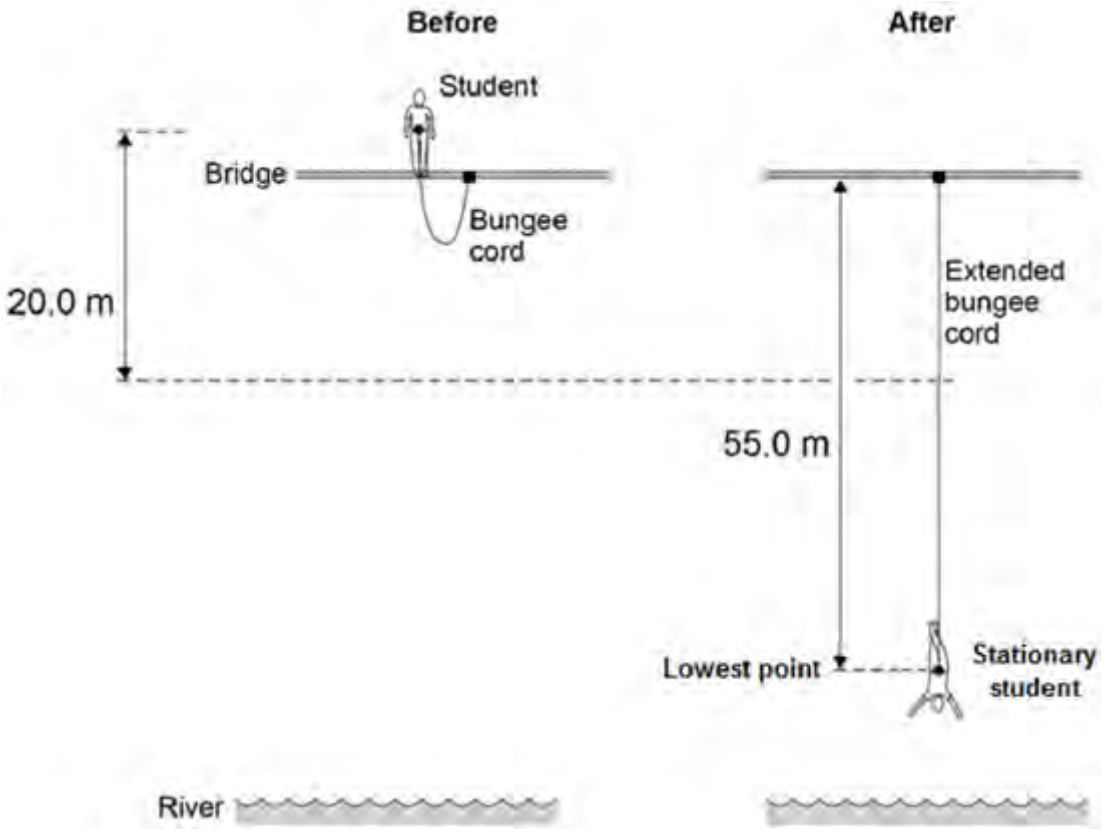
Q1. The figure below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N / kg.

(a) Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

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(1)

(b) Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

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Change in gravitational potential energy = ... J

(2)

(c) 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

Kinetic energy gained = ... J

(1)

(d) Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

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Speed = ... m / s

(4)

(e) At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

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Spring constant = ... N / m

(3)

(Total 11 marks)

Q2. When a gun is fired, a very large force acts on the bullet for a very short time.

The change in momentum of the bullet is given by the following relationship:

force (N) × time(s) = change in momentum (kg m/s)

(a) An average force of 4000 newton acts for 0.01 seconds on a bullet of mass 50g.

Calculate the speed of the bullet. (*Show your working*.)

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Answer ..... m/s

(4)

(b) The bullet is fired horizontally. In the short time it takes for the bullet to reach its target, its horizontal speed has fallen to 80% of its initial speed.

(i) Explain why the speed of the bullet decreases so quickly.

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(2)

(ii) Calculate the percentage of its original kinetic energy the bullet still has when it reaches its target.

(Show your working.)

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(4)

(Total 10 marks)

Q3. (a) When an object is moving it is said to have momentum.
Define momentum.

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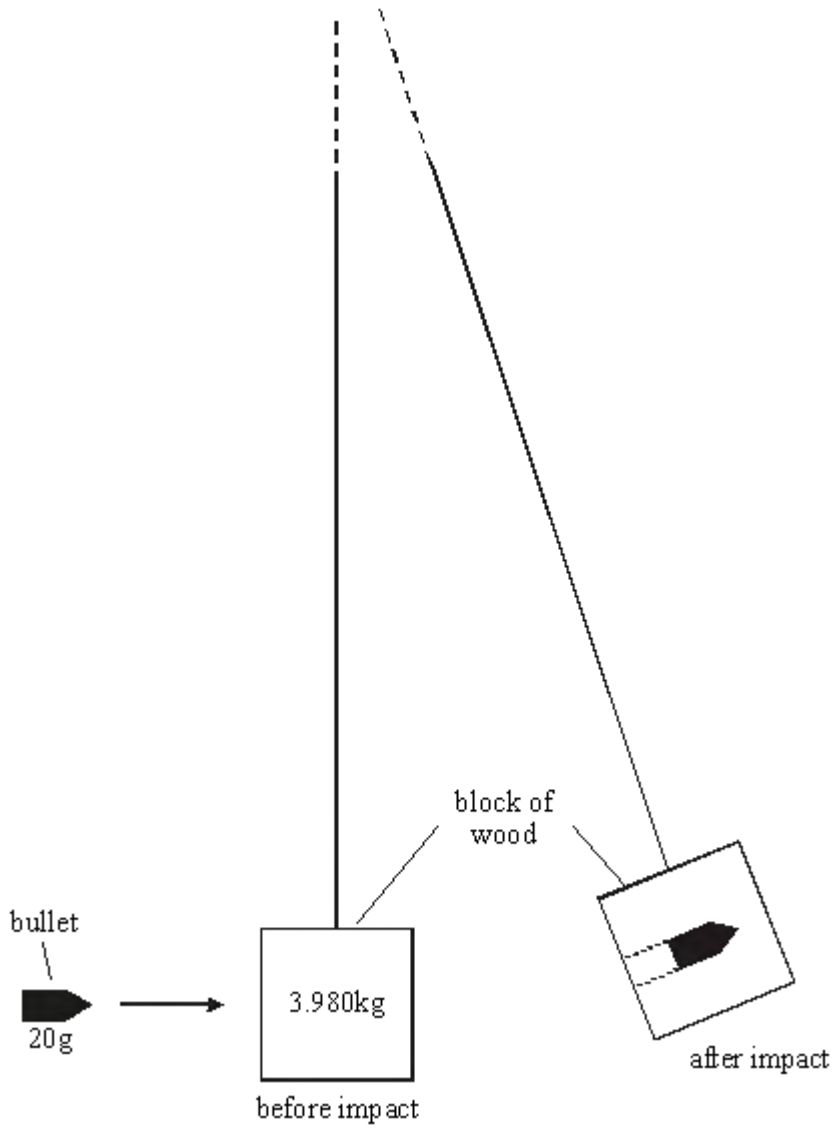
(1)

(b) The diagram below shows one way of measuring the velocity of a bullet.



A bullet is fired into a block of wood suspended by a long thread.
The bullet stops in the wooden block.
The impact of the bullet makes the block swing.
The velocity of the wooden block can be calculated from the distance it swings.

In one such experiment the block of wood and bullet had a velocity of 2 m/s

immediately after impact. The mass of the bullet was 20 g and the mass of the wooden block 3.980 kg.

(i) Calculate the combined mass of the block of wood and bullet.

..... Mass .....

(1)

(ii) Calculate the momentum of the block of wood and bullet **immediately after** impact.

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…..... Momentum .....

(3)

(iii) State the momentum of the bullet **immediately before** impact.

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(1)

(iv) Calculate the velocity of the bullet **before** impact.

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……..... Velocity ..... m/s

(3)

(v) Calculate the kinetic energy of the block of wood and bullet **immediately**

after impact.

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……..... Kinetic energy ..... J

(3)

(vi) The kinetic energy of the bullet before the impact was 1600 joules. This is much greater than the kinetic energy of the bullet and block just after the impact.
What has happened to the rest of the energy?

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(1)
(Total 13 marks)

Q4. The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.

(a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

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Change in gravitational potential energy = ... J

(2)

(b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

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Maximum possible speed = ... m/s

(3)

(c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

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(3)
(Total 8 marks)