ResultsPlus edexcel

Examiners' Report
June 2014

IAL Physics WPH05 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus. Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2014

Publications Code IA039745

Introduction

The assessment structure of unit 5 mirrors that of other units in the specification. The examination consists of 10 multiple choice questions, a number of short answer questions and some longer, less structured questions with synoptic elements incorporated throughout.

This paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from this unit, with all of the questions eliciting responses across the range of marks. However, marks for questions Q12(c), Q15(a), Q16(a), Q16(c), Q16(d), Q17(b)(i), Q17(b)(iv), Q18(b)(iv) and Q18(c)(i) tended to be clustered at the lower end of the scale.

In general, calculation and 'show that' questions gave candidates an opportunity to demonstrate their problem solving skills to good effect. Some very good responses were seen for such questions, with well-crafted solutions which were accurate and clearly set out.

Occasionally in calculation questions the final mark was lost due to a missing unit. Most candidates understood the convention that in the "show that" question it was necessary to give the final answer to at least one more significant figure than the value quoted in the question.

Once again there was evidence that some candidates have problems in appreciating the magnitudes of calculated values. Similarly, scientific terminology was used imprecisely and incorrectly in a number of responses seen on this paper. In Q16(a) there was confusion demonstrated between atoms, molecules, and nuclei. At A2 level it is to be expected that, where candidates use such terms, they do so with accuracy.

Once again, there were examples of candidates disadvantaging themselves by not expressing themselves using suitably precise language. This was particularly the case in extended answer questions such as Q16 (a) and Q17 (b)(i) where candidates had knowledge of the topic, but were sometimes unable to express it accurately and succinctly.

Some candidates did not spend enough time reading the question before they started to write their answer. In question Q16(a) the majority of candidates simply gave a description of the fission process, rather than targeting their response towards an energy discussion. Similarly, if a question asked candidates to answer "with the aid of calculation" as did Q18(c)(ii), then full marks will only be awarded if a calculation is included in the candidate's response.

Diagrams provide important means of communicating information and we should expect A2 candidates to be able to draw diagrams to achieve this as in question Q12(c) in which a labelled diagram could have gained both marks.

The space allowed for responses was usually sufficient. However, candidates should be encouraged to consider the number of marks available for a question, and to use this to inform their response.

Responses to the multiple choice questions were generally good with 5 of the questions having 70 % or more correct answers. In order of highest percentage correct they were: Q4 (95%), Q5 (92%), Q9 (92%), Q3 (83%), Q6 (72%), Q1 (68%), Q2 (66%), Q10 (57%), Q7 (53%), and Q8 (43%).

Q8, which has the lowest percentage of correct answers, revealed a common misconception amongst candidates. The correct answer was only chosen by a minority of candidates, with a large proportion choosing incorrect responses. The question refers to simple harmonic motion, which may or may not be damped. If undamped, total energy would remain constant (no answer key), but this is not a condition of simple harmonic motion. In general, none of the energies stated must remain constant, and so the correct response is B.

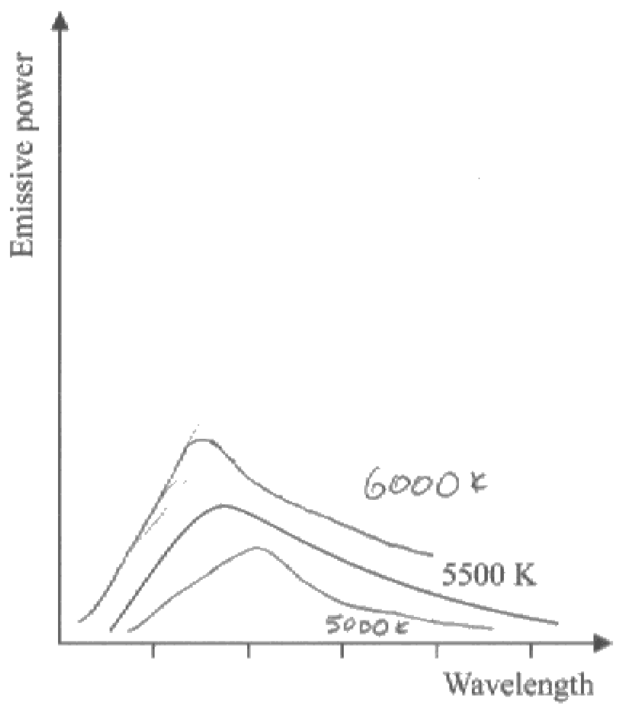
Question11

Many candidates gained full credit despite their diagrams being poorly drawn in many cases. It has been a feature of similar items in previous series that students tend to rush free hand sketching and sometimes lose marks unnecessarily.

Candidates lost marks mostly because at least one of their added lines was in line with the original, although nearly all had one peak above and one peak below 5500 K. Those who used construction lines to help position their peaks correctly tended to score well.

On the same axes sketch graphs to show how the emissive power varies with wavelength for stars with surface temperatures of 5000 K and 6000 K. Label each graph clearly.

(3)

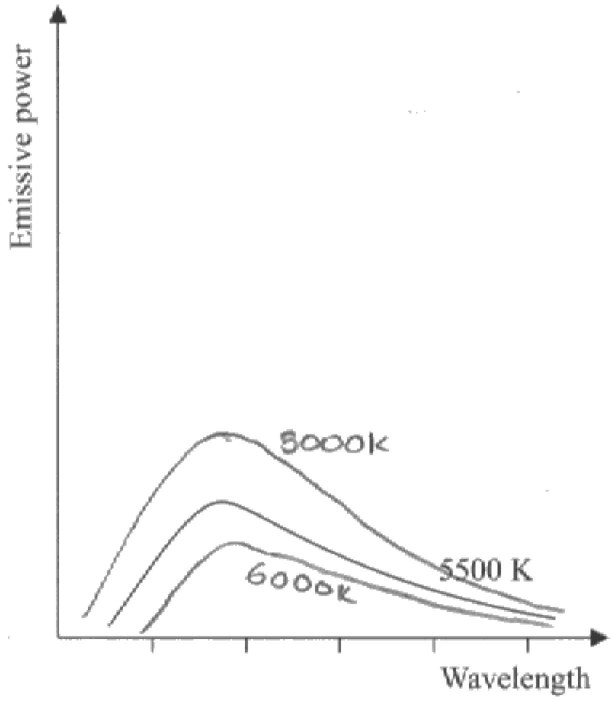


ResultsPlus
Examiner Comments

This is a well drawn set of curves and gains 3 marks.

On the same axes sketch graphs to show how the emissive power varies with wavelength for stars with surface temperatures of 5000 K and 6000 K. Label each graph clearly.

(3)



ResultsPlus

Examiner Comments

This response gains a mark for one peak being higher and the other peak being lower than the 5500 K curve, but the peaks appear to be centred on the same wavelength and so no further marks are awarded.

ResultsPlus

Examiner Tip

Take care when sketching graphs – all essential features must be correct. It may help to draw guiding points to help you draw the curve.

Question 12 (a)

Most candidates were able to make some attempt at this question with a significant number gaining full credit. A common mistake was to forget to square the distances, giving an answer of 9.75N kg^{-1}, although quite a few candidates forgot to add the 36.6km onto the Earth radius.

It was disappointing to see that only a small proportion of candidates used the ratio method, although most of those that did got full marks. Perhaps teachers could encourage candidates to attempt using ratios when solving problems of this type where there are unknown quantities that cancel.

12 In October 2012, Felix Baumgartner completed his world record free-fall attempt, jumping from just above the atmosphere from a height of 36.6 km.

(a) At the surface of the Earth the gravitational field strength has a magnitude of 9.81 N kg^{-1}. Calculate the magnitude of the gravitational field strength at the position from which Baumgartner jumped.

Earth radius = 6400 km

(3)

~~$g = F$~~ ~~$V = gr$~~ $g \propto \frac{1}{r^2}$

~~$g = \frac{Gm}{r}$~~ ~~$= 9.81 \times 6400$~~

$=$ $g_1 r^2 = g_2 r^2$

$\therefore 9.81 \times (36.6)^2 = g\,(6400)^2$

$\therefore g = 3.21 \times 10^{-4}\ \text{N kg}^{-1}$

Gravitational field strength = 3.21×10^{-4} N kg^{-1}

ResultsPlus

Examiner Comments

This response attempts to make use of ratios, but the distance used for the initial height does not include the Earth's radius and so the final answer is incorrect.

12 In October 2012, Felix Baumgartner completed his world record free-fall attempt, jumping from just above the atmosphere from a height of 36.6 km.

(a) At the surface of the Earth the gravitational field strength has a magnitude of 9.81 N kg^{-1}. Calculate the magnitude of the gravitational field strength at the position from which Baumgartner jumped.

Earth radius = 6400 km   Felix's mass ≈ 80kg

(3)

$g = \frac{GM}{r^2}$ $M = \frac{gr^2}{G} = \frac{9.81 \text{ N/kg} \times 6436.6\times10^3 \text{ m}}{6.67\times10^{-11} \text{ Nm}^2 \text{kg}^{-2}}$

~~r = 36.6×10³~~

$M = 9.4667233539 \times 10^{17}$ kg

r = 6400km + 36.6km $M = 9.47 \times 10^{17}$ kg.

r = 6436.6 km

Gravitational field strength = ...

ResultsPlus
Examiner Comments

This response makes an attempt at using the field strength equation to calculate a mass. However, the distance used is not squared when substituted into the equation and so there are no marks awarded.

ResultsPlus
Examiner Tip

Check carefully for indices when substituting into equations.

Question 12 (b)

Many candidates gained full marks on this question. Most lines were continued into the centre of the circle, and a few lost marks by drawing radial lines that were not spaced evenly. A very small number drew arrows pointing away from the Earth or only within the circle drawn to represent the Earth.

Question 12 (c)

Many candidates lost marks by restating the question in the answer, 'the gravitational field is uniform' was commonly seen. Responses showed that many did not have a clear understanding of the difference between gravitational field lines, gravitational field strength and the gravitational constant. Consequently, some answers were very confused and did not make sense.

A significant number gained the first marking point by appreciating that the height of the jump was small when compared to the radius of the Earth, although it was rarer to see answers going on to secure the second marking point.

(c) Explain why the gravitational field can be thought of as approximately uniform over the distance of the jump.

(2)

Because he falls a relatively small distance in comparison to Earth's radius so, there is small change in the gravitational field strength which is considered approximately uniform for small distances from Earth's surface

ResultsPlus

Examiner Comments

This says enough to score both marks.

Question 13 (a)

The calculation was generally carried out correctly, but the assumptions were often less clear. There was a tendency just to say ‘energy is lost’ with no further details. Candidates should be aware that energy is never lost, although there is often a transfer of energy to the surroundings which, unless taken into account, may lead to discrepancies in calculated values.

13 An outdoor swimming pool is heated using an electric heater.

(a) The swimming pool contains 1.6×10^4 kg of water at a temperature of 12 °C.

Calculate how much energy an electric heater must supply to raise the temperature of the water to 20 °C. State any assumption that you have made.

specific heat capacity of water = 4200 J kg^{-1} K^{-1}

(3)

$\Delta E = mc \times \Delta\theta$

$= 1.6 \times 10^4 \times 4200 \times ((20-12)+273)$

$= 1.6 \times 10^4 \times 4200 \times 281 = 1.88 \times 10^{10}$ J

Energy = 1.88×10^{10} J

Assumption: No heat (energy) is lost to the surrounding.

ResultsPlus
Examiner Comments

The candidates attempts a conversion from Celsius to kelvin after finding the temperature difference. This leads to an incorrect final answer. There is no need to apply any conversion factor if a temperature difference in being calculated.

ResultsPlus
Examiner Tip

Think through the calculation before you start.

13 An outdoor swimming pool is heated using an electric heater.

(a) The swimming pool contains 1.6×10^4 kg of water at a temperature of 12 °C.

Calculate how much energy an electric heater must supply to raise the temperature of the water to 20 °C. State any assumption that you have made.

specific heat capacity of water = 4200 J kg^{-1} K^{-1}

(3)

$\Delta E = mc\Delta\theta$

$= (1.6\times10^4)(4200)(8+273)$

$= 1.89\times10^{10}$ J

Energy = 1.89×10^{10} J

Assumption No heat energy is lost

ResultsPlus

Examiner Comments

Once again a temperature difference has been "converted" by adding 273 K. In addition the assumption does not gain a mark, as we are not told where the "lost" energy goes to.

Question 13 (b)

This synoptic question based on theory from unit 2 was generally well answered. Most candidates obtained a correct answer with only a few losing marks due to an incorrect conversion from seconds to hours.

(b) The electric heater runs from a 230 V supply and takes 30 hours to supply 0.55 GJ of thermal energy.

Calculate the current in the heater.

(3)

E = VIt

$1 GJ = 1 \times 10^{12} J$

$0.55 GJ = 5.5 \times 10^{11} J$

$5.5 \times 10^{11} = 230 \times I \times 108000 s$

1 hr = 3600 s

30 hr = 108000 s

I = 22141.7 A

Current = 2.2×10^{-4} A

ResultsPlus
Examiner Comments

There is a power of ten error here, as G (giga) has been incorrectly replaced by 10^{12}.

ResultsPlus
Examiner Tip

Learn the power of 10 conversions for the standard SI prefixes.

Question 14 (a)

This was a well answered question with most candidates making correct substitutions into Wien's equation to obtain the correct answer. In a small number of responses the decay constant equation, l = ln 2 / $t_{1/2}$, was used. This tends to suggest that not all candidates are familiar with the equations provided in the question paper.

14 Proxima Centauri is a red dwarf star about 4.2 light years away from the Earth with an average surface temperature of 3.04×10^3 K.

(a) Calculate the wavelength λ_{max} at which peak power emission from Proxima Centauri occurs.

(2)

$T \lambda_{max} = 2.898 \times 10^{-3}$

$\lambda_{max} = \frac{2.898 \times 10^{-3}}{3.04 \times 10^3} = 9.53 \times 10^{-7}$

$\lambda_{max} = 9.53 \times 10^{-7}$

ResultsPlus
Examiner Comments

This is a correct calculation, but the units are omitted from the final answer.

ResultsPlus
Examiner Tip

Always check units for quantities that you calculate.

14 Proxima Centauri is a red dwarf star about 4.2 light years away from the Earth with an average surface temperature of 3.04×10^3 K.

(a) Calculate the wavelength λ_{max} at which peak power emission from Proxima Centauri occurs.

(2)

$\lambda_{max} T = \ln 2$

$\lambda_{max} = \frac{\ln 2}{3.04 \times 10^3}$

$\lambda_{max} = 2.28 \times 10^{-4}$ m

$\lambda_{max} = 2.28 \times 10^{-4}$ m

ResultsPlus
Examiner Comments

An incorrect equation has been used. Either the candidate remembered the equation incorrectly, or they selected the wrong equation from the list in the question paper.

ResultsPlus
Examiner Tip

Us the equation list as an *aide memoir* to check you have the correct form.

Question 14 (b)

Both parts were consistently well done, although there were some candidates who obtained incorrect answers as a result of forgetting to apply the required powers to r and T when performing the calculation.

(b) The radius of Proxima Centauri is estimated to be 3.2×10^6 m.

(i) Show that its luminosity is about 6×10^{20} W.

(2)

$\therefore L = 4\pi r^2 \sigma T^4$

$= 4 \times \pi \times (3.2 \times 10^6)^2 \times (5.67 \times 10^{-8}) \times (3.04 \times 10^3)^4$

$= 1.95 \times 10^{14}$ ~~$= 1 \times 94 \times 10^{14}$~~

(ii) When measured on the surface of the Earth the radiation flux from the Sun is 1.38×10^3 W m^{-2}.

At a point in space the radiation flux from Proxima Centauri also has this magnitude.

Calculate the distance of this point from Proxima Centauri.

(2)

$F = \dfrac{L}{4\pi d^2}$

$\Rightarrow 1.38 \times 10^3 = \dfrac{6 \times 10^{20}}{4 \times \pi \times d^2}$

$\Rightarrow d = \sqrt{\dfrac{6 \times 10^{20}}{4 \times \pi \times 1.38 \times 10^3}} = 186007797.3$ m

Distance 186007797.3 m

ResultsPlus
Examiner Comments

There is a calculation error in part (i), although the "use of equation" mark is awarded. Part (ii) is correct, so full marks here.

ResultsPlus
Examiner Tip

Check that you have carried out all of the numerical processes that the equation demands.

Question 15 (a)

Many candidates referred to red and blue shift and attempted to phrase the answer in terms of the expansion of the Universe. A significant number of candidates seemed to think that the effect is caused by distance from the observer rather than relative speed, hence their assertion that the effect is due to X being further away than Y.

Some who attempted an explanation of the Doppler effect without direct reference to Doppler tended to give answers which were too vague to gain any credit. Nonetheless a significant number of candidates managed to gain both marks for a reference to Doppler shift and appreciating that X was moving away and Y towards.

(a) When the rings are observed from the Earth, sunlight reflected from X is found to have slightly longer wavelengths than sunlight reflected from Y.

Suggest a reason for these observations.

(2)

~~The rings are spinning anti-clockwise so that~~

The Doppler effect states that $\frac{v}{c} = \frac{\Delta\lambda}{\lambda} = \frac{\Delta f}{f}$ so if λ of light at X is greater than at Y

then light from X has a smaller frequency so ~~the ring~~ X is moving away from us

as the rings spin in a clockwise way. Y is moving towards us.

ResultsPlus
Examiner Comments

This response scores full marks.

(a) When the rings are observed from the Earth, sunlight reflected from X is found to have slightly longer wavelengths than sunlight reflected from Y.

Suggest a reason for these observations.

(2)

Y is closer to us than X,

due to Red shift

Particles in X are moving faster

than ~~Y~~ particles in Y

ResultsPlus
Examiner Comments

This response scores no marks. The candidate makes no reference to the Doppler effect and is confusing relative movement with distance.

Question 15 (b) (i)

This was well done. A few candidates mistakenly opted for a centripetal force equation, but otherwise good solutions were seen.

(b) A rock of mass 2500 kg, in one of the rings, is orbiting at a distance of 1.75×10^8 m from the centre of Saturn. The rock has a speed of 1.45×10^4 m s^{-1} as it orbits the planet.

(i) Calculate the time in hours the rock takes to complete one orbit.

(3)

$V = \frac{2\pi r}{T}$ $\quad F = ma_c = (2500)(\frac{v^2}{r})$

$= \frac{2500 \times (1.45 \times 10^4)^2}{1.75 \times 10^8} = 3003.6\text{N}$ $\quad$ 75831.60 → x hours

$a_c = a_c$ $\quad$ 60s → 1 hour

$\frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$ $\quad v^2T^2 = 4\pi^2r^2$ → $T = \frac{2\pi r}{v} = \frac{(2\pi)(1.75 \times 10^8)}{1.45 \times 10^4} = 75831.55\text{ s}$ $\quad 60x = 75831.$

$vT = 2\pi r$ $\quad$ T = 1263.859 hours

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

Time for one orbit = 1263.9 hours

ResultsPlus
Examiner Comments

In this response the candidate makes a relatively common error of converting the time into seconds incorrectly.

Question 15 (b) (ii)

This was well done.

(ii) By considering the gravitational force acting on this orbiting rock calculate a value for the mass of Saturn.

(3)

$F = mv^2$ $\quad$ ~~2500~~ $\times (1.45 \times 10^4)^2 = \frac{GM \text{~~2500~~}}{(1.75 \times 10^8)^2}$

$F = \frac{GMm}{r^2}$

$M = \frac{(1.45 \times 10^4)^2 \times (1.75 \times 10^8)^2}{6.67 \times 10^{-11}}$

$M = 9.65 \times 10^{24}$

Mass of Saturn = 9.65×10^{24} Kg

ResultsPlus

Examiner Comments

The candidate has re-arranged the equation incorrectly. They cannot score a "use of equation" mark, since they are substituting into an incorrect equation.

ResultsPlus

Examiner Tip

Substitute values before re-arranging equations, as a substitution into an incorrectly re-arranged equation will not be given the "use of equation" mark.

(ii) By considering the gravitational force acting on this orbiting rock calculate a value for the mass of Saturn.

(3)

$\frac{GMm}{r^2} = \frac{mv^2}{r}$

$\therefore M = \frac{v^2 \times r}{G}$

$= \frac{(1.45 \times 10^4)^2 \times (1.75 \times 10^8)}{6.67 \times 10^{-11}} = 5.516 \times 10^{26}$

Mass of Saturn = 5.52×10^{26}

ResultsPlus

Examiner Comments

This scores 2 marks out of 3. The final marking point is not awarded, since the unit is omitted.

ResultsPlus

Examiner Tip

Always check the units for quantities that you calculate in a question.

Question 16 (a)

As fission is a GCSE topic it may be the case the candidates have not moved on in their thinking after revisiting this topic at A2. The majority of candidates simply gave a description of the fission process, rather than targeting their response towards an energy discussion. Quite a few candidates referred to atoms / molecules rather than nuclei, and many of the responses seen referred to mass difference and binding energy but with insufficient detail to meet the marking criteria.

This was a QWC question, and some candidates lost out of full marks as a result of disorganised, poorly worded responses. Many used "decay" instead of "splitting" of the nucleus or did not distinguish the relative sizes of the larger and smaller nuclei.

*(a) State what is meant by nuclear fission and explain why energy is released during the fission of a nucleus such as uranium.

(3)

Nuclear fission ~~it~~ is the splitting of ~~an~~ the neclues of an element, ~~into~~ resulting in the formation of element with smaller proton numbers. The fission of uranium causes a chain reaction to occur, and ~~st~~ this causes a release of high amount of high-energy ~~gamma~~ gamma particles.

$A = A_0 e^{-\lambda t}$

$\ln A = \ln A_0 = e^{-\lambda}$

ResultsPlus
Examiner Comments

There is very little detail supplied in this response, and no marks were awarded.

ResultsPlus
Examiner Tip

Be specific and use technical terms wherever possible.

Question 16 (b)

This question was well done by most candidates.

(b) A sample of coolant from the reactor contains 1.2×10^{13} nuclei of sodium-24.

Calculate the activity of this sample when it is first removed from the reactor.

decay constant of sodium-24 = $1.3 \times 10^{-5}\ s^{-1}$

(2)

Activity $= \frac{dN}{dt} = 1.3 \times 10^{-5}\ s^{-1} \times 1.2 \times 10^{13}$ nuclei

$= 1.56 \times 10^{8}$ nuclei s^{-1}

Activity = 1.56×10^{8} nuclei/s

ResultsPlus
Examiner Comments

This response scores full marks.

Question 16 (c)

Many candidates gave the property as 'able to absorb radiation'. This is what the shielding needs to do but it is not a property of a material. Lead was the most popular answer seen, although concrete was also frequently seen.

Question 16 (d)

This was generally poorly answered, as it was difficult to find a comparison of the same issue. Often a relevant factor was given for one process that was not contrasted with reference to the other process. In describing the merits of fusion reactors it was as if candidates assumed that the properties of fission reactors needn't be stated as they could be taken as read.

The fact that more energy could be derived from one or other of the reactors was a popular response but not credit worthy in the context of this question. Some answers claimed that hydrogen is a renewable resource, whereas uranium is non-renewable. The use of the terms renewable and non-renewable in this context was not accepted.

(d) Many governments are funding research into replacing fission reactors with fusion reactors. Suggest why.

(2)

Fussion yields more energy then fision.

The fuel for fussion is hydrogen which is unlimited, whereas ~~the~~ fission need a relative llimite source (uranium)

(Total for Question 16 = 9 marks)

ResultsPlus
Examiner Comments

Although quite poorly expressed, this response says enough to gain MP2.

(d) Many governments are funding research into replacing fission reactors with fusion reactors. Suggest why.

(2)

Uranium is ~~ores are~~ non-renewable resource. Fission produces harmful ~~ionising radi~~ radioactive isotopes which are difficult to store. These isotopes, sometimes, have a very long half-life.

ResultsPlus
Examiner Comments

Like many responses seen, this concentrates on fission and makes no reference to fusion. Similarly, responses which only referred to fusion were also seen.

ResultsPlus
Examiner Tip

Plan your answer to a question like this before you start to write. Planning your response will help you to write your answer out logically and with a minimum of omission.

Question 17 (a)

This was a well answered synoptic question which used ideas from unit 1.

Question 17 (b) (i)

This was not well attempted generally. There were some very superficial responses seen to this question which did not get to the real physics of the situation at all. Candidates often appreciated that the volume decreased and that KE or speed increased. However, they then failed to mention rate of collision, momentum change, or collision with the walls of the ball. Instead they went on to use the gas laws as an "explanation".

*(i) Using ideas about molecules and momentum, explain why the pressure of the gas increases.

(4)

When the ball hits the ground, the ball compresses reducing volume of the ball and heat energy is gained during impact therefore molecules ~~in a smaller~~ gain more energy from the heat and ~~coll~~ move faster, colliding more frequently with the walls of the ball ~~as~~ because ~~?~~ ~~molec~~ ~~molecules have more~~ and as the volume of ball decreases molecules collide more frequently.

ResultsPlus
Examiner Comments

This answer scores the first three marking points, but fails to link the collision rate with an increased rate of change of momentum (and hence force on the walls).

ResultsPlus
Examiner Tip

Read through your answers to ensure that what you have written makes sense.

*(i) Using ideas about molecules and momentum, explain why the pressure of the gas increases.

(4)

$E_k = p^2/2m$.

$\frac{1}{2} m \langle c^2 \rangle = \frac{3}{2} kT$.

$\frac{PV}{NK} = T$

$PV = NKT$

the momentum increases which causes an increase in kinetic energy. ~~This an ideal~~ We can assume it is an ideal gas as the molecules only have kinetic energy. If the kinetic energy increases, temperature becomes higher, which results in an increase in pressure. ~~B~~ Momentum increases as the particles gain velocity. It is an inelastic collision

ResultsPlus

Examiner Comments

This response adopts an approach of putting down as many things as the candidate can think of which might possibly relate to the situation. The reference to an increase in the kinetic energy of the molecules is enough for MP1 to be awarded.

ResultsPlus

Examiner Tip

Always base your explanations on physical principles.

Question 17 (b) (ii)

A common issue here was the assumption that the volume remained constant, even though most candidates had already identified that it changes. There were also responses with temperature substituted in °C rather than K.

(ii) Calculate the temperature of the gas inside the tennis ball at the instant the tennis ball is stationary during impact with the ground.

(2)

$\frac{P_2 V_2}{T_2} = \frac{P_1 V_1}{T_1}$ $T_2 = \frac{197 \times 101 \times 20}{182 \times 107}$

$\frac{197 \times 101}{T_2} = \frac{182 \times 107}{20}$ $T_2 = 20.4$ °C

Temperature = 20.4°C

ResultsPlus
Examiner Comments

The candidate has used the correct equation, but temperatures have not been converted into kelvin.

(ii) Calculate the temperature of the gas inside the tennis ball at the instant the tennis ball is stationary during impact with the ground.

(2)

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\Rightarrow T_2 = \frac{P_2 \cdot T_1}{P_1}$

$= \frac{197 \times 10^3 \times 293}{182 \times 10^3} = 317$ K

~~$\frac{182 \times 10^3}{293} = \frac{P_2}{T_2}$~~

$= 44$°C

Temperature = ~~317K~~ 44°C

ResultsPlus
Examiner Comments

In this response the candidate has assumed that the volume stays constant, and so they do not score any marks.

(ii) Calculate the temperature of the gas inside the tennis ball at the instant the tennis ball is stationary during impact with the ground.

(2)

$pV = NkT$

$$\frac{182 \times 10^3 \times 107}{293} = \frac{197 \times 10^3 \times 101}{T} = T = \frac{293 \times 197 \times 10^3 \times 101}{182 \times 10^3 \times 107} = 299.364$$

Temperature = 299 K

ResultsPlus

Examiner Comments

This response uses the ideal gas equation and scores full marks.

ResultsPlus

Examiner Tip

Use the standard equations given in the specification and listed on the formula sheet at the end of the exam paper.

Question 17 (b) (iii)

Many candidates were able to calculate the value of N correctly. Once again a common error was to use Celsius instead of Kelvin for the temperature in the calculation. The latter part of the question proved to be less well answered with candidates finding the change in KE of individual molecules but then forgetting to multiply by N to find the total change. Having used $3kT/2$ correctly to work out the energy of the nitrogen molecules at the higher temperature some candidates simply subtracted 1.42 J, the kinetic energy of the tennis ball just before impact, to obtain the change in KE, instead of repeating the calculation for the lower temperature.

(iii) Show that the number of nitrogen molecules inside the tennis ball is about 5×10^{21} and hence find the change in total kinetic energy of the nitrogen molecules during the impact.

(4)

$PV = NkT$

$\Rightarrow (132 \times 10^3) \times \frac{107}{100^3} = N \times 1.38 \times 10^{-23} \times (20 + 273)$

$\Rightarrow N = 4.82 \times 10^{21}$ molecules.

Change in ~~total~~ kinetic energy $= \frac{3}{2} k \Delta T = \frac{3}{2} \times 1.38 \times 10^{-23} \times (26 - 20)$

$= 1.242 \times 10^{-22}$ J

~~∴ Change in kinetic energy of each nitrogen~~

∴ Change in total kinetic energy $= 1.242 \times 10^{-22} \times 4.82 \times 10^{21} = 0.599$ J

Change in total kinetic energy = ~~1.242~~ 0.599 J

ResultsPlus

Examiner Comments

This is an example of a good response, gaining all 4 marks.

(iii) Show that the number of nitrogen molecules inside the tennis ball is about 5×10^{21} and hence find the change in total kinetic energy of the nitrogen molecules during the impact.
(4)

$pV = NkT$

$N = \frac{pV}{kT} = \frac{197 \times 101}{1.38 \times 10^{-23} \times 3.88 \times 10^{3}}$

$= 5 \times 10^{21}$ molecules.

Change in total kinetic energy = ...

ResultsPlus
Examiner Comments

Although this candidate appears to have substituted into the ideal gas equation, their value for temperature is not one that is given or which can be derived from data in the question. In addition they have written down the "show that" value. Had their temperature been correct, they would not have gained MP2, since answers to "show that" questions must be given to at least one more significant figure than the "show that" value.

Question 17 (b) (iv)

This was not a well answered question with many candidates failing to distinguish between the kinetic energy of the ball and the kinetic energy of the molecules of the gas within it. Many candidates thought that the change in KE of the molecules identified in (iii) would give additional KE to the ball so that it would bounce higher. The correct interpretation was not seen as frequently as might have been expected. Even when candidates appreciated that there is less KE for the ball, and hence a smaller bounce height, there was often not much stated in addition to be able to award MP2.

However some candidates did realise the difference between the two aspects of kinetic energy in the question and described the "change in kinetic energy" as the way in which some of the kinetic energy of the ball is initially dissipated.

(iv) Explain how the change in total kinetic energy will affect the bounce height of the tennis ball.

(2)

The change in total kinetic energy will decrease the bounce height of the ball as the nitrogen molecules gained some kinetic energy from the kinetic energy of the entire ball which will decrease ball's kinetic energy and decrease bounce height.

(Total for Question 17 = 14 marks)

ResultsPlus
Examiner Comments

This response includes just enough detail for both MP to be awarded.

(iv) Explain how the change in total kinetic energy will affect the bounce height of the tennis ball.

(2)

~~mg~~ ~~KE~~ kinetic energy = mgh
so ~~ws~~ height is proportional to energy
if ~~kmtee~~ kinetic energy increases
~~bough~~ bounce height increases.

ResultsPlus
Examiner Comments

This was a common answer, with the two types of kinetic energy being confused. The candidate concludes that the ball will bounce higher due to a gain in kinetic energy, which would appear to go against sensible logic.

ResultsPlus
Examiner Tip

Read through your answers to ensure that what you have written makes sense.

Question 18 (a) (i)

This question was generally well answered. Many candidates knew that random meant not being able to say when a nucleus will decay or which nucleus will decay next. Some penalised themselves by using atom/molecule/particle instead of nucleus.

Candidates may be trying to explain something in their own words where a standard definition would be entirely appropriate here.

(a) The decay of polonium is said to be random and spontaneous.

Explain what is meant by a decay that is

(i) random

(1)

It is impossible to determine which molecule will decay when.

ResultsPlus

Examiner Comments

The reference to molecules here spoils what would otherwise be a good answer.

Question 18 (a) (ii)

As for part (i), this was well answered, although there were a few more responses confusing random and spontaneous here than there were in part (i).

(ii) spontaneous.

(1)

It can decay at any time it is unpredictable

at

ResultsPlus
Examiner Comments

A small proportion of responses seen linked spontaneous with unpredictable.

ResultsPlus
Examiner Tip

Learn the definitions of standard terms that occur in the specification.

Question 18 (b) (i)

This was well answered by almost all candidates.

Question 18 (b) (ii)

This was generally well answered, although some candidates used mixed mass units which led to the final answer being incorrect.

Question 18 (b) (iii)

Part 1 was generally well answered. Many candidates realised that momentum was conserved and that the initial/final momentum was zero.

In part 2 many candidates were able to use the fact that momentum of the lead nucleus was equal and opposite to that of the alpha particle. Some did not realise that the masses could be expressed as 4u and 206u which made the calculation straightforward. Some candidates used the mass of polonium instead of lead to find the speed of recoil of the lead nucleus.

(1) Explain why the lead nucleus recoils during the decay.

(2)

Since the momentum of the initial particle ${}_{84}Po$ was 0, in order for momentum to be conserved the momentum after the decay should be 0, so the particles move in opposite directions with same momentum in order for the total $p = 0$.

(2) Calculate the speed at which the lead nucleus begins to recoil.

(2)

$1.6 \times 10^7 \times 6.64 \times 10^{-27} = 206 \times 1.67 \times 10^{-27}$ kg $\times v$

$v = 3.1 \times 10^5$ ms^{-1}

Speed = 3.1×10^5 ms^{-1}

ResultsPlus

Examiner Comments

The response is worth all 4 marks. The candidate has converted from atomic mass units into kg, although the conversion cancels and is therefore unnecessary.

(1) Explain why the lead nucleus recoils during the decay.

(2)

Repulsion occurs. Alpha particle and lead ~~n~~ nucleus are positively charged and like charges repels the other.

(2) Calculate the speed at which the lead nucleus begins to recoil.

Mass of Pb

(2)

$= 1.66 \times 10^{-27} \times 206$

$= 3.42 \times 10^{-25}$ kg.

$8.50 \times 10^{-13} = \frac{1}{2} \times 3.42 \times 10^{-25} \times v^2$

$v = \sqrt{\frac{8.50 \times 10^{-13}}{\frac{1}{2} \times 3.42 \times 10^{-25}}}$

Speed = 2.23×10^6 ms^{-1}

ResultsPlus

Examiner Comments

This response scores no marks. The idea that the nuclei recoil due to electrostatic repulsion was much less prevalent that the last time that a question similar to this was asked. The calculation in (2) is based upon the wrong physical principle, and therefore scores nothing.

ResultsPlus

Examiner Tip

Try to relate questions to theory relevant to the context.

Question 18 (b) (iv)

This was a poorly answered question with quite a few responses on completely the wrong track with references to ionising capability/charge/stability/binding energy.

Of those scoring MP1, most did not link greater velocity with v^2 for MP2. Technical language was a problem for some, with "lighter" being used instead of "less massive".

(iv) Explain why most of the energy released in this decay is transferred to the alpha particle.

(2)

The β α particle is almost 52 times smaller than Pb.

ResultsPlus

Examiner Comments

In this response the candidate refers to the alpha particle being 52 times smaller than the lead (nucleus), although it is not clear that it is the mass that is smaller. In any case there is no link with the greater speed, and so MP1 cannot be awarded.

Question 18 (c) (i)

This was a straightforward question, although some candidates were confused by what they had to do.

Instead of using the values given some attempted to find the number of moles. Some candidates also included the decay constant in their calculation.

Question 18 (c) (ii)

Not all candidates followed the instruction given in the question to "explain, using a calculation in your answer".

Of those who did, the calculation of the half life was generally well done. However, not many answers made the link between half-life and activity or power in the explanation.

(ii) This sample of polonium would **not** be suitable to provide energy for a period of several years.

Explain why, using a calculation in your answer.

(3)

$\lambda = \frac{\ln 2}{t_{1/2}} \Rightarrow t_{1/2} = 138.6$ days

The half life is short, less than half a year, so over several years the activitely would decrease, not providing sufficient energy.

ResultsPlus

Examiner Comments

This response has gained the first two marking points as, although the substitution is not shown, the half life is correctly calculated. There are problems in awarding MP3 since there is a reference to energy rather than power and activitely rather than activity.

ResultsPlus

Examiner Tip

Be sure to select and spell technical wording with accuracy.

(ii) This sample of polonium would **not** be suitable to provide energy for a period of several years.

Explain why, using a calculation in your answer.

(3)

This is because eventually, the energy produced becomes too little. And so it is not suitable ~~for~~ after several years.

ResultsPlus

Examiner Comments

There is no calculation here, and so the response cannot score any marks. If there had been a calculation included, MP3 would still not have been awarded as the candidate refers to too little energy rather than too little power.

ResultsPlus

Examiner Tip

Use technical language carefully in answering questions such as this.

Paper Summary

In order to improve their performance candidates should:

- Ensure they have a thorough knowledge of the physics for this unit,
- Read the question and answer what is asked,
- For descriptive questions, make a note of the marks and include that number of different physics points,
- Show all their workings in calculations,
- For descriptive questions, try to base the answer around a specific equation which is quoted.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE