - 1 Viviparous
 - 2 External ear
 - 3 Hide covering
 - 4 Three bones in the middle ear
 - 5 Stereoscopic vision

Answer 3 (Encyclopaedia Britannica)

Mammals are a group of vertebrate animals in which the young are nourished with milk from special mammary glands of the mother. In addition to these characteristic milk glands, mammals are distinguished by several other unique features. Hair is a typical mammalian feature, although in many whales it has disappeared except in the foetal stage. The mammalian lower jaw is hinged directly to the skull, instead of through a separate bone (the quadrate) as in all other vertebrates. A chain of three tiny bones transmits sound waves across the middle muscular ear. Α diaphragm separates the heart and the lungs from the abdominal cavity. Only the left aortic arch persists. (In birds the right aortic arch persists; in reptiles, amphibians, and fishes both arches are retained.) Mature red blood cells (erythrocytes) in all mammals lack a nucleus: all other vertebrates have nucleated red blood cells. Except for the monotremes (an egg-laying order of mammals comprising echidnas and the duck-billed platypus), all mammals are viviparous-they bear live young. In the placental mammals (including humans), the young are carried within the mother's womb, reaching a relatively advanced stage of development before birth. In the marsupials (kangaroos, opossums, and allies), the newborn are incompletely developed at birth and continue to develop outside the womb, attaching themselves to the female's body in the area of her mammary glands. Some marsupials have a pouch-like structure or fold, the marsupium, that shelters the suckling young. The class Mammalia is worldwide in distribution. It has been said that mammals have a wider distribution and are more adaptable than any other single class of animals, with the exception of certain less-complex forms such as arachnids and insects. This versatility in exploiting the Earth is attributed in large part to the ability of mammals to regulate their body temperatures and internal environment both in excessive heat and aridity and in severe cold.

- 20 What are fullerenes mainly used for?
 - 1 As fluxing agent in the making of glass
 - 2 As superconductors
 - 3 As catalysts
 - 4 As dehydrating agents
 - 5 As cleaning agents

Answer 2 (Encyclopaedia Britannica)

Fullerenes, also called buckminsterfullerene are a series of hollow carbon molecules that form either a closed cage ("buckyballs") or a cylinder (carbon "nanotubes"). The first fullerene was discovered in 1985 by Sir Harold W. Kroto of the United Kingdom and by Richard E. Smalley and Robert F. Curl, Jr., of the United States. Using a laser to vaporize graphite rods in an atmosphere of helium gas, these chemists and their assistants obtained cage-like molecules composed of 60 carbon atoms (C₆₀) joined together by single and double bonds to form a hollow sphere with 12 pentagonal and 20 hexagonal faces—a design that resembles a football, or soccer ball. In 1996 the trio was awarded the Nobel Prize for their pioneering efforts. The C₆₀ molecule was named

buckminsterfullerene (or, more simply, the buckyball) after the American architect R. Buckminster Fuller, whose geodesic dome is constructed on the same structural The elongated cousins principles. of carbon buckyballs, nanotubes, were identified in 1991 by Iijima Sumio of Japan. Prior to their discovery, only two well-defined allotropes of carbon were known-diamond three-dimensional (composed of а crystalline array of carbon atoms) and graphite (composed of stacked sheets of two-dimensional hexagonal arrays of carbon atoms). The fullerenes constitute a third form, and their discovery has led to an entirely new understanding of the behaviour of sheet materials, and it has opened an entirely new chapter of nanoscience and nanotechnology-the "new chemistry" of complex systems at the atomic scale that exhibit advanced materials behaviour. Nanotubes in particular exhibit a wide range of novel mechanical and electronic properties. They are excellent conductors of heat and electricity, and they possess an astonishing tensile strength. Such properties hold the promise of exciting applications in electronics, structural materials. and medicine. Practical applications, however, will only be realized when accurate structural control has been achieved over the synthesis of these new materials.

The C_{60} molecule undergoes a wide range of novel chemical reactions. It readily accepts and donates electrons, a behaviour that suggests possible applications in batteries and advanced electronic devices. The molecule readily adds atoms of hydrogen and of the halogen elements thus opening useful routes to a wide range of novel fullerene derivatives. Some of these derivatives exhibit advanced materials behaviour. Particularly important are crystalline compounds of C_{60} with alkali metals and alkaline-earth metals; these compounds are the only molecular systems to exhibit superconductivity at relatively high temperatures above 19 K. Superconductivity is observed in the range 19 to 40 K, equivalent to -254 to -233 °C or -425 to -387 °F.

- 21 On which planet in our solar system do the winds have the greatest velocities?
 - 1 Jupiter
 - 2 Saturn
 - 3 Earth
 - 4 Mars
 - 5 Neptune

Answer: Wikipedia

Jupiter is the fifth planet from the Sun and the largest planet within the solar system. It is two and a half times as massive as all of the other planets in our solar system combined. Jupiter, along with Saturn, Uranus and Neptune, is classified as a gas giant. Together, these four planets are sometimes referred to as the Jovian planets, where Jovian is the adjectival form of Jupiter. The planet was known by astronomers of ancient times and was associated with the mythology and religious beliefs of many cultures. The Romans named the planet after the Roman god Jupiter (also called Jove). When viewed from Earth, Jupiter can reach an apparent magnitude of -2.8, making it the third

brightest object in the night sky after the moon and Venus. (However, at certain points in its orbit, Mars can briefly exceed Jupiter's brightness.). Jupiter is primarily composed of hydrogen with a small proportion of helium; it may also have a rocky core of heavier elements. Because of its rapid rotation the planet is an oblate spheroid (it possesses a slight but noticeable bulge around the equator). The outer atmosphere is visibly segregated into several bands at different latitudes, resulting in turbulence and storms along their interacting boundaries. A prominent result is the Great Red Spot, a giant storm that is known to have existed since at least the seventeenth century. Surrounding the planet is a faint planetary ring system and a powerful magnetosphere. There are also at least 63 moons, including the four large moons called the Galilean moons that were first discovered by Galileo Galilei in 1610. Ganymede, the largest of these moons, has a diameter greater than that of the planet Mercury. Jupiter has been explored on several occasions by robotic spacecraft, most notably during the early Pioneer and Voyager fly-by missions and later by the Galileo orbiter. The latest probe to visit Jupiter was the Pluto-bound New Horizons spacecraft in late February 2007. The probe used the gravity from Jupiter to increase its speed and adjust its trajectory toward Pluto, thereby saving years of travel. Future targets for exploration include the possible ice-covered liquid ocean on the Jovian moon Europa.

Saturn is the sixth planet from the Sun and the second largest planet in the Solar System, after Jupiter. Along with the planets

Jupiter, Uranus, and Neptune, it is classified as a gas giant (also known as a Jovian planet, after the planet Jupiter). It was named after the Roman god Saturnus, equated to the Greek Kronos (the Titan father of Zeus) and the Babylonian Ninurta. The day in the week Saturday gets its name from the planet. Saturn is primarily composed of hydrogen, with small proportions of helium and trace elements. The interior consists of a small core of rock and ice, surrounded by a thick layer of metallic hydrogen and a gaseous outer layer. Wind speeds on Saturn can reach 1,800 km/h, significantly faster than those on Jupiter. Saturn has a planetary magnetic field intermediate in strength between that of Earth and the more powerful field around Jupiter. Saturn has a prominent system of rings, consisting mostly of ice particles with a smaller amount of rocky debris and dust. Sixty known moons orbit the planet. Titan, Saturn's largest and the Solar System's second largest moon (after Ganymede), is larger than the planet Mercury and is the only moon in the Solar System to possess a significant atmosphere.

Earth is the third planet from the Sun and is the largest of the terrestrial planets in the Solar System, in both diameter and mass. It is also referred to as *the Earth*, *Planet Earth*, *Gaia*, *Terra*, and "the World". Home to millions of species including humans, Earth is the only place in the universe known to harbor life. Scientific evidence indicates that the planet formed 4.54 billion years ago, and life appeared on its surface within a billion years. Since then, Earth's biosphere has significantly altered the atmosphere and other abiotic conditions on the planet,

enabling the proliferation of aerobic organisms as well as the formation of the ozone layer which, together with Earth's magnetic field, blocks harmful radiation, permitting life on land. Earth's outer surface is divided into several rigid segments, or tectonic plates, that gradually migrate across the surface over periods of many millions of years. About 71% of the surface is covered with salt-water oceans, the remainder consisting of continents and islands; liquid water, necessary for all known life, is not known to exist on any other planet's surface. Earth's interior remains active, with a thick layer of relatively solid mantle, a liquid outer core that generates a magnetic field, and a solid iron inner core. Earth interacts with other objects in outer space, including the Sun and the Moon. At present, Earth orbits the Sun once for every roughly 366.26 times it rotates about its axis. This length of time is a sidereal year, which is equal to 365.26 solar days. The Earth's axis of rotation is tilted 23.4° away from the perpendicular to its orbital plane, producing seasonal variations on the planet's surface with a period of one tropical year. Earth's only known natural satellite, the Moon, which began orbiting it about 4.53 billion years ago, provides ocean tides, stabilizes the axial tilt and gradually slows the planet's rotation.

Mars is the fourth planet from the Sun in the Solar System. The planet is named after Mars, the Roman god of war. It is also referred to as the "Red Planet" because of its reddish appearance as seen from Earth. A terrestrial planet with a thin atmosphere, Mars has surface features reminiscent both of the impact craters of the Moon and the

volcanoes, valleys, deserts and polar ice caps of Earth. It is the site of Olympus Mons, the highest known mountain in the solar system, and of Valles Marineris, the In largest canyon. addition to its geographical features, Mars' rotational period and seasonal cycles are likewise similar to those of Earth. Until the first flyby of Mars by Mariner in 1965, it was speculated that there might be liquid water on the planet's surface. Still, of all the planets in our solar system other than Earth, Mars is the most likely to harbour liquid water, and perhaps life. Mars is currently host to three functional orbiting spacecraft: Mars Odyssey, Mars Express, and Mars Reconnaissance Orbiter. This is more than any planet except Earth. The surface is also home to the two Mars Exploration Rovers (Spirit and *Opportunity*). Geological evidence gathered by these and preceding missions suggests that Mars previously had large-scale water while coverage, observations also indicate that small geyserlike water flows have occurred in recent years. Mars has two moons, Phobos and Deimos, which are small and irregularly shaped. These may be captured asteroids, similar to 5261 Eureka, a Martian Trojan asteroid. Mars can be seen from Earth with the naked eye. Its apparent magnitude reaches -2.9, a brightness surpassed only by Venus, the Moon, and the Sun, though most of the time Jupiter will appear brighter to the naked eye than Mars.

Neptune is the eighth and farthest known planet from the Sun in the Solar System. It is the fourth largest planet by diameter, and the third largest by mass. Neptune is 17 times the mass of Earth and is slightly more

massive than its near-twin Uranus, which is 14 Earth masses and less dense. The planet is named after the Roman god of the sea. Neptune's atmosphere is primarily composed of hydrogen and helium along with traces of methane. The methane in the atmosphere, in part, accounts for the planet's blue appearance, but because Neptune's colour is much more vivid than that of Uranus, which has a similar amount of methane. another component is presumed to contribute to Neptune's intense colour. Neptune also has the strongest winds of any planet in the solar system, measured as high as 2,100 km/h. At the time of the 1989 Voyager 2 flyby, it had in its southern hemisphere a Great Dark Spot comparable to the Great Red Spot on Jupiter. Neptune's temperature at its cloud tops is usually close to -218 ℃, one of the coldest in the solar system, due to its great distance from the sun. The temperature in Neptune's centre is about 7,000 ℃, which is comparable to the Sun's surface and similar to most other known planets. Discovered on September 23, 1846, Neptune was the first discovered mathematical planet by prediction rather than regular observation. Perturbations in the orbit of Uranus led astronomers to deduce Neptune's existence. It has been visited by only one spacecraft, Voyager 2, which flew by the planet on August 25, 1989. In 2003, there was a proposal to NASA's "Vision Missions Studies" to implement a "Neptune Orbiter with Probes" mission that does Cassini-level science without fission-based electric power or propulsion.

22 Which land animal has the biggest heart?

- 1 Rhinoceros
- 2 Black rhinoceros
- 3 White rhinoceros
- 4 Hippopotamus
- 5 Giraffe

Answer 5 (Wikipedia)

For its great height and size, modifications to the giraffe's structure have evolved, particularly to the circulatory system. A giraffe's heart, which can weigh up to 10 kg (22 lb) and measure about 2 feet long, has to generate around double the normal blood pressure for an average large mammal in order to maintain blood flow to the brain against gravity. In the upper neck, a complex pressure-regulation system called the rete mirabile prevents excess blood flow to the brain when the giraffe lowers its head to drink. Conversely, the blood vessels in the lower leas are under great pressure (because of the weight of fluid pressing down on them). In other animals such pressure would force the blood out through the capillary walls; giraffes, however, have a very tight sheath of thick skin over their lower limbs, which maintains high extra vascular pressure in exactly the same way as a pilot's g-suit.

23 What is bryology?

- 1 Study of embryos
- 2 Study of mosses
- 3 Study of pine trees
- 4 Study of ferns
- 5 Study of snails

Answer 2 (Wikipedia)

Bryology is the branch of botany concerned with the scientific study of bryophytes (mosses, liverworts. hornworts). and Bryophytes were first studied in detail in the 18th century. The German botanist Johann Jacob Dillenius (1687-1747) was a professor at Oxford and in 1717 produced the work "Reproduction of the ferns and mosses." The beginning of bryology really belongs to the work of Johannes Hedwig, who clarified the reproductive system of mosses (1792, Fundamentum historiae naturalist muscorum) and arranged a taxonomy. Areas of research include bryophyte taxonomy, bryophytes as bioindicators, DNA sequencing, and the interdependency of bryophytes and other plant and animal species. Among other things, scientists have learned that certain species of mosses are carnivorous.

- 24 The NASA space probe, Gallileo, was recently deliberately crashed. Into which planet did it crash to avoid possible contamination of that planet's moon, Europa?
 - 1 Jupiter
 - 2 Saturn
 - 3 Venus
 - 4 Mars
 - 5 Neptune

Answer: Wikipedia

Galileo was an unmanned spacecraft sent by NASA to study the planet Jupiter and its moons. Named after the astronomer and Renaissance pioneer Galileo Galilei, it was launched on October 18, 1989 by the Space

Shuttle Atlantis on the STS-34 mission. It arrived at Jupiter on December 7, 1995, a little more than six years later, via gravitational assist flybys of Venus and Earth. Despite antenna problems, Galileo conducted the first asteroid flyby, discovered the first asteroid moon, was the first spacecraft to orbit Jupiter, and launched the first probe into Jupiter's atmosphere. On September 21, 2003, after 14 years in space and 8 years of service in the Jovian system, Galileo's mission was terminated by sending the orbiter into Jupiter's atmosphere at a speed of nearly 50 kilometres per second to avoid any chance of it contaminating local moons with bacteria from Earth. Of particular concern was the ice-crusted moon Europa, which, thanks to *Galileo*, scientists now suspect harbours a salt water ocean beneath its surface.

- 25 The last Rolls Royce NASA Space Probe is on its way towards Saturn and will reach the planet within the next two years. What is the space probe's name?
 - 1 Galileo
 - 2 Hubble
 - 3 Cassini
 - 4 Sojoirner
 - 5 Viking

Answer 3 (NASA)

Cassini is the first spacecraft to orbit Saturn. The NASA orbiter is studying the intriguing features of Saturn's system of rings and moons. It also delivered the European Space Agency's Huygens Probe into the atmosphere of Saturn's moon Titan. Just hours after it arrived at Saturn, the orbiter sent back surprising science data and images that shed new light on the structure of Saturn's beautiful rings. The orbiter's 4-year primary mission should reveal much about Saturn and its intriguing system of rings and moons.



- 26 Modern cars are deigned to use lead-free fuels. What is the **main reason** for this?
 - 1 The lead damages the modern catalytic converter
 - 2 The lead causes recession of the valve seat
 - 3 The lead causes high combustion temperatures
 - 4 The lead causes poisonous gases
 - 5 The lead is too heavy for modern engines

Answer (Wikipedia)

The mixture known as gasoline, when used in high compression internal combustion engines, has a tendency to ignite early (*preignition* or *detonation*) causing a damaging "engine knocking" (also called "pinging" or "pinking") noise. The discovery that lead additives modified this behaviour led to the widespread adoption of the practice in the 1920s and therefore more powerful higher compression engines. The most popular additive was tetra-ethyl lead. However, with the discovery of the environmental and health damage caused by the lead, and the incompatibility of lead with catalytic converters found on virtually all US automobiles since 1975, this practice began to wane in the 1980s. Most countries are phasing out leaded fuel; different additives have replaced the lead compounds. The most popular additives include aromatic hydrocarbons, ethers and alcohol (usually ethanol or methanol). A side effect of the lead additives was protection of the valve seats from erosion. Many classic cars' engines have needed modification to use lead-free fuels since leaded fuels became unavailable.

27 Under standard conditions, the boiling point of water in the following three temperature scales is

	^o Celsius	^o Fahrenheit	Kelvin
1	100	212	273
2	100	132	373
3	100	212	373
4	100	320	373
5	373	212	100

Answer 3 (Wikipedia)

Fahrenheit is a temperature scale named after the German-Dutch physicist Daniel Gabriel Fahrenheit (1686–1736), who proposed it in 1724. In this scale, the melting point of water is 32 degrees Fahrenheit (written "32 °F"), and the boiling point is 212 degrees, placing the boiling and melting points of water exactly 180 degrees apart. On the Celsius scale, the melting and boiling points of water are exactly 100 degrees apart, thus the unit of this scale, a degree Fahrenheit, is $\frac{5}{9}$ of a degree Celsius. The Fahrenheit scale coincides with the Celsius scale at - 40 °F, which is the same temperature as - 40 °C.

The kelvin (symbol: K) is a unit increment of temperature and is one of the seven SI base units. The Kelvin scale is a thermodynamic (absolute) temperature scale where absolute zero — the coldest possible temperature is zero kelvin (0 K). The Kelvin scale and the kelvin are named after the Irish-born physicist and engineer William Thomson, 1st Baron Kelvin (1824 – 1907). Absolute zero-the temperature at which nothing could be colder and minimal heat energy remains in a substance—is defined as being precisely 0 K and -273.15℃. The triple point of water (the temperature and pressure at which three phases (gas, liquid, and solid) substance may coexist of that in thermodynamic equilibrium) is defined as being precisely 273.16 K and 0.01 C. This definition fixes the magnitude of both the degree Celsius and the unit kelvin as being precisely 1 part in 273.16 parts. Thus, it sets the magnitude of one degree Celsius and the kelvin to be exactly equivalent. Additionally, it establishes the difference between the two scales' null points as being precisely 273.15 degrees Celsius

 $(-273.15 \ ^{\circ}C = 0 \ K \text{ and } 0.01 \ ^{\circ}C = 273.16 \ K).$

Celsius is, or relates to, the Celsius temperature scale (previously known as the centigrade scale). The degree Celsius (symbol: °C) can refer to a specific temperature on the Celsius scale as well as serve as unit increment to indicate a temperature *interval* (a difference between two temperatures or an uncertainty).

"Celsius" is named after the Swedish astronomer Anders Celsius (1701 – 1744), who developed a similar temperature scale two years before his death.

- 28 Which famous scientist made the equation E = mc² well known world-wide?
 - 1 Isaac Newton
 - 2 Albert Einstein
 - 3 Stefan Boltzman
 - 4 Erwin Schrödinger
 - 5 Werner Heisenberg

Answer (Wikipedia)

Sir **Isaac Newton** FRS (4 January 1643 – 31 March 1727) [OS: 25 December 1642 – 20 March 1727] was an English physicist, mathematician, astronomer, natural philosopher, and alchemist. His treatise *Philosophiae Naturalis Principia*

Mathematica, published in 1687, described universal gravitation and the three laws of motion, laying the groundwork for classical mechanics, which dominated the scientific view of the physical universe for the next three centuries and is the basis for modern engineering. He showed that the motion of objects on Earth and of celestial bodies are governed by the same set of natural laws by demonstrating the consistency between Kepler's laws of planetary motion and his theory of gravitation, thus removing the last doubts about heliocentrism and advancing the scientific revolution. In mechanics, Newton enunciated the principles of conservation of momentum and angular momentum. In optics, he invented the reflecting telescope and developed a theory

of colour based on the observation that a prism decomposes white light into a visible spectrum. He also formulated an empirical law of cooling and studied the speed of sound. In mathematics, Newton shares the credit with Gottfried Leibniz for the development of the calculus. He also demonstrated the generalized binomial theorem, developed the so-called "Newton's method" for approximating the zeroes of a function, and contributed to the study of power series.

Albert Einstein (March 14, 1879 – April 18, 1955) was a German-born theoretical physicist. He is best known for his theory of relativity and specifically mass-energy equivalence, $E = mc^2$. Einstein received the 1921 Nobel Prize in Physics "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect." Einstein's many contributions to physics include his special theory of relativity, which reconciled mechanics with electromagnetism, and his general theory of relativity which extended the principle of relativity to non-uniform motion, creating a new theory of gravitation. His other contributions include relativistic cosmology, capillary action, critical opalescence, classical problems of statistical mechanics and their application to quantum theory, an explanation of the Brownian movement of molecules, atomic transition probabilities, the quantum theory of a monatomic gas, thermal properties of light with low radiation density (which laid the foundation for the photon theory), a theory of radiation including stimulated emission. the conception of a unified field theory, and the geometrization of physics.

Ludwig Eduard Boltzmann (February 20, 1844 – September 5, 1906) was an Austrian physicist famous for his founding contributions in the fields of statistical mechanics and statistical thermodynamics. He was one of the most important advocates for atomic theory when that scientific model was still highly controversial.

Erwin Rudolf Josef Alexander

Schrödinger (August 12, 1887 – January 4, 1961) was an Austrian - Irish physicist who achieved fame for his contributions to quantum mechanics, especially the Schrödinger equation, which describes the space- and time-dependence of quantum mechanical systems and for which he received the Nobel Prize in 1933. In 1935. after extensive correspondence with personal friend Albert Einstein, he proposed the Schrödinger's cat thought experiment.

Werner Karl Heisenberg (December 5, 1901 – February 1, 1976) was a celebrated German physicist and Nobel laureate, one of the founders of quantum mechanics and acknowledged to be one of the most important physicists of the twentieth century. He was born in Würzburg, Germany and died in Munich. Heisenberg was the head of the German nuclear energy project, though the nature of this project, and his work in this capacity, has been heavily debated. He is most well-known for discovering one of the central principles of modern physics, the Heisenberg uncertainty principle.

- 29 What is the thickness of the Antarctic ice layer?
 - 1 1000 m
 - 2 2000 m

3	3000 m
4	4000 m

5 5000 m

Answer (Encyclopaedia Britannica)

Lying almost concentrically around the South Pole, Antarctica—the name of which means "opposite to the Arctic" - is the southernmost continent, a circumstance that has had momentous consequences for all aspects of its character. It covers about 5.5 million square miles (14.2 million square km), and would be essentially circular except for the outflaring Antarctic Peninsula, which reaches toward the southern tip of South America (some 600 miles [970 km] away), and for two principal embayments, the Ross Sea and the Weddell Sea. These deep embayments of the southernmost Pacific and Atlantic oceans make the continent somewhat pear-shaped, dividing it into two unequal-sized parts. The larger is generally known as East Antarctica because most of it lies in east longitudes. The smaller, wholly in west longitudes, is generally called West Antarctica. East and West Antarctica are separated by the 1,900mile-long Transantarctic Mountains.

Whereas East Antarctica consists largely of a high, ice-covered plateau, West Antarctica consists of an archipelago of mountainous islands covered and bonded together by ice. The continental ice sheet contains approximately 7 million cubic miles (29 million cubic km) of ice, representing about 90 percent of the world's total. The average thickness is about 1.5 miles (2.45 km). Many parts of the Ross and Weddell seas are covered by ice shelves, or ice sheets floating on the sea. These shelves-the

Ross Ice Shelf and the Filchner-Ronne Ice Shelf-together with other shelves around the continental margins, constitute about 10 percent of the area of Antarctic ice. Around the Antarctic coast, shelves, glaciers, and ice sheets continually "calve," or discharge, icebergs into the seas. Because of this vast ice, the continent supports only a primitive indigenous population of cold-adapted land plants and animals. The surrounding sea is as rich in life as the land is barren. With the decline of whaling and sealing, the only economic base in the past, Antarctica now principally exports the results of scientific investigations that lead to а better understanding of the total world environment.

- The Lotto consists of 6 winning numbers plus one bonus number.
 How many possible combinations can be made with the 6-digit winning number?
 - 1 46 658
 - 2 6 000 000
 - 3 15 625 000 000
 - 4 11 441 304 000
 - 5 254 251 200

Answer 3 (The Independent OnLine)

Win by taking every Lotto combination *February 14 2003 at 05:57AM*

You have one in 14 million chances of winning Saturday night's estimated R40million Lotto jackpot. By spending about R35-million, you could get every possible combination of numbers - and come out R5million richer. Explaining the odds, Uthingo spokesperson Shenanda Janse van Rensburg said: "If you want to cover all the permutations, you will have to spend a lot of money. You will have to cover about 14 million combinations, and that's impossible." "We don't want anybody to spend so much money. Most of our millionaires have spent just R2, 50 or R5. You don't necessarily increase your chances the more tickets you buy." This is part of an article that was originally published on page 1 of The Star on February 14, 2003

- 31 Which greenhouse gas has the greatest influence on the greenhouse effect?
 - 1 Ozone
 - 2 Carbon dioxide
 - 3 Water vapour
 - 4 Nitrogen dioxide
 - 5 Oxygen

Answer (Encyclopaedia Britannica)

The greenhouse effect is the warming of the Earth's surface and troposphere (the lowest layer of the atmosphere), caused by the presence of water vapour, carbon dioxide, methane, and certain other gases in the air. Of these gases, known as greenhouse gases, water vapour has the largest effect. The atmosphere allows most of the visible light from the Sun to pass through and reach the Earth's surface. As the Earth's surface is heated by sunlight, it radiates part of this energy back toward space as infrared radiation. This radiation, unlike visible light, tends to be absorbed by the greenhouse gases in the atmosphere, raising its temperature. The heated atmosphere in turn radiates infrared radiation back toward the Earth's surface. (Despite its name. the greenhouse effect is different from the warming in a greenhouse, where panes of glass transmit visible sunlight but hold heat inside the building by trapping warmed Without the heating caused by air). the greenhouse effect, the Earth's average surface temperature would be only about -18 $^{\circ}$ C (0 $^{\circ}$ F). On Venus the very high concentration of carbon dioxide in the atmosphere causes an extreme greenhouse effect resulting in surface temperatures as high as 450 °C (840 °F). Although the greenhouse effect is a naturally occurring phenomenon, it is possible that the effect could be intensified by the emission of greenhouse gases into the atmosphere as the result of human activity. From the beginning of the Industrial Revolution through the end of the 20th century, the amount of carbon dioxide in the atmosphere increased 30 percent and the amount of methane more than doubled. A number of scientists have predicted that human-related increases in atmospheric carbon dioxide and other greenhouse gases could lead to an increase in the global average temperature of 1.4 to 5.8 ℃ (2.5 to 10.4 °F) by the end of the 21st century. This global warming could alter the Earth's climates and thereby produce new patterns and extremes of drought and rainfall and possibly disrupt food production in certain regions. Other scientists involved in climatic research maintain that such predictions are overstated.

32 Which one of the following waves is NOT electromagnetic?

- 1 micro-waves
- 2 visible light
- 3 radio waves
- 4 sound waves
- 5 X-rays

Answer 4 (Encyclopaedia Britannica)

In terms of classical theory, electromagnetic radiation is the flow of energy at the universal speed of light through free space or through a material medium in the form of the electric and magnetic fields that make up electromagnetic waves such as radio waves, visible light, and gamma rays. In such a wave, time-varying electric and magnetic fields are mutually linked with each other at right angles and perpendicular to the direction of motion. An electromagnetic wave is characterized by its intensity and the frequency f of the time variation of the electric and magnetic fields. In terms of the modern quantum theory, electromagnetic radiation is the flow of photons (also called light quanta) through space. Photons are packets of energy hv that always move with the universal speed of light. The symbol h is Planck's constant, while the value of v is the same as that of the frequency of the electromagnetic wave of classical theory. Photons having the same energy hv are all alike, and their number density corresponds the intensity of the radiation. to Electromagnetic radiation exhibits а multitude of phenomena as it interacts with charged particles in atoms, molecules, and larger objects of matter. These phenomena as well as the wavs in which electromagnetic radiation is created and observed. the manner in which such radiation occurs in nature, and its

technological uses depend on its frequency v. The spectrum of frequencies of electromagnetic radiation extends from very low values over the range of radio waves, television waves, and microwaves to visible light and beyond to the substantially higher values of ultraviolet light, X rays, and gamma rays.



Refer to page 41

33 All units can be re-written in terms of base units. For example, a Newton can be written as a kg.m.s⁻². How many base units are there?

1	7
2	10
3	15
4	17
5	19

Answer 1 (Encyclopaedia Britannica)

The following base units have been adopted and defined:

The **metre** has been defined as the distance travelled by light in a vacuum in 1/299,792,458 second.

The standard for the unit of mass, the **kilogram**, is a cylinder of platinum-iridium

alloy kept by the International Bureau of Weights and Measures, located in Sèvres, near Paris. A duplicate in the custody of the National Institute of Standards and Technology serves as the mass standard for the United States.

The **second** is defined as the duration of 9,192,631,770 cycles of the radiation associated with a specified transition, or change in energy level, of the cesium-133 atom.

The **ampere** is defined as the magnitude of the current that, when flowing through each of two long parallel wires separated by one metre in free space, results in a force between the two wires (due to their magnetic fields) of 2 x 10^{-7} newton (the newton is a unit of force equal to about 0.2 pound) for each metre of length.

The thermodynamic, or **Kelvin**, scale of temperature used in SI has its origin or zero point at absolute zero and has a fixed point at the triple point of water (the temperature and pressure at which ice, liquid water, and water vapour are in equilibrium), defined as 273.16 kelvins. The Celsius temperature scale is derived from the Kelvin scale. The triple point is defined as 0.01 degree on the Celsius scale, which is approximately 32.02 degrees on the Fahrenheit temperature scale.

The **mole** is defined as the amount of substance containing the same number of chemical units (atoms, molecules, ions, electrons, or other specified entities or groups of entities) as exactly 12 grams of carbon-12.

The **candela** is defined as the luminous intensity in a given direction of a source that emits monochromatic radiation at a

frequency of 540 x 10^{12} hertz and that has a radiant intensity in the same direction of $\frac{1}{683}$ watt per steradian (unit solid angle).

34 How far is the moon from the earth (in km)?

1	70 000
2	134 800
3	278 540
4	384 400
5	400 000

Answer 4 (Encyclopaedia Britannica)

The moon is the earth's sole natural satellite and nearest large celestial body. Known since prehistoric times, it is the brightest object in the sky after the Sun. The Moon is a spherical rocky body, probably with a small metallic core, revolving around Earth in a slightly eccentric orbit at a mean distance of about 384,000 km (238,600 miles). Its equatorial radius is 1,738 km (1,080 miles), and its shape is slightly flattened in such a way that it bulges a little in the direction of Earth. Its mass distribution is not uniform-the centre of mass is displaced about 2 km (1.2 miles) toward Earth relative to the centre of the lunar sphere, and it also has surface mass concentrations, called mascons for short, that cause the Moon's gravitational field to increase over local areas. The Moon has no global magnetic field like that of Earth, but some of its surface rocks have remanent magnetism, which indicates one or more periods of magnetic activity in the past. The Moon presently has very slight seismic activity and little heat flow from the interior,

indications that most internal activity ceased long ago.

dodecahedron have?	
1 11	
2 12	
2 12	
4 20	
5 22	

Answer 2 (Wikipedia)

A dodecahedron is any polyhedron with twelve faces, but usually a regular dodecahedron is meant: a Platonic solid composed of twelve regular pentagonal faces, with three meeting at each vertex. It has twenty (20) vertices and thirty (30) edges. lts dual polyhedron is the icosahedron. To the ancient Greeks, the dodecahedron was a symbol of the universe.

36 The speed of sound differs from medium to medium. Through which medium will sound travel at 1 500 m/s?

1	Air
2	Water
3	Wood
4	Stone
5	Steel

Answer 1 (Wikipedia)

The speed at which sound travels depends on the medium through which the waves are passing, and is often quoted as a fundamental property of the material. In general, the speed of sound is proportional to the square root of the ratio of the elastic modulus (stiffness) of the medium and its density. Those physical properties and the speed of sound change with ambient conditions. For example, the speed of sound in gases depends on temperature. In air at sea level, the speed of sound is approximately 769.5 mph (1,238.3 km/h) at 68 °F (20 °C), in water 3,315.1 mph (5,335.1 km/h) at 20 ℃ (68 °F), and in steel 13,332.1 mph (21,446 km/h). The speed of sound is also slightly sensitive (a second order effect) to the sound amplitude, which means that there are nonlinear propagation effects, such as the production of harmonics and mixed tones not present in the original sound.

- 37 Which one of the following formulas is the correct one for candle wax?
 - 1 C₁₈H₃₀
 - 2 C₂₃H₄₀
 - 3 C₂₀H₄₀
 - 4 C₂₃H₄₆
 - 5 C₁₈H₃₂

Answer (Wikipedia)

Candles are mainly made from beeswax or paraffin wax. The main components of beeswax are palmitate, palmitoleate, hydroxypalmitate and oleate esters of longchain (30-32 carbons) aliphatic alcohols, with the ratio of triacontanylpalmitate CH₃(CH₂)₂₉O-CO-(CH₂)₁₄CH₃ to cerotic acid $CH_3(CH_2)_{24}COOH$, the two principal components, being 6:1. Paraffin wax is mostly found as a white, odourless, tasteless, waxy solid, with a typical melting

point between about 47 °C and 64 °C. It is insoluble in water, but soluble in ether, benzene, and certain esters. Pure paraffin wax is an extremely good electrical insulator, with an electrical resistivity of between 10¹³ and 10¹⁷. This is better than nearly all other materials except some plastics (notably teflon). It is an effective neutron moderator and was used in James Chadwick's 1932 experiments to identify the neutron. Paraffin wax $(C_{25}H_{52})$ is an excellent material to store heat, having a specific heat capacity of 2.14-2.9 J g⁻¹ K⁻¹ and a heat of fusion of 200-220 J/g.^[5] The substance expands considerably when it melts and this property is exploited in thermostats for industrial, domestic and, particularly, automobile use.

- 38 "There was a young lady from Dwight who could travel much faster than light. She went out one day, in a relative way, and came back the previous night." Which famous scientist's theory is referred to in this limerick?
 - 1 Rutherford
 - 2 Bohr
 - 3 La Grange
 - 4 Halley
 - 5 Einstein

Answer (Wikipedia)

The special theory of relativity was proposed in 1905 by Albert Einstein in his article "On the Electrodynamics of Moving Bodies". The principle of relativity was proposed some three centuries earlier by Galileo and Einstein's theory generalized Galilean

relativity from only mechanics to all laws of physics including electrodynamics. To stress this point, Einstein not only widened the postulate of relativity, but added the second postulate - that all observers will always measure the speed of light to be the same no matter what their state of uniform linear motion is. This theory has a variety of surprising consequences that seem to violate common sense, but all have been experimentally verified. lt yields the equivalence of matter and energy, as expressed in the mass-energy equivalence formula $E = mc^2$, where c is the speed of light in a vacuum. Special relativity agrees with Newtonian mechanics in their common realm of applicability, in experiments in which all velocities are small compared to the speed of light. The theory was called "special" because it applies the principle of relativity only to inertial frames. Einstein developed general relativity to apply the principle generally, that is, to any frame, and that theory includes the effects of gravity. Special relativity does not account for gravity, but it can deal with accelerations. Although special relativity makes some quantities relative, such as time, that we would have imagined to be absolute based on everyday experience, it also makes absolute some others that we would have thought were relative. In particular, it states that the speed of light is the same for all observers, even if they are in motion relative to one another. Special relativity reveals that c is not just the velocity of a certain phenomenon - light - but rather a fundamental feature of the way space and time are tied together. In particular, special

relativity states that it is impossible for any material object to accelerate to light speed.

39 Between which two degrees of latitude does South Africa lie?

1	22º to 35º south
2	16º to 33º south
3	20º to 40º south
4	16º to 35º north
5	22º to 35º north

The most correct answer is 1

The answer can be worked out from the following world map.



South Africa occupies the southern tip of the African continent, stretching from $22^{\circ}S$ to $35^{\circ}S$ latitude and from $17^{\circ}E$ to $33^{\circ}E$ longitude.

40 The primary coil of a transformer has 200 windings. The secondary coil has 250 windings. The transformer can convert a potential difference of

- 2 240 V to 192 V
- 3 120 V to 125 V
- 4 220 V to 250 V
- 5 220 V to 176 V

Answer 1

As there are more turns on the secondary than the primary coil, it is a step-up transformer: the secondary PD, $P_S > P_P$, Primary PD. Answers 2 & 5 impossible.

$$V_{\rm P}/200 = V_{\rm S}/250$$
 or $V_{\rm P}/V_{\rm S} = 0.8$

200/250 = 0.8

Thus, 1 is the correct answer

41 The speed of sound through air is 330 m/s. A boy stands at a distance from a cliff. He shouts "hallo" and 3 seconds later he hears the echo. How far is the boy from the cliff?

1	990 m
2	660 m
3	495 m
4	110 m
5	55 m

Answer 3

In 3 seconds sound travels 990 m which is from the boy **and** back, i.e. the cliff face is 990/2 m away, or 495 m

- 42 For a ray of light to be able to reflect internally, it must
 - I go from optically denser to optically less dense medium
 - II go from optically less dense to optically more dense medium
 - III have an angle of incidence greater than the critical angle
 - IV have an angle of incidence smaller than the critical angle

Which of the above statements is/are correct?

i unu m

2 II and IV

3 I and IV

4 II and III

5 only III

Answer 1

The diagram shows the correct details for total internal reflection. So statements (ii) ands (iv) are incorrect.



- 43 A biconcave lens will form an image
 - 1 behind the leans, real and enlarged
 - 2 behind the lens, non-real and diminished
 - 3 in front of the lens, real and enlarged
 - 4 in front of the lens, non-real and diminished
 - 5 in front of the lens, non-real and enlarged

Answer 4

From the diagram it is clear that answer 4 is correct.



- 44 The colours of a rainbow, as they appear next to each other, are
 - 1 violet, blue, indigo, yellow, green, orange, red
 - 2 violet, indigo, blue, green, yellow, orange, red
 - 3 red, yellow, orange, green, blue, indigo, violet
 - 4 red, orange, yellow, green, indigo, blue, violet

Answer 2

The well known "rhyme" (or mnemonic) "Richard Of York Gave Battle In Vain" meaning Red, Orange, Yellow, Green, Blue, Indigo, Violet. Going backwards gives the answer.

- 45 Which one of the following statements is/are **true** for an object moving at constant velocity?
 - I The forces on the object are balanced
 - II The acceleration is zero
 - III There is no equilibrant force
 - IV The resultant force is in the direction of the motion
 - 1 I, II, III and IV
 - 2 I, II and III
 - 3 II and III
 - 4 Only II
 - 5 Only III

Answer 2

Statements (i) and (ii) are true.

Statement (iii): the equilibrant is what puts a resultant force into equilibrium. If there is no equilibrant, then there is no resultant, which is the same as statement 1, so (iii) is true. Statement (iv) is wrong.

46 A man stands on the roof of a tall building and throws a golf ball vertically upwards with an initial velocity of 20 m/s. The displacement, velocity and acceleration of the ball at 2 seconds are

	Displacement	Velocity	Acceleration
1	20 m up	0 m/s	0 m/s ²
2	15 m up	5 m/s up	10 m/s ² down
3	20 m up	0 m/s	10 m/s ² down
4	20 m down	20 m/s down	10 m/s ² down
5	20 m up	10 m/s up	10 m/s ² up

Answer 3

Using $s = ut + \frac{1}{2}at^2$ and putting in the given values we get:

s = 20 x 2 - $\frac{1}{2}$ x 10 x 2² = 20 m. Similarly using v = u + at and putting in the values we get: v = 20 - 10 x 2 = 0 (g < 0 because up is taken as +). So after 2 seconds, s = 20 m; v = 0 and g = -1 0 m.s⁻²

47 The graph shows the motion of a ball which is thrown vertically upwards, hits the ground and then moves up again, etc.



At which point on the graph does the ball leave the ground for the first time?

1	Α
2	В
3	С
4	D
5	Е

Answer 4

The ball is moving upwards (at say U m.s⁻¹) and at A reaches it highest point (U = 0) and starts falling down. It strikes the floor at B (at - U m.s⁻¹), reaches zero speed at C and leaves the floor at D (at say V m.s⁻¹).

48 In the equation of $s = ut + 1/2at^2$ and v = u + atthe unit of the last term of each, is

	1/2 at ²	at
1	m	m/s
2	m/s	m
3	m/s	m/s ²
4	m²/s²	m/s
5	m	m/s ²

Answer 1

In the first equation, each term must the same units as ${\bf s}$ and in the second equation

each term must have the same units as $\boldsymbol{v},$ i.e. m and m.s^{-1} respectively.

The following information must be used to answer the next <u>four</u> multiple choice questions

The velocity-time graph below represents the motion of a rocket which accelerates from rest going vertically upwards. After a certain time the engines are switched off.



49 What was the magnitude of the acceleration of the rocket during the first 20 seconds of its motion?

1	10 m/s²
2	5 m/s ²
3	2 m/s ²
4	1 m/s ²
5	0

Answer

For the next four questions the following can be used.

Answer 3



From O to Y:

a = v/t since (u = 0) or a = $100/20 = 5 \text{ m.s}^{-2}$ From the moment the rocket's engine is cut it decelerates at -10 m.s^{-2} (from Y to X): twice that from O to Y. This means that time from O to Y is twice that from Y to X (or MX). So the time from M to X is 10 seconds, so OX is 30 s.

The total displacement is equal to areas OMY + YMX.

 $OMY = 100 \times 20 \times \frac{1}{2} = 1000 \text{ m}$, and

 $YMX = 100 \times 10 \times \frac{1}{2} = 500 \text{ m}.$

So displacement = 1 500 m

Answer 2

50 What happens to the rocket on time x?

This is the moment at which

- 1 the engines are switched off
- 2 the acceleration of the rocket becomes zero
- 3 the rocket starts to move downwards
- 4 the rocket hits the ground
- 5 the direction of the acceleration changes

51 What is the value of the time x on the graph?

1	20 s
2	25 s
3	30 s
4	40 s
5	50 s

Answer 3

52 What is the maximum height that the rocket reaches above the ground?

1	1000 m
2	1500 m
3	2000 m

- 4 2500 m
- 5 3000 m
- 0 0000

Answer 2

53 Three objects are connected to each other by two strings, as shown in the diagram. A force F moves the system to the right on a frictionless horizontal surface.



The tension in the strings T_1 and T_2 respectively, is

- 1 F/5 and F/3
- 2 F/6 and F/2
- 3 F/3 and F/2
- 4 5F/3 and 2F/3
- 5 F/2 and F/3

Answer 2

By looking at the forces acting on each block we get:

$F - T_2 = 3a$	(1)
$T_2 - T_1 = 2a$	(2)
T ₁ = a	(3)

This means that F = 6a and so a = F/6. Putting this value into equation 1 we get:

 $F - 3F/6 = T_2 = F/2$ and similarly for equation. $3T_1 = F/6$

54 The object in the diagram is being pushed over a horizontal surface with a force F. The object moves with a constant velocity. The force of friction between the object and the surface is f.

The work done to push the object in a straight line over **distance**, **s**, is

1	F.s
2	f.s
3	(F -f). s
4	ma. s

Answer 1

Work is defined as force x distance moved by a force (in direction of force). In the question, some of the effort goes into accelerating the block and the rest goes into doing work against friction. So $W = F \times s$

Another way of looking at this is: the work done against friction is $W_F = f \times s$ and so what's left over (F - f_S) is the work done in accelerating the object over distance, **s**, which is: Total work done: $W = W_A + W_F = (F - f_S)s + f_Ss$ $= Fs - f_Ss + f_Ss = Fs.$ $W_A = (F - f_S) \times s = m \times a \times s$ (if a = 0, then all the work is done against friction and $F = f_S$)

55 A rocket with weight W on the earth is projected into space. When it is on a height equal to the diameter of the earth, above the earth, the mass of the rocket is only half of the original mass because of the fuel being used up. What will the weight of the rocket be now?

1	W/18
2	W/8
3	W/4
4	2W/9
5	W

Answer 1



On Earth W = mg = GmM/r² so g = GM/r² In space the rocket is 2r above the Earth's surface or 3r from the centre, so: g' = GM/9r² Here the rockets weight is W' = m/2 x g' = G x m/2 x M/9r²

=
$$GmM/18r^2$$

But W = GmM/r^2 so W' = W/18

56 A ball, mass m, falls vertically downwards and hits the ground with a speed of 3v. The ball the goes away from the ground with a speed of 2v.



The impulse of the ground on the ball is

- 1 mv upwards
- 2 mv downwards
- 3 5mv upwards
- 4 5mv downwards
- 5 2.5mv upwards

Answer 3

The magnitude of the change of momentum is 3V - (-2V) = 5V.

Since the ball moves upwards afterwards, the impulse of the floor on the ball is upwards.

> The following information was used to set the next two multiple choice questions:

The diagram below shows a few of the electrical filed lines around two electrically charged particles P and Q.



57 With reference to the charge

- 1 the charge on P is the biggest
- 2 the charge on Q is the biggest
- 3 the charge on P and Q is the same

Answer 2

- 58 With reference to the forces
 - 1 the force of P on Q is the biggest
 - 2 the force of Q on P is the biggest
 - 3 the force of P on Q has the same magnitude as the force of Q on P

Answer 3

59 S straight current carrying conductor is placed in such a way that the current in the conductor flows in the direction out of the plane of the paper. The conductor is placed between two poles of two magnets as shown.



The conductor will experience a force in the direction

- 1 P
- 2 Q
- 3 R
- 4 S
- 5 Into the plane of the paper

Answer 2

If the Thumb, Forefinger and Index finger (representing the Thrust or force, Field and Current I) of the left hand are held at right angles to each other, the force on the conductor will be towards Q.

60 In a Millikan-type experiment there are two oil droplets P and Q between the charged plates, as shown in the diagram. Droplet P is at rest while droplet Q is moving upwards.



The polarity of the charges on P and Q is

	Р	Q
1	+	+
2	neutral	-
3	-	-
4	-	+
5	+	-

Answer 3

The upper plate is positively charged, and both particles are attracted to it, so both must have a negative charge. The reason why one is moving upwards and the other is stationary is:

For the stationary particle the upward force of the negative charge is balanced exactly by the weight of the particle, and for the particle moving upwards, the force produced by the negative charge is greater than its weight.

- 61 The concept "emf" of a battery can be explained as
 - 1 the rate at which chemical energy is converted to electrical energy in the battery
 - 2 the rate at which charge is supplied to the circuit
 - 3 the rate at which energy is supplied to the circuit
 - 4 the charge supplied per unit energy
 - 5 rates at which energy is supplied per unit current

Answer 5

From the definition of the volt: "work done per unit charge" – the best answer is 5.

62 The following two questions are set with reference to the circuit below.



Three identical bulbs are connected as shown in the circuit diagram below. The battery has internal resistance.

What will happen to the reading on the ammeter if the switch is closed? It will

- 1 increase
- 2 decrease by very little
- 3 stay the same
- 4 become zero
- 5 decrease significantly

Answer 1

If the switch is closed, then the total resistance will decrease and so the total current will increase: reading on ammeter will increase. This is because for identical resistors in parallel, the total resistance of the combination will be less than the resistance of a single element of the combination.

- 63 What will happen to the reading on the voltmeter if the switch is closed?It will
 - 1 increase
 - 2 decrease
 - 3 stay the same
 - 4 become zero
 - 5 first increase and then decrease

Answer 2

Since the battery has internal resistance, an increase in current will cause a small decrease in the PD across the terminals.

64 The diagram shows a circuit with two identical resistors. The battery has a negligible internal resistance.



What will be the effect on the ammeter and voltmeter if the switch S is closed?

	Ammeter reading	Voltmeter reading
1	Increases	Increases
2	Increases	Decreases
3	Decreases	Becomes zero
4	Decreases	Increases
5	Decreases	Decreases

Answer 1

When the switch is closed the resistor beneath the switch is effectively "shorted out" which means that the total resistance of the circuit decreases and so the current increases.

When the switch is open, the voltmeter is measuring the PD across one resistor or 1/2 the PD across the battery). When the switch is closed, the voltmeter is effectively reading the PD across the battery and so the reading will increase (or effectively double).



For more information:

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