Candidate Name	Centre Number	Candidate Number

A LEVEL PHYSICS

COMPONENT 1

Newtonian Physics

SPECIMEN PAPER

2 hours 15 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	10	
	2.	10	
	3.	10	
	4.	10	
	5.	20	
	6.	20	
Section B	**7.**	20	
	Total	100	

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

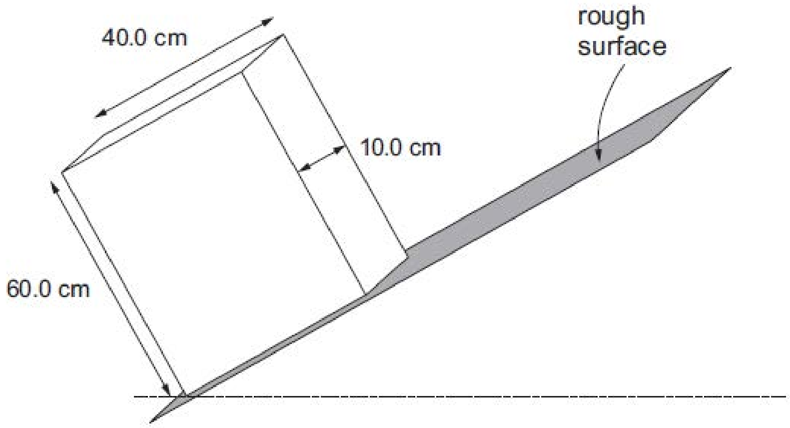
This paper is in 2 sections, **A** and **B**.
Section **A**: 80 marks. Answer **all** questions. You are advised to spend about 1 hour 35 minutes on this section.
Section **B**: 20 marks; Comprehension. You are advised to spend about 40 minutes on this section.

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in questions 5*(d)* and 7*(c)*.

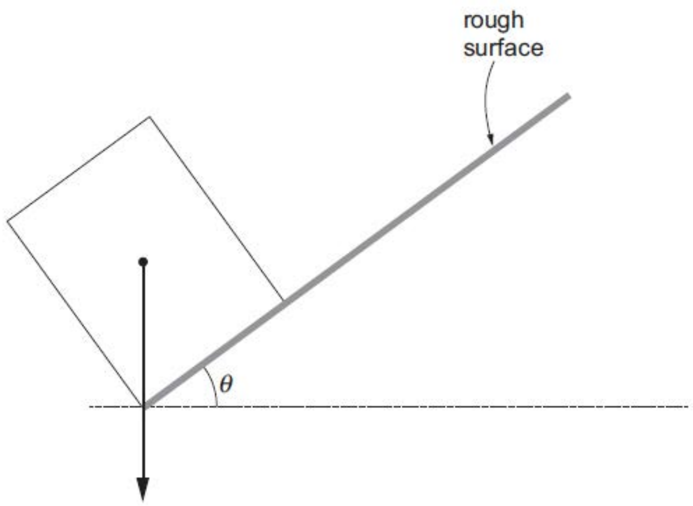
No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A
*Answer **all** questions.*

1. *(a)* A solid block of uniform density with sides 60.0 cm, 40.0 cm and 10.0 cm rests on a sloping rough surface.



The following diagram shows the block viewed from the side **at the point of toppling.** An arrow is shown passing through the centre of gravity of the block.



(i) Explain what is meant by *centre of gravity*. [1]

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(ii) Explain how you would measure the angle θ in practice. [2]

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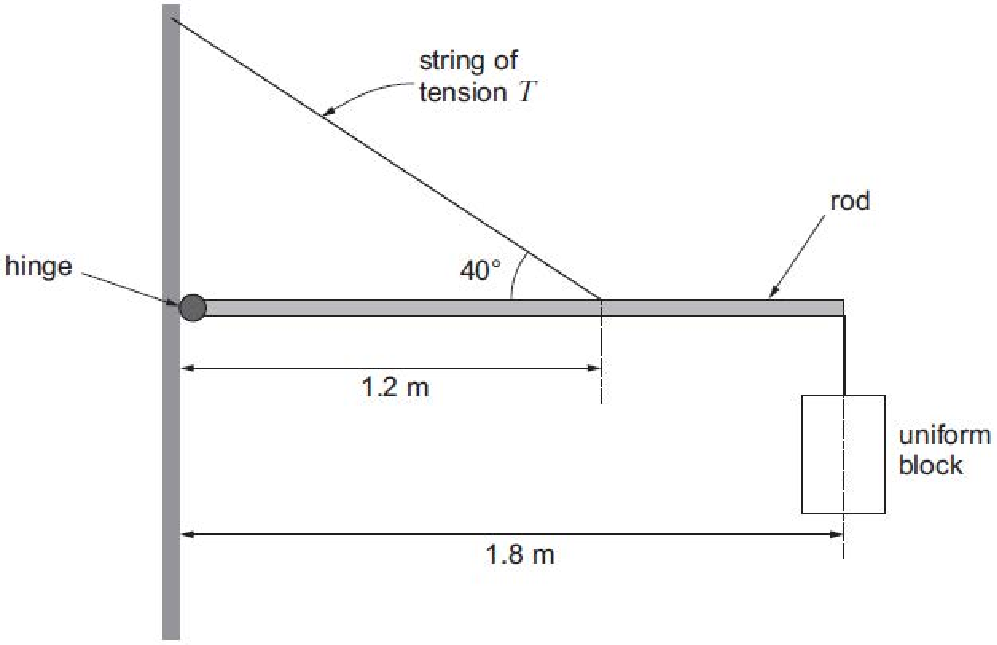
(b) The block (in part *(a)*) is now attached to a rod of **negligible weight** which is supported by a string and a frictionless hinge as shown in the diagram below.



(i) Calculate the tension in the string. The density of the material of the block is 400 kg m^{-3}. [5]

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(ii) Hence calculate the horizontal component of the force that the rod exerts on the hinge. [2]

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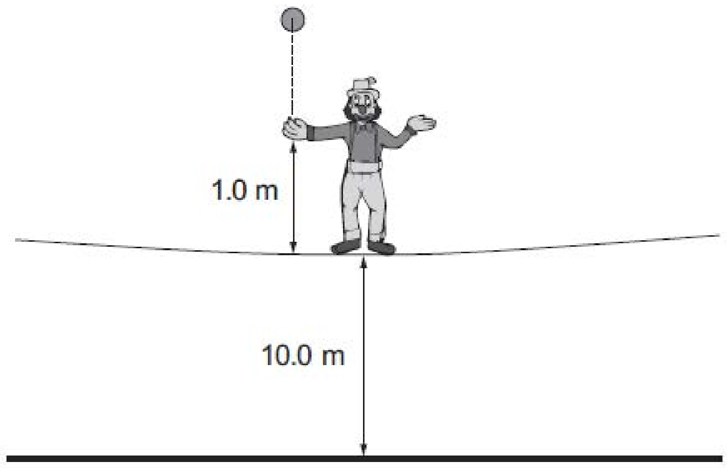
2. *(a)* A circus performer standing on a tightrope 10.0 m above the ground throws a ball vertically upwards at a speed of 6.0 m s^{-1}. The ball leaves his hand 1.0 m above the tightrope as shown. *The diagram is not to scale.* Ignore air resistance for part (a) only.



(i) Calculate the maximum height **above the ground** that the ball reaches. [3]

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(ii) The performer fails to catch the ball as it drops. Calculate the **total** time the ball is in the air. [4]

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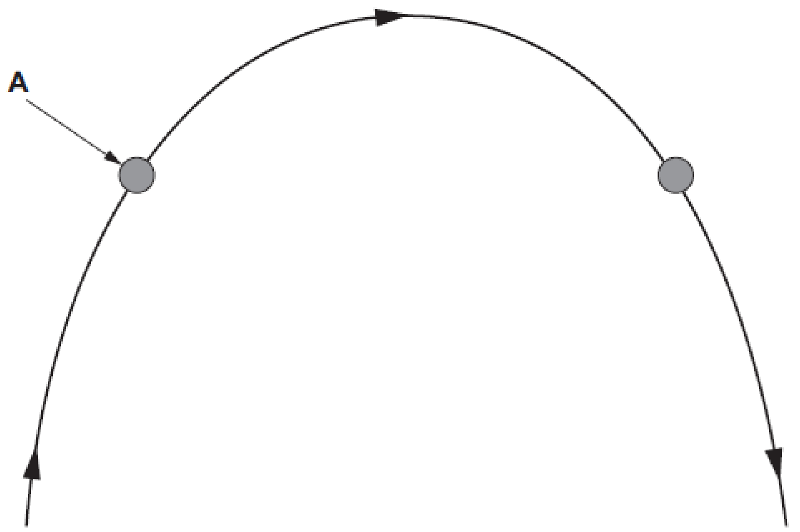
(b) Another ball is thrown **into the air** and follows the path shown. The ball is shown at a point labelled **A**.



Sketch a diagram to show the forces acting on the ball when it is at **A**. Justify your answer. [3]

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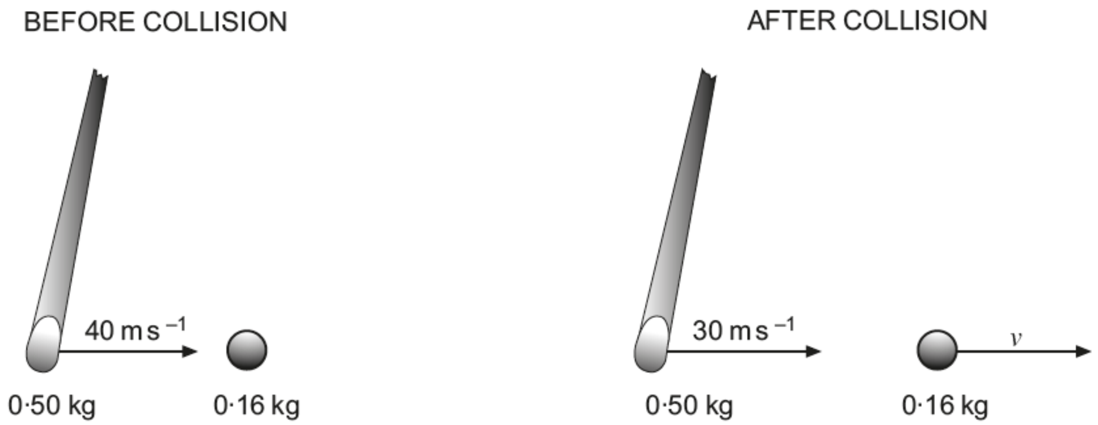
3. A hockey player swings her stick so that the head of the stick (mass 0.50 kg) strikes a stationary ball (mass 0.16 kg). The velocity of the stick drops from 40 m s^{-1} to 30 m s^{-1} during the collision. Assume that all velocities are horizontal, as shown in the diagram.



(a) (i) Apply the *Principle of Conservation of Momentum* to find a value for the velocity of the ball after the collision. [2]

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(ii) Momentum is not strictly conserved in this collision between the ball and the hockey stick. Justify this statement. [2]

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(b) The ball and club-head are in contact for 1.5×10^{-3} s. Naming the law of physics that you use, calculate the mean force exerted by the club-head on the ball. [3]

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(c) (i) Show that approximately 100 J of kinetic energy is lost in this collision. [1]

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(ii) Estimate the temperature rise of the hockey ball. [2]

(Specific heat capacity of ball = 850 $J\,kg^{-1}\,{}^{o}C^{-1}$)

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4. *(a)* Define *work*. [1]

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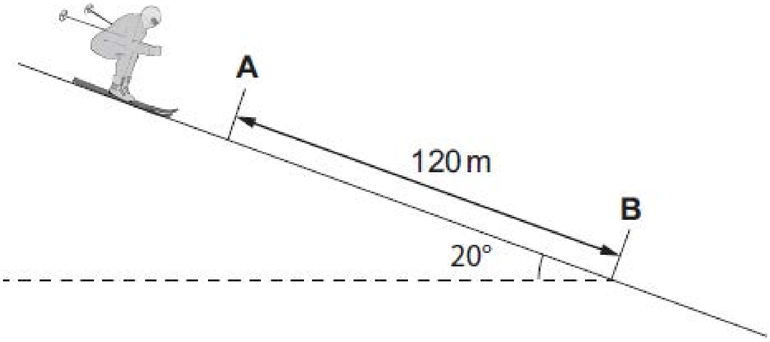

A skier of mass 70 kg descends a slope inclined at 20° to the horizontal as shown. The skier passes point **A** at a speed of 6 m s^{-1} and a second point **B** at a speed of 21 m s^{-1}. The distance between **A** and **B** is 120 m.

Calculate, for the descent from **A** to **B**:

(i) the gravitational potential energy lost by the skier; [2]

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(ii) the kinetic energy gained by the skier. [3]

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(c) Calculate the mean resistive force experienced by the skier between **A** and **B**. [4]

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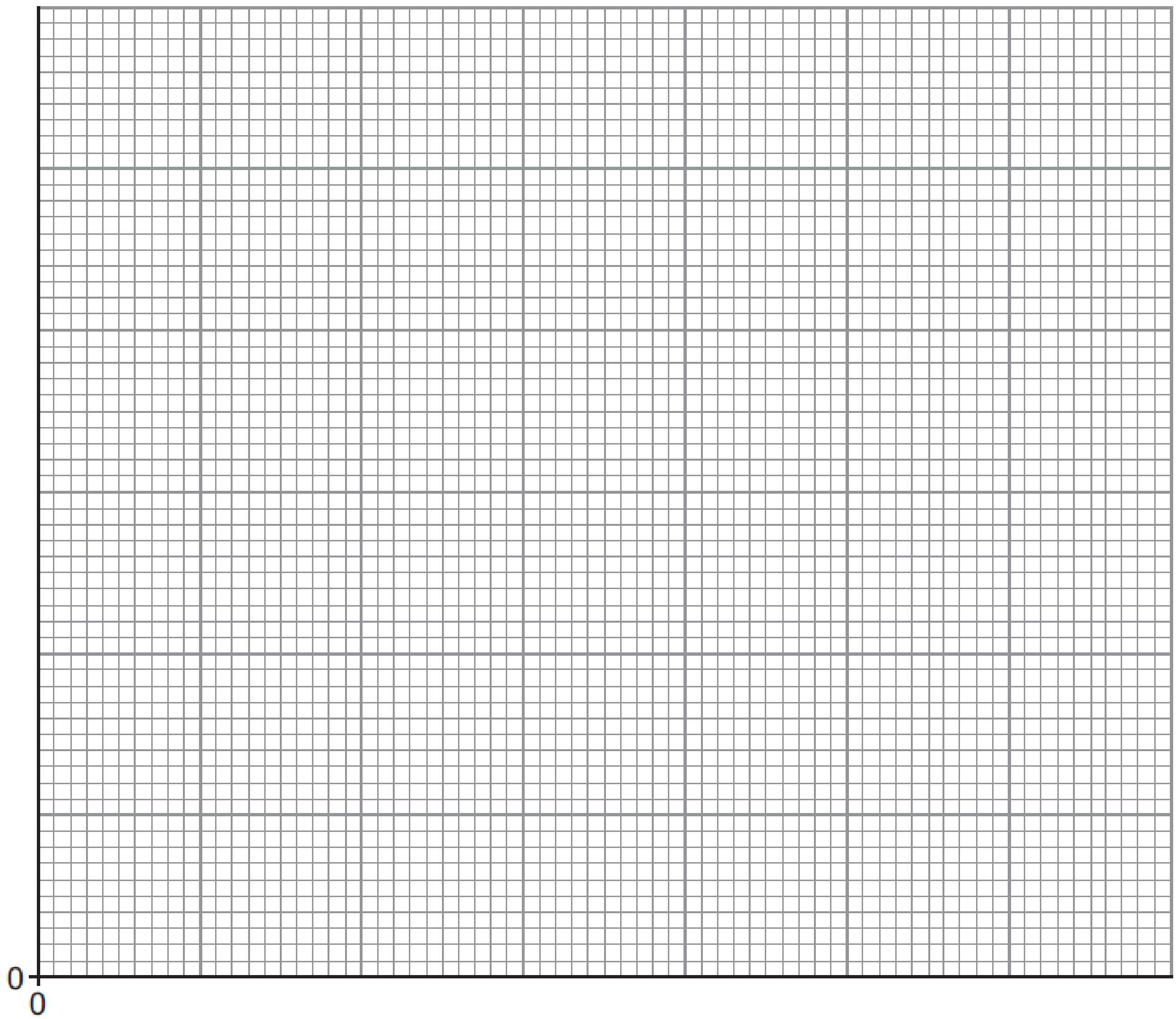
5. A container made of an insulating material contains 1.13 kg of water. The water is heated by a 3.0 kW electric immersion heater. A student records the water temperature at 20 second intervals. There is an uncertainty of ± 2 °C in the temperature measurements. The uncertainty in the time is negligible.

Time (s)	Water temperature (°C) (± 2 °C)
20	32
40	45
60	58
80	70
100	83
120	96

(a) Plot a graph of the water temperature (y-axis) against time in seconds (x-axis). Draw a line of maximum gradient and a line of minimum gradient through the data.
Plot error bars for the water temperature. [4]



(b) (i) State the main hazard involved in this experiment. [1]

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(ii) State a precaution to ensure the accuracy of the water temperature. [1]

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(c) (i) Calculate the maximum and minimum gradients for your graph. [2]

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(ii) Calculate the mean gradient with its **percentage** uncertainty. [3]

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(iii) Hence use the mean gradient to calculate the specific heat capacity of the water and its absolute uncertainty. [3]

P = power supplied to the water (3.0 kW)
m = mass of the water (1.13 kg)

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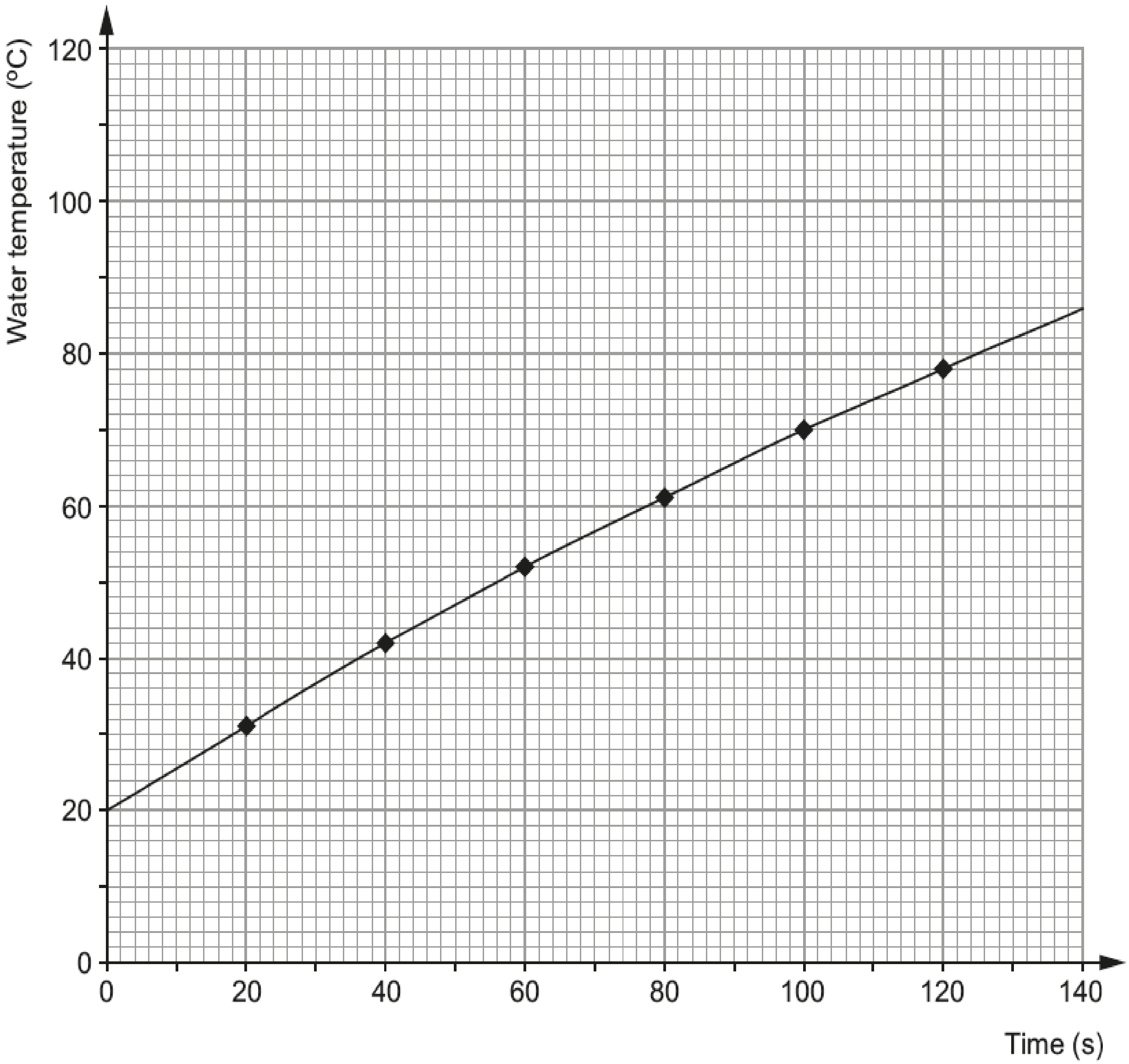
(d) Another student repeats the experiment with exactly the same mass of water and with exactly the same power of electric immersion heater but with a different container. The results of the second student are shown in the table below along with the better results of the first student.

Time (s)	First student Water temperature (°C) (± 2 °C)	Second student Water temperature (°C) (± 2 °C)
20	32	31
40	45	42
60	58	52
80	70	61
100	83	70
120	96	78

These are the second student's data when plotted in a graph.



Without further calculation and by comparing the results of both students suggest valid conclusions for the second student's experiment. Evaluate the second student's results critically. [6 QER]

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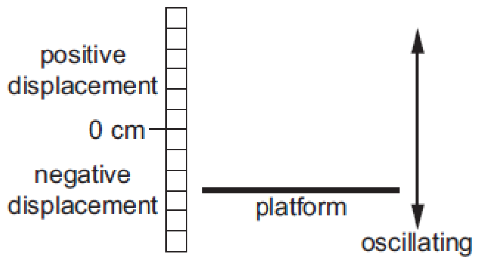
6. A horizontal platform oscillates vertically with simple harmonic motion around a central position with a period 0.40 s and amplitude 5.0 cm.



(a) Define *simple harmonic motion*. [2]

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(b) Determine the frequency of oscillation. [2]

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(c) Show that the angular frequency, ω, of oscillation is 15.7 rad s^{-1}. [1]

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(d) Calculate:

(i) the maximum velocity of the platform; [2]

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(ii) the maximum acceleration of the platform; [2]

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(iii) the acceleration of the platform when it is 0.020 m above the centre of oscillation. [3]

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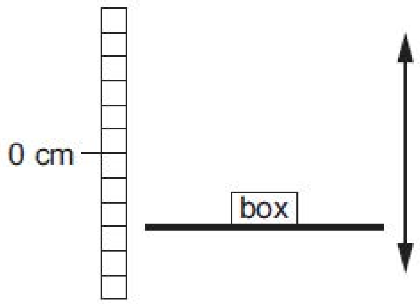
(e) (i)



A small box is carefully placed on the platform when it is at its lowest point. As the platform rises the box is seen to leave the platform when x = 4.0 cm. Explain this observation and justify your answer with a calculation. [5]

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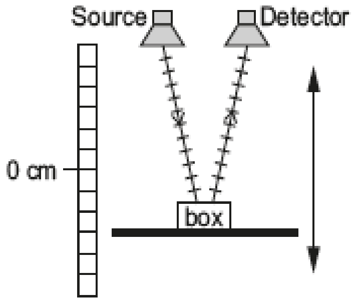
(ii) The velocity of the box is measured by having a microwave source and detector above it.



The microwaves that are reflected from the box are detected by the detector. Explain how the wavelength shift of the reflected microwaves can lead to a measurement of the platform's speed. [3]

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SECTION B

7. Read through the following article carefully.

DEPLETED URANIUM (DU) WEAPONRY: TECHNICAL AND POLITICAL ASPECTS

[Edited excerpts of a Panel discussion in the United Nations on October 26, 1999 sponsored by the NGO Committee on Disarmament, in cooperation with the UN Department for Disarmament Affairs.]

ROGER SMITH: We have a distinguished panel this afternoon to speak on the subject of "Depleted Uranium (DU) Weaponry: Technical and Political Aspects." This is an issue that is emerging. It is not prominent on the UN's agenda, but it relates to a form of weaponry which is now in active use. It was used both in the Gulf War and in the Bosnia and Kosovo operations of NATO.

DAMACIO LOPEZ: When the Depleted Uranium (DU) penetrator strikes the target it will have what appears to be an explosion. There are no explosives in the DU missile. It is the mass and speed and the energy from the radioactivity that gives the impression of an explosion. The projectile is referred to as a kinetic energy penetrator. It burns through like molten metal, and as it burns it is giving off smoke. The particles in that smoke are very tiny, somewhere between 1 and 5 micrometers in size. 30% to 70% of the depleted uranium goes up as smoke into the air, and is taken by winds.

COLONEL ERIC DAXON: Science does not support the contention that DU is a weapon of mass destruction. Science does not support the contention that the use of DU will result in an environmental catastrophe.
The explosion is not due to the radioactivity of the DU. When the penetrator first hits you see something that looks like a sparkler. That is the nature of the DU. It self-ignites when exposed to high temperatures and high pressures. A tungsten penetrator becomes blunt. A DU penetrator will become sharper as it is penetrating armor, and that is the primary reason that we are using it, along with its density. The self-sharpening effect gives it a significant tactical advantage.

DR. NAOMI HARLEY: Many workers have been exposed to high air concentrations of uranium during the extraction process. Uranium-235 is extracted by gaseous diffusion from natural uranium (that originally contained the isotopes, U-238 and U-235). The residual uranium, after extraction of the U-235, is called depleted uranium. Depleted uranium is about half as radioactive as the original natural uranium.
There is a lot of history of these workers with exposure to uranium. There are a tremendous number of people that have been followed for years to detect any health effects. There have been industrial exposures that have been quite enormous, from accidents, etc. Nobody has seen a significant health effect to date.

HARI SHARMA: Previous speakers have already described the radioactive properties of DU and, of course, it emits energetic alpha particles. Radioactivity should be treated with the care and respect it deserves. If you disperse it in the environment, one way or the other it will harm people. I learned during the course of my professional career that people should not disperse radioactive materials in the environment. And that is why I am here to spread this message.
How do we analyze for DU? We can determine the isotopic ratio of U-238 to U-235. It is a fixed ratio (137.8) in uranium from natural sources. If the isotopic ratios in the urine specimens of Gulf War veterans are significantly higher, then DU is present.
I thought the task could be performed easily because eight years had gone by, and the uranium that was inhaled or ingested by the veterans would not be present in their urine specimens. The biological half-life of uranium in the human body is very short. It is twelve hours. Within a week it is completely flushed out of the human system, provided uranium compounds are of soluble type.
As a matter of fact, I found that there was evidence of the presence of depleted uranium in the urine samples. This is a reality. The question then arises, where is it coming from?

We stress that we are dealing here not just with uranium dioxide, but with uranium dioxide produced at very high temperature. It is a ceramic compound, highly insoluble like silica. Its initial excretion rate may be complex but not necessarily enhanced.

STEVEN FETTER: Uranium is everywhere. There are 2-8 $\times$ 10^3 kg/km^2 in the top metre of natural soil. Compare this with <1 $\times$ 10^3 kg/km^2 for DU in battlefield areas.

We conclude that the risks of exposure to DU are very small, except for people in the following categories:

- People who were in vehicles struck by DU projectile, or
- People who entered struck vehicles subsequently to clean up the vehicles, or scavengers
- People who have continuous contact of bare skin with bare DU

Steps should still be taken to minimize exposure. For example, contaminated vehicles should be isolated from the public, soldiers should be trained to avoid any unnecessary contact with contaminated vehicles. The public should also be educated so that they do not pick up pieces of DU and fashion them into bracelets.

DAN FAHEY: In my report, I have reports from the Pentagon's own interviews with veterans showing people climbed on and entered multiple contaminated vehicles. The dust was being stirred up, and some of the very people the Pentagon interviewed are having health problems. Was it related to DU? That is another question. But because we have no base line data, no testing was done after the Gulf War, we simply don't know how much DU veterans were exposed to.

Answer the following questions in your own words. Direct quotes from the original article will not be awarded marks.

(a) Explain why a small particle “goes up as smoke into the air and is taken by winds” whereas a larger particle might not. You will need to refer to the forces acting on the particle and its cross-sectional area in your answer. [5]

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(b) Damacio Lopez and Colonel Eric Daxon seem to disagree about the energies involved in the initial explosion of the depleted uranium (DU) missile. Explain how these two experts disagree. [2]

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(c) Depleted uranium (DU) is a by-product that is obtained after the isotope U-235 has been removed from naturally occurring uranium. Discuss whether or not U-235 should continue to be produced and whether or not DU should be used in weapons. [6 QER]

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(d) Assuming a uniform surface concentration of 0.5×10^3 kg/km^2 and an activity of 12.3 MBq per kg of DU, calculate the activity of 1 cm^2 of the surface. How does your answer compare with normal background radiation activity? [3]

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(e) It is claimed that ingesting or inhaling insoluble uranium dioxide might lead to a ratio of U-238 to U-235 higher than 137.8 in urine samples and the ratio could remain high for a long time in the samples. Explain whether or not this claim is correct. [4]

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