AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.6.2 ELECTROMAGNETIC WAVES (PACK 5)

SCORE	PERCENTAGE
/164	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

(a) R

1

(b) they have the same wave speed as visible light

1

they have a lower frequency than gamma rays

1

(c) any **two** from:

- ageing of the skin

  allow sunburn
  burn unqualified is insufficient

- skin cancer

  cancer is insufficient
  allow mutation of genes in skin cells

- eye damage

  allow blindness

2

(d) any **two** from:

- gamma (rays)
- X-rays
- ultraviolet

2

[7]

Q2.

(a) in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer

allow direction of travel for energy transfer

1

in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer

allow direction of travel for energy transfer

*if no other mark scored allow **1** mark for (oscillations / vibrations of) longitudinal waves are parallel **and** (oscillations / vibrations of) transverse waves are perpendicular*

*if no other mark scored allow **1** mark for transverse waves have peaks and troughs **and** longitudinal waves have compressions and rarefactions*

1

(b) $3.0 \times 10^8 = 4.8 \times 10^9 \times \lambda$

STEMUP.CO.UK

allow $\lambda = \frac{3.0 \times 10^8}{4.8 \times 10^9}$

this mark may be awarded if the standard form values are incorrectly converted

1

λ = 0.0625 (m)

1

λ = 0.063 (m)
or
λ = 6.3 × 10^{-2} (m)

allow an answer to 2 sig figs that is consistent with their calculated value of λ and has required rounding

1

*an answer of 0.063 (m) scores **3** marks*

(c) any **three** from:

- (the car aerial) absorbs radio waves or energy
- electrons are made to vibrate (in the aerial)
- creating an alternating current (in the aerial circuit)
- the (signal) frequency is the same (as the radio wave)

3

[8]

Q3.

(a) any **three** from:

- same surface area of bag (exposed to sun)
  allow same sized bag
- same volume / mass of water
  allow same amount of water
- use same starting temperature of water
  allow measure temperature at the start
- place all bags out at the same time
- place all bags out in same area / conditions
- same thickness of material / bag
- same type of material (for each bag)
- use IR lamp in a lab

3

(b) 0.1 (°C)

1

(c) any **one** from:

- more cloudy
- less sunny
  ignore less Sun

STEMUP.CO.UK

- less sunlight
- cooler day

1

(d) 24.3 (°C)

1

(e) black

1

(it has the) greatest (temperature) rise

allow it is the best absorber of IR (radiation)
ignore best emitter of IR (radiation)

1

reason only scores if black is given

[8]

Q4.

(a) light

1

ionising

1

(b) x-rays have a longer wavelength and a lower frequency

1

(c) $\frac{0.039 + 0.035 + 0.040}{3}$

1

= 0.038 (milllisieverts)

*an answer of 0.038 scores **2** marks*

1

(d) the dose decreases if you stand further from the machine

1

(e) $\frac{0.180}{0.012}$

1

= 15 days

*an answer of 15 days scores **2** marks*

1

(f) the benefit (of a correct diagnosis) outweighs the risk

allow the (increased) risk of cancer is very small for an x-ray
allow for medical imaging, eg to see broken bones

1

(g) $20 \times \frac{40}{100}$

allow 20 × 40%

1

STEMUP.CO.UK

= 8 (millisieverts)

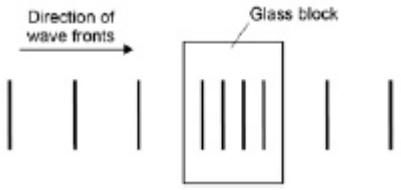
*an answer of 8 (millisieverts) scores **2** marks*

1

[11]

Q5.

(a) at least two wave fronts drawn to the right of the glass block, parallel to the other wave fronts and with equal spacing compared with the wave fronts to the left of the glass block



1

(b) ray of light refracts towards the normal where it is incident on the glass block

1

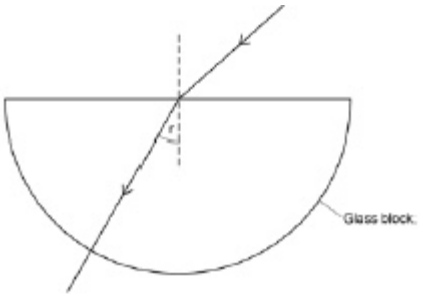
ray of light does not refract when it exits the glass block

1

a normal is drawn on where the ray is incident on the glass block

1

the angle of refraction is labelled



lines should be drawn with a ruler

1

(c) light travels more slowly (in the glass block than in the air)

1

so it changes direction

allow so it bends towards the normal

1

(d) the angle of incidence

1

the type of glass used

allow the glass block

1

(e) the <u>resolution</u> of a normal protractor is too big

1

STEMUP.CO.UK

so it could not measure the difference between results

allow so it could not read angles to 2 decimal places

1

(f) a longer wavelength gives a greater angle of refraction

1

(g) absorbed / reflected

1

[13]

Q6.

(a) **B**

1

(b) **A**

1

(c) $\frac{2.5 \text{ (waves)}}{0.5 \text{ (s)}}$

1

5(.0)(Hz)

1

(d) longitudinal

1

(e) timing (from seeing the blocks bang together and hearing the sound)

or

risk of cancelling the timer

ignore human error unqualified

*allow reaction time (of student **B**)*

1

(f) student to stand further away (so there is a greater time lag to measure)

allow other correct methods, eg using echoes

1

(g) both are transverse waves

1

both can travel through a vacuum

1

[9]

Q7.

(a) any **four** from:

- light waves are transverse whereas sound waves are longitudinal
- light waves travel faster than sound waves
- light waves have a higher frequency than sound waves
- light waves have a shorter wavelength than sound waves
- light waves have oscillations perpendicular (to the direction of energy transfer) whereas sound waves are parallel (to the direction of energy transfer)

4

STEMUP.CO.UK

(b) the baby can be seen in the dark

1

(c) wave speed = frequency × wavelength

accept $v = f\lambda$

1

(d) $3 \times 10^8 = f \times 0.125$

1

$f = 3 \times 10^8 / 0.125$

1

$f = 2.4 \times 10^9$ (Hz)

*allow 2.4×10^9 with no working for **3** marks*

1

[9]

Q71.

(a) (i) a ray drawn leaving the block parallel to the incident ray

straight, continuous line judged by eye

*do **not** accept a ray of light with an arrow towards the block*

1

(ii) normal

1

(b) (i) a smooth curve drawn through the points

1

(ii) as the angle of incidence increases the angle of refraction increases

allow correct description of their answer to (i)

ignore the angle of incidence is always larger than the angle of refraction

1

it is a non-linear graph

or

not directly proportional

allow a correct description of the graph / points

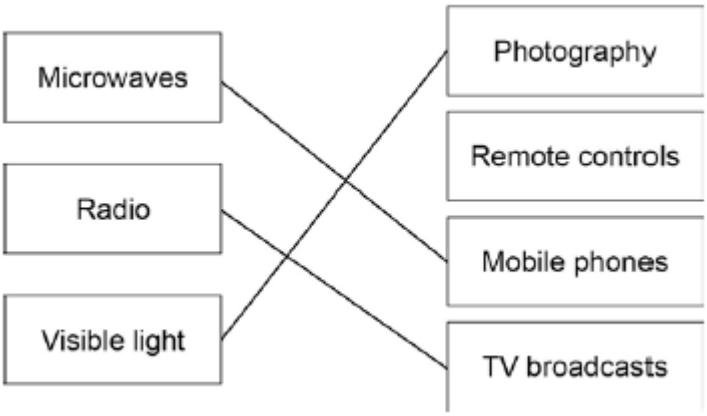
1

[5]

Q72.

Part	Use

STEMUP.CO.UK



any extra line negates mark

3

[3]

Q73.

(a) *straight line continued through glass block to meet edge of the block*

do not allow dotted / dashed lines

judge by eye

1

straight line drawn through crosses *to meet the edge of block*

judge by eye

ignore reflection within the block

ignore 'normal' line

1

(b) *any **one** from*

- safety / dark glasses

  ignore goggles / glasses unqualified
- safety / dark goggles

  ignore special goggles / glasses
  ignore sunglasses / eye protection
- don't look at laser (directly)

  allow don't shine laser into someone's eyes

1

(c) (i) any **one** from:

- too many points above line

  allow line of best fit only goes through 2 points

  allow line doesn't go through most points

  allow line should go through more / most points

  allow 3 points have been ignored
- no points below the line
- line should be curved

  allow there should be equal numbers of points on both sides of line

1

STEMUP.CO.UK

(ii) any **two** from:

- use smaller interval between readings
  eg allow go up in 10's
- take readings at more angles
  allow take readings at different angles / named angles
- repeat the experiment / readings *and calculate a mean*
  allow repeat the experiment to identify anomalies
- use a narrower ray of light
  ignore take more readings
  ignore compare results (with other students)

2

[6]

Q74.

(a) radiation

ignore infra red, IR, or heat

1

(b) (i) 105 000 000

(E = mcθ)

accept answers in standard form eg. 1.05 × 10^8

*E = 5000 × 4200 × 5 gains **1** mark*

Unit mark is independent, but must match value given for full marks

if no other marks gained 1 mark for any correct unit of energy

2

J / joules

not lower case j

allow Joules

allow units in words eg kilojules

*allow 105 000 kJ or 105 MJ for **3** marks. These figures must have units.*

allow units written as words Eg. kilojoules

not KJ, kj, mJ, Mj

1

(ii) 6600(s) / 6560(s) / 6563(s) / 6562.5(s)

(E = Pt)

allow ecf from (b)(ii)

allow answers in minutes and hours provided correct and unit changed on answer line

eg. 109 / 110 minutes or 1.8 hours

*if correct answer given with incorrect unit, maximum mark of **2** eg 6600 minutes*

*105 000 000 = 16 000 × t gains **1** mark*

*t = 105 000 000 / 16 000 gains **2** marks*

*t = 105 000 000 / 16 gains **1** mark*

STEMUP.CO.UK

or

6 562 500(s) gains 2 marks

3

(iii) energy gained from surroundings / air

allow heat

ignore air is warmer or pool is colder

1

[8]

Q75.

(a) transverse

1

(b) (i) 700

in either order

1

400

1

(ii) stays the same

1

[4]

Q76.

(a) 1st box ticked

1

(b) (i) continuous reflected ray parallel to incident ray (by eye)

1

an arrow shown correctly

arrow must be drawn on a continuous ray reflected by top mirror

1

(ii) normal

1

[4]

Q77.

(a) X = wavelength

1

Y = frequency

1

wavelength in metres / m and frequency in hertz / Hz

*both units correct for **1** mark (independent of first two marking points)*

correct units must match correctly named quantities

allow Hertz

allow multiples of the units eg kHz, km (or in words)

STEMUP.CO.UK

1

(b) (i) galaxy A is stationary (relative to Earth / us)

1

galaxy B is moving towards (Earth / us)

allow 1 mark for identifying galaxies B and C are moving in opposite directions

1

galaxy C is moving away from (Earth / us)

*allow **1** mark if say <u>all</u> moving away / towards **or** stationary*

1

(ii) galaxy C is fast<u>er</u> (than galaxy B)

allow converse statement

*do **not** accept galaxy C <u>expanding</u> faster*

1

(iii) sample is too small

accept three is too few

allow not enough evidence

ignore inaccurate, invalid, anomalous

1

compared to the size of the population

accept there are a very <u>large</u> number of galaxies in the Universe

*allow A, B and C are moving differently (from each other) for **1** mark*

1

[9]

Q78.

(a) (i) absorb

1

(ii) more

1

(b) (i) conduction

1

(ii) colour (of cube)

allow colour (of box)

1

(iii) Cube Y

*all three in correct order for **2** marks*

Cube X

Cube Z

*one or two correct for **1** mark*

allow grey for X

STEMUP.CO.UK

allow white for Y
allow black for Z

2

(iv) results can be compared
accept start temperature affects rate of energy transfer
or
start temperature affects how quickly the cube cools down
ignore fair test / reliability / accuracy / control variable / valid

1

(v) control (variable)
allow controls / controlled

1

[8]

Q79.

(a) energy transferred from athlete / skin / body to water / sweat
allow water / sweat heated by athlete

1

(so) more energetic (water / sweat) particles escape (from the liquid)
accept particles with higher speeds escape (from the liquid)

1

water / sweat <u>evaporates</u>
accept particles escape from the (surface of the) liquid

1

(which) lowers the <u>average</u> energy of (remaining) water / sweat particles
allow reference to the total energy of the liquid reducing
allow lowers the athlete's <u>temperature</u>
ignore cool down

1

(b) any **three** from:
accept IR / radiation / heat / infrared / energy throughout

- the blanket traps air
- air is an insulator
  accept for 2 marks trapped air reduces conduction / convection
- space blanket reflects infrared radiation (back to the body)
  ignore incident solar radiation
  ignore reflects light
  ignore bounces off
- space blanket is a poor emitter / radiator of infrared radiation
  *do **not** accept does not emit infrared radiation*

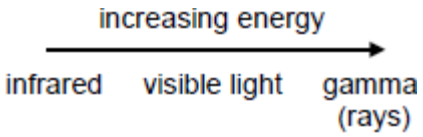
3

[7]

STEMUP.CO.UK

Q80.

(a)



*3 correct = **2** marks*
*1 or 2 correct = **1** mark*
allow IR for infrared
allow visible or light for visible light

2

(b) (i) frequency

1

(ii) vacuum

1

(c) IR - remote control / fibre optic
ignore phones and cables unless qualified

1

microwave - mobile phone / satellite (TV)

1

radio – (terrestrial) TV / radio transmissions
allow walkie talkies

1

visible light – photography / fibre optic
allow valid examples of communication using visible light
e.g. traffic lights, sign language

1

[8]

Q81.

(a) convection

1

(b) any **two** from:

- easier / clearer to read **or** reading error less likely / takes readings for you
- greater resolution / temperature displayed to two decimal places
  ignore precision / accurate / reliable / sensitivity
- more frequent readings
  ignore readings every second / plots graph / quicker
- more data
- live graphical representation
  allow references to safety
  allow no need to open lid (thus preventing cooling)

2

STEMUP.CO.UK

(c) (i) black is a better <u>emitter</u> / <u>radiator</u> of energy / infrared radiation

allow heat

for full marks there must be a comparison in terms of emission / radiation

*allow **1** mark for: temperature of black can decreases faster / more*

or

water in black can has reached room / constant temperature whilst water in white can is still cooling

or

correct description of temperature drop in both cans after 14 minutes

2

(ii) (any) line drawn between the white can and black can lines on graph **starting at 100** (°C)

1

line shows the same trend as white can line **or** black can line

second mark only scores if first marking point correct

*do **not** award this mark if line shows intentional rise at any point*

1

[7]

Q82.

(a) (light waves) are transverse

1

(sound waves) are longitudinal

1

(b) (i) B

1

(ii) D

1

[4]

Q83.

(a) *correct order only*

gamma (rays)

allow waves

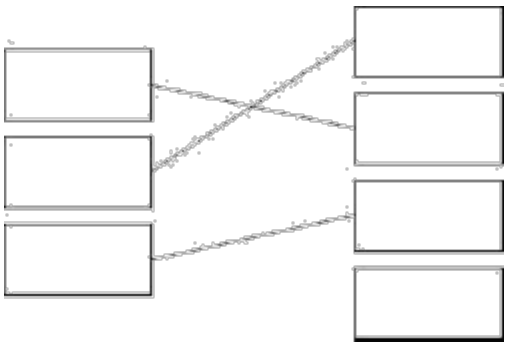
1

(visible) light

1

(b)

STEMUP.CO.UK



extra line from statement cancels the mark

1
1
1

[5]

Q84.

$v = f \times \lambda$

1.5×10^{10} (hertz)
or
15 000 000 000

*allow **1** mark for correct substitution and transformation*
$(3 \times 10^8 / 0.02)$
*allow **1** mark for 1.5×10^8*
***or** 150 000 000*

2

[2]

Q85.

(a) (i) radio (waves)

1

(ii) gamma (rays)

accept γ

*do **not** accept α*

1

(iii) X-rays
or
gamma (rays)

accept γ

*do **not** accept α*

1

(b) (i) 2

1

(ii) 4(cm)

1

(iii) 3(cm)

ignore + or – in front of 3(cm)

1

STEMUP.CO.UK

(iv) transverse

1

[7]

Q86.

(a) any **two** similarities and any **two** differences

read whole answer to ensure that there are no contradictory statements which negates that mark

ignore reference to senses in similarities and differences

similarities

- (both can be) reflected
- (both can be) refracted

  allow both travel through any correctly named solid / gas / liquid
- (both can be) diffracted
- (both) interfere
- (both) transfer energy

  ignore both are types of energy / waves / oscillations
- (both exhibit) Doppler effect

  *do **not** accept statements like both are transverse as a similarity*

differences

- light can travel through a vacuum
  or
  sound cannot travel through a vacuum

  allow sound requires a medium / particles to travel through
- (different) speed / velocity
- one is longitudinal and one is transverse

  accept light is faster than sound

  *do **not** accept sound is transverse and light is longitudinal*

  allow correct description:

  (longitudinal) the oscillations / vibrations are parallel to / same direction as (the direction of energy transfer)

  and

  (transverse) the oscillations / vibrations are 90° to / perpendicular to (the direction of energy transfer)
- sound is a mechanical wave / caused by vibrations and light is an electromagnetic wave

  accept sound waves have a longer wavelength / lower frequency

  *if no other marks gained allow **1** mark for any correct*

STEMUP.CO.UK

difference(s) where the waves are not specified
eg one is transverse
eg have different wavelengths / frequencies

4

(b) (i) *working must be shown for **3** marks*

4800 x 0.25

1

1200(m/s)

1

(liquid) C
ignore water / named liquid

1

(ii) (yes / no)
ignore yes / no, marks are for the explanation

speed increases as density increases
allow positive correlation
allow the more dense the liquid the less time (for sound to travel through)
ignore they both increase
ignore there was no pattern

1

but, mercury should have a (much) greater speed given the higher density
allow mercury does not fit the pattern / is an anomaly

1

[9]

Q87.

(a) *accept 'they' as referring to microwaves*

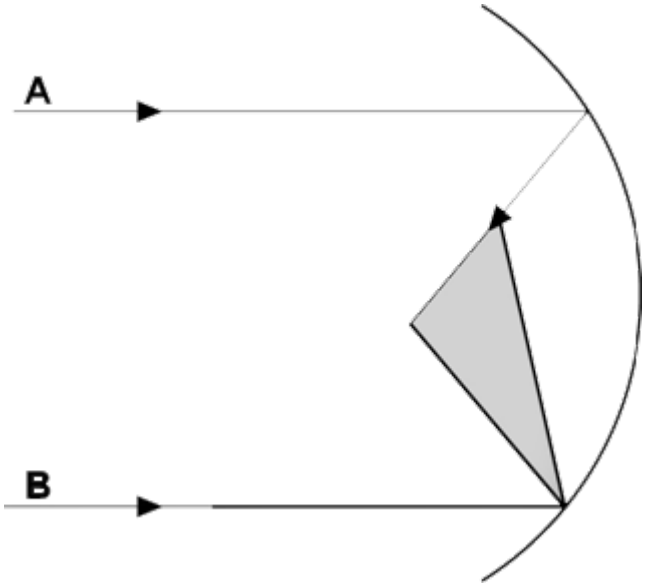
microwaves can travel through the atmosphere / ionosphere
accept not reflected by ionosphere

or
radio waves cannot (escape from the atmosphere)
allow cannot penetrate / travel through
ignore frequency / wavelength
ignore reference to speed of waves

1

(b) (i) straight continuous lines drawn to show microwave B reflected by satellite dish
reflected ray should be within limits of grey area

STEMUP.CO.UK



1

(ii) receiver drawn using rectangle symbol where microwaves A and B meet / cross over

allow ecf from (b)(i)

if (b)(i) not attempted no marks can be awarded for (b)(ii)

if lines do not meet / cross over allow receiver where extended lines would meet

allow any clear indication where receiver should be

1

[3]

STEMUP.CO.UK

Q1.

(a) Just over 50% of students were able to identify the position of ultraviolet light within the electromagnetic spectrum. Many believed it came between microwaves and visible light.

(b) Only 15% gained both marks with a further 52% gaining one mark. It was noticeable the number of students who ticked more than the required number on this question. In this situation the list principle is applied. The most common error was that they would have a longer wavelength than microwaves.

(c) 41% of students gained one mark on this question, however only 15% managed to score both marks. Many of those failing to gain marks gave weaker responses of "cancer" or "burning" without further qualification.

(d) Many students failed to read the question carefully and so gave examples of medical imaging or other applications. 32% did gain two marks and a further 35%, one mark. Other incorrect responses of note were longitudinal, transverse and ultrasound.

Q2.

(a) Nearly 13% gave accurate answers to score both marks. A further 20% were able to score a compensation mark by vague references to parallel and perpendicular, but it was clear that many students do not realise the importance of what is oscillating and the direction of energy transfer. There were many vague incorrect descriptions of 'up and down' and 'side to side'.

(b) 25% gained full marks, and a further 18% gained two marks, usually not giving the answer to two significant figures. There were a large number of responses using an incorrect rearrangement of the equation and generally the use of standard form was not the cause of the errors.

(c) This was very poorly done, with just over 1% gaining full marks. There were many vague responses and a significant number of candidates wrote about transverse and longitudinal waves. There was also considerable reference to radio waves being reflected off the ionosphere.

A significant minority of students did not attempt this question which might suggest that they were unfamiliar with the material.

Q3.

Foundation

(a) Most students attempted to improve this method. Using the same size bags was the most common correct answer, followed by using the same volume of water. Many students gave answers to extend the investigation instead, such as suggesting using more colours.

The common answer of repeating for more time or on more days did not gain credit. 69% of students gained some credit.

(b) Resolution appears to be a concept that is not well understood, with 6% of students providing a correct answer. 22% of students did not attempt to answer this question.

STEMUP.CO.UK

(c) This was generally well understood, but all too often inaccuracy in expression resulted in the mark not being awarded.

(d) The mean value was correctly calculated by 67% of students.

(e) 87% of students concluded that it was black bag that would be best to use. However, approximately half of these students did not gain the mark for their reason. Those that did so usually referred to the greatest rise in temperature. A very common misconception is that the colour black 'attracts the Sun / heat'.

Higher

(a) 60% of students achieved two or more marks for this question. Answers such as, 'the size of the bag' and, 'the volume of water' were not uncommon, but do not answer the question. The most common correct answer seen was 'use the same size bag'.

(b) Resolution appears to be a concept that is not well understood with 31% giving a correct answer.

(c) The stem of the question requires an answer which is comparative, so 'it was a cold day' was not awarded the mark. 64% of students achieved the mark.

(d) This proved a successful question for 93% of students. However, poor formation of numerals meant that '4' could often easily be interpreted as '7' or '9'.

(e) Most students selected 'black bag' with reasons based on evidence or knowledge that black is the best absorber of heat. The statement based on evidence from Table 1 required an answer such as 'because it had the great**est** temperature rise'. A common misconception is that that black **attracts** heat and light.

Q71.

(a) (i) Ray diagrams are difficult to draw without a ruler. We do allow some tolerance, but the line must look straight by eye. Rays were drawn in many directions – reflected from the top surface, reflected internally at both possible and impossible angles, emerging directly down the normal and at very large or very small angles. The easiest way to draw the refracted ray is to position a ruler along the incident ray and then move it parallel to this until it meets the normal on the lower surface of the block.

(ii) Less than half of the students knew that the dashed line drawn on ray diagrams is called the normal.

(b) (i) In science a line of best fit may be a straight line or a curve. Many students drew a straight line, rather than a smooth curve. Others did not include the point drawn at 0,0. The curve had to touch at least some part of each point, and could not be constructed from a series of straight lines drawn from point to point.

(ii) Most students gained the first marking point for stating that as the angle of incidence increased, the angle of refraction increased. The mark was not awarded if cause and effect were written the wrong way round, i.e. as the angle of refraction increased, the angle of incidence increased. The second marking point was rarely attempted.

STEMUP.CO.UK

Q72.

There was 1 mark for each of three correct lines. Almost all students gained at least 1 mark, usually for visible light being used for photography. Many thought that either microwaves or radio waves are used for remote controls.

Q73.

(a) Many students did not use a ruler to draw the rays, and many drew rays that were too thick. Those students who gained 1 mark usually gained it for correctly drawing the ray that was outside the block. A large number of students drew the first ray from the end of the ray within the block to the first cross, and therefore did not draw a straight line. As they had not extended the ray already printed within the block they could not gain the first marking point. This often meant they did not gain the second mark, which was for drawing a ray through the two crosses to meet the edge of the block, as their ray only went to the first cross, and did not reach the block.

(b) Just under half of the students gained the mark for saying “Wear safety glasses”, “Don’t shine the laser into someone’s eyes”, or “Don’t look directly at the laser light”. Goggles, glasses, sunglasses or eye protection were insufficient responses. The idea of safety, or ideally dark, glasses was needed.

(c) (i) A wide range of correct responses was given. Many said the line should go through more points or they said there should be an equal number of points on both sides of the line. Identifying that there were too many points above the line, or that the line simply connected two points, the first and the last, was also creditworthy. Only a few recognised that the line should have been drawn as a curve. Incorrect statements made reference to anomalies, when there were no anomalies in the data, or students said that the line didn’t go through any points, when it went through two points.

(ii) Many students said the investigation could have been improved by repeating it. This was not enough to gain the mark; they had to continue and add that a mean should then be calculated, or that it would allow anomalies to be identified. The most common correct response was to measure more angles. An incorrect answer that was frequently seen was to measure five different values for angle b. This was what had been done in the investigation, so perhaps students had just got the idea from the question, which told them the student measured five different values for angle a. Others said they should compare the results with other students, which was ignored.

Q74.

(a) The question asked for a method of energy transfer, but many students gave infrared radiation as the answer. In this instance, infrared was ignored, so they gained the mark.

(b) (i) Most students gained at least 1 mark for 5000 × 4200 × 5, however they often then wrote down an incorrect answer. It is always good to check the answer. Some made avoidable errors when writing down the number of noughts. A variety of units was given.

Any unit of energy could gain a mark, if no other marks had been given, as long as it was written correctly. Many wrote j instead of J, or KJ instead of kJ.

(ii) Most students managed to substitute into the correct equation and many also reorganised the equation to find the time. However, a lot of students forgot to convert the kJ to J, so could only gain 2 marks.

STEMUP.CO.UK

(iii) Many responses referred to the air being warmer than the pool, but did not go on to explain that the water would absorb energy from the air or surroundings. Some talked about the Sun being hotter or cooler, or the use of heaters.

Q75.

(a) Less than half the students knew that electromagnetic waves are transverse waves, the majority thought they were longitudinal.

(b) (ii) Less than ten per cent of the students knew that the wave speed of an electromagnetic wave would stay the same if the frequency increased.

Q76.

(a) More than half the students selected the correct diagram showing a ray of light travelling from air into glass.

(b) (i) Some very untidy rays were drawn by hand. Ray diagrams should be drawn with a ruler. There were 2 marks for this question. 1 mark is for drawing a continuous straight line parallel to the incident ray and a second mark for showing an arrow on the ray. If the ray was shown to reflect into the shaded part of the cat's eye no marks were given.

(ii) Very few students knew the dotted line is called the normal.

Q77.

(a) Most students did not know what quantities X and Y were, but those who did often scored the third mark for naming the correct units.

(b) (i) Many responses referred to the speed that the galaxies were travelling at, rather than their directions relative to Earth. Others gave their relative distances from Earth. Many gained 1 mark for realising that galaxies B and C were moving in opposite directions. A few gave detailed explanations for their conclusions in terms of red and blue shift.

(ii) The question asked for a comparison between the speed of galaxy B and the speed of galaxy C, relative to the observer. Many responses did not refer to one being faster or slower than the other, but to relative distances from the observer, or amount of red or blue shift.

(iii) Only a few students realised that there wasn't enough evidence, or that 3 galaxies were too few to base conclusions about all galaxies on. Even fewer mentioned that there are a very large number of galaxies in the Universe.

Q78.

(a) (i) Almost two thirds of the students knew that all objects absorb infrared radiation. The most common incorrect answer was that they conduct infrared radiation.

(ii) Just over two thirds of the students knew that hotter objects emit more infrared radiation. The most common incorrect answer was that they emit less infrared radiation.

(b) (i) Less than half of the students said that energy is transferred through the

STEMUP.CO.UK

sides of the metal cubes by conduction. Only slightly fewer students thought that energy was transferred through the metal by convection.

(ii) Only half of the students identified the independent variable as being the colour of the cube.

(iii) The majority of students gained 1 mark for this question, usually for realising that Cube X would follow the middle line of the three on the graph.

(iv) Few students scored on this question. The vast majority said that the starting temperatures had to be the same to make it a fair test, which was too vague. If they went on to explain the effect of different starting temperatures on the rate of heat loss they could have gained the mark.

(v) Less than half of the students said that variables kept the same in an investigation are called control variables. Some students had not read the question properly and gave an example of a control variable.

Q79.

(a) Many responses included biological explanations of thermoregulation, much of which did not relate to this question. Few students mentioned that energy is transferred from the athlete to the sweat. Some explained that the particles would gain energy, but did not go on to say that the most energetic or fastest particles would escape. The third marking point was the one that most students gained, for stating that the sweat evaporated. However, many thought that particles evaporated, rather than the liquid. Reference to lowering the average energy of the particles that were left on the skin was rarely seen. “Lowering temperature” was seen more often.

(b) Most students gained a mark for saying that the foil blanket would reflect energy back to the athlete, although others thought it would reflect radiation from the Sun, which was ignored. Some mentioned that shiny surfaces are poor emitters of infrared radiation, but students could not gain this mark if they said no energy was emitted. The idea that air was trapped by the blanket was rarely seen.

Q80.

(a) Most common 1 mark responses identified gamma as the part of the spectrum with the most energy. Many students mixed up visible and infrared in terms of energy.

(b) (i) Just under two thirds of students knew that the number of waves passing a point in 1 second is called the frequency. The most common incorrect response was wavelength.

(ii) Over half of the students knew that electromagnetic waves travel at the same speed through a vacuum.

(c) The specification focusses on the uses of parts of the electromagnetic spectrum for communication only. Microwave ovens are not used for communication, so did not gain credit. Many students gave remote control as a use for infrared, and mobile phones for microwave. Few correct answers were seen for radio waves and visible light, as to see things was insufficient for light.

Q81.

STEMUP.CO.UK

(a) Many students thought the lid prevented energy loss by conduction rather than convection.

(b) This question was not answered well with a very small proportion of students able to gain both marks. Schools are reminded to use the correct version of the glossary. Many students said the data logger was more precise, which related to the glossary used with the previous specification and was therefore ignored. The required answer was greater resolution, although a description of this would gain the mark. Many responses were simply copies of information given in the stem of the question or that it was faster.

(c) (i) An explanation for the difference in temperature was required, but one mark was allowed for a description of the temperature difference as long as the answer was comparative and not just a statement about one can. Many students thought that the cans were warming up or explained the greater temperature drop in the black can as being because black surfaces absorb more energy. In relation to radiation, students should understand the difference between absorption and emission.

(ii) This question was well answered with over three-quarters of students gaining full credit.

Q82.

(a) Most students scored a mark for this question. For incorrect answers, longitudinal and transverse were often given the wrong way round.

(b) (i)+(ii) These questions were well answered with a few students putting answers B and D the wrong way round.

Q83.

(a) A range of errors was made in this question. Some students gave the names of rays already given in the spectrum, the names of appliances or words such as transverse, sound, solar, electric, gametes, satellite and indicator. Some wrote visible but with no mention of light and a few wrote invisible. The position of gamma in the electromagnetic spectrum was better known than that of light.

(b) Once again extra lines were drawn. The methods of transmission for satellite and terrestrial TV were not well known, with most thinking that satellite TV was transmitted by radio waves and terrestrial TV by microwaves or UV rays. Almost a fifth of students achieved full marks.

Q84.

It was apparent that most students are unfamiliar with working in standard form, a mathematical requirement for Higher Tier students on this new specification. Only one third of the students scored one mark, the majority of which for 1.5×10^8.

STEMUP.CO.UK

Q85.

(a) (i) Two-thirds of students identified radio waves as having a wavelength longer than microwaves.

(ii) Almost two-thirds of students identified gamma rays as having more energy than X-rays.

(iii) Despite the high number of correct responses for questions (a)(i) and (a)(ii), less than half the students could identify a part of the electromagnetic spectrum with a higher frequency than ultraviolet.

(b) (i) Just under two-thirds of students identified that two complete waves were shown on the diagram.

(ii) Only a quarter of students were able to work out the correct wavelength from the diagram.

(iii) Just over half the students gave the correct amplitude of the waves.

(iv) Only a quarter of students were able to identify the type of wave as transverse.

Q86.

(a) Very few students gained three or four marks. Most students struggled to give two similarities of light and sound waves. The most common difference given was that light travels faster than sound. A few said sound waves cannot travel through a vacuum. Many got transverse and longitudinal waves mixed up. Many students said light can be seen, but sound cannot, rather than focussing on the properties of the waves themselves.

(b) (i) Many students identified the wavelength and frequency from the question, but had trouble substituting into the equation. Although almost half the students scored full marks, a number of students attempted to guess what the liquid was; a common answer was ‘water’, rather than choosing a letter from the bar chart.

(ii) Over half the students did not score any marks on this question. Many students gained one mark for either identifying the pattern (up to mercury) or by identifying the fact that mercury did not fit the pattern. The irregular intervals between values in the table confused many students and they were unfamiliar with the way that the hypothesis was stated: ‘There is a link between…’. Some students attempted to find a mathematical relationship between the two quantities rather than simply identifying the trend.

Q87.

(a) Most responses referred to the speed, wavelength or frequency of the waves or to the strength or amount of energy they transferred. All of these were ignored. Very few students said microwaves can travel through the atmosphere or that radio waves cannot.

STEMUP.CO.UK

(b) (i) Most students drew a reflected ray that met the end of microwave A. This was allowed, although it should have been reflected at a slightly larger angle than this. Most students drew a straight continuous line, but should be encouraged to use a ruler.

(ii) The receiver was usually positioned where the two reflected rays met. Students could still gain a mark for question (b)(ii) even if they had drawn the position of the reflected ray incorrectly. Several students used their own symbol for a receiver, rather than the one shown in the question. This was allowed.

STEMUP.CO.UK