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AS LEVEL

Examiners' report

FURTHER MATHEMATICS A

H235

For first teaching in 2017

Y533/01 Summer 2022 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper Y533/01 series overview

This is one of the optional modules in the new specification for AS Further Maths, alongside the compulsory Pure Core, and the other optional modules in Statistics, Discrete Mathematics and Additional Pure Mathematics. This component complements the Mechanics content of the AS Mathematics course and requires candidates to solve practical problems using a variety of techniques including energy, power, momentum, connected particles, horizontal and vertical circles, and dimensional analysis.

To do well on this paper, candidates needed to be able to work systematically and accurately with the standard principles of Mechanics. They will often need to make sense of more complex situations, for example, correctly combining several forces and/or types of energy in a variety of situations, such as two or more sources of gravitational potential and/or kinetic energy and resistance, and have some understanding of the purpose of mathematical modelling.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• recognised the different sources of energy change relevant to a problem and combined them systematically • recognised the different forces that were acting and the correct direction • made good use of diagrams to help them understand the problem • were able to use Newton's Second Law (F = ma) confidently together with the relationship between Force and Power • were able to apply their knowledge to complex and unfamiliar problems such as working with an unknown coefficient of restitution in order to find its value, and recognise the difference between speed and velocity in collisions • were efficient and effective in applying their knowledge, always choosing the simplest possible route to the solution.	• did not consider the different directions that objects might be travelling, especially in collisions and momentum questions • were not always able to use Newton's Second Law in the context of a fixed Power source producing a variable force at different speeds • did not recognise all the forces and/or energy sources present in a situation, especially where gravitational potential energy was involved (Question 2 (b), 3)) • made avoidable errors in calculations • used very laborious and inefficient methods, particularly for momentum problems, leading to errors in both method and application.

Question 1 (a)

1 Two stones, A and B, are sliding along the same straight line on a horizontal sheet of ice. Stone A, of mass 50 kg, is moving with a constant velocity of $2.1\,\mathrm{ms}^{-1}$ towards stone B. Stone B, of mass 70 kg, is moving with a constant velocity of $0.8\,\mathrm{ms}^{-1}$ towards stone A.

A and B collide directly. Immediately after their collision stone A's velocity is $0.35\,\mathrm{ms}^{-1}$ in the same direction as its velocity before the collision.

(a) Find the speed of stone B immediately after the collision. **[2]**

This was a nice starter question on conservation of momentum, which all candidates were able to access and almost all candidates scored at least 1 mark for using the correct technique. A large minority of candidates did not realise that the velocity of stone B needed to be negative and therefore lost the second mark. A very small number of candidates did not know the correct technique or confused the velocity with the mass.

Question 1 (b)

(b) Find the coefficient of restitution for the collision. **[2]**

This question was again tackled with some success by the vast majority of candidates, with a substantial minority again not using a negative value for the initial velocity of B and a few making critical errors such as confusing mass and velocity. A small number of candidates did not give the final answer to the required 3sf or exact value, despite this being stated in the instructions, which should be regularly reinforced. Some candidates ended up with a value of $e > 1$ but were unaware that this is impossible, although we allowed the M mark for this if it was consistent with their results from part (a).

Assessment for learning

Consider getting students to critique various responses where an error has been made such that $e > 1$ or $e < 0$, including cases where the initial velocity has the wrong sign or has velocity/mass confusion. This could make a good starter or plenary activity.

Question 1 (c)

(c) Find the total loss of kinetic energy caused by the collision. **[3]**

Again, nearly all candidates understood the concept of (change of) kinetic energy. A very small number just calculated the change for one of the objects rather than the global change, and a few added values where they should have been subtracted to find the difference. A small number found the difference separately for each object and then combined them, but then subtracted the results rather than adding them. A very small number of candidates made other errors such as missing out one of the values.

Question 1 (d)

(d) Explain whether the collision was perfectly elastic. **[1]**

Almost all candidates showed awareness that a perfectly elastic collision means that e = 1 and/or that KE is conserved, although a small number of candidates did not know how to express this, talking about energy being transferred into kinetic energy, for example. A few confused "not perfectly elastic" ($0 \le e < 1$ or $e \ne 1$) with "not inelastic" ($e \ne 0$). On this occasion we did accept statements such as "energy was lost", although candidates should be strongly encouraged to be specific about what type of energy they are referring to.

Question 2 (a)

2 A hockey puck of mass 0.2 kg is sliding down a rough slope which is inclined at 10° to the horizontal. At the instant that its velocity is $14\,\mathrm{m\,s^{-1}}$ directly down the slope it is hit by a hockey stick. Immediately after it is hit its velocity is $24\,\mathrm{m\,s^{-1}}$ directly up the slope.

(a) Find the magnitude of the impulse exerted by the hockey stick on the puck. **[2]**

This question tested the candidates' knowledge of impulse. As with Question 1, almost all candidates were able to use the formula confidently, but again some did not recognise that on this occasion the initial velocity should be a different sign to the final velocity. Most candidates chose to reference positive velocity up the slope, but a some did the opposite and ended up with a negative value, leaving them open to the possibility of not finding the magnitude at the end and thereby losing the second mark. A very small number of candidates made critical errors such as having a final velocity of 0 for example.

Question 2 (b)

After it has been hit, the puck first comes to instantaneous rest when it has travelled 15 m up the slope. While the puck is moving up the slope, the resistance to its motion has constant magnitude R N.

(b) Use an energy method to determine the value of R. **[5]**

This was the first question on the paper that presented a serious challenge with only about half of candidates getting full marks for this. Aside from the small number of candidates that tried to use suvat instead of using an energy method as instructed (for which we allowed 2 marks for a correct answer by this method), some ended up with a negative value for the friction, which is not possible. We did allow 3.5N rather than 3.50N for the final answer, and similarly in Question 4, although answers should be given to 3sf so this should not be taken as a precedent.

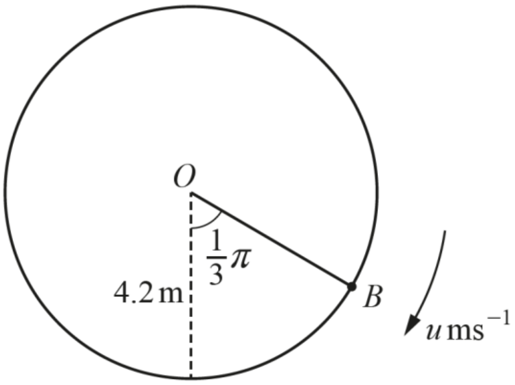
Other common errors included:

- equating the force of gravity and/or resistance down the slope with the kinetic energy lost
- using the wrong signs for one or more of the energy components
- using the wrong formula or missing out entire components of the energy mix.

Question 3

3 A smooth wire is shaped into a circle of radius 4.2 m which is fixed in a vertical plane with its centre at a point O. A small bead B is threaded onto the wire. B is held so that OB makes an angle of $\frac{1}{3}\pi$ radians with the downwards vertical through O.

B is projected downwards along the wire with initial speed $u\,\text{ms}^{-1}$ (see diagram). In its subsequent motion B describes complete circles about O.



Given that the lowest speed of B in its motion is $4\,\text{ms}^{-1}$ determine the value of u. **[5]**

This question again required candidates to use an energy method, this time to find an unknown velocity in a vertical circle. Candidates were more successful overall than in 2 (b), with well over half of candidates getting full marks perhaps because it only involved kinetic and potential energy as it was modelled as having no resistance.

The main issue here was having to find the difference of two potential energy levels, which was not always handled correctly. Candidates generally managed the trigonometry; the most common problem was when candidates omitted one of the potential energy levels in the overall equation. The small number of candidates that tried to use suvat were not given any credit as the acceleration cannot be constant in such a situation.

Question 4

4 A cyclist is riding a bicycle along a straight road which is inclined at an angle of 4° to the horizontal. The cyclist is working at a constant rate of 250 W. The combined mass of the cyclist and bicycle is 80 kg and the resistance to their motion is a constant 70 N.

Determine the maximum constant speed at which the cyclist can ride the bicycle

- up the hill, and
- down the hill. **[5]**

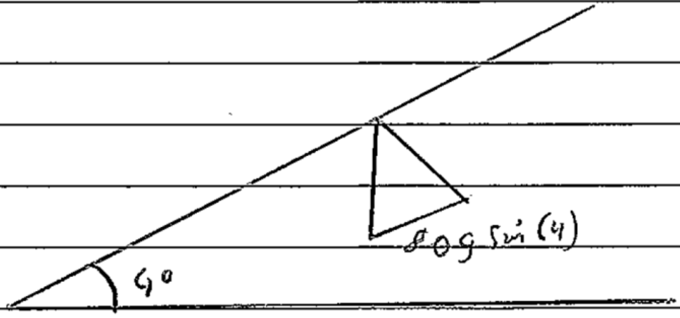
For this question, candidates were required to recognise the connection between power, speed, and velocity in the context of Newton's First Law, going up and down a slope with a constant resistance.

Again, most candidates gained full marks for this; the best candidates considered the forces as a whole and equated their sum to zero. A significant number made errors such as:

- introducing kinetic energy into a force problem, e.g. equating the total force down the slope with the kinetic energy
- omitting one or more forces
- using the wrong sign or introducing an element of acceleration
- dividing the power output by the net force (e.g. D – 70) instead of just the driving force, or including the gravitational component in the driving force
- some assumed that the driving force was equal to the resistance to give $v = \frac{250}{70}$, as would be the case on a horizontal road
- some treated the downhill version of the problem completely differently to the uphill version, not recognising that they are essentially the same other than the need to change the sign for the gravitational component of force down the slope.

Exemplar 1

4 up the hill



54.69 N

$\cancel{\tfrac{1}{2}mv^2}$ $250 = \tfrac{1}{2}mv^2 + 54.69 + 70$

$250 - 70 - 54.69$

$125.31 = \tfrac{1}{2}mv^2$

$250.62 = mv^2 \quad m = 80$

$\frac{250.62}{80} = v^2$

$3.13 = v^2$

$v = 1.77 \text{ ms}^{-1}$

This is a good illustration of a dimensionally inconsistent response which has managed to include three different types of quantity in a single equation. Here the candidate has equated the power on the LHS of the equation with the kinetic energy + component of weight and frictional force down the slope on the RHS. They have then rearranged for the KE, divided by ½m to give v^2 and finally taken the square root to get a value for v. This gets M0 for the equation, B0 for not using P = Fv, and A0 for the wrong answer. The second half of the response uses the same incorrect reasoning.

Assessment for learning

Consider making students aware of the need to make all equations dimensionally consistent by getting them to critique solutions to a variety of problems where this is not necessarily the case. This can be connected later to the topic of dimensional analysis to give prior familiarity and enhance learning.

Question 5

5 One end of a light inextensible string of length 3.5 m is attached to a fixed point O on a smooth horizontal plane. The other end of the string is attached to a particle P of mass 0.45 kg. P moves with constant speed in a circular path on the plane with the string taut.

The string will break if the tension in it exceeds 70 N.

Determine the minimum possible time in which P can describe a complete circle about O. **[4]**

This problem required candidates to set up a horizontal circle problem and equate the tension in the string to the centripetal acceleration, and then relate the (angular) velocity to the period. As the object is supported by the horizontal plane, the weight of the object is not relevant to the problem.

Fewer candidates (just over half) managed to get full marks on this problem, with a significant number (around a fifth) making no relevant progress or omitting the question altogether. Some candidates treated the problem as a conical pendulum, for which we gave partial credit if they got the correct answer by this means as it does lead mathematically to the same answer.

Common issues included:

- not knowing the formula for centripetal acceleration or that this replaces the acceleration in the equation F = ma
- confusing the horizontal and vertical forces, e.g. getting a "net" force of 70 – 0.45g
- assuming that constant speed means an acceleration of zero
- dividing the force by the mass to get the velocity instead of the acceleration
- not knowing the connection between speed or angular speed and period
- treating the problem as a conical pendulum or vertical circle
- not giving an answer correct to 3sf.

Question 6 (a)

6 A particle moves in a straight line with constant acceleration a. Its initial velocity is u and at time t its velocity is v.

It is assumed that v depends only on u, a and t.

(a) Assuming that this dependency is of the form $u^{\alpha}a^{\beta}t^{\gamma}$, use dimensional analysis to find α and γ in terms of β. **[5]**

This question required candidates to carry out a simple dimensional analysis on the familiar scenario of speed and time under constant acceleration. As always, it is critical that candidates do not make any assumptions based on prior knowledge but approach it as if it were a completely unfamiliar situation. This goes particularly for the latter parts of the question.

It was pleasing to see that this time almost all candidates produced a dimensional equation as part of the analysis prior to relating the unknowns to each other, and that the vast majority got all or most of the marks on this part of the question, with just a very few getting 0, 1 or 2 marks, which is a significant improvement from previous years.

The main issues here were:

- sign errors when substituting for α in the equation for T
- incorrect rearrangement of $\alpha + \beta = 1$ e.g. $\alpha = \beta - 1$ was quite common, and $\alpha = -\beta$ and $\beta = 1/\alpha$ were also seen
- other incorrect manipulation to find α and γ in terms of β, or not attempting to do so at all
- setting the equations for the powers equal to zero, i.e. ignoring or omitting LHS of the dimensional equation
- not multiplying the powers of all elements of their terms by α or β, often in conjunction with the omission of brackets, or otherwise multiplying incorrectly
- one or two candidates tried to add terms in the dimensional equation instead of multiplying them, e.g. $u^{\alpha} + a^{\beta} + t^{\gamma}$.

Exemplar 2

6(a)

$$ms^{-1} = (ms^{-1})^{\alpha} \times (ms^{-2})^{\beta} \times (s)^{\gamma}$$

$$LT^{-1} = L^{\alpha}T^{-\alpha} \times L^{\beta}T^{-2\beta} \times T^{(\gamma)}$$

$1 = \alpha + \beta$ $\qquad$ $-1 = \alpha - 2\beta + \gamma$

$\alpha = \beta - 1$ $\qquad$ $-1 = -\beta + 1 - 2\beta + \gamma$

$\gamma = 3\beta - 2$

This is quite a common error where the candidate has wrongly rearranged the first equation in terms of β, losing the first A mark. As a result, the expression for γ is also wrong.

Question 6 (b), (c)

(b) By noting that the graph of v against t must be a straight line, determine the possible values of β. **[2]**

You may assume that the units of the given quantities are the corresponding SI units.

(c) By considering v when $t = 0$ seconds and when $t = 1$ second, derive the equation of motion $v = u + at$, explaining your reasoning. **[3]**

In 6 (b) candidates were required to use the results of part (a), and the fact that the associated (t, v) graph is a straight line, to deduce the possible values of β. This was the first question that was largely inaccessible to candidates, with about half getting 0 marks and only a very small minority getting full marks.

The key to this question is to understand that there is more than one possible value of β, as hinted at by the question, as there is more than one way to get the dimensions of velocity. These are $[u]^1 = LT^{-1}$ or $[a]^1[t]^1 = LT^{-1}$, which corresponds to a straight line of the form $y = mx + c$, or $v = k_1u + k_2at$.

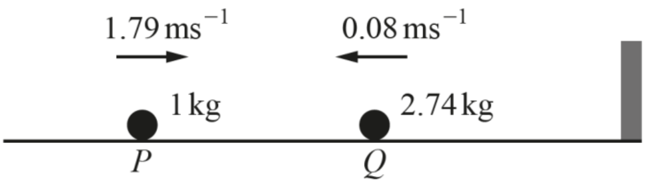
For the first term, this means that $\gamma = 0$ (corresponding to 'c' or k_1u), so $\beta = 0$ from the results in part a) or by inspection. For the second term, $\gamma = 1$, so $\beta = 1$. Most candidates who scored 1 mark considered the simpler case of a straight line passing through the origin or stated direct proportion. We allowed 1 mark for any candidate who got $\beta = 1$ provided there was nothing else that was incorrect.

6 (c) followed directly on from part (b) and required candidates to find the unknown constants of proportion for the two terms found in part (b) by substituting in known values. This is akin to the technique of using boundary conditions in a differential equation to find the constants of proportion and/or of integration.

It is evident that future candidates need much more exposure to these techniques as almost all candidates scored zero for this and all but the most able realised that the terms needed to be preceded by an unknown constant. As a reference, Question 3 (b) on the 2018 paper used the equation $s = k(u^\alpha + v^\beta)t^\gamma$. On that occasion the unknown constant was given in the question, with candidates required to find its value by considering that when the acceleration is zero, $u = v$, so $s = 2kut = ut$, giving $k = \frac{1}{2}$.

Question 7 (a)

7 Two particles, P and Q, are on a smooth horizontal floor. P, of mass 1 kg, is moving with speed $1.79\,\text{ms}^{-1}$ directly towards a vertical wall. Q, of mass 2.74 kg, is between P and the wall, moving directly towards P with speed $0.08\,\text{ms}^{-1}$ (see diagram).



P and Q collide directly and the coefficient of restitution for this collision is denoted by e.

(a) Show that after this collision the speed of Q is given by $0.42 + 0.5e\,\text{ms}^{-1}$. **[5]**

This question required candidates to use the concept of restitution, along with conservation of momentum, to find and solve two equations simultaneously in terms of an unknown coefficient of restitution, *e*. Most candidates found this question accessible and about two thirds scored full marks, with a small proportion gaining less than half marks. The best candidates set out their two equations clearly and simply and used the restitution equation to substitute for v_P in terms of v_Q in the momentum equation. Some opted to do the reverse, which was more challenging, and some used elimination.

The majority of issues were due to careless numerical errors and slips or poor algebraic technique, such as:

- not using a negative velocity for object Q
- not combining the two equations to eliminate v_P and find an expression for v_Q
- confusion between terms, such as using the mass in the restitution equation
- not showing detailed reasoning in a "show that" question
- adding terms together in the restitution equation instead of subtracting them
- only forming one equation.

Question 7 (b)

After this collision, Q then goes on to collide directly with the wall. The coefficient of restitution for the collision between Q and the wall is also e. There is then no subsequent collision between P and Q.

(b) Determine the range of possible values of e. **[7]**

This question required candidates to find v_P by using their value of v_Q from part (a), together with the velocity of Q after rebounding from the wall. They then had to use the constraint that the two objects must not collide again to find possible values for e.

This question served as a very good differentiator between the more able candidates who could follow through and those who could not, with most candidates getting 5 or 6 marks or 1 or 2 marks, and a small number getting 3-4 marks. Very few candidates scored full marks on this question.

The key to this question was to multiply the velocity of Q from part a) by $-e$ and not e, which is therefore negative after collision with the wall; and to note that the particles will not collide again if the velocity of Q is greater than or equal to the velocity of P (assuming that positive is referenced towards the right).

The other crucial element was recognising the need to find v_P as well as v_Q, using the equations from part (a), ideally by substituting v_Q in terms of v_P into the restitution equation. Some candidates opted to substitute it into the momentum equation instead, which was considerably more challenging and led in some cases to unnecessary errors.

A small number of candidates attempted to work with the speeds of P and Q, but this was generally not successful as it is not immediately evident that v_P is also negative.

The resulting quadratic inequality was generally handled well by those that got that far, but those candidates who did get a correct quadratic were not always able to combine their solution with the natural limits of $0 \leq e \leq 1$ and fully justify their answer to get the final mark.

Other common issues included:

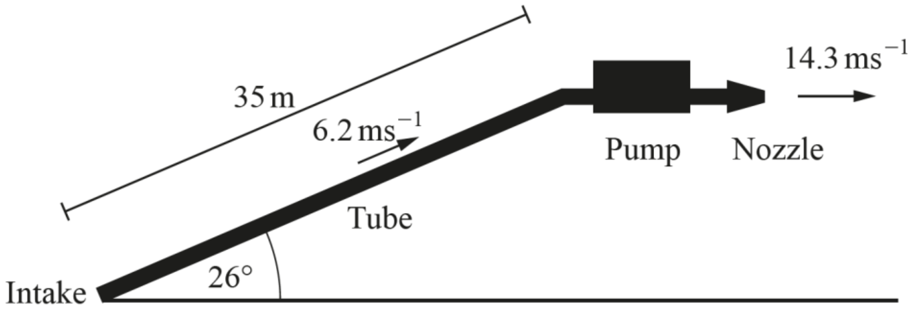
- Not finding v_P
- Multiplying v_Q by e instead of $-e$
- Forming an inequality using v_Q and $-ev_Q$
- Getting the inequality sign the wrong way round
- Not solving the quadratic inequality
- Setting up separate inequalities for v_P and $(-e)v_Q$ (> 0 or < 0)
- Using strict rather than inclusive inequalities
- Not fully justifying the inequality
- Failing to state the critical values of the quadratic inequality before combining with $0 \leq e \leq 1$

Question 8 (a)

8 As part of an industrial process a single pump causes the intake of a liquid chemical to the bottom end of a tube, draws it up the tube and then discharges it through a nozzle at the top end of the tube.

The tube is straight and narrow, 35 m long and inclined at an angle of 26° to the horizontal. The chemical arrives at the intake at the bottom end of the tube with a speed of $6.2\,\mathrm{ms}^{-1}$. At the top end of the tube the chemical is discharged horizontally with a speed of $14.3\,\mathrm{ms}^{-1}$ (see diagram).

In total, the pump discharges 1500 kg of chemical through the nozzle each hour.



In order to model the changes to the mechanical energy of the chemical during the entire process of intake, drawing and discharge, the following modelling assumptions are made.

- At any instant the total resistance to the motion of all the liquid in the tube is 40 N.
- All other resistances to motion are ignored.
- The liquid in the tube moves at a constant speed of $6.2\,\mathrm{ms}^{-1}$.

(a) State **one** other modelling assumption which is required to model the changes to the mechanical energy of the liquid with the given information. **[1]**

This question requires candidates to critique the model and find additional assumptions that are required beyond those given in the question. Essentially, all the essential assumptions within the tube and up to the nozzle are covered, so candidates needed to consider that losses or changes of energy may occur as the liquid enters the tube and changes direction, for example.

Most candidates found this very challenging and only a very small minority were able to make suggestions that were distinct from the assumptions given in the text. Typical responses included that the speed of intake and/or discharge is constant/exactly 6.2m/s or 14.3m/s respectively, the liquid should be modelled as a particle, no air resistance, KE is fully transferred to GPE, the tube is smooth, constant power output of the pump, etc. One or two candidates were quite creative and even mentioned reflux of the liquid, which was unfortunately again not suitable.

Question 8 (b)

(b) Determine the power at which the pump is working, according to the model. **[5]**

This question required candidates to have a very good grasp of the processes going on in the model and combine and relate more than one type of quantity to find the overall power output of the motor. This proved to be very challenging, and most candidates scored no more than 2 marks.

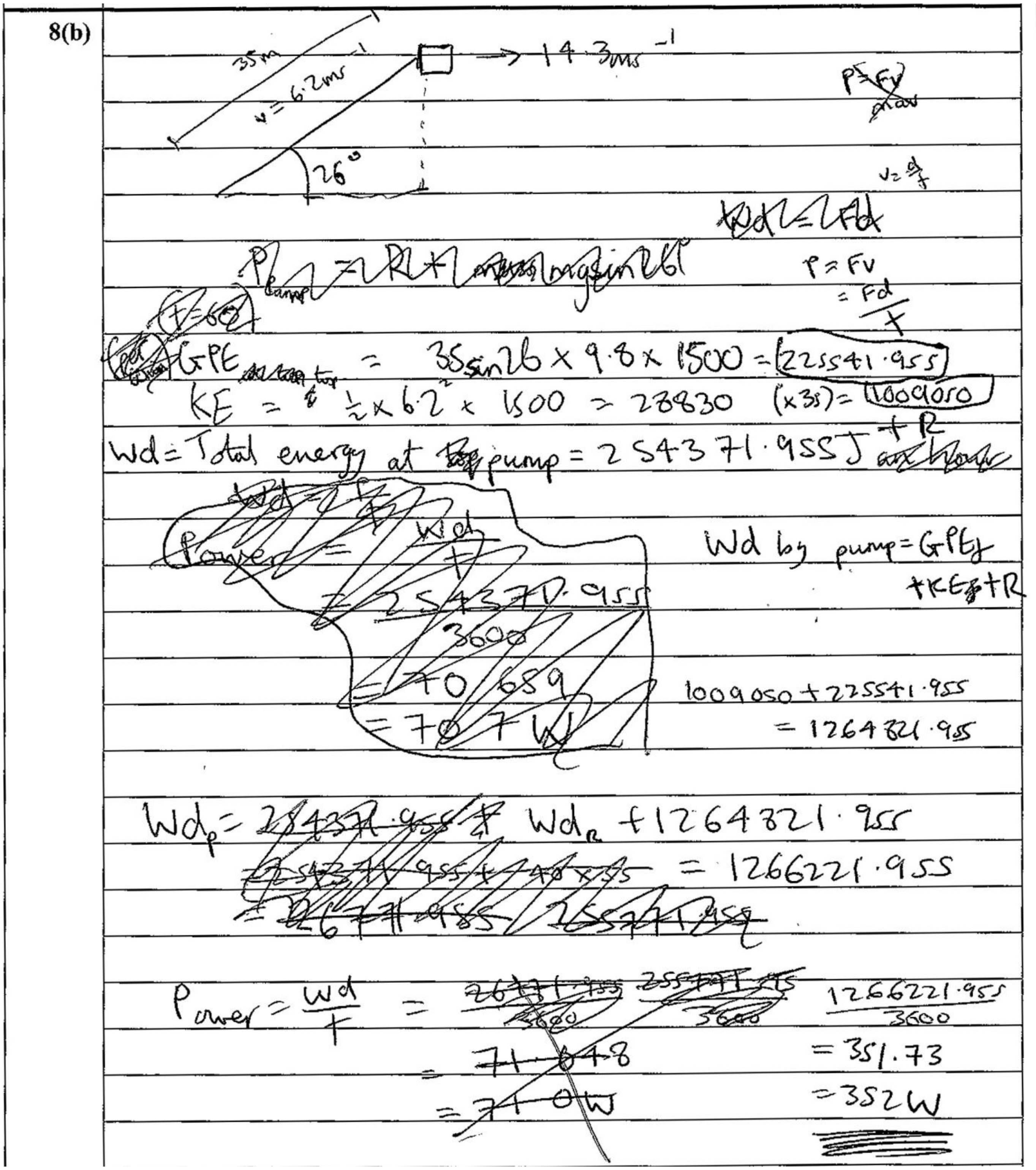
Most candidates recognised the need to find the overall change in PE and KE and to divide this by the time taken to get the power attributable to this aspect of the process. The main difficulty was that the resistance is a force, which needs to be multiplied by the correct speed to get the power required. In the question this is given as 6.2m/s, so the power required to overcome it is 40 x 6.2 = 248W. Most candidates simply multiplied by the length of the tube (35m) to get 1400J as they had done with the gravitational force. They then added it to the KE and PE without realising that it takes approximately 5.65s for the liquid to go up the tube, rather than 1 hour. We decided not to penalise the last M mark for this understandable error, provided the final equation was dimensionally consistent with the units of power and had all other terms present, i.e. initial and final KE and gravitational potential energy.

A significant minority of candidates chose to normalise the KE and PE for $\frac{5}{12}$ kg of fluid over 1 second to give the power attributable to each component separately, while a small number tried to normalise for 1kg of fluid, generally unsuccessfully. Some candidates then forgot that energy spent on the resistive force also needed to be divided by the time taken and therefore lost the second M mark.

The most common errors were:

- multiplying the resistance by 40 and dividing by 3600 or not at all (as above)
- omitting one or more of initial KE, final KE, GPE or resistance
- attempting to use momentum/impulse, F = ma and/or suvat instead of energy
- equating the resistance with the driving force
- multiplying the force of gravity (on 1kg of liquid) by the speed of the liquid
- dimensional inconsistency
- sign and calculation errors.

Exemplar 3


8(b)

35m, $v = 6.2\,ms^{-1}$, $26°$, $14.3\,ms^{-1}$

$P = Fv$

$v = \frac{d}{t}$

$P = Fv = \frac{Fd}{t}$

$GPE = 35\sin 26 \times 9.8 \times 1500 = 225541.955$

$KE = \frac{1}{2} \times 6.2^2 \times 1500 = 28830 \quad (\times 35) = 1009050$

$Wd = \text{Total energy at pump} = 254371.955\,J + R$

Wd by pump = GPE + KE + R

$1009050 + 225541.955 = 1264821.955$

$Wd_p = Wd_R + 1264821.955 = 1266221.955$

$Power = \frac{Wd}{t} = \frac{1266221.955}{3600} = 351.73 = 352\,W$

In this example there is a correct expression for the GPE clearly visible near the top, gaining the first M mark. Only the initial KE is found, so this gets B0. It is then also multiplied by 35(m), i.e. the length of the tube, which does not give a meaningful quantity.

An expression for the total energy is then found, which includes the initial KE (not multiplied by 35 this time) and the GPE, plus the resistance force, which is dimensionally inconsistent. Below that, the KE × 35 has now been added to the GPE.

In the next line, the work done by the resistance is also added to the GPE + KE(×35) and a quick calculation shows that the 40N resistance has been multiplied by 35m, which is a very common error and gets B0.

Finally, this is all divided by 3600 to give the power. As they have used KE × 35, and have also not calculated the change in KE, this gets M0 and a final A0, so 1 mark overall.

Question 8 (c) (i)

When the power at which the pump is working is measured it is in fact found to be 450 W.

(c) (i) Find the difference between the total amount of energy output by the pump each hour and the total amount of mechanical energy gained by the chemical each hour. **[2]**

This question required candidates to consider the actual net loss of energy in the system over an hour prior to challenging the model in part (c) (ii), by finding the difference between the energy output by the motor, i.e. 450W x 3600s and the mechanical energy gained, i.e. the PE + KE found in part (b) by most candidates.

This question proved to be surprisingly challenging, with the small proportion of candidates that scored any marks generally getting 2 marks rather than 1 mark and a substantial number of candidates omitting the question altogether.

The most common problems were:

- not knowing how to set up the problem
- comparing the revised energy output of the pump with the original energy output of the pump
- omitting the KE or PE or both
- including the resistance from part b) as well as or instead of the mechanical energy gained
- working out the force of the pump rather than the energy
- forgetting to multiply their gain in energy for 1 second of fluid flow by 3600s.

Question 8 (c) (ii)

(ii) Give **one** reason why the model underestimates the power of the engine. **[1]**

This question required candidates to critique carefully the assumptions made in the question and give a valid reason for the discrepancy between the calculated output of the motor and the actual power output of 450W.

For this we required a specific reference to the assumptions already stated in the model and why they might be wrong, or an example of a valid alternative source of energy loss, such as the effect of turbulence/internal friction in the fluid or friction between the pump blades and the fluid. At the very minimum candidates needed to reference the 40N stated in the question and suggest that it might be an underestimate for the resistance, or that the question acknowledges the presence of other resistances which have been ignored (such as those occurring after the tube), thus increasing the actual value. Any losses within the pump are not relevant as the question is about the power output rather than the power input.

Not many candidates were able to provide a convincing explanation of the discrepancy, with most stating in very general terms that there must be variations in velocity or resistance, that there is more friction, there might be other (unspecified) resistive forces, gravity, resistance has not been taken into account, etc.

Assessment for learning

Get students to examine one or more complex practical scenarios from real life in small groups and get them to think of all possible modelling assumptions and/or sources of wasted energy. Then justify them and rank them in order of importance and share with the rest of the class.

Alternatively, get students to sort a number of modelling assumptions about a scenario or scenarios into different categories depending on whether they are important, irrelevant or uncertain, and justify their choices.

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Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals.

It allows you to:

- review and run analysis reports on exam performance
- analyse results at question and/or topic level
- compare your centre with OCR national averages
- identify trends across the centre
- facilitate effective planning and delivery of courses
- identify areas of the curriculum where students excel or struggle
- help pinpoint strengths and weaknesses of students and teaching departments.

Find out more.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
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