Q1.

Figure 8 shows two ice skaters during a performance.

Figure 8

(i) The two ice skaters are travelling together in a straight line at 3.50 m/s.
Their total momentum is 371 kgm/s.
The man has a mass of 64.5 kg.
Calculate the mass of the woman.

(4)

(ii) Calculate the kinetic energy of the man.

(2)

Q2.

(i) An aircraft lands with a velocity of 71 m/s.
The mass of the aircraft is 3.6×10^5 kg.
Calculate the kinetic energy of the aircraft as it lands.

(2)

(ii) When the aircraft has come to a stop, all the kinetic energy has been transferred to the surroundings.
Give **one** way that the energy has been transferred to the surroundings.

(1)

Q3.

(i) A microwave oven uses waves of frequency 2.45 GHz.
Calculate the wavelength of the microwaves.
The velocity of light is 3.00×10^8 m/s. (3)

(ii) The microwave oven is 55% efficient and transfers 42 000 J of energy to some food when it is heated.
Calculate the total amount of energy that must be supplied to the oven.

(3)

Q4.

A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 1.

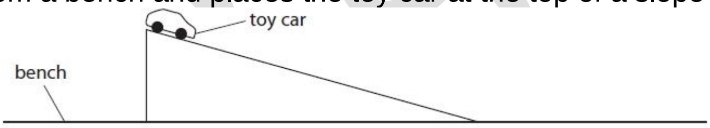

Figure 1

Describe an energy transfer that occurs when the student lifts the toy car from the bench and places the toy car at the top of the slope.

(2)

Q5.

Expanded polystyrene, used to insulate buildings, has different densities.
Figure 2 shows how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

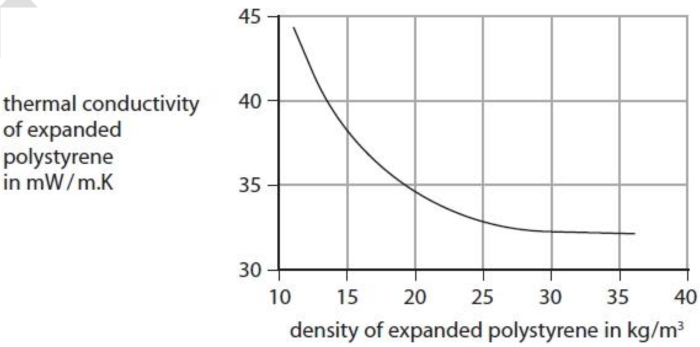

Figure 2

Using the graph in Figure 2, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene. (2)

Q6.

A student uses the apparatus in Figure 1 to find out which of two materials, sand or sawdust, is the better insulator.

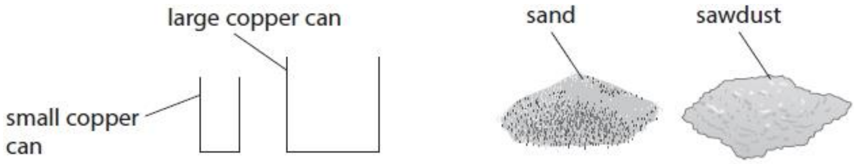

Figure 1

The student also has a kettle to boil water, a thermometer and a stop clock.

(i) Draw a labelled diagram to show how the student should set up the equipment to investigate which material is the better insulator.

(3)

(ii) Give **three** factors that the student must control in this investigation.

(3)

Q7.

The photograph shows a man dropping an egg inside a padded box from a height.

He is investigating to see if the padding stops the egg from breaking.

(a) State the type of energy which the egg gains as it falls.

(1)

(b) The weight of the egg is 0.6 N.

Calculate the work done on the egg to lift it up by 20 m. State the unit.

(3)

(c) The velocity of the container was 18 m/s as it hit the floor.

The mass of the container was 0.5 kg.

Calculate the momentum of the container.

(2)

*(d) A student stands on the ground with an egg in his hand.

He throws the egg vertically upwards.

The egg rises to a height of 10 m.

Then the egg falls and lands on the ground.

Describe the energy changes of the egg during this sequence of events.

(6)

Q8.

Shot-put is an Olympic event.

The shot is a heavy ball.

An athlete throws the shot as far as possible.

A sports scientist analyses an athlete's throw to help improve performance.

(a) The scientist takes pictures of the athlete every 0.1 s during one throw.

Figure 3 shows the pictures of one throw.

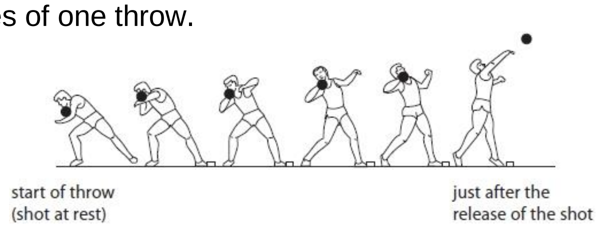

Figure 3

(i) Estimate the amount of time during the throw when the shot is in the athlete's hand.

(1)

(ii) Explain how the scientist could improve this method of analysing the throw.

(2)

(iii) The average acceleration of the shot while in the athlete's hand is 20.6 m/s^2.
The mass of the shot is 7.26 kg.
Calculate the average force that the athlete applies to the shot during the throw.

(2)

(iv) In another throw, the shot is in the athlete's hand for 0.48 s.
The average acceleration during this time is 23 m/s^2.
Calculate the velocity of the shot as it leaves the athlete's hand.

(3)

(b) In one throw, the shot continues to rise by another 1.3 m after it leaves the athlete's hand.
The mass of the shot is 7.26 kg.
Calculate the amount of gravitational potential energy gained by the shot.

(2)

Q9.

Andrew skis down a hill.

(a) Andrew starts from the top of the hill and his speed increases as he goes downhill.
He controls his speed and direction by using his skis.
He brings himself to a stop at the bottom of the hill.
Describe the energy changes that happen between starting and stopping.

(3)

(b) Andrew returns to the top of the hill and starts again.
(i) His mass is 67 kg.
Show that his momentum is about 2000 kg m/s when his velocity is 31 m/s.

(2)

(ii) He falls over when his momentum is 2000 kg m/s.
After he falls over, he slows down by sliding across the snow.
It takes 2.3 s for his momentum to reduce to zero.
Calculate the average force on Andrew as he slows down.

(2)

(iii) Andrew is not injured by the fall even though he was moving quickly.
Use ideas about force and momentum to explain why he is not injured.

(2)

Q10.

A student investigates how the average speed of the trolley varies with starting height.
Figure 9 shows the trolley and runway.

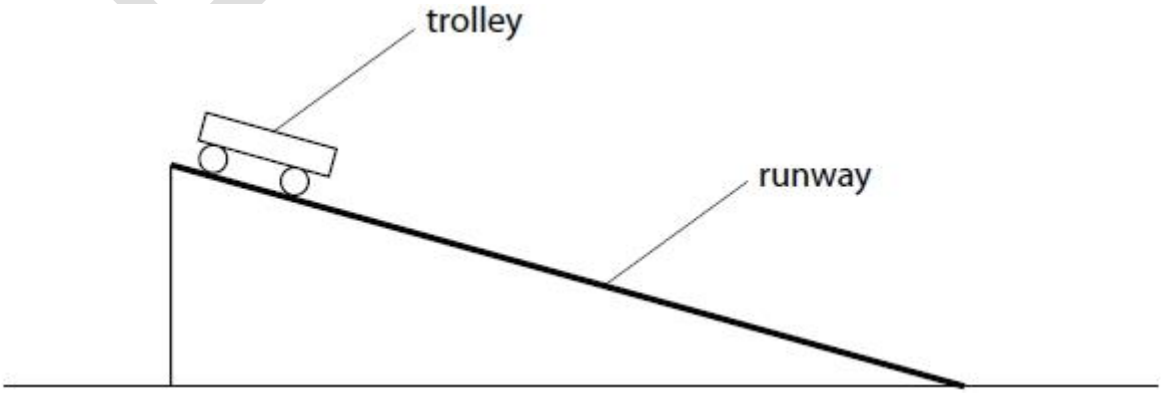

Figure 9

(a) Describe how the student can determine the average speed of the trolley.

(4)

(b) Figure 10 shows his results.

starting height / m	v / ms^{-1}
0.01	0.22
0.02	0.31
0.04	0.44
0.09	0.66
0.12	0.77
0.14	0.83
0.18	0.94

Figure 10

Figure 11 shows the student's graph.

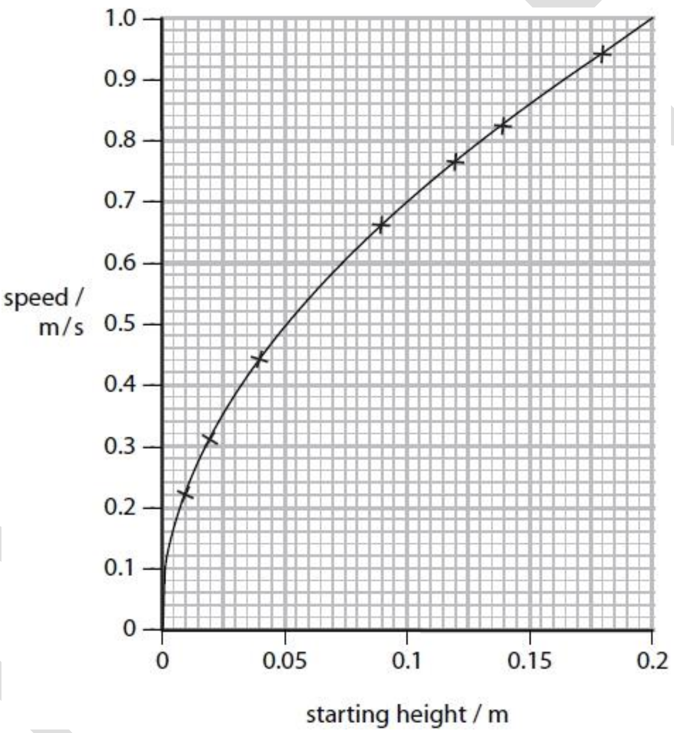

Figure 11

(i) The trolley has a mass of 650 g.
Calculate the average kinetic energy of the trolley which had a starting height of 0.075 m.

(2)

(ii) Determine the gradient of the graph when the height is 0.1 m.

(2)

(iii) Describe how the speed of the trolley varies with the changes in height made by the student between 0.04 m and 0.12 m.

(2)

(c) The student wants to change his experiment to investigate how different surfaces of the runway affect the speed of the trolley down the slope.
Devise an experiment that would allow him to investigate the effect of different surfaces on the average speed of the trolley.

(3)

Q11.

Electricity can be generated using a water turbine.

(i) Water gains kinetic energy by falling from the top of a dam.
Calculate the minimum height that 7.0 kg of water must fall to gain 1300 J of kinetic energy.

(3)

(ii) As water enters the turbine at the bottom of the dam, the kinetic energy of 8.0 kg of moving water is 1100 J.
Calculate the speed of the moving water as it enters the turbine.

(3)

Q12.

Moving air can be used to generate electricity using a wind turbine.
Figure 8 is a graph of kinetic energy against wind speed for a mass of moving air.

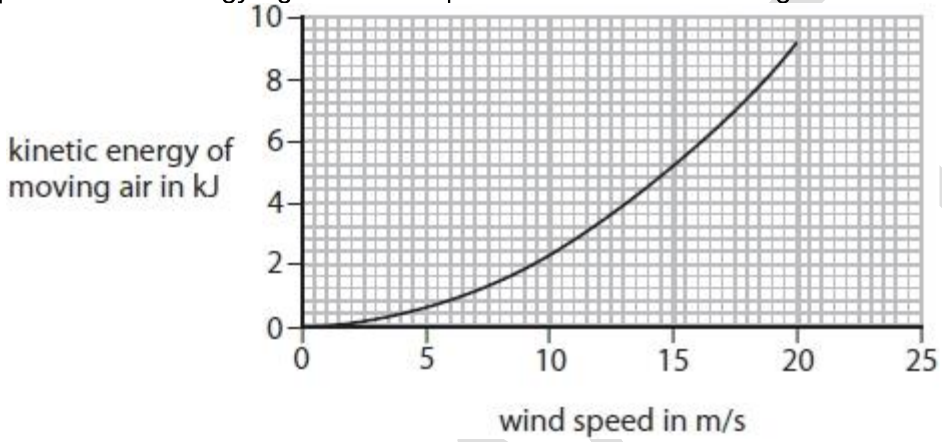

Figure 8

Just before the air reaches a wind turbine it has a wind speed of 15 m/s.
When the air has gone through the turbine it has a wind speed of 13 m/s.
As the air moves through the turbine some of its kinetic energy is transferred to the turbine.
Use the graph to determine the percentage of the kinetic energy transferred to the turbine from the air.

(3)

Q13.

Which of these is a non-renewable source of energy?

(1)

- ☐ **A** geothermal
- ☐ **B** natural gas
- ☐ **C** tidal
- ☐ **D** solar

Q14.

Explain why renewable sources provide an increasing fraction of the electricity supply for many countries.

(2)

Q15.

A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 1.

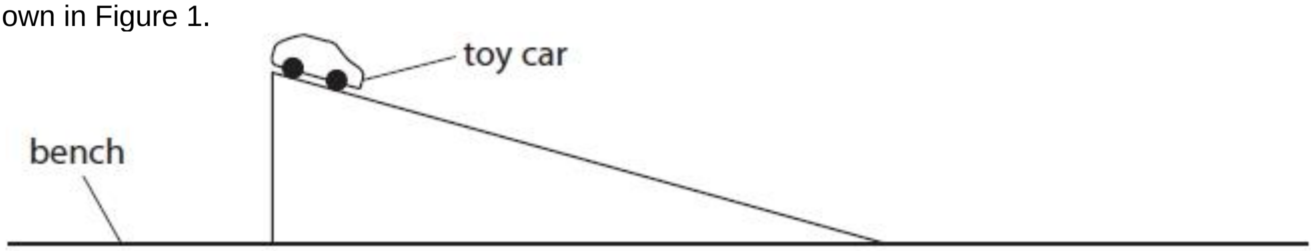

Figure 1

When the toy car rolls down the slope, some energy is transferred to the surroundings as thermal energy.
State how the student could calculate the amount of energy transferred to the surroundings.

(1)

Q16.

Figure 2 shows a way of projecting a small trolley up a sloping track.

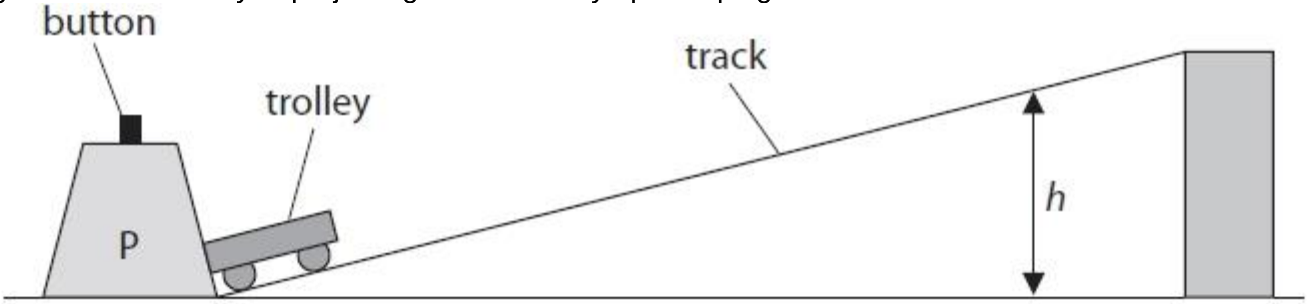

Figure 2

When the button is pressed, a spring is released in P that projects the trolley up the track.
The trolley travels up the track, stops and then rolls back down.
The spring in P always exerts the same force when projecting the trolley.
A student investigates how the mass of the trolley affects the maximum vertical height, *h*, reached by the trolley.
State the measurements the student should make to complete the investigation.
You should make use of the equipment shown in Figure 2 and any other equipment that is needed.

(4)

Q17.

A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 1.

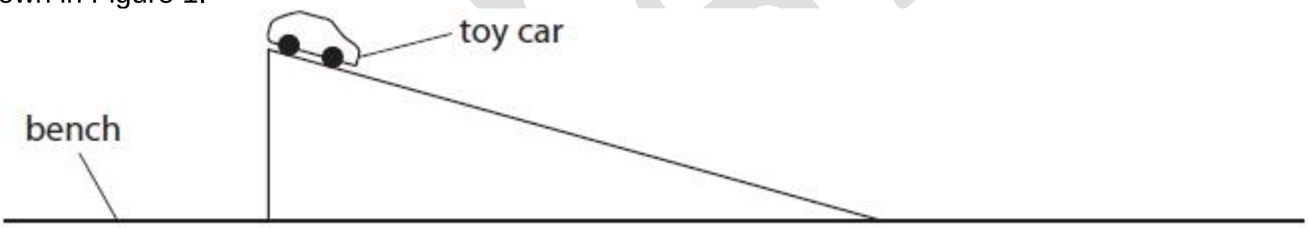

Figure 1

The student needs to develop the experiment to determine the loss in potential energy and the gain in kinetic energy as the toy car is rolling down the slope.
State the other measurements the student must make.

(2)

Q18.

Figure 2 shows a way of projecting a small trolley up a sloping track.

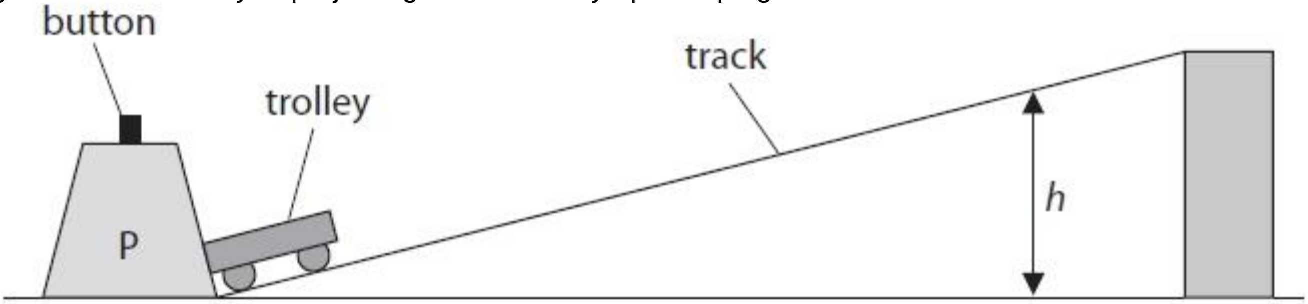

Figure 2

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The spring in P always exerts the same force when projecting the trolley.
A student investigates how the mass of the trolley affects the maximum vertical height, *h*, reached by the trolley.
Figure 3 is a graph of the student's results.

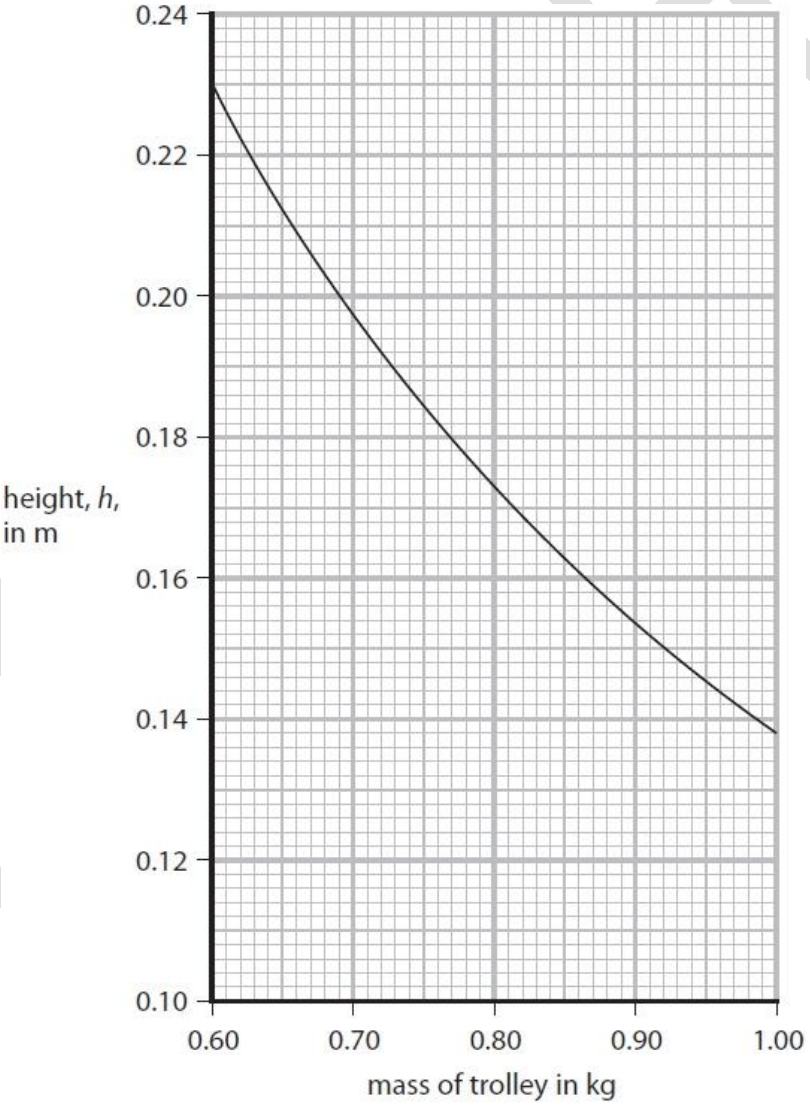

Figure 3

The student states that the energy transferred by the spring is the same each time it is used.
Use data from any two points on the graph in Figure 3 to support this statement.

(3)

Q19.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which statement describes conservation of energy in a closed system?

(1)

- ☐ **A** when there are energy transfers, the total energy reduces
- ☐ **B** when there are energy transfers, the total energy does not change
- ☐ **C** when there are no energy transfers, the total energy reduces
- ☐ **D** when there are no energy transfers, the total energy increases

(Total for question = 1 mark)