Curriculum Council

Tertiary Entrance Examination, 2005

Question/Answer Booklet

PHYSICS

Please place your student identification label in this box

Student Number: In figures

In words ______________________________

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Time allowed for this paper

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Materials required/recommended for this paper

To be provided by the supervisor
This Question/Answer Booklet
Physics: Formulae and Constants Sheet (inside front cover of this Question/Answer Booklet)

To be provided by the candidate
Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter

Special items: MATHOMAT and/or Mathaid, drawing compass, protractor, set square and calculators satisfying the conditions set by the Curriculum Council for this subject.

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Ref: 691

Structure of this paper

Section	No. of questions	No. of questions to be attempted	No. of marks out of 200	Proportion of examination total
A Short Answers	15	All	60	30%
B Problem Solving	8	8	100	50%
C Comprehension and Interpretation	2	2	40	20%

Instructions to candidates

1. The rules for the conduct of Tertiary Entrance Examinations are detailed in the booklet *TEE Handbook*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in the spaces provided in this Question/Answer Booklet.

3. You may remove the enclosed *Physics: Formulae and Constants Sheet* from the booklet and use as required. This sheet is not to be handed in at the end of the examination.

4. Your answers to questions involving calculations should be evaluated and given in decimal form. It is suggested that you quote all answers to three significant figures, with the exception of questions for which estimates are required. Despite an incorrect final result, you may obtain marks for method and working, provided these are clearly and legibly set out.

5. Questions containing the specific instruction "**show working**" should be answered with a complete, logical, clear sequence of reasoning showing how your final answer was arrived at. For these questions, correct answers which do not show working will not be awarded full marks.

6. Questions containing the instruction "**estimate**" may give insufficient numerical data for their solution. You should provide appropriate figures to enable an approximate solution to be obtained.

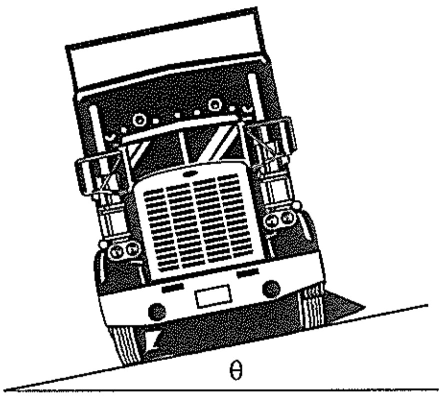
7. When descriptive answers are required, you should display your understanding of the context of a question. An answer which does not display an understanding of Physics principles will not attract marks.

SECTION A: Short Answers **(60 Marks)**

Attempt **ALL** 15 questions in this section. Each question is worth 4 marks. Answers are to be written in the space provided.

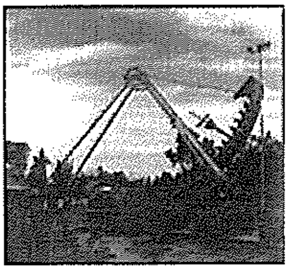
1. **Estimate** the speed of the middle point of the skipping rope while the girl is skipping. The rope completes two cycles every second. State any assumptions that you make.

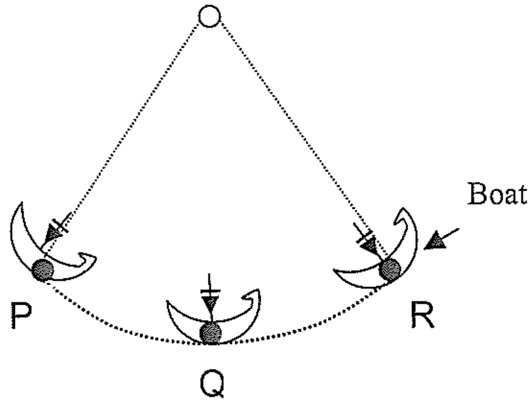
2. The centre of gravity of a vehicle depends on how it is loaded. The truck shown in the diagram is 4.4 m high and 2.4 m wide and its centre of gravity, due to its heavy load, is 2.4 m above ground level and above the centre of the truck.
What is the largest angle θ before this truck will tip over sideways?



3. Police handheld radar guns emit pulses of microwave radiation. If the frequency of the radiation is 3.3×10^9 Hz and the pulse duration is 0.10 μs, how many waves does one pulse contain?

4. Bounty's Revenge is a ride at the Adventure World fun park. Riders sit in a large 'boat', which can swing like a pendulum suspended from a frame. When it swings freely (without friction or a driving force), what is the **direction** of the acceleration of a child sitting in the middle of the boat when he is at the highest and lowest points in his motion, P, Q and R?



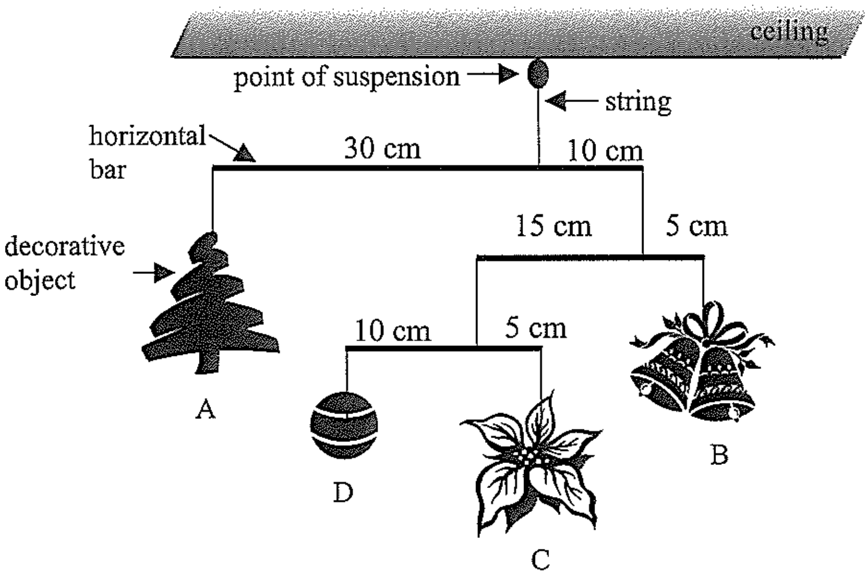


Choose your answer from the following:

Answer	Acceleration at P	Acceleration at Q	Acceleration at R
A	↘	↑	↙
B	↓	a = 0	↓
C	a = 0	→	a = 0
D	→	↓	←

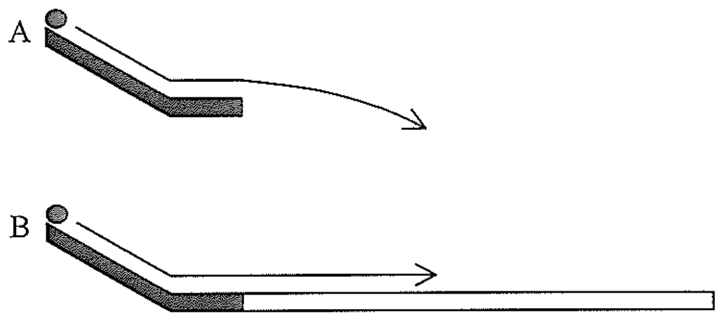
Answer: ________________

5. The following decorative mobile is suspended from a ceiling. The mobile has three small horizontal bars and decorative objects connected by strings such that it is in equilibrium. Assume that the bars have negligible mass. Object B (the bells) has a mass of 90 g and object D (the ball) has a mass of 10 g. Determine the mass of object A. Show your reasoning.



6. Australian astronaut Andy Thomas weighs 780 N on the surface of the Earth. What would be his weight near the surface of Mars if the mass of Mars is 0.107 times that of the mass of the earth, and the radius of Mars is 0.529 times that of the radius of the Earth?

7. In a school experiment, students release two billiard balls, A and B, at the same instant, and the balls run down two identical tracks, one 50 cm directly above the other.



Where is ball A most likely to land in relation to ball B? (Neglect the effect of air resistance and friction.)

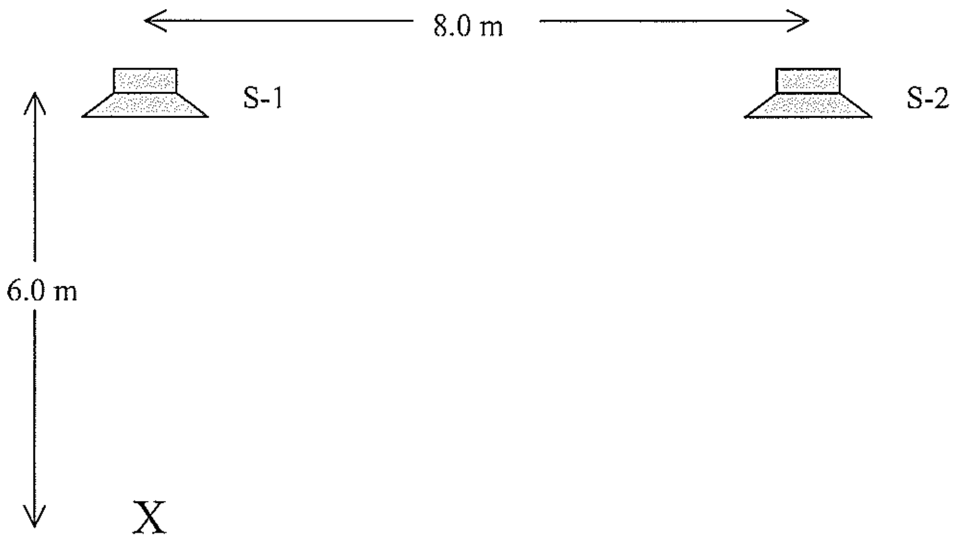
A ahead (in front) of ball B
B on top of ball B
C behind ball B

Answer: ______________________

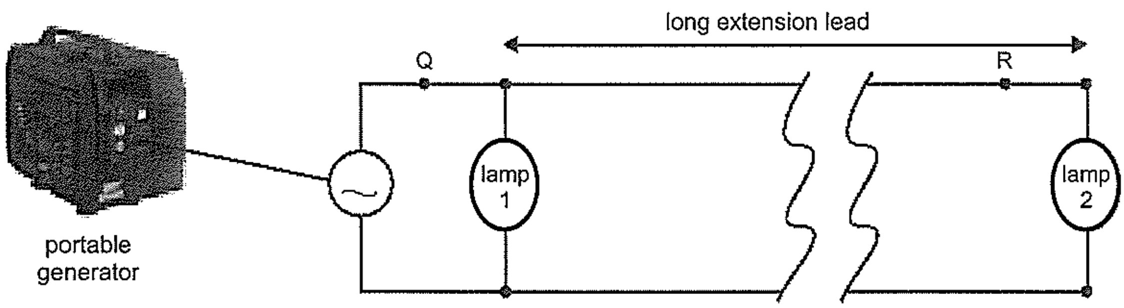
Explain your choice of answer.

8. S-1 and S-2 are two speakers wired **in phase** with each other. The two speakers are each playing the same constant frequency of sound. The distance between the two speakers is 8.0 m. At point X, the sound is louder than at other points. Point X is directly in front of speaker S-1 and is 6.0 m from it.

Calculate the two longest possible wavelengths of sound coming from the speakers.



9. On a camping trip, Jane uses a small portable 12 V generator to light two identical 12 V camping lamps. The first lamp is connected directly to the low voltage output of the generator. The second lamp is a distance away and requires a 20 m extension lead. The total resistance of both wires of the extension lead is 0.50 Ω. When the generator is started, both lamps glow but lamp 1 is brighter than lamp 2. Jane measures the current at R to be 4.0 A. Assume both lamps have constant resistance and obey Ohm's law.



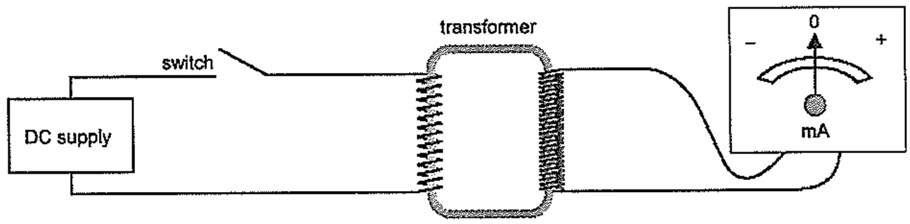
The power dissipated in lamp 1 is 58W. Calculate the power dissipated in lamp 2.

10. Lee has bought a second-hand electric stove but when she gets it home she finds that the clock in it is not working. When she takes out the clock she finds a transformer attached to it, and the transformer looks as if it has been burnt.

(a) What is the function of a transformer?

(b) Explain why a transformer might generate enough heat to damage itself.

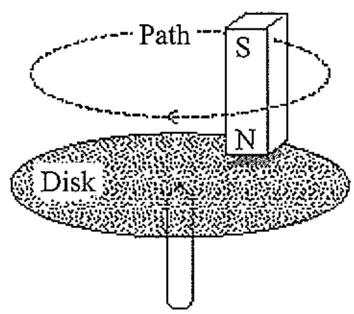
11. A transformer is being tested as shown in the diagram below. The primary coil is connected to a battery and switch. The switch is initially open and no current is flowing in the primary coil. An ammeter is connected to the secondary coil and initially shows no deflection. When the switch is pressed and held closed, the ammeter needle momentarily deflects to the right and then returns to its original position.



(a) Explain why the meter needle deflects when the switch is closed.

(b) Explain why the needle returns to the undeflected position even though the switch remains closed.

12. A classroom physics demonstration apparatus consists of a non-magnetic metal disk balanced on a support as shown in the diagram below. The metal disk is initially stationary. A magnet is moved in a circular path just above the surface of the disk without touching it.



Will the disk:

A. remain stationary,
B. rotate in the same direction as the magnet, or
C. rotate in the opposite direction to the magnet?

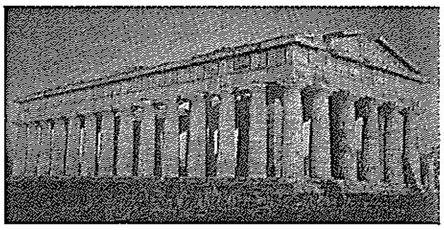
Answer: ____________________

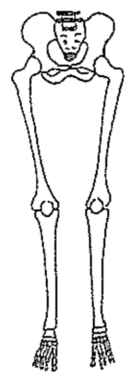
Explain your answer.

13. Ancient buildings were often made from stone, which is weak under tension but strong under compression. Because of this, the design of ancient buildings was limited. Similarly, human bone is weaker under tension than it is under compression, and this limits the shape of the human skeleton.

Explain the features of either the ancient building OR the human skeleton that illustrate the relative tensile and compressive strengths of the material of which they are made.

Label the diagram to illustrate your answer.

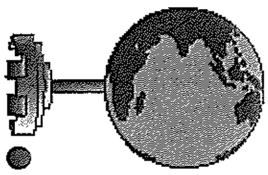




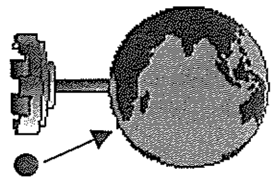
14. In 1895, Konstantin Tsiolkovsky thought about putting a Celestial Castle at the end of a thin rigid cable, with the Castle orbiting the Earth in a geosynchronous orbit at an altitude of 35 800 kilometres. Assume that the Castle and cable have a negligible mass compared with the Earth.

A person on top of the Castle accidentally releases a ball. Which diagram shows the path of the ball in relation to the castle after the ball is released?

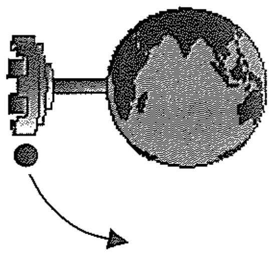
(A)



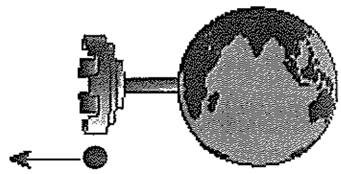
(B)



(C)



(D)



NB: These diagrams are not drawn to scale.

Answer: ____________________

Explain your answer.

15.

(a) Diagram A at the right shows two horizontal, rigid walkways suspended on the outside of a building, one above the other. Each section of the walkway is supported by two vertical posts, one on each side of the handrails (only one is shown). The mass of each walkway section is 2000 kg.

Determine the force acting on the single metal pin at A.

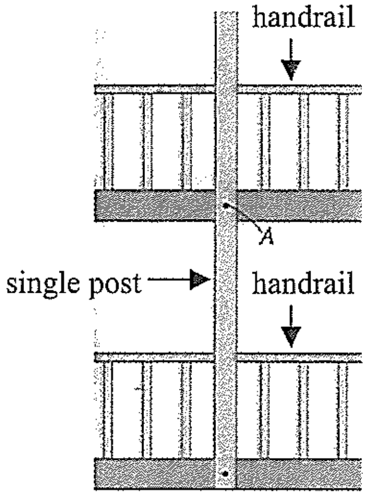


Diagram A

(b) Despite the engineer's design, when the builders came to construct the walkways, they did not have supporting posts long enough. Consequently, the builders substituted each single post with two posts attached to the upper walkway by two identical metal pins, X and Y, one below the other as shown in diagram B.

Show clearly why this arrangement is *less* safe than the one above.

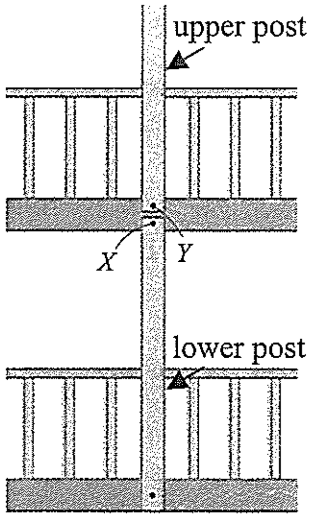


Diagram B

SECTION B: Problem Solving **(100 Marks)**

Attempt **ALL** 8 questions in this section.

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1. [13 marks]

Each engine of a twin-engine jet aeroplane emits 1.5×10^6 J of sound energy in five seconds.

(a) What is the total acoustic power of the aeroplane's engines? [2 marks]

(b) What is the sound intensity level due to the two jet engines at a distance of 50.0 m from the aeroplane? [4 marks]

(c) When sound energy spreads out over large distances, it becomes much less intense. This reduces the sound intensity level at any point. The sound intensity level *also* decreases because the air absorbs sound energy. [4 marks]

(i) What is the theoretical sound intensity level due to the jet engines at a distance of 3.0 km from the aeroplane?

(ii) If air absorbs sound energy at the rate of 7.0 dB/km, what is the actual sound intensity level 3.0 km from the jet engines?

(d) Much of the noise heard from jet engines comes from rapidly spinning air compressors. Occasionally, the frequencies of rotation of the compressors on a pair of engines are not quite identical. How will this affect the noise heard by passengers in the aeroplane? Explain your response. [3 marks]

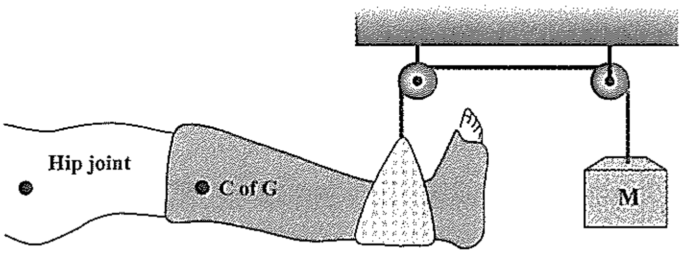
2. [12 marks]

The diagrams below show how a mass and pulley system can be used in hospitals—to support a broken leg encased in plaster, as shown in diagram A, or to keep an injured leg in traction (i.e. under tension) as shown in diagram B.

(a) In Diagram A, what mass M is needed to hold the person's leg horizontal? The leg and plaster cast weigh 124 N and the centre of gravity of the leg and plaster cast is 28 cm from the hip joint about which the leg pivots. The sling supporting the leg is 71 cm from the hip joint.

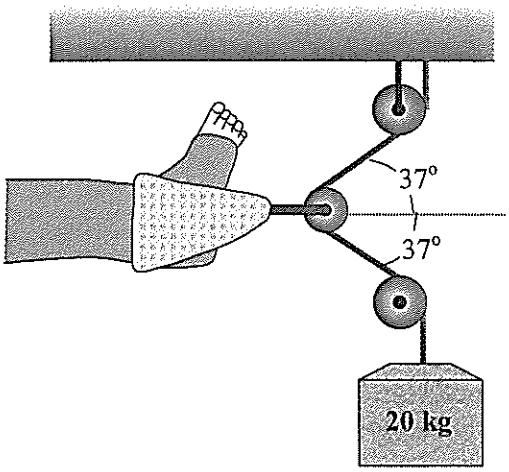
[3 marks]

Diagram A



(b) In Diagram B what is the tension in the leg if the suspended mass is 20.0 kg? [3 marks]

Diagram B



(c) The requirement for the 0.50 cm diameter cord used in the hospital applications is that it must be able to

(i) support a weight of at least 1000 N without breaking, and
(ii) not stretch by more than 1.0% when under a load of 400 N.

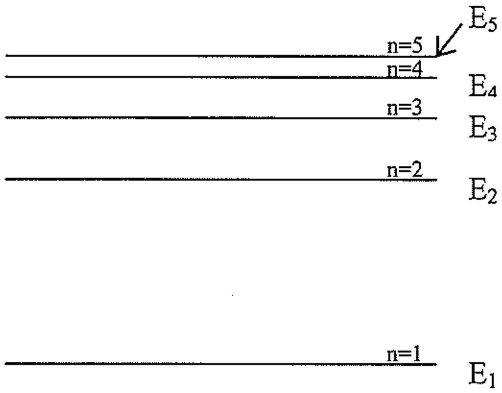
Which one or more of the following cords would be suitable (i.e. has both the required Young's Modulus and breaking stress)? To earn any marks, you must support your answer with clear and appropriate reasoning.

[6 marks]

	Young's modulus $\times 10^9$ Pa	Breaking stress $\times 10^7$ Pa
Magicord	4.2	5.5
Superope	2.1	3.2
Newire	1.2	7.8

3. [15 marks]

(a) The following energy level diagram is for the hydrogen atom. [6 marks]

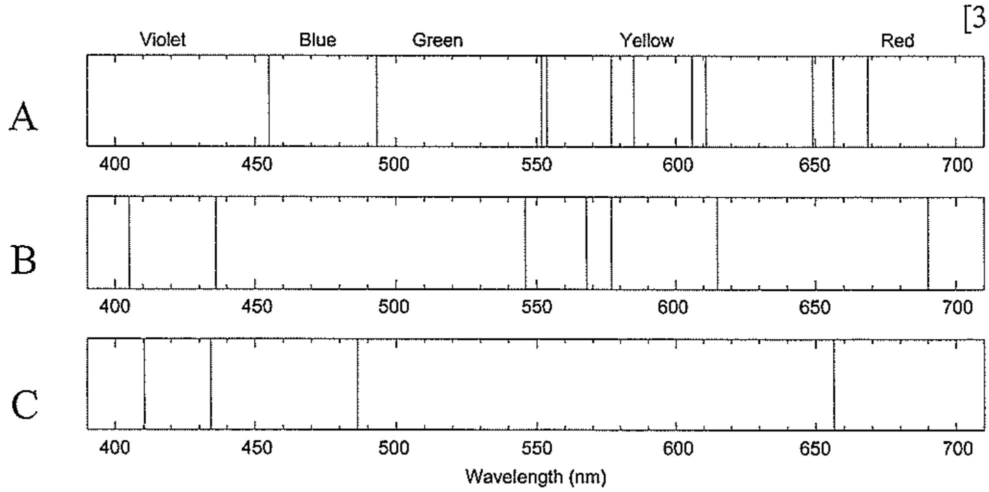


(i) Assuming the atom is in the n = 4 energy state, on the diagram above draw all transitions that can contribute to the emission spectrum.

(ii) The transition between levels 1 and 2 results in a photon of wavelength 121.5 nm. The transition between levels 1 and 3 results in a photon of wavelength 102.6 nm. Calculate the wavelength of the transition between levels 2 and 3.

(b) Below are the visible emission spectra for hydrogen, helium and mercury, not necessarily in that order.

[3 marks]



Part (b) continued

Identify the hydrogen spectrum and use evidence from the diagram to *explain* your choice.

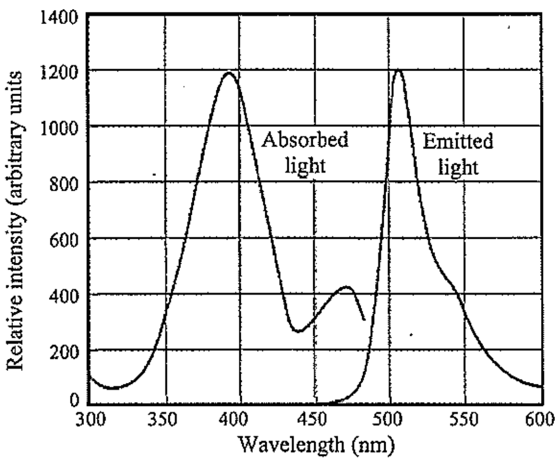
(c) A particular protein in jellyfish glows with a visible colour when viewed under ultraviolet light. Scientists have managed to extract this protein, called GFP, and incorporate it into the DNA of micro-organisms as well as larger animals. One such animal is a white rabbit, which appears coloured under UV light.

[6 marks]

(i) Name the physical phenomenon which is occurring here.

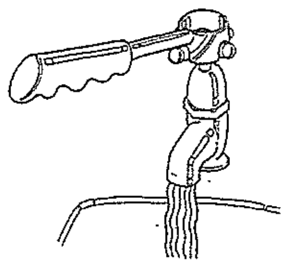
(ii) Describe how it occurs.

(iii) Use the following diagram (and any other information in Question 3) to predict the colour of the 'GFP rabbit'. Explain your reasoning carefully.

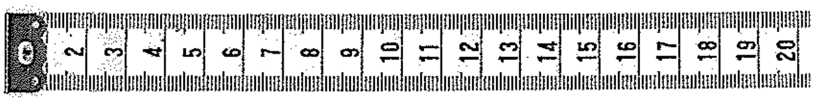


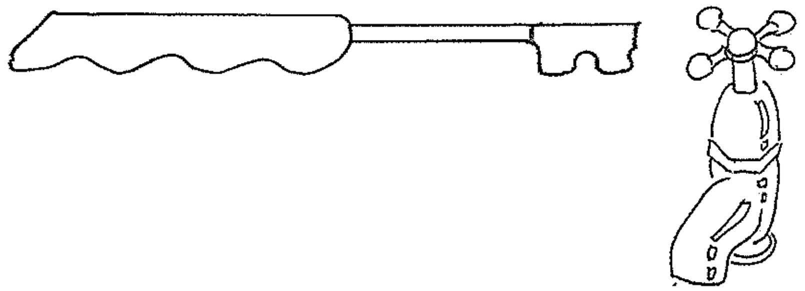
4. [8 marks]

For people with hands weakened by injury or arthritis, turning on a tap can be difficult. The tap-turner shown right, which fits over taps with four-prong handles, is designed to make it easier for people to operate their taps.



The dimensions of the tap and tap-turner can be **estimated** using the ruler.





(a) Compare the forces required to turn the tap *with* and *without* the tap-turner. Express your answer as the ratio: $\frac{\text{force with tap turner}}{\text{force without tap turner}}$

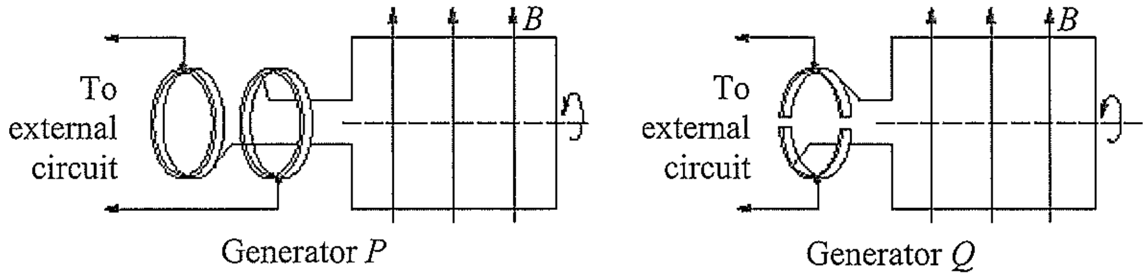
[4 marks]

(b) **Estimate** the force exerted on each of the four prongs of the tap handle when a person exerts a force of 2.0 N on the tap-turner. State any assumptions that you make.

[4 marks]

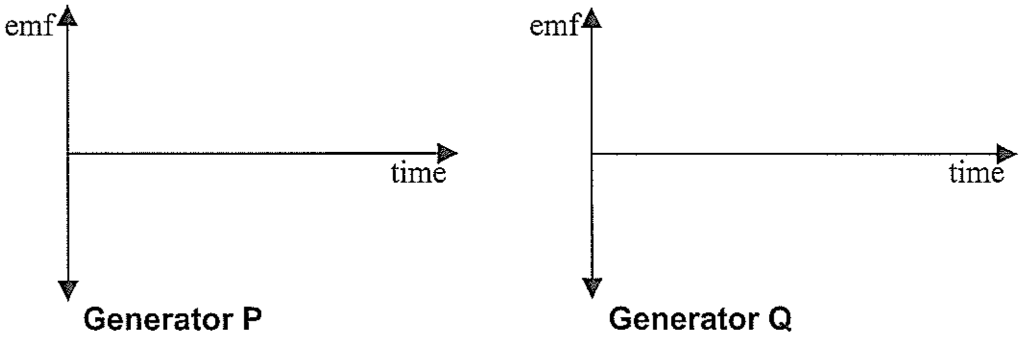
5. [Total 10 marks]

Two types of generator are shown below. Generator P has slip rings and Generator Q has a commutator.



(a) What is the function of the *brushes* in a generator? [2 marks]

(b) Sketch a graph of the emf against time for each of the generators. You need not add a scale to the axes. [2 marks]



(c) Why are AC generators rather than DC generators usually used in large-scale electrical power production? [2 marks]

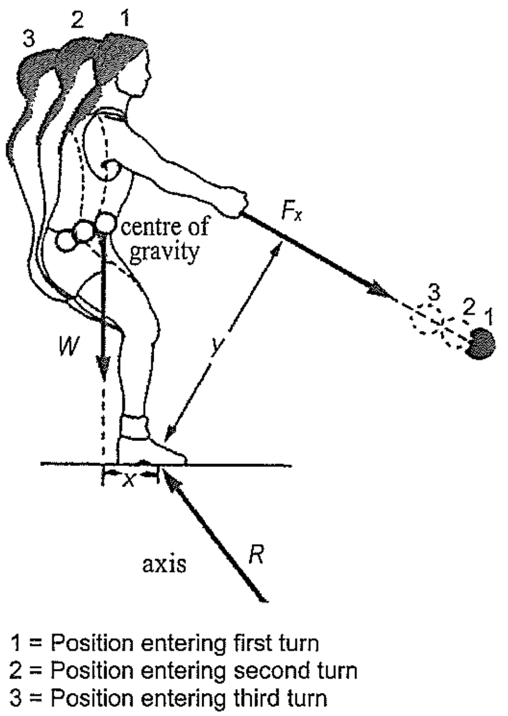
(d) An AC generator has a 120 cm^2, 300-turn coil rotating in a magnetic field of 0.20 T. The average output is 240 V. At what frequency does it rotate?

[4 marks]

6. [14 marks]

The 'hammer throw' is an athletic event in which the thrower must throw the 'hammer' as far as possible. The hammer consists of a metal ball attached to one end of a strong wire, about 1 m long, with a handle attached to the other end. The thrower swings the hammer in three circles, and with each turn (rotation), the speed of the hammer increases until it is finally released.

The diagram shows three forces W, F_x and R acting on the thrower during the turns before releasing the hammer.



(a) Forces always exist between two objects. Name the object, other than the thrower, involved in each of the following forces: [3 marks]

W: ______________________________

F_x: ______________________________

R: ______________________________

(b) With the aid of one or more diagrams, explain why the thrower must lean back a little further each time she turns. [3 marks]

(c) The mass of the hammer is 6.0 kg (ignore the mass of the wire) and the radius of the circular path is 1.40 m. If the hammer is released at a speed of 28 ms^{-1}, what is the tension in the wire the instant before it is released? Assume the path of the hammer is horizontal.

[3 marks]

(d) If a thrower can release the hammer 1.2 m above the ground, at a speed of 28 ms^{-1}, and (by tilting the swinging circle) at an angle of 42° above the horizontal, how far will the hammer travel after it is released? Assume it travels in a parabolic arc and air resistance does not affect its flight.

[5 marks]

7. [12 marks]

In July 1969, the Apollo 11 Command Module orbited the Moon while waiting for the return of the Ascent Module containing the two astronauts who had landed on the Moon's surface. The mass of the command module was 9.98×10^3 kg, its period was 119 minutes, and the radius of its orbit from the Moon's centre was 1.85×10^6 m.

(a) Assuming the Command Module was in circular orbit, show all working used to calculate [6 marks]

(i) the magnitude of the orbital velocity of the Command Module.

(ii) the mass of the Moon.

(b) On its way back to Earth, Apollo 11 would have passed the point where gravitational acceleration toward the Earth is equal to gravitational acceleration toward the Moon. What percentage of the return distance is this point?

[6 marks]

Use the Formulae and Constants Sheet for relevant data.
Hint: In determining a solution to this problem, you might find the following useful:

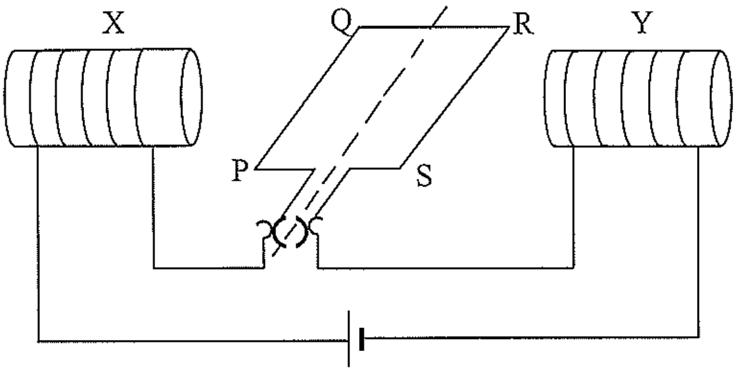
$$\text{If } \frac{a^2}{b^2} = c \quad \text{then} \quad \frac{a}{b} = \sqrt{c}$$

moon

Earth

8. [16 marks]

The schematic diagram below shows an electric motor that produces its magnetic field from *field coils* either side of the *armature coil*. It is called a series wound motor because the field coils X and Y are wired in series with the armature coil.



The armature coil of the motor has 150 turns. Side PQ is 5.0 cm long and side QR is 4.0 cm long. When the armature coil is connected to the 12 V supply as shown, a current of 0.75 A produces a magnetic field of 0.095 T across the armature coil.

(a) [4 marks]

(i) Draw one arrow on the above diagram to show the direction of the magnetic field created by the field coils X and Y. Label this arrow B.

(ii) Draw one arrow on the above diagram to show the direction of the force on the side PQ due to the current in the armature coil. Label this arrow F.

(iii) Will the armature rotate clockwise or anticlockwise (as viewed from the point of connection to the external circuit)?

Answer: ______________________________

(b) Calculate the force on the side PQ of the armature. [3 marks]

(c) Calculate the torque produced on the armature coil when PS is: [4 marks]

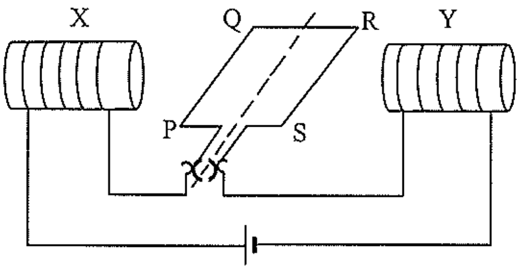
(i) horizontal, as shown in the diagram.

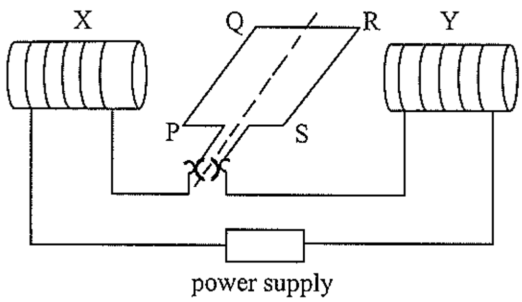
(ii) Vertical.

(d) State two ways in which the motor can be modified so that a greater torque is obtained.
[2 marks]

(e) One advantage of this type of motor is that it works on either AC or DC electrical supplies. Using either or both of the diagrams below as part of your answer, explain why this motor will turn in the same direction, regardless of the direction of the electric current.

[3 marks]





SECTION C: Comprehension and Interpretation **(40 Marks)**

BOTH questions should be attempted.

Read the following passages and answer the questions at the end of each. Candidates are reminded of the need for clear and concise presentation of answers. Diagrams (sketches), equations and/or numerical results should be included as appropriate.

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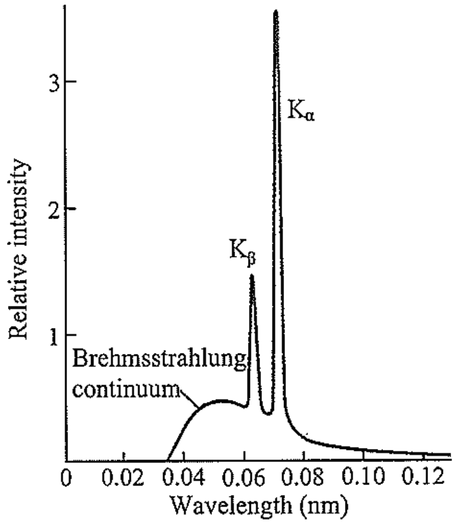
1 USING X-RAYS [20 marks]

(a) [6 marks]

When metals are bombarded with high-speed electrons they can emit X-rays. For example, when electrons of a particular energy are fired at a molybdenum target, a range of X-rays of different wavelengths are produced—as shown in the graphical spectrum on the right. Many metals produce a similarly shaped spectrum.



(i) Explain how the X-rays are produced. In particular, explain the origin of the peaks in the X-ray spectrum (labelled K_α and K_β).

(ii) The electrons fired at the molybdenum target are accelerated by a high potential difference. Which of the potential differences below would most likely have produced the above X-ray spectrum? You will only earn marks if you justify your answer.

15 kV 35 kV 50 kV

(b) In 1914, a physicist called Henry Moseley tested the X-rays produced by different target metals and found that there was a relationship between the wavelength of the peak marked K_α and the Atomic Number (Z) of the metal. The relationship is expressed in the following equation:

$Z = \text{const}_1 \times \frac{1}{\sqrt{\lambda}} + \text{const}_2$ where λ is the wavelength of the K_α peak.

This equation has the general form: $y = mx + c$ which means that if Z is graphed against $\frac{1}{\sqrt{\lambda}}$, the result will be a straight line. The following experimental data might have resulted from experiments like Henry Moseley conducted.

Element	Atomic Number (Z)	Wavelength (pm)	Wavelength (m)	$\frac{1}{\sqrt{\lambda}}$ ($m^{-½}$)
Molybdenum	42	54		
Tin	50	38		
Barium	56	30		
Ytterbium	70	19		
Tungsten	74	17		
Platinum	78	15		
Lead	82	14		

[6 marks]

(i) The wavelengths in the table above are given in units of pm. Convert all wavelengths to metres (column 4) and calculate appropriate values for column 5.

(ii) Use the data to produce a graph of Z vs $\frac{1}{\sqrt{\lambda}}$, with Z on the vertical axis.

Do this ***either*** on the graph paper provided or using your graphics calculator.

State here the method you will use: ______________________________

If you have used a graphics calculator, write the equation of the line of best fit (regression line) below using the variables given.

(c) [4 marks]

(i) Determine the gradient of the line of best fit (the regression line).

Gradient = ____

(ii) How many significant figures should you use for value of the gradient? _______
Explain.

(d) [4 marks]

The actual equation of the straight line is:

$$Z = \left(6.60 \times 10^{8} \sqrt{hc}\right) \times \frac{1}{\sqrt{\lambda}} + 3$$

where c = speed of light and h = Planck's Constant.

Use the gradient you determined in part (c) to work out an experimental value for Planck's Constant, h. [If you were unable to work out a gradient, use the value 2.5×10^{-4}]

2 WHY CAN'T WE UNDERSTAND SOME WORDS WHEN SOPRANOS SING HIGH NOTES [20 marks]

[paragraph 1]
Women who can sing very high frequency notes are called sopranos. When a soprano sings words such as 'bird', 'barred' or 'bored' at a high note such as A5 (880 Hz), listeners cannot understand which word it is. Researchers at the University of New South Wales believe they have worked out why.

Singing
[paragraph 2]
A singer produces musical notes—particular frequencies that vary in quality and loudness. When someone sings a note, the fundamental frequency (f_0) of the note is determined by the frequency of vibration of the vocal cords at the back of their throat. The fundamental frequency is also accompanied by a series of harmonics or overtones, f_0, $2f_0$, $3f_0$ etc.

[paragraph 3]
Without any *resonance* effects, successive overtones would decrease in loudness by about 12 dB but the shape of the human vocal tract (the space in the throat, mouth and lips) enables resonance to occur. Resonance of the air in the vocal tract increases the loudness of harmonics that have a frequency close to one of the resonant frequencies, particularly R_1 and R_2. See figure 1.

Singing vowel sounds
[paragraph 4]
The resonant frequencies of the human voice also play a very important part in our ability to speak or sing vowel sounds. To speak different vowel sounds, such as a, e, i, o or u, a person must change the shape of their vocal tract. In turn, this changes the resonant frequencies. The distinction between different vowel sounds in Western languages is determined almost completely by the two lowest resonant frequencies R_1 and R_2. And this is what can make the singing of vowel sounds difficult.

[paragraph 5]
When a woman sings the vowel sound '*oo*' (as in '*hood*'), R_1 is approximately 440 Hz and R_2 is approximately 1100 Hz. In contrast, when she sings the vowel sound '*a*' (as in '*had*'), R_1 is raised to about 660 Hz and R_2 to about 1500 Hz. However, she is limited in how high she can raise R_1 by her ability to change the shape of her vocal tract. There is a limit to how wide someone can open their mouth or stretch their lips!

[paragraph 6]
When ordinary people sing, the fundamental frequencies of most notes are generally well below R_1 and we have no difficulty singing different words. However, when a soprano sings, the fundamental frequencies of the notes are often very high and they may be above the highest R_1 she can produce. If the fundamental frequency is above R_1, she cannot sing the word clearly enough for an audience to tell the difference between it and a similar word. She also cannot sing the fundamental note very loudly because she can't get the extra loudness from resonance.

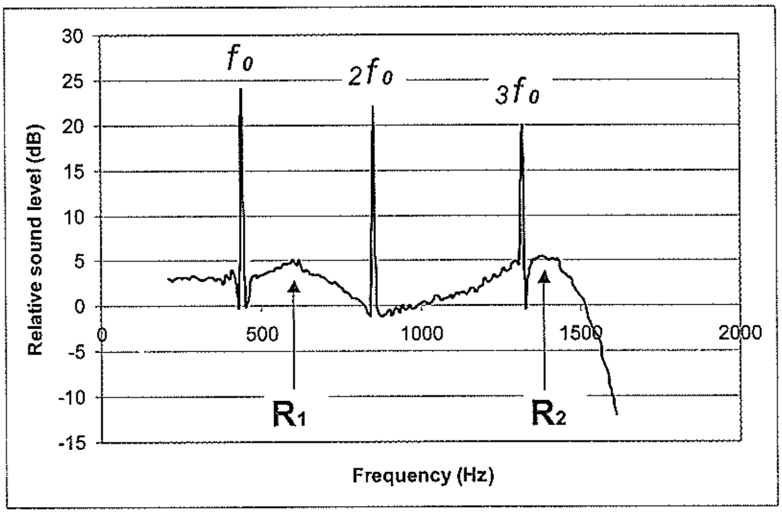


Figure 1: The fundamental frequency, overtones and first two resonant frequencies produced by a soprano singing the word *'hard'* at 440 Hz.

[paragraph 7]
The spectrum shown in Figure 1 was produced by a soprano singing the vowel sound in *'hard'* at 440 Hz for four seconds. The researchers recorded this sound spectrum by combining the voice of the singer and the resonant effect on the sound from a music synthesiser connected to a microphone taped just beside her mouth. As you can see, the first resonant frequency R_1 is about 600 Hz, much higher than the 440 Hz fundamental note she was singing.

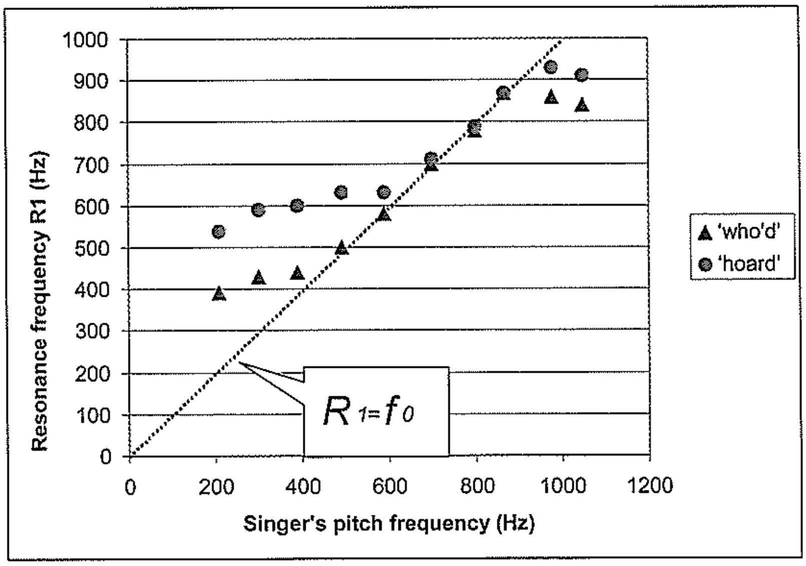


Figure 2: The value of R_1 produced by the soprano as she sang *'who'd'* and *'hoard'* at higher and higher frequencies.

[paragraph 8]
The researchers then determined R_1 as the soprano sang two different vowel sounds (*'who'd'* and *'hoard'*) at higher and higher pitch frequencies. See Figure 2. The graph shows that as the fundamental frequency f_0 of her voice increases, so does R_1 – up until about 750 Hz. After that, the resonant frequency equals f_0 and then *decreases* slightly even though the pitch frequency gets higher. Above about 750Hz, the soprano cannot sound the vowel sound properly and so the audience cannot understand the word she sings.

(a) What do the following symbols used in the article represent? [2 marks]

(i) f_0 ______________________________

(ii) R_2 ______________________________

(b) [5 marks]

(i) Explain what the term resonance means.

(ii) How does resonance affect our ability to speak or sing? [paragraphs 2-6]

(c) [7 marks]

(i) If the soprano sings the word *'hoard'* at 200 Hz, what is the lowest resonant frequency of her vocal tract?

If she sings the word *'hoard'* at 1000 Hz, what is the lowest resonant frequency of her vocal tract?

(ii) What happens to make vowel sounds indistinguishable from one another?

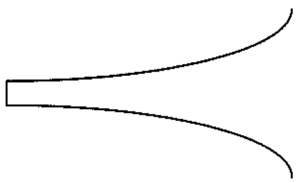
(iii) Explain why we cannot clearly understand the soprano when she sings *'who'd'* at a fundamental frequency of 1000 Hz?

(d) [6 marks]

(i) When the soprano sings a 510 Hz note, what two other frequencies are most likely sounded at the same time?

(ii) The length of an adult's vocal tract is typically between 15 cm and 20 cm long. If we consider the vocal tract to be a closed pipe, **estimate** the range of fundamental frequencies that will resonate within the range of lengths of the pipe.

(iii) A trumpet has a flared shape, like the following:



The flaring has the effect of decreasing the effective length of the trumpet thus changing the resonant frequencies. Explain how a singer uses this principle to increase the resonant frequencies of her vocal tract.

END OF PAPER

Check that you have written your Student Number on the front cover of this booklet.

ACKNOWLEDGEMENTS

SECTION A

Question 1: Diagram from: http://www.bupashop.co.uk/media/images/S418_Aerobic_fitness_skipping_rope_with_electronic_counter_L2.jpg

Question 4: Diagram from: http://www.adventureworld.net.au/

Question 9: Diagram from: http://www.vcaa.vic.edu.au/vce/studies/physics/pastexams/physicspilot22004.pdf

Question 11: Diagram from: http://www.vcaa.vic.edu.au/vce/studies/physics/pastexams/physicspilot22004.pdf

Question 12: Diagram from: http://www.boardofstudies.nsw.edu.au/hsc_exams/hsc2003exams/pdf_doc/physics_03.pdf

Question 13: Adapted from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/pdf_doc/physics_specexam.pdf

Question 14: Diagram from: Hewitt, P.G. (1998) *Conceptual physics* (8th ed.) Sydney: Addison Wesley, p. 205.
Skeleton image adapted from: de Jong, E., Armitage, F., Brown, M., Butler, P. & Hayes, J. (1991). *Physics two.* Port Melbourne: Heinemann, p. 321.

Question 15: Diagram from: Giancoli, D.C. (1995). *Physics: principles with applications* (4th ed.). Englewood Cliffs NJ: Prentice Hall.

SECTION B

Question 2: Diagrams adapted from: Giancoli, D.C. (1995). *Physics: principles with applications* (4th ed.) Englewood Cliffs NJ: Prentice Hall.

Question 3(c): Graph from: Walker, J.S. (2004). *Physics* (2nd ed.). Upper Saddle River NJ: Pearson Education, p. 1042.

Question 4: Diagram from: Education Department of WA. [n.d.]. [Year 8–10 science curriculum materials]. East Perth, WA: Author.

Question 5: Diagram from: http://www.boardofstudies.nsw.edu.au/hsc_exams/hsc2002exams/pdf_doc/physics_02.pdf

Question 6: Image from: de Jong, E., Armitage, F., Brown, M., Butler, P. & Hayes, J. (1991). *Physics two.* Port Melbourne: Heinemann, p. 202.

SECTION C

Question 1: Image scanned from: Walker, J.S. (2004). *Physics* (2nd ed.). Upper Saddle River NJ: Pearson Education.

Question 2: Developed from article: Schwarzschild, B. (2004, March). Acoustics experiment shows why it's so hard to make out the heroine's words at the opera. *Physics Today*, p. 23–25. Both graphs modified and re-drawn.m

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