**Physics Paper 1**

**Mark Schemes**

**Topics P1 – P4**

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

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

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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

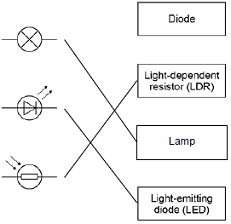
**1**

**[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*

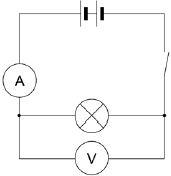
**2**

(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**

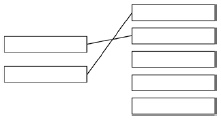
(c)     50 (Hz)

**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**

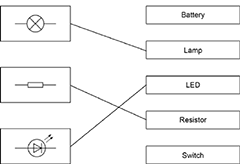
P2 – Electrical Energy Transfers – Mark schemes

**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]**