1 (a) Figure 1.1 shows a speed–time graph for a car journey.

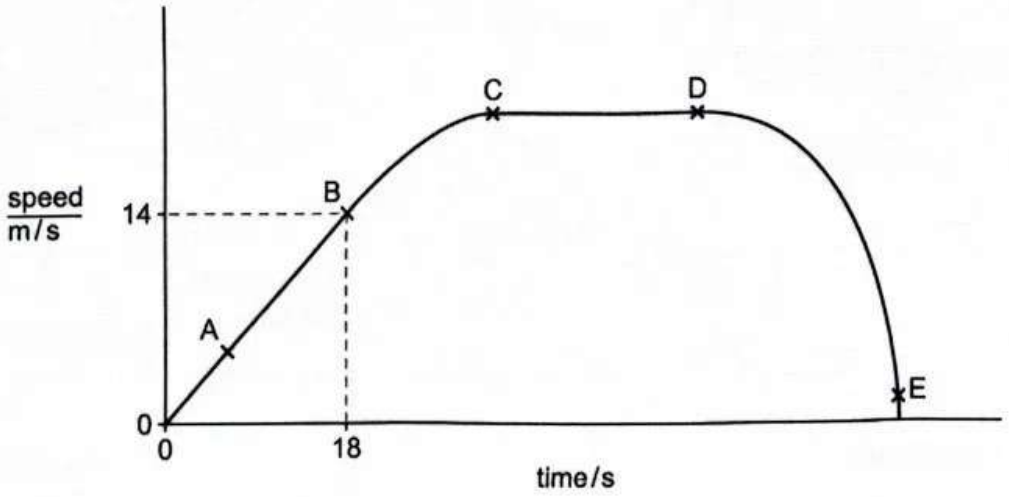

Figure 1.1

(i) State the motion of the car between:

A and B ..... constant acceleration .....

C and D ..... constant speed .....

D and E ..... deceleration at changing rate .....

[3]

(ii) Calculate the distance travelled between time = 0 and time = 18 s.

Distance : Area under the graph

$= \frac{1}{2} \times 18 \times 14 = 126\text{m}$

distance = ... 126 ..... m [2]

(b) Velocity is a vector quantity.

(i) Complete the sentence.

A vector quantity has magnitude (size) and ..... direction ..... . [1]

(ii) Draw a line under each of the quantities in the list that is a vector quantity.

acceleration **electric field strength** **energy**

mass **time** **weight**

[2]

2 **(a)** A satellite is in a circular orbit around the Earth.

(i) State the direction of the force acting on the satellite.

Towards the center of the earth ..... [1]

(ii) A rocket is used to carry the satellite into space.

The initial mass of the rocket and satellite is 1.5×10^4 kg.

The initial force provided by the rocket is 1.9×10^5 N.

Calculate the initial acceleration of the rocket.

$W = mg = 1.5 \times 10^4 \times 9.8 = 1.47 \times 10^5 N$

$\Sigma F = F - W = 1.9 \times 10^5 - 1.47 \times 10^5 = 0.43 \times 10^5 N$

$\Sigma F = ma \quad a = \frac{F}{m}$

$a = \frac{43000}{1.5 \times 10^4} \simeq 2.9 ms^{-2}$

2.9

acceleration = ... m/s^2 [3]

(b) A large balloon filled with helium floats in the Earth's atmosphere.

(i) Explain, in terms of particles, how the helium gas exerts a pressure on the inside of the balloon.

Gas particles move freely and collide with the wall of ballon, Force exerted on the inner wall where pressure caused on inner area [3]

(ii) The temperature of the air at the balloon's highest point above the Earth is 228 K.

Determine, in °C, the temperature of the air at this height.

$K = °C + 273 \quad °C = 228 - 273 = -45°C$

- 45

temperature = ...°C [1]

[Total: 8]

3 Figure 3.1 shows an electric shower.

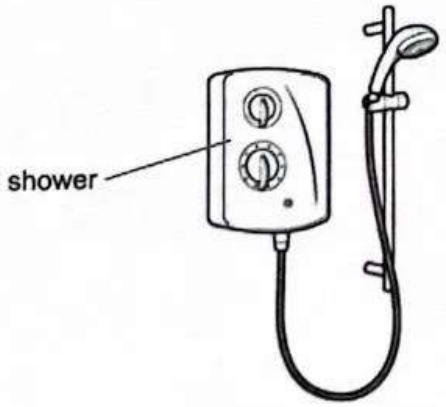

Figure 3.1

The temperature of water as it enters the shower is 15 °C. The water is heated in the shower. The water leaves the shower at a temperature of 38 °C.

(a) The density of water is 1000 kg/m^3.
The specific heat capacity of water is 4200 J/(kg °C).

(i) The water flows through the shower at a rate of 0.0045 m^3/min.

Show that the mass of water that leaves the shower in 4.0 min is 18 kg.

$V = 0.045\ m^3/min \times 4\ min = 0.018\ m^3$

$M = \rho V = 1000 \times 0.018 = 18\ kg$

[2]

(ii) Calculate the energy required to increase the temperature of 18 kg of water from 15 °C to 38 °C.

$\Delta\theta = 38°C - 15°C = 23°C$

$C = \frac{E}{m\Delta\theta}$ $E = mC\Delta\theta = 4200 \times 18 \times 23$

$= 1.7 \times 10^6\ J$

energy = 1.7×10^6 J [2]

(iii) The energy in 3(a)(ii) is transferred to the water in 4.0 min.

Calculate the power transferred to the water.

$P = \frac{W}{t} = \frac{\Delta E}{t} = \frac{1.7 \times 10^6}{4 \times 60} = 7 \times 45 W \approx 7200 W$

power = 7200 W [2]

(b) At another time, the temperature of the water leaving the shower is higher. The power supplied to the water remains constant.

Suggest **one** reason for this increase in temperature.

smaller water flowing rate

less mass [1]

[Total: 7]

less heat loss to surrounding

higher room temperature

4 (a) Define 'impulse' in words.

Impulse = Force x time (change of momentum) [1]

(b) A student jumps from the top of a low wall to the ground. The mass of the student is 55 kg. As the student reaches the ground, her speed is 4.6 m/s.

(i) The student stops moving 0.95 s after her feet first touch the ground.

Calculate the resultant force exerted on the student as she stops moving.

↑ +v

$F = \frac{\Delta p}{t} = \frac{mv - mu}{t} = \frac{55 \times (0 - 4.6)}{0.95} = -266\,N$

$\approx -270\,N$

resultant force = (-) 270 N [2]

(ii) As the student lands, she bends her knees.

Explain how this prevents the student from being injured.

Use ideas about force, momentum and time in your answer.

Student could bend her knees, which increases the landing time. Momentum doesn't change, hence the force acted on her is smaller [3]

(iii) Another student stands on the ground.

The area in contact with the ground is 380 cm^2.

The weight of the student is 530 N.

Calculate the pressure exerted by the student on the ground. State the unit.

$P = \frac{F}{A} = \frac{530}{380} = 1394\,Pa = 1.4 \times 10^{4}\,Pa$

pressure = 1.4×10^4 unit = Pa [2]

[Total: 8]

5 (a) On a hot day, a student wets his skin with cold water. The water on the student's skin evaporates.

Explain, in terms of particles, why the student's skin temperature decreases.

when evaporation happens, most energetic particles escape from the surface of water. The remaining particles are less energetic, the temperature of remaining water descreases, and the thermal energy transfers from skin to the remaining water, so skin's temperature decreases [3]

(b) Figure 5.1 shows wet clothes on a line in the open air.

Figure 5.1

Water evaporates from the clothes.

State **two** factors which affect the rate of evaporation of the water.

1 wind blowing

2 temperature

[2]

[Total: 5]

6 (a) Complete the definition of the 'principal focus' of a lens.

The principal focus of a lens is a point on the principal axis where ..rays of light parallel to the principle axis converage after passing through a converging lens..... [2]

(b) Figure 6.1 is a full-scale diagram of a converging lens and an object O.

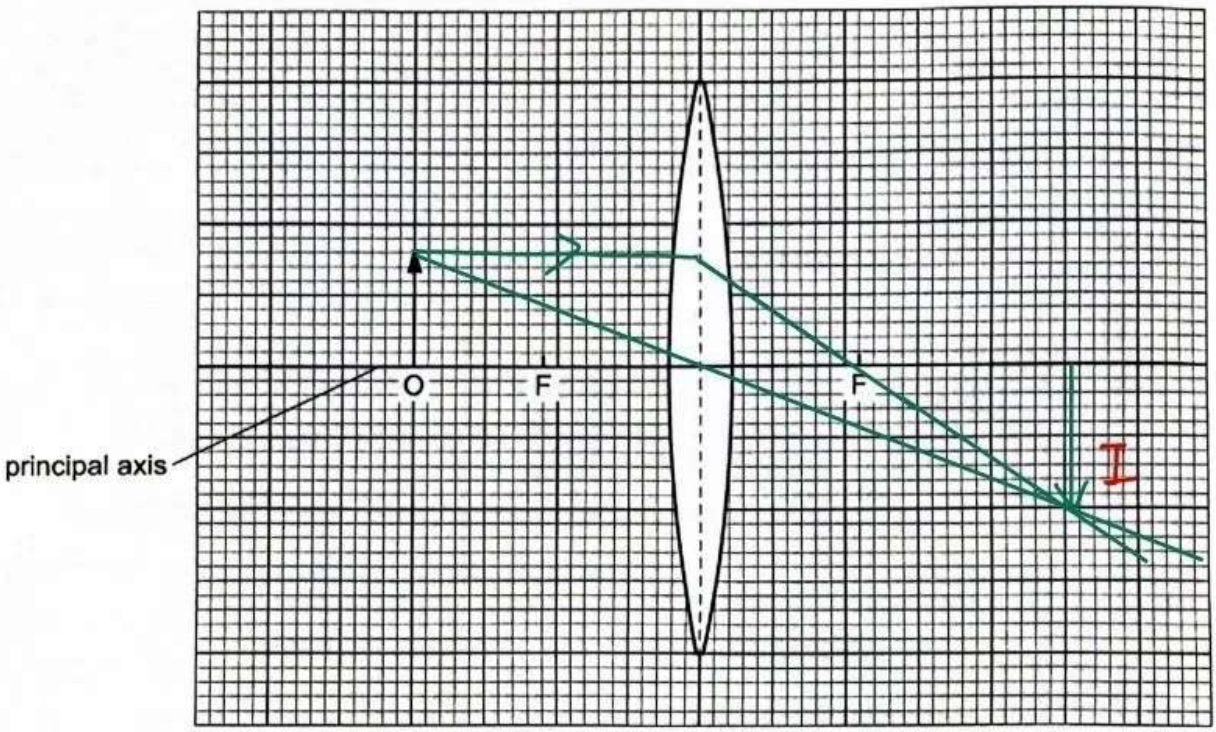

Figure 6.1

The two points labelled F show the positions of the focal points.

On Figure 6.1, draw **two** rays to locate the position of the image. Label the image I. [3]

(c) Visible light is one region of the electromagnetic spectrum.

State the name of the region of the electromagnetic spectrum which has the lowest frequency.

.....radio wave..... [1]

[Total: 6]

7 (a) Figure 7.1 shows a simplified diagram of a loudspeaker.

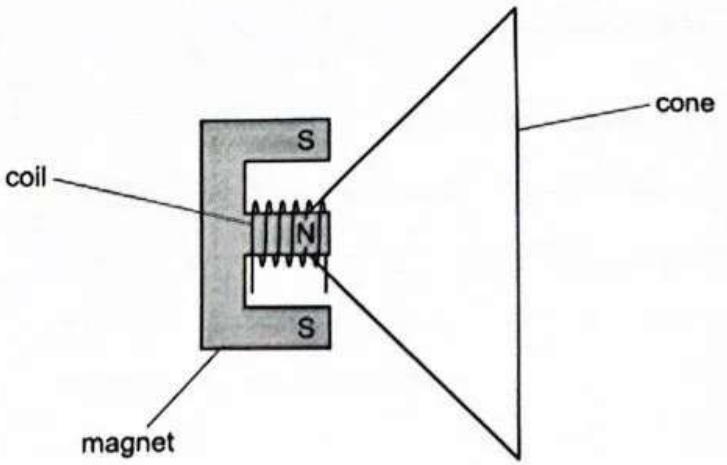

Figure 7.1

(i) Complete the sentences to describe and explain how a loudspeaker produces sound.

A changing magnetic field is produced by the ...alternating current... in the coil.

This magnetic field interacts with the magnetic field due to

the .....magnet..... .

This causes the cone to vibrate. The vibration of the .....air particles.....

transfers energy to a student as sound.

[3]

(ii) A sound of frequency 440 Hz is produced by the loudspeaker. The speed of the sound is 340 m/s.

Calculate the wavelength of this sound. State the unit.

$f = 440\,Hz \quad V = 340\,ms^{-1}$

$V = f \cdot \lambda \quad \lambda = \frac{V}{f} = \frac{340}{440} = 0.77\,m$

wavelength = ...0.77..... unit ...m..... [2]

(b) Define 'ultrasound'.

.....Sound with frequency is more than 20kHz.....

..... [1]

[Total: 6]

8 (a) (i) Complete the definition of an 'electric field'.

An electric field is a region where ....an electric charge.....

experiences ....a force..... .

[2]

(ii) Figure 8.1 shows two parallel, oppositely charged metal plates.

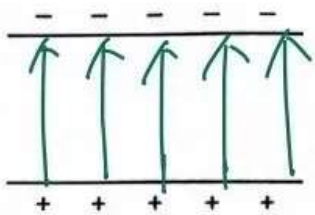

Figure 8.1

On Figure 8.1, draw **four** field lines to show the pattern and the direction of the electric field between the two parallel plates. [2]

(b) Figure 8.2 shows an electric circuit that includes a thermistor, component X and a relay. The relay operates a lamp.

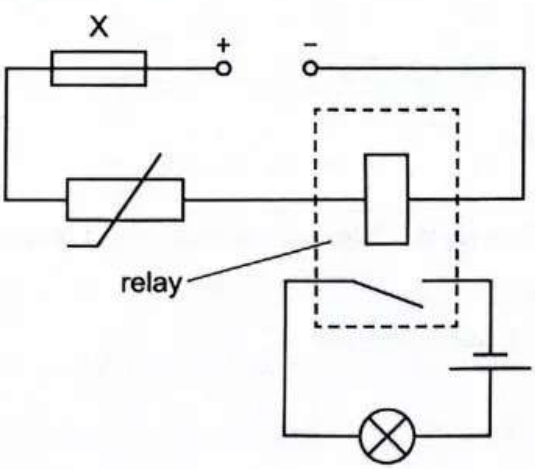

Figure 8.2

(i) Identify component X.

.....fuse..... [1]

(ii) The temperature increases. The lamp lights.

Complete the sentences to explain, in terms of potential difference (p.d.) and resistance, why the lamp lights.

When the temperature of the thermistor increases, the ....resistance..... of the thermistor .....decreases..... . This causes the p.d. across the ....relay coil..... to increase. The magnetic field produced by the relay coil .....increases..... . The relay coil attracts .....switch..... , which causes the lamp to light.

[3]

(iii) The current in the lamp is 3.2A.

Calculate the charge that flows through the lamp in 120 s.

$I = 3.2A \quad t = 120s$

$I = \frac{Q}{t} \quad Q = It = 3.2 \times 120 = 380C$

charge = ...380..... C [2]

[Total: 10]

9 (a) Carbon-14 is the only radioactive isotope of carbon that occurs naturally.

(i) State **one** similarity and **one** difference in the composition of the nuclei of atoms of different isotopes of the same element.

similarity ....same proton number.....

difference .....different neutron number.....

[1]

(ii) When a tree dies, no new carbon-14 is absorbed by the tree.

A tree contains 16 μg of carbon-14 when it dies.

Carbon-14 has a half-life of 5700 years.

On Figure 9.1, sketch a graph to show how the mass of carbon-14 in the tree decreases during the first 15000 years after the tree dies.

Show your working and label the axes with suitable values for **one** point on the graph.

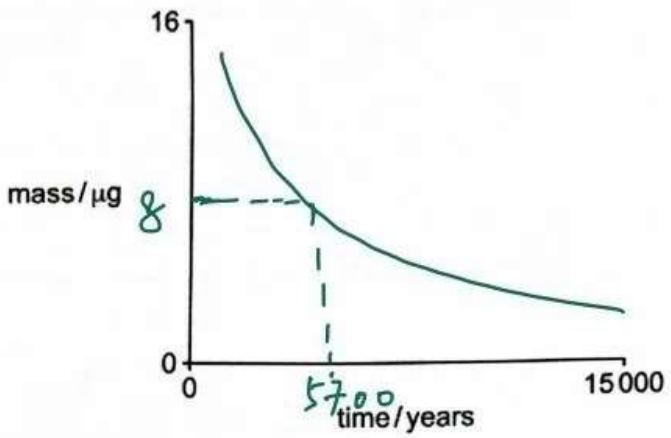

Figure 9.1

[3]

(b) Complete the sentence about radiation.

Ionising nuclear radiation that is always present in the environment is known as .....background..... radiation.

[1]

(c) State **one** source that makes a significant contribution to the ionising nuclear radiation that is always present in the environment.

.....radon gas..... [1]

10 (a) Nuclear fission is the process used to transfer energy in a nuclear reactor in a power station.

(i) Describe the process which occurs when heavy nuclei undergo fission in a power station.

unstable large neucleus splits into two or more smaller nuclei called daughter nuclei with similar mass during the process the energy is released

[3]

(ii) Complete the sentences to describe how energy is used to generate electricity in a nuclear power station.

Thermal energy is used to heat water in boiler to produce water steam at high pressure. This drives a turbine connected to a generator.

[2]

(iii) State **one** advantage and **one** disadvantage of the use of nuclear energy to generate electricity compared with the use of light from the Sun (solar cells).

advantage produce large amount of energy

disadvantage danger of leak of radiation

[2]

(b) Radiation from the Sun is **not** the source of energy for nuclear energy.

State **one** other energy resource which does **not** have the Sun as its main source of energy.

Geothermal [1]

[Total: 8]

11 (a) Figure 11.1 shows some statements about the Earth and the approximate time taken for the events described in these statements to take place.

statement	approximate time taken
The Earth orbits the Sun once.	365 days
The Earth rotates once on its axis.	24 hours
Light travels from the Sun to the Earth.	8.3 minutes
The Moon orbits the Earth once.	1 month

Figure 11.1

Draw a line from each statement to the correct time taken. One has been completed for you. [2]

(b) The planet Jupiter orbits the Sun. The average radius of the orbit of Jupiter is 7.78×10^8 km. The average orbital speed of Jupiter is 4.70×10^4 km/h.

Show that the orbital period of Jupiter is 11.9 years.

$r = 7.78 \times 10^8$ km

$V = 4.7 \times 10^4$ km/h

$V = \frac{2\pi r}{T}$ [3]

$T = \frac{2\pi r}{V}$

$= \frac{2 \times \pi \times 7.78 \times 10^8}{4.7 \times 10^4}$

$= 104006.7$ h

$= 104006.7 \div 24 \div 365$

≈ 11.9 years

(c) (i) Define a 'light-year' in words.

distance travelled by light in one year

..... [1]

(ii) A distant galaxy is 1.6×10^8 light-years away from the Earth.

The current estimate for the Hubble constant is 2.2×10^{-18} per second.

Calculate the speed at which this galaxy moves away from the Earth.

Give your answer in m/s.

$v = H_0 d$

$= 1.6 \times 10^8 \times 3 \times 10^8 \times 365 \times 24 \times 3600 \times 2.2 \times 10^{-18}$

$= 3.3 \times 10^6$ m/s

speed = 3.3×10^6 m/s [2]

[Total: 8]