**Physics Paper 1**

**Mark Schemes**

**Topics P1 – P4**

**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Class \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Contents Page**

|  |
| --- |
| **P1 – Energy** |
| **Topic** | **Exam Questions Pages** | **Mark Scheme Pages** |
| Energy Changes in Systems | 4-10 | 3-5 |
| Conservation and Dissipation of Energy | 11-16 | 6-8 |
| National and Global Energy Resources | 17-23 | 9-12 |

|  |
| --- |
| **P2 – Electricity**  |
| **Topic** | **Exam Questions Pages** | **Mark Scheme Pages** |
| Circuit Electricity | 24-33 | 13-15 |
| Domestic Electricity Supply and Safety | 34-40 | 16-18 |
| Electrical Energy Transfer | 41-45 | 19-20 |

|  |
| --- |
| **P3 – Particle Model of Matter** |
| **Topic** | **Exam Questions Pages** | **Mark Scheme Pages** |
| The Particle Model and Particle Motion | 46-53 | 21-23 |
| Density (RP) |
| Internal Energy and Temperature Changes | 54-63 | 24-27 |
| State Changes and Latent Heat |

|  |
| --- |
| **P4 – Atomic Structure** |
| **Topic** | **Exam Questions Pages** | **Mark Scheme Pages** |
| Atoms and Isotopes | 64-67 | 28-29 |
| Nuclear Radiation | 68-71 | 30-31 |
| Decay Equations and Half-Life | 72-80 | 32-34 |
| Contamination and Irradiation | 81-86 | 35-36 |

P1 – Energy Changes in Systems – Mark schemes

**Q1.**

(a)    (i)        kinetic (energy)

*allow gravitational potential (energy) / gpe*

*movement is insufficient*

**1**

(ii)     dissipates into the surroundings

*allow warms up the surroundings / air / motor*

*accept lost to the surroundings*

*accept lost as heat*

*ignore reference to sound*

*it is lost is insufficient*

**1**

(b)     energy (required) increases with load

*accept positive correlation*

*do* ***not*** *accept (directly) proportional*

**1**

further amplification eg increases slowly at first (or up to 4 / 5 N),
then increases rapidly

*simply quoting figures is insufficient*

*an answer that only describes the shape
of the line gains no marks*

**1**

(ii)     any sensible suggestion eg

conserves fossil fuels

less (fossil) fuels burned

less pollutant gas (produced)

*accept a named pollutant gas*

less greenhouse gas (produced)

*saves energy is insufficient*

**1**

**[8]**

**Q2.**

(a)     E = 15 000 × 36

**1**

E = 540 000

**1**

E = 540 (kJ)

*an answer of 540 (kJ) scores* ***3*** *marks*

**1**

(b)     (the motor in) scooter **B** has a higher power

**1**

therefore

(because both motors have the same efficiency) scooter **B** will have a greater kinetic energy

**1**

(c)     the battery in scooter **B** has a greater store of chemical energy

**1**

(d)     energy transferred = power × time

*allow E = P × t*

**1**

(e)     20 × 60

**1**

E = 1 200 × 700

**1**

E = 840 000 (J)

*an answer of 840 000 (J) scores* ***3*** *marks*

**1**

**[10]**

**Q3.**

(a)     thermometer

**1**

stopclock / stopwatch

*accept measuring cylinder*

*accept top pan balance*

**1**

(b)     independent: type of oil

**1**

dependent: temperature rise in °C

**1**

(c)     wear safety goggles

**1**

oil not heated directly

*accept any reasonable comment about not handling hot apparatus.*

**1**

(d)     repeat the experiment

**1**

and calculate the mean temperature rise

**OR**

heat the oil for a longer period of time (1)

to get a wider range of temperatures (1)

**1**

(e)     (17 + 17 + 18) / 3 (= 17.33)

**1**

temperature rise = 17 (°C)

**1**

*accept 17 (°C) with no working shown for* ***2*** *marks*

*allow 17.33 with no working shown for* ***1*** *mark*

(f)     E = 0.025 × 1800 × 20 (J)

**1**

E = 900 (J)

**1**

*allow 900 without working shown for the* ***2*** *calculation marks*

Joule

**1**

**[13]**

P1 – Conservation and Dissipation of Energy – Mark schemes

**Q1.**

(a)      chemical

**1**

kinetic

**1**

thermal

**1**

(b)     48% or 0.48

*an answer of 0.48 with a unit gains* ***1*** *mark
an answer of 0.48% gains* ***1*** *mark
an answer of 48 with or without a unit gains* ***1*** *mark*

**2**

**Q2.**

(a)     (i)      electrical

**1**

kinetic

**1**

thermal

**1**

(ii)     transferred into surroundings / atmosphere

*accept warms the surroundings*

*allow released into the environment*

*becomes heat or sound is insufficient*

**1**

(b)     0.7 / 70 %

*an answer of 70 without % or with the wrong unit* ***or*** *0.7 with a unit gains* ***1*** *mark*

**2**

**Q3.**

(a)     (i)      150

**1**

(ii)     transferred to the surroundings by heating

*reference to sound negates mark*

**1**

(iii)    0.75

*450 / 600 gains* ***1*** *mark*

*accept 75% for* ***2*** *marks*

*maximum of* ***1*** *mark awarded if a unit is given*

**2**

(iv)    20 (s)

*correct answer with or without working gains* ***2*** *marks*

*correct substitution of 600 / 30 gains* ***1*** *mark*

**2**

(b)     (i)      to avoid bias

**1**

(ii)     use less power and last longer

**1**

1 LED costs £16, 40 filament bulbs cost £80

**or**

filament costs (5 times) more in energy consumption

**1**

(iii)    any **one** from:

•        availability of bulbs

•        colour output

•        temperature of bulb surface

**1**

**Q4.**

(a)     the store of chemical energy (in the battery) decreases

**1**

the internal energy of the surrounding air increases.

**1**

*accept description of energy becoming less usefully stored for* ***2*** *marks*

(b)     kinetic energy = ½ mass × velocity2

**1**

(c)     EK = ½ × 0.8 × 122

**1**

EK = 57.6 (J)

**1**

*allow 57.6 (J) without working shown for* ***2*** *marks*

(d)     lower proportion of wasted energy

*accept less energy is wasted*

**1**

higher proportion of energy is converted into kinetic energy

*accept more kinetic energy*

**1**

(e)     **Level 2 (3–4 marks):**

A relevant and coherent argument which demonstrates processing and numerical
analysis of the information presented and draw a conclusion which is logically consistent with the reasoning and refers to payback time for the vehicles.

**Level 1 (1–2 marks):**

Simple comparisons are made which demonstrate a basic ability to numerically analyse
the information presented. The conclusion, if present, may not be consistent with the calculations.

**0 marks:**

No relevant content

**Indicative content**

•        The electric car costs £12 000 more to buy

•        Running cost of electric car = £3 000

•        Running cost of petrol engine car = £24 000

•        Total cost of electric car = £30 000

•        Total cost of petrol engine car = £39 000

•        The electric car cost £1 750 less to run each year

•        The electric car will save £9 000

•        Additional cost is covered in 6.9 years

•        So the electric car will be cheaper over the 12 year lifetime

**or**

Electric
27000 / 12 = 2250
Annual cost = 2250 + 250 = 2500

Petrol
15000 / 12 = 1250
Annual cost = 1250 + 2000 = 3250

So electric is £750 cheaper per year

**4**

P1 – National and Global Energy Resources – Mark schemes

**Q1.**

(a)     geothermal

**1**

nuclear

**1**

biofuel

**1**

(b)     gravitational (potential)

**1**

kinetic

**1**

sound

**1**

(c)     (i)      90% or 0.9(0)

*an answer of 0.9(0) with a unit gains* ***1*** *mark*

**2**

(ii)     60 (MW)

*allow 10%*

**1**

(iii)     increased

**1**

**[10]**

**Q2.**

(a)     (i)      high levels of infrared radiation (from the Sun)

*allow lots of (solar) energy (available)*

*do* ***not*** *accept ‘heat’ for infrared*

*‘it is hot’ is insufficient
‘lots of sunlight’ is insufficient*

**1**

(ii)     reflected

**1**

(iii)    boiler

**1**

turbine

**1**

transformer

**1**

(b)     2 100 000 (kWh)

*allow* ***1*** *mark for correct substitution i.e. 140 000 × 15 provided no subsequent step*

**2**

(c)     (i)      only 1 wind turbine was considered

*accept only one location is considered*

**1**

**or**

other wind turbines may have generated more electricity

*accept insufficient sample size*

only 1 week’s weather was reported on

**or**

wind speed varies from one week to another

*‘wind speed varies’ is insufficient*

**1**

(ii)     any **one** from:

•        wind speed is too high / low

*allow no wind
allow too windy*

•        wind is unreliable.

**1**

(iii)    any **one** from:

•        wind is a renewable energy source

•        do not use fuel

•        energy source is free

•        do not release carbon dioxide

•        do not release greenhouse gases

•        do not release sulfur dioxide

•        do not cause acid rain

•        do not cause climate change

•        do not cause global warming

•        do not cause global dimming.

*answer must be an advantage of wind, converse answers in terms of fossil fuels are insufficient*

*accept do not release pollutant gases*

*‘no pollution’ is insufficient*

**1**

**[11]**

**Q3.**

(a)     any **one** from:

•     high cost of installing overhead power lines or underground cables or pylons

•     high cost as (very) long cables needed

•     amount of electricity required is too low

*allow not enough (surplus) electricity would be generated*

**1**

(b)     Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

**Level 3 (5 – 6 marks):**

clear comparison of advantages **and** disadvantages of **each** method

**Level 2 (3 – 4 marks):**

at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method

**Level 1 (1 – 2 marks):**

at least **one** advantage **or one** disadvantage of either method

**Level 0 (0 marks):**

No relevant information

**examples of physics points made in the response**

**Advantages of both methods:**

•     both renewable sources of energy

•     both have no fuel (cost)

•     both have very small (allow 'no') running costs

•     no carbon dioxide produced

*accept carbon neutral*

*accept no greenhouse gases*

*accept doesn't contribute to global warming*

**Advantages of wind:**

•     higher average power output

*produces more energy is insufficient*

**Advantages of hydroelectric:**

•     constant / reliable power (output)

•     lower (installation) cost

**Disadvantages of wind:**

•     higher (installation) cost

•     variable / unreliable power output

•     (may) kill birds / bats

**Disadvantages of hydroelectric:**

•     lower power output

•     (may) kill fish or (may) damage habitats

•     more difficult to set up (within river)

**Disadvantages of both methods:**

•     (may be) noisy

•     visual pollution

*ignore payback time unless no other relevant points made*

*ignore time to build for both*

**6**

**[7]**

**Q4.**

(a)     advantage

any **one** from:

•        produce no / little greenhouse gases / carbon dioxide

*allow produces no / little polluting gases*

*allow doesn’t contribute to global warming / climate change*

*allow produce no acid rain / sulphur dioxide*

*reference to atmospheric pollution is insufficient*

*produce no harmful gases is insufficient*

•        high(er) energy density in fuel

*accept one nuclear power station produces as much power as several gas power stations*

*nuclear power stations can supply a lot of or more energy is insufficient*

•        long(er) operating life

*allow saves using reserves of fossil fuels or gas*

**1**

disadvantage

any **one** from:

•        produce (long term) radioactive waste

*accept waste is toxic*

*accept nuclear for radioactive*

•        accidents at nuclear power stations may have far reaching or long term consequences

•        high(er) decommissioning costs

*accept high(er) building costs*

•        long(er) start up time

**1**

(b)     (i)      12 000 (kWh)

*allow* ***1*** *mark for correct substitution eg*

*2000  ×  6*

***or****2 000 000  ×  6*

***or*****

*an answer of 12 000 000 scores* ***1*** *mark*

**2**

(ii)     any idea of unreliability, eg

•        wind is unreliable

*reference to weather alone is insufficient*

•        shut down if wind too strong / weak

•        wind is variable

**1**

 **[5]**

P2 – Circuit Electricity – Mark schemes

**Q1.**

(a)



*allow* ***1*** *mark for each correct line if more than one line is drawn from any symbol then all of those lines are wrong*

**3**

(b)     (i)      half

**1**

(ii)     3(V)

**1**

(iii)    V1

**1**

(c)     (i)      potential difference / voltage of the power supply

*accept the power supply*

*accept the voltage / volts*

*accept number of cells / batteries*

*accept (same) cells / batteries*

*do not accept same ammeter / switch / wires*

**1**

(ii)     bar drawn – height 1.(00)A

*ignore width of bar*

*allow* ***1*** *mark for bar shorter than 3rd bar*

**2**

(iii)    as the number of resistors increases the current decreases

**1**

**Q2.**

(a)     25(Ω)

**1**

(b)     (i)      2(V)

*allow* ***1*** *mark for showing a correct method, ie 6 / 3*

**2**

(ii)     equal to

**1**

**Q3.**

(a)



*battery connected correct way round*

**1**

*ammeter and voltmeter correct way round*

**1**

(b)     6.4 V

**1**

(c)     (the lamp will) get dimmer

**1**

because increasing the resistance decreases the current

**1**

(d)     potential difference = current × resistance

*allow V = IR*

**1**

(e)     3.3 = 0.15 × *R*

**1**

*R* = 3.3 ÷ 0.15

**1**

= 22(Ω)

**1**

*allow 22 with no working shown for* ***3*** *marks*

**Q4.**

(a)     filament bulb

**1**

(b)     (i)      6 V

**1**

(ii)     3 Ω or their  correctly calculated

*allow 1 mark for correct substitution ie*

*6 = 2 × R*

*or their (i) = 2 × R*

**2**

(iii)    1 A

**1**

(iv)    6 Ω or their (i) / their (iii) correctly calculated

**1**

(v)

|  |  |  |
| --- | --- | --- |
| **Decrease** | **Stay the same** | **Increase** |
|   |  |   |
|  |   |   |
|  |   |   |

**Q5.**

(a)     ammeter

**1**

voltmeter

*must be in the correct order*

**1**

(b)     0.300 (m)

**1**

there is the smallest spread about the mean

**1**

(c)     to reduce the effect of random errors

**1**

(d)     potential difference = current × resistance

*allow V = I × R*

**1**

(e)     R = V / I

**1**

R = 2.1 / 0.30

**1**

R = 7.0 Ω

*an answer of 7.0 Ω scores* ***3*** *marks*

**1**

(f)      length in m

**1**

resistance in Ω

*must be in the correct order*

*allow other correct labelling eg*

*length / m*

*length (m)*

*allow 1 mark if units are omitted*

**1**

(g)     resistance is directly proportional to length

**1**

P2 – Domestic Electricity Supply and Safety – Mark schemes

**Q1.**

(a)     earth

**1**

(b)     it can prevent an electric shock from the toaster

**1**

(c)     230 V

**1**

(d)     (the potential difference) for the alternating supply changes direction

*allow current*

**1**

(the potential difference) for the alternating supply changes magnitude

*allow current*

*allow converse*

*allow potential difference of alternating supply is greater*

**1**

(e)     there is an overall decrease

*allow there is an decrease in percentage energy loss until 2013*

**1**

but there is a (small) increase since 2013

**1**

(f)      1.92, 1.72, 1.70, 1.74, 1.77

**1**

(1.92 + 1.72 + 1.70 + 1.74 + 1.77)/5

**1**

1.77(%)

*an answer of 1.77(%) scores* ***3*** *marks*

**1**

**Q2.**

(a)     2100 W

**1**

(b)     power = potential difference × current

**1**

(c)     50 (Hz)

**1**

(d)     direct current (dc) only

**1**

(e)



 (f)      green **and** yellow

*both colours required*

**1**

(g)      any **two** from:

•        good conductor

•        hard

•        corrosion resistant

**2**

(h)

|  |  |
| --- | --- |
| **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account. | 3-4 |
| **Level 1:** Facts, events or processes are identified and simply stated but their relevance is not clear. | 1-2 |
| No relevant content | 0 |
| **Indicative content**allow voltage / volts / pd for potential difference•   cables transmit electricity at very high potential differences•   transformers change the potential difference•   step up transformer increases potential difference•   overhead cables transfer electricity at a higher potential difference•   step down transformer decreases potential difference•   the potential difference to the consumers is much lower than the potential difference from the power station•   the potential difference to the consumers is much lower than the potential difference in the cables |   |

**Q3.**

(a)     mains electricity is an alternating current (ac) which is constantly changing direction

**1**

a battery supplies a direct current (dc) which flows in one direction only

**1**

(b)     one watt = one volt × one amp

**1**

(c)     green and yellow - brown - blue

**1**

(d)     the potential of the live wire is 230 V

**1**

a person’s potential is 0 V

**1**

(so) there is a large potential difference between live wire and a person

**1**

and so the charge / current passes through the person’s body

*allow would result in an electric shock*

**1**

P2 – Electrical Energy Transfers – Mark schemes

**Q1.**

(a)     electrons

**1**

(b)

****

**3**

(c)     the total power = 7360 watts

**1**

current = 7360 ÷ 230

**1**

= 32 A

*allow 32 with no working shown for* ***3*** *marks*

**1**

so the current is greater than 30 A

**1**

(d)     to increase the voltage (across the cables) or to decrease the current (through the cables)

**1**

reducing energy losses (in the cables)

*do* ***not*** *allow electricity for energy*

*do* ***not*** *allow no energy loss*

**1**

increasing the efficiency of transmission

**1**

(e)     to decrease the potential difference for domestic use

**1**

(f)    

**1**

(g)     405 / 900

**1**

=0.45

*accept 45%*

**1**

*allow 0.45* ***or*** *45% with no working shown for* ***2*** *marks*

**Q2.**

(a)     iron

**1**

hairdryer

**1**

kettle

**1**

*answers can be in any order*

(b)     (i)       **Y**

**1**

(ii)      bar drawn with any height greater than **Y**

*ignore width of bar*

**1**

(c)     (bigger volume) takes more time (to boil)

*accept explanation using data from graph*

**1**

(so) more energy transferred

*do* ***not*** *accept electricity for energy*

**1**

(and) this costs more money

*ignore reference to cost of water*

*wasting more money because heating more water than needed is insufficient*

**1**

P3 – Particle Model and Particle Motion – Mark schemes

**Q1.**

(a)     (i)      Z

**1**

(ii)     X

**1**

(b)     (i)      moving randomly

**1**

(ii)     stronger than

**1**

(c)     (i)      evaporation

**1**

(ii)     any **one** from:

•         becomes windy

•         temperature increases

*accept (becomes) sunny
“the sun” alone is insufficient*

•         less humid

**1**

**Q2.**

(a)      (i)     random distribution of circles in the box with at least 50 % of circles touching

**1**

random distribution of circles occupies more than 50 % of the space

*judged by eye*

**1**

(ii)     (large) gaps between particles

*accept particles do not touch*

*accept particles are spread out*

**1**

(so) easy to push particles closer (together)
**or**forces between particles are negligible / none

*an answer in terms of number of particles is insufficient*

**1**

(b)    (i)       (both are) random

*accept a correct description of random eg unpredictable or move around freely or in all directions*

*they take up all the space is insufficient*

*they are spread out is insufficient*

*they move in straight lines is insufficient*

**1**

(ii)     (speed also) increases

**1**

**Q3.**

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

**0 marks**

No relevant content.

**Level 1 (1–2 marks)**

Considers either solid or gas and describes at least one aspect of the particles.

**or**

Considers both solids and gases and describes an aspect of each.

**Level 2 (3–4 marks)**

Considers both solids and gases and describes aspects of the particles.

**or**

Considers one state and describes aspects of the particles and explains at least one of the properties.

**or**

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

**Level 3 (5–6 marks)**

Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

**examples of the points made in the response**

***extra information***

**Solids**

•        (particles) close together

•        (so) no room for particles to move closer (so hard to compress)

•        vibrate about fixed point

•        strong forces of attraction (at a distance)

•        the forces become repulsive if the particles get closer

•        particles strongly held together / not free to move around (shape is fixed)

*any explanation of a property must match with the given aspect(s) of the particles.*

**Gases**

•        (particles) far apart

•        space between particles (so easy to compress)

•        move randomly

•        negligible / no forces of attraction

•        spread out in all directions (to fill the container)

**[6]**

**Q4.**

(a)     kilograms per metre cubed, kg / m3

**1**

(b)     (solid has) more particles

*allow atoms for particles*

**1**

in the same volume **or** in a given volume

*allow description of a given area*

**1**

(c)     randomly

*this order only*

**1**

kinetic

**1**

(d)     (pressure) rises

**1**

**[6]**

**Q5.**

(a)     ice

water

steam

*allow* ***1*** *mark for 1 or 2 correct answers*

**2**

(b)     1 kg of steam

**1**

(c)     steam

**1**

(d)     ρ = 11 200 / 12.0

**1**

ρ = 933 (kg/m3)

*an answer of 933 (kg/m3) scores* ***2*** *marks*

**1**

(e)     the internal energy of the iceberg increases

*allow there is a temperature difference between ice and water / air*

**1**

because

*therefore*

energy is transferred from the sea/water to the ice(berg)

**1**

**[8]**

P3 – Internal Energy, State Changes and Latent Heat – Mark schemes

**Q1.**

(a)     (approximate same size particles as each other and as liquid and gas) touching

*do* ***not*** *accept particles that overlap*

**1**

regular arrangement (filling the square)

**1**

(b)     condensing

**1**

(c)     solid

**1**

(d)     physical

**1**

(e)     particles have more kinetic energy

**1**

particles move faster

**1**

(f)      mass of the liquid

**1**

specific latent heat of vaporisation

**1**

(g)     2 × 4 200 × 80

**1**

672 000 (J)

*an answer of 672 000 (J) scores* ***2*** *marks*

**1**

**Q2.**

(a)     (similarity) same size / shape particles

**1**

(difference) further apart / fewer in same area

*allow none / not many touching*

**1**

(b)     any **two** from:

•        no movement shown

•        atoms / molecules / ions / particles are not solid spheres

•        no forces between the spheres

•        only 2D

**2**

(c)     •        different forces between particles

*allow substances have different types of bond*

**1**

•        (so) different amounts of energy required (to break forces)

**1**

(d)     high(er) pressure (within fire extinguisher)

**1**

(e)     liquid to gas

**1**

(f)     (change from solid to liquid) 80 seconds

**and**

(change from liquid to gas) takes 550 seconds

**1**

(therefore) takes longer so more (thermal) energy is supplied (to change state)

**1**

(g)     1 695 000 = m × 2.260 × 106

**1**

****

**1**

0.75

*an answer of 0.75 scores* ***3*** *marks*

*allow conversion of kJ to J*

**1**

**Q3.**

(a)     (i)      70

*accept ± half a square
(69.8 to 70.2)*

**1**

(ii)     15

*accept 14.6 to 15.4 for* ***2*** *marks*

*allow for* ***1*** *mark 70 − 55*

*ecf from (b)(i) ± half a square*

**2**

(iii)    C

**1**

biggest drop in temperature during a given time

**1**

(iv)    starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

**1**

(v)     because 20 °C is room temperature

*accept same temperature as surroundings*

**1**

(b)     (i)      6720

*correct answer with or without working gains* ***3*** *marks*

*6 720 000 gains* ***2*** *marks*

*correct substitution of E = 0.2 × 4200 × 8 gains* ***2*** *marks*

*correct substitution of E = 200 × 4200 × 8 gains* ***1*** *mark*

**3**

(ii)     the fastest particles have enough energy

*accept molecules for particles*

**1**

to escape from the surface of the water

**1**

therefore the mean energy of the remaining particles decreases

*accept speed for energy*

**1**

the lower the mean energy of particles the lower the temperature (of the water)

*accept speed for energy*

**1**

**Q4.**

(a)     78 (°C)

*allow* ***2*** *marks for correct temperature change ie 22 °C*

*allow* ***1*** *mark for correct substitution*

*ie 46 200 = 0.5 × 4200 x θ*

***or***

******

**3**

(b)     6.4 (W)

*allow* ***2*** *marks for an answer that rounds to 6.4*

*allow* ***1*** *mark for correct substitution*

*ie 46 200 = P × 7200*

*an answer of 23 000 or 23 100 or 385 gains 1 mark*

**2**

**Q5.**

(a)     80 °C

**1**

ΔE = 0.5 × 3400 × 80

**1**

ΔE = 136 000 (J)

*an answer of 136 000 (J) scores* ***3*** *marks*

**1**

(b)     energy is dissipated into the surroundings

*allow any correct description of wasted energy*

**1**

(c)     put a lid on the pan

*allow any sensible practical suggestion*

*eg add salt to the water*

**1**

(d)     efficiency = 300/500

**1**

efficiency = 0.6

*an answer of 0.6 or 60% scores* ***2*** *marks*

*allow efficiency = 60%*

*an answer of 0.6 with a unit scores* ***1*** *mark*

*an answer of 60 without a unit scores* ***1*** *mark*

**1**

(e)     lower rate of energy transfer

**1**

(so) potato soup will remain at a higher temperature

**1**

P4 – Atoms and Isotopes – Mark schemes

**Q1.**

(a)     neutron discovered

**1**

(b)      neutron

*all 3 in correct order*

electron

*allow* ***1*** *mark for 1 correct*

proton

**2**

**Q2.**

(a)     neutrons and protons

**1**

(b)     0

**1**

(+)1

**1**

(c)     (i)      total positive charge = total negative charge

*accept protons and electrons have an equal opposite charge*

**1**

(because) no of protons = no of electrons

**1**

(ii)     ion

**1**

positive

**1**

**Q3.**

(a)     **L**

**J**

**K**

*all 3 in correct order*

*allow* ***1*** *mark for 1 correct*

**2**

(b)     number of electrons = number of protons

*accept amount for number*

**1**

(c)     neutrons

*this answer only*

**1**

(d)     loses / gains electron(s)

**1**

**Q4.**

(a)     **Y** and **Z**

**1**

          they have the same number of protons **or** same atomic number

*accept they have the same number of electrons* ***or*** *same number of protons* ***and*** *electrons
allow only different in number of neutrons N.B. independent marks*

**1**

(b)     **Quality of written communication**

*for correct use of terms underlined in B* ***or*** *C*

*Q  Q *

**1**

          A – alpha particle passes straight through the empty space of the atom
**or**   it is a long way from the nucleus

*describes 3 tracks correctly for* ***2*** *marks
describes 2 or 1 track correctly for* ***1*** *mark*

          B – alpha particle deflected / repelled / repulsed by the (positive) nucleus

          C – alpha particle heading straight for the nucleus is deflected / repelled /
       repulsed backwards

*do* ***not*** *accept hits the nucleus
do* ***not*** *accept answers referring to refraction
do* ***not*** *accept answers in terms of reflected backwards unless qualified in terms of repulsion*

*mention of difference in charge on nucleus negates that track*

**max 2**

**[5]**

P4 – Nuclear Radiation – Mark schemes

**Q1.**

(a)     1 × 10-10 m

**1**

(b)     (a helium atom) has 2 electrons

*accept it has more mass*

*allow it is not charged*

**1**

(c)     2

**1**

(d)     neutral

*accept 0 or ‘no charge’*

**1**

(because) protons have positive charge and electrons have negative charge

**1**

(and) there are equal numbers of protons and electrons

**1**

(e)     helium will one day run out

**1**

there will be none left for medical uses so balloons waste helium

**1**

**[8]**

**Q2.**

(a)     gamma

*allow* ***1*** *mark for 1 or 2 correct*

beta

alpha

**2**

(b)     any **two** from:

•        do not point (radioactive) source at students

•        keep (radioactive) source outside the box for minimum time necessary

•        wear safety glasses **or** eye protection **or** do not look at source

•        wear gloves

•        hold (radioactive) source away from body

•        hold (radioactive) source with tongs / forceps

**2**

(c)     as time increases count rate decreases

**1**

count rate halves every 80 seconds

**1**

(d)     half-life is 80 seconds

**1**

so after 200 seconds count rate = 113

**1**

(e)     because a very small amount of radiation will be emitted **or** will be similar to / same as background radiation

**1**

(f)     Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should apply a best-fit approach to the marking.

**0 marks**No relevant content

**Level 1 (1 – 2 marks)**There is a basic description of at least **one** of the particles in terms of its characteristics.

**Level 2 (3 – 4 marks)**There is a clear description of the characteristics of **both** particles
**or**a full description of either alpha **or** beta particles in terms of their characteristics.

**Level 3 (5 – 6 marks)**There is a clear and detailed description of **both** alpha and beta particles in terms of their characteristics.

**examples of the physics points made in the response:**

**structure**

•        alpha particle consists of a helium nucleus

•        alpha particle consists of 2 protons and 2 neutrons

•        a beta particle is an electron

•        a beta particle comes from the nucleus

**penetration**

•        alpha particles are very poorly penetrating

•        alpha particles can penetrate a few cm in air

•        alpha particles are absorbed by skin

•        alpha particles are absorbed by thin paper

•        beta particles can penetrate several metres of air

•        beta particles can pass through thin metal plate / foil

•        beta particles can travel further than alpha particles in air

•        beta particles can travel further than alpha particles in materials eg metals

**6**

**[15]**

P4 – Decay Equations and Half-Life – Mark schemes

**Q1.**

(a)     (mass number) 231

**1**

(protons) 92

**1**

(neutrons) 141

**1**

(b)     2 / two (hours)

**1**

(because) count rate halves in that time

**1**

(c)     A high-speed electron

**1**

(d)     uncontrolled

**1**

benign

**1**

**[8]**

**Q2.**

(a)     The nucleus will emit a neutron.

**1**

(b)     **Similarity**

same mass number

*allow same number of nucleons (protons + neutrons)*

**1**

**difference**

different atomic number

*allow different number of protons*

**1**

(c)     Radioactive decay is random.

**1**

(d)     1.3 (billion years)

*allow 1.2-1.4 (billion years)*

**2**

*allow* ***1*** *mark for horizontal line drawn from ~ 550*

(e)     alpha

**1**

**[7]**

**Q3.**

(a)     alpha particles **cannot** pass through…

**or**

alpha particles can pass through a very thin sheet of **paper** / **card**

**1**

(b)     (i)      horizontal and vertical line drawn at correct positions on the graph

*accept a cross drawn at 4500 / 500 on the curve*

***or***

*two pairs of lines drawn, for example, at 600 and 300*

*accept a horizontal line drawn at 500 on its own*

*do* ***not*** *accept vertical lines only*

**1**

(ii)     4500 million years

**1**

(iii)    half-life too long

*do* ***not*** *accept simply its half-life is 4500 million years*

**1**

no (measurable) change in count rate

*do* ***not*** *accept have not got the equipment*

*do* ***not*** *accept it’s harmful (to children)*

*if neither of the above points scored, accept not enough time to measure it for* ***1*** *mark*

**1**

**[5]**

**Q4.**

2 weeks

*if answer is incorrect 2 gains two marks weeks gains one mark
half of 68 or 34 gains one mark / allow working shown on graph*

**[3]**

**Q5.**

(a)      (i)     **K** and **L**

*both answers required either order*

**1**

(ii)     (1) same number of protons

*accept same number of electrons*

*accept same atomic number*

**1**

(2) different numbers of neutrons

**1**

(b)     (i)     90

**1**

(ii)     140

**1**

(c)     alpha (particle)

*reason may score even if beta or gamma is chosen*

**1**

mass number goes down by 4
**or**number of protons and neutrons goes down by 4
**or**number of neutrons goes down by 2

*candidates that answer correctly in terms of why gamma****and*** *beta decay are not possible gain full credit*

**1**

atomic / proton number goes down by 2
**or**number of protons goes down by 2

*accept an alpha particle consists of 2 neutrons and 2 protons for* ***1*** *mark*

*accept alpha equals 42He or 42α for* ***1*** *mark*

*an alpha particle is a helium nucleus is insufficient for this mark*

**1**

**[8]**

**Q6.**

(a)     two half lives

*gains 1 mark*

          **but**20 minutes

*gains 2 marks*

**2**

(b)     alphas will be stopped by skin / air **or** do not penetrate betas and gammas
can reach / damage organs / cells

*for 1 mark each*

**2**

**[4]**

P4 – Contamination and Irradiation – Mark schemes

**Q1.**

(a)     (i)      alpha particles cannot penetrate covering

*do not credit any answer not relating to film badge**or**its case*

**1**

(ii)     film gets fogged **or** blackened

*accept film gets exposed
do not credit film changes colour* ***or*** *goes white* ***or*** *blotchy*

**1**

(b)     (i)      any **one** from

         may cause cancer may damage cells **or** cell nucleii causes mutations
changes DNA

*accept (causes) burns* ***or*** *kills cells*

**1**

(ii)     any **two** from

         treating cancers
tracers in body
sterilising instruments **or** bandages

*accept two descriptions of named treatments, eg thyroid check and circulation monitoring*

*accept is a source of X-rays, eg for dentistry* ***or*** *taking X-rays of bones*

**2**

(c)     calculation that 1000 is 3 half lives on

*8000 → 4000 → 2000 →1000*

**1**

time elapsed is 3 × half life = 31.8 hr

          **award both marks for 31.8 hr or 1 day 7.8 hr with no working shown**

**1**

**[7]**

**Q2.**

(a)      (i)      200 to 50

*accept either order*

**1**

(ii)     5.3

*accept values between 5.2 and 5.4 inclusive*

**1**

(iii)     5.3

*accept values between 5.2 and 5.4 inclusive*

**or**their (a)(ii)

**1**

(b)     (i)      Make the conveyor belt move more slowly

**1**

(ii)     lead

**1**

(c)     Exposure increased the content of some types of vitamin.

**1**

**[6]**

**Q3.**

(a)     **C**

**1**

(b)     beta

*accept gamma*

*if answer alpha can still gain marks for saying why not beta or gamma*

**1**

          any **two** from:

*must have at least one quantitative statement to get* ***2*** *marks*

•        range in air for beta is (at least) 50cm

•        count-rate does not drop (much) in first 40cm

•        count-rate does not fall much until distance is 60cm

•        alphas cannot travel more than 5cm in air / alphas
could not travel 100cm in air

*accept alphas cannot travel that far*

•        alphas would not be detected

•        gammas not absorbed by 100cm of air

*accept gammas not stopped by air
accept gammas travel further than alphas and betas*

*strength of source is neutral*

*references to penetrating power is neutral*

**2**

(c)     (i)      increases

**1**

(ii)     Group **A** think that (even a very small level of exposure) gives some risk

*accept there is always a risk, no matter how small the level of exposure*

**1**

         Group **B** think that there is no risk (from a very low level of exposure)

*accept below a certain level of exposure there is no risk*

*no marks for a simple graph description*

**1**

**[7]**