Surname: **First Name:**

Current School:

SHREWSBURY SCHOOL

SIXTH FORM ENTRANCE EXAMINATION
2023 ENTRY

PHYSICS

(1 Hour)

Instructions to candidates:

- Attempt all questions.
- Spend approximately 40 minutes on section A and 20 minutes on section B.
- Assume $g = 9.8\ m/s^2$
- You may use a scientific calculator.
- Circle your multiple-choice answers on the answer sheet provided for Section A.
- Please answer Section B on the exam paper.

Useful Equations

Word equation	Symbol equation
weight = mass × gravitational field strength (g)	$W = m\, g$
work done = force × distance (along the line of action of the force)	$W = F\, s$
force applied to a spring = spring constant × extension	$F = k\, e$
moment of a force = force × distance (normal to direction of force)	$M = F\, d$
pressure = $\frac{\text{force normal to a surface}}{\text{area of that surface}}$	$p = \frac{F}{A}$
distance travelled = speed × time	$s = v\, t$
acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$
resultant force = mass × acceleration	$F = m\, a$
momentum = mass × velocity	$p = m\, v$
kinetic energy = 0.5 × mass × (speed)^2	$E_k = \frac{1}{2} m\, v^2$
gravitational potential energy = mass × gravitational field strength (g) × height	$E_p = m\, g\, h$
power = $\frac{\text{energy transferred}}{\text{time}}$	$P = \frac{E}{t}$
power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$	
efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	
wave speed = frequency × wavelength	$v = f\, \lambda$
charge flow = current × time	$Q = I\, t$
potential difference = current × resistance	$V = I\, R$
power = potential difference × current	$P = V\, I$
power = (current)^2 × resistance	$P = I^2\, R$
energy transferred = power × time	$E = P\, t$
energy transferred = charge flow × potential difference	$E = Q\, V$
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$

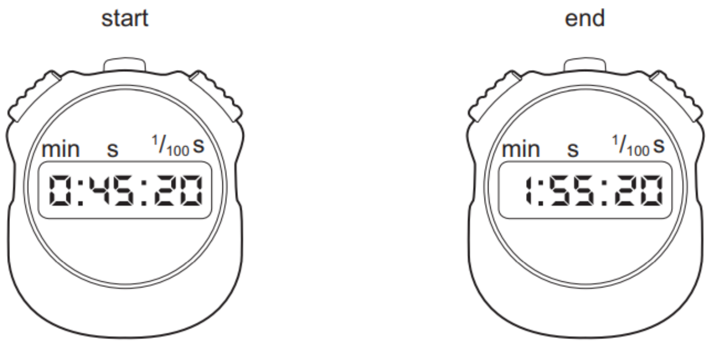
Name: ....

Circle your answers for Section A:

Q.1	A	B	C	D
Q.2	A	B	C	D
Q.3	A	B	C	D
Q.4	A	B	C	D
Q.5	A	B	C	D
Q.6	A	B	C	D
Q.7	A	B	C	D
Q.8	A	B	C	D
Q.9	A	B	C	D
Q.10	A	B	C	D
Q.11	A	B	C	D
Q.12	A	B	C	D
Q.13	A	B	C	D
Q.14	A	B	C	D
Q.15	A	B	C	D
Q.16	A	B	C	D
Q.17	A	B	C	D
Q.18	A	B	C	D
Q.19	A	B	C	D
Q.20	A	B	C	D
Q.21	A	B	C	D
Q.22	A	B	C	D
Q.23	A	B	C	D
Q.24	A	B	C	D
Q.25	A	B	C	D
Q.26	A	B	C	D
Q.27	A	B	C	D
Q.28	A	B	C	D
Q.29	A	B	C	D
Q.30	A	B	C	D

Section A - 30 marks: Attempt all questions

1 A stopwatch is used to time a runner in a race. The diagrams show the stopwatch at the start and at the end of the race.



How long did the runner take to run the race?

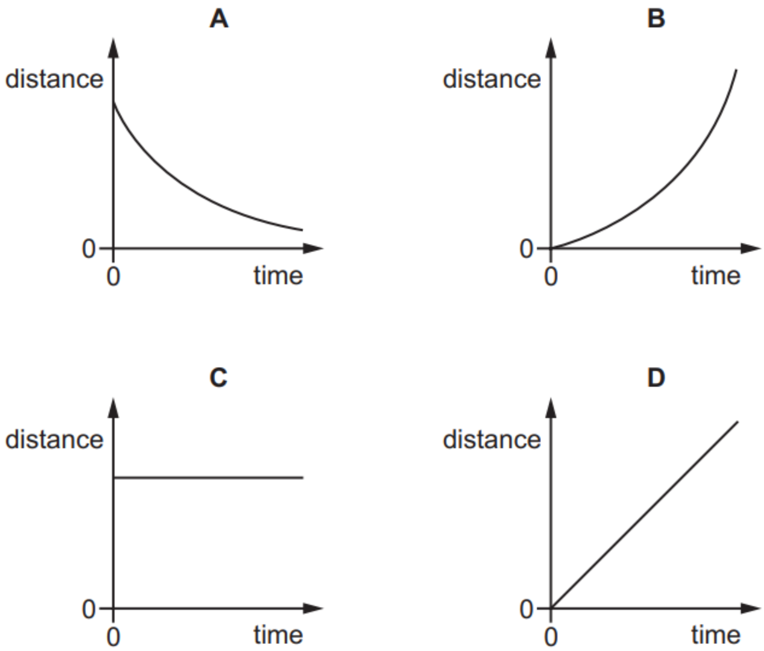
A 70.00 seconds

B 110.00 seconds

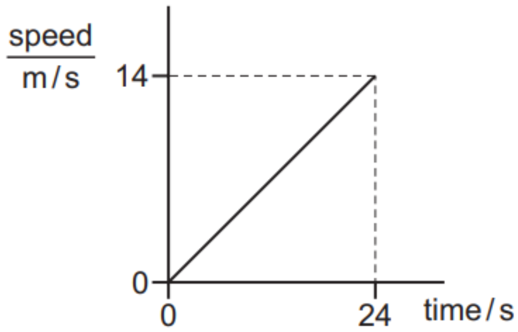
C 115.20 seconds

D 155.20 seconds

2 Which distance / time graph represents the motion of an object moving at constant speed?



3 The graph shows how the speed of a car changes with time.



Which calculation gives the distance travelled by the car in 24 seconds?

A $\left(\frac{14}{24}\right)$m

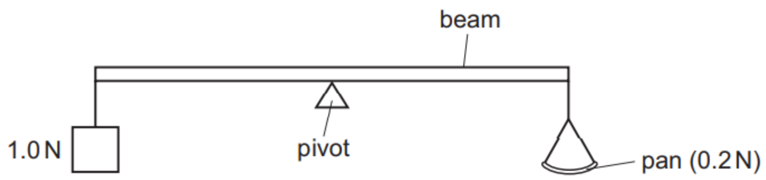
B $\left(\frac{24}{14}\right)$m

C $\left(\frac{24 \times 14}{2}\right)$m

D (24×14)m

4 The diagram shows a uniform beam being used as a balance. The beam is pivoted at its centre.

A 1.0N weight is attached to one end of the beam. An empty pan weighing 0.2N is attached to the other end of the beam.

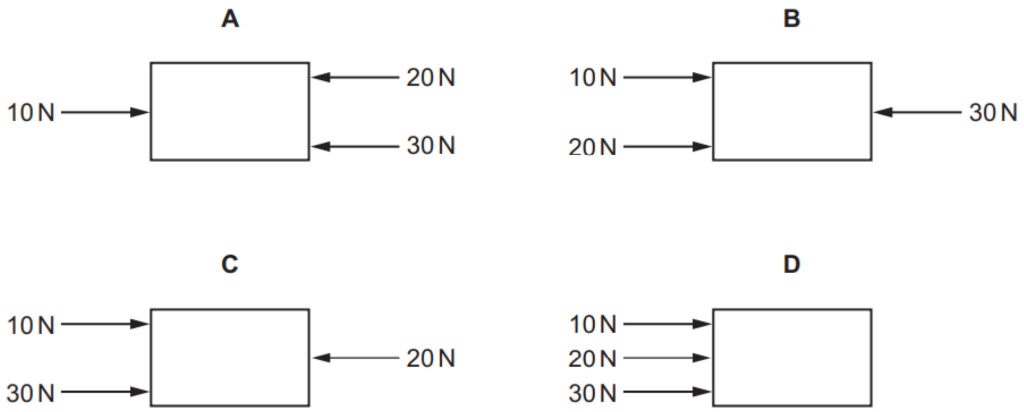


How many 0.1N weights must be placed on the pan in order to balance the beam?

A 5 **B** 8 **C** 10 **D** 12

5 The diagrams show four identical objects. Each object is acted on by only the three forces shown.

Which object accelerates to the right, with the **smallest** acceleration?



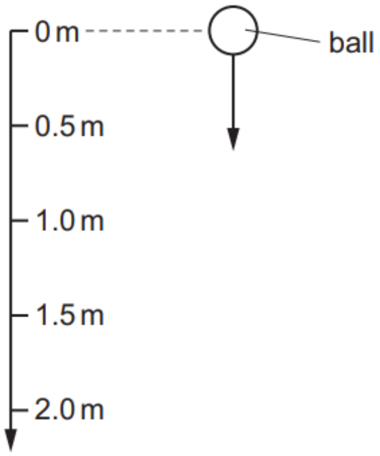
6 A train begins a journey from a station and travels 60 km in a time of 20 minutes.

What is the average speed of the train?

A 3.0 m/s **B** 5.0 m/s **C** 50 m/s **D** 60 m/s

7 On Earth, a ball is dropped and falls 2.0 m in a vacuum.

The acceleration of the ball at 1.0 m is 10 m/s^2.



What is the acceleration of the ball at 0.5 m?

A 5.0 m/s^2 **B** 10 m/s^2 **C** 15 m/s^2 **D** 20 m/s^2

8 An object has a mass of 50 kg.

The gravitational field strength on Earth is 10.0 N / kg.

The gravitational field strength on a distant planet is 4.0 N / kg.

What is the weight of the object on Earth, and what is its weight on the distant planet?

	on Earth	on the distant planet
A	5.0 kg	12.5 kg
B	5.0 N	12.5 N
C	500 kg	200 kg
D	500 N	200 N

9 Which is an example of a force?

A energy

B power

C pressure

D weight

10 Which source of energy involves the splitting of heavy atoms?

A chemical energy

B geothermal energy

C hydroelectric energy

D nuclear energy

11 A cyclist travels down a hill from rest at point X, without pedalling.

The cyclist applies his brakes and the cycle stops at point Y.

Which energy changes have taken place between X and Y?

A gravitational potential → kinetic → thermal (heat)

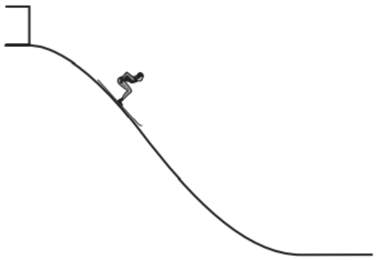
B gravitational potential → thermal (heat) → kinetic

C kinetic → gravitational potential → thermal (heat)

D kinetic → thermal (heat) → gravitational potential

12 A skier walks from the bottom of a ski slope to the top and gains 10 000 J of gravitational potential energy.

She skis down the slope. At the bottom of the slope, her kinetic energy is 2000 J.



How much energy is dissipated in overcoming friction and air resistance as the skier moves down the slope?

A 2000 J **B** 8000 J **C** 10 000 J **D** 12 000 J

13 A coal-fired power station generates electricity. Coal is burnt and the energy released is used to boil water. The steam from the water makes the generator move and this produces electricity.

Which words are used to describe the energy stored in the coal and the energy of the moving generator?

	coal	generator
A	chemical	hydroelectric
B	chemical	kinetic
C	geothermal	hydroelectric
D	geothermal	kinetic

14 Four cars are driven along a road.

The table shows the work done by the engine in each car and the time taken by each car.

Which engine produces the most power?

	work done by engine / J	time taken / s
A	50 000	20
B	50 000	40
C	100 000	20
D	100 000	40

15 Energy resources are used to generate electricity.

Which resource is renewable and does **not** release carbon dioxide when being used to produce electricity?

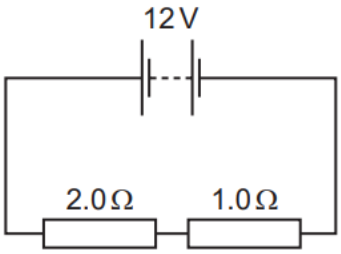
A biomass

B nuclear

C oil

D wind

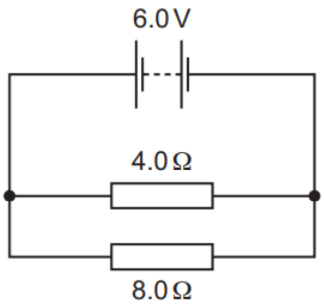
16 The circuit shows a 2.0 Ω resistor and a 1.0 Ω resistor connected to a 12 V battery.



What is the current in the 2.0 Ω resistor?

A 4.0 A **B** 6.0 A **C** 24 A **D** 36 A

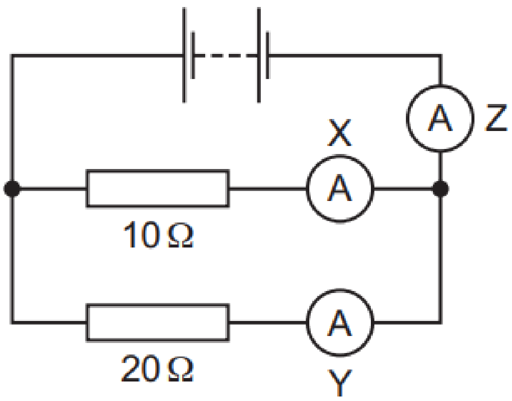
17 The circuit diagram shows a 4.0 Ω resistor and an 8.0 Ω resistor connected to a 6.0 V battery.



What is the potential difference (p.d.) across the 4.0 Ω resistor?

A 0.5 V **B** 2.0 V **C** 4.0 V **D** 6.0 V

18 The circuit shown contains three ammeters X, Y and Z.



Which ammeter has the largest reading?

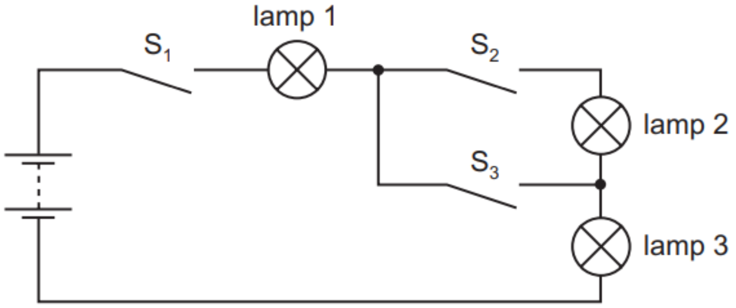
A X

B Y

C Z

D They all have the same reading.

19 The diagram shows a circuit containing three lamps and three switches S_1, S_2 and S_3.



Lamp 1 and lamp 3 are lit, but lamp 2 is not lit.

Which switch or switches is/are closed?

A S_1 only

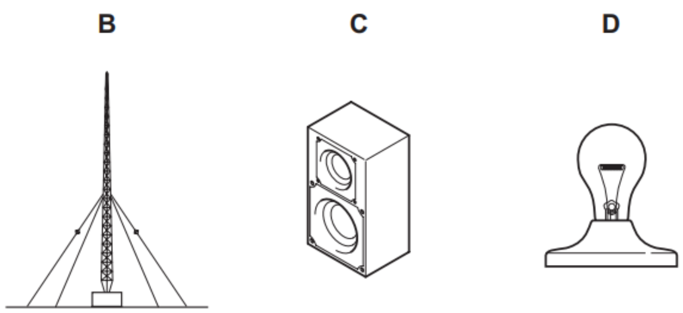
B S_1 and S_2

C S_1 and S_3

D S_2 and S_3

20 The diagrams show four sources of waves.

Which source produces longitudinal waves?



stick pushed up and down in water — radio transmitter — loudspeaker — lamp

21 The table shows different types of wave in the electromagnetic spectrum.

radio waves	micro-waves	infra-red waves	visible light	ultraviolet waves	X-rays	gamma rays

Where do all the waves travel at the same speed?

A in a vacuum

B in diamond

C in glass

D in water

22 A quiet sound is produced by a loudspeaker. The loudness of the sound is increased.

Which property of the sound wave is increased?

A amplitude

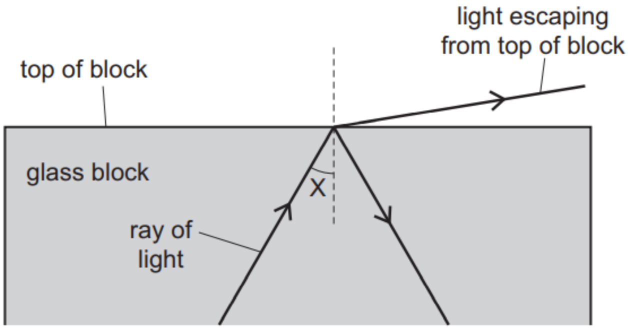
B frequency

C speed

D wavelength

23 A scientist tries to direct a ray of light in a glass block so that no light escapes from the top of the block.

However, some light does escape.

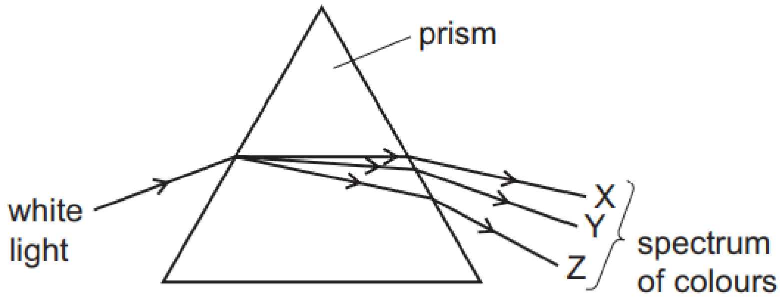


The scientist changes angle X and stops the light escaping from the top.

Which row in the table describes the change to angle X and the name of the effect produced?

	change to angle X	name of effect produced
A	decrease	total internal reflection
B	decrease	total internal refraction
C	increase	total internal reflection
D	increase	total internal refraction

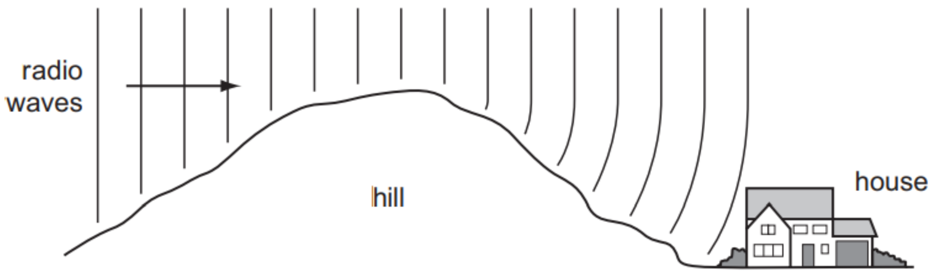
24 The diagram shows the dispersion of white light by a prism.



Which row could be correct for the colours seen at X, at Y and at Z?

	colour at X	colour at Y	colour at Z
A	red	violet	yellow
B	red	yellow	violet
C	violet	yellow	red
D	yellow	red	violet

25 Radio waves are received at a house at the bottom of a hill.



The waves reach the house because the hill has caused them to be

A diffracted.

B radiated.

C reflected.

D refracted.

26 A sample of radioactive isotope is decaying.

The nuclei of which atoms will decay first?

A It is impossible to know because radioactive decay is random.

B It is impossible to know unless the age of the material is known.

C The atoms near the centre will decay first because they are surrounded by more atoms.

D The atoms near the surface will decay first because the radiation can escape more easily.

27 Which statement about α-radiation is correct?

A It is a stream of fast-moving electrons.

B It is a form of electromagnetic radiation.

C It is more highly ionising than γ-radiation.

D It is more penetrating than β-radiation.

28 A radioactive source produces a count rate on a detector of 1600 counts / s.

After 32 hours the count rate has fallen to 100 counts / s.

Both count rates have been corrected for background radiation.

What is the half-life of the source?

A 2.0 hours **B** 6.4 hours **C** 8.0 hours **D** 16 hours

29 A nuclide has the symbol $^{22}_{10}Ne$.

What is the proton number of a nucleus of this nuclide?

A 10 **B** 12 **C** 22 **D** 32

30 A radioactive nucleus emits either an α-particle or a β-particle.

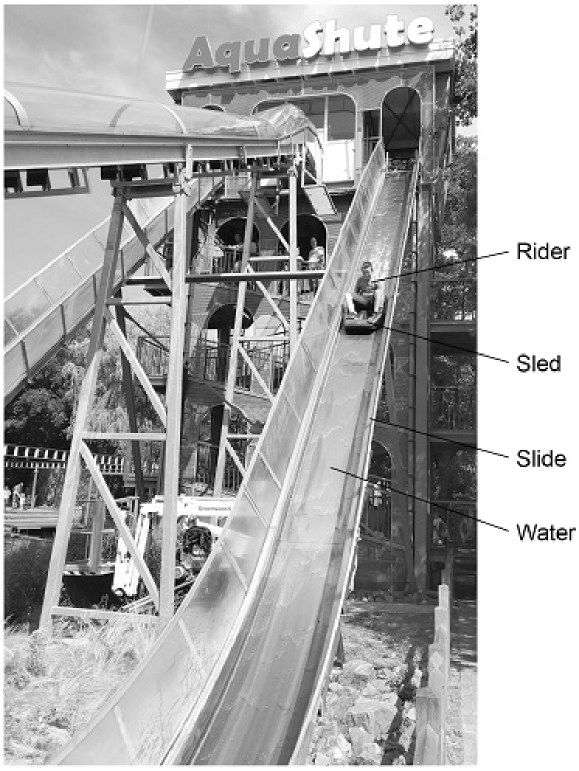
What are the products of these two types of radioactive emission?

	product after α-emission	product after β-emission
A	a nucleus of a different element	a nucleus of a different element
B	a nucleus of a different element	a nucleus of the same element
C	a nucleus of the same element	a nucleus of a different element
D	a nucleus of the same element	a nucleus of the same element

Section B – 20 marks: Attempt all questions

Q1. The photograph below shows a theme park ride called AquaShute.

Riders of the AquaShute sit on a sled and move down a slide.



(a) A light gate and data logger can be used to determine the speed of each rider and sled.

What two measurements are needed to determine the speed of a rider and sled?

Tick (✓) **two** boxes.

Gravitational field strength	☐
Length of sled	☐
Mass of rider and sled	☐
Temperature of surroundings	☐
Time for sled to pass light gate	☐

(2)

(b) The decrease in gravitational potential energy of one rider on the slide was 8.33 kJ.

The rider moved through a vertical height of 17.0 m.

gravitational field strength = 9.8 N/kg

Calculate the mass of the rider.

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____

____

____

Mass of rider = ________________ kg

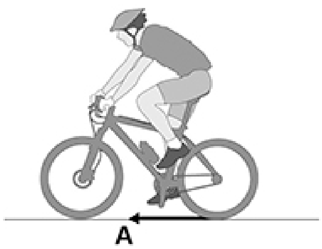
(4)

(Total 6 marks)

Q2. Figure 1 shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 1



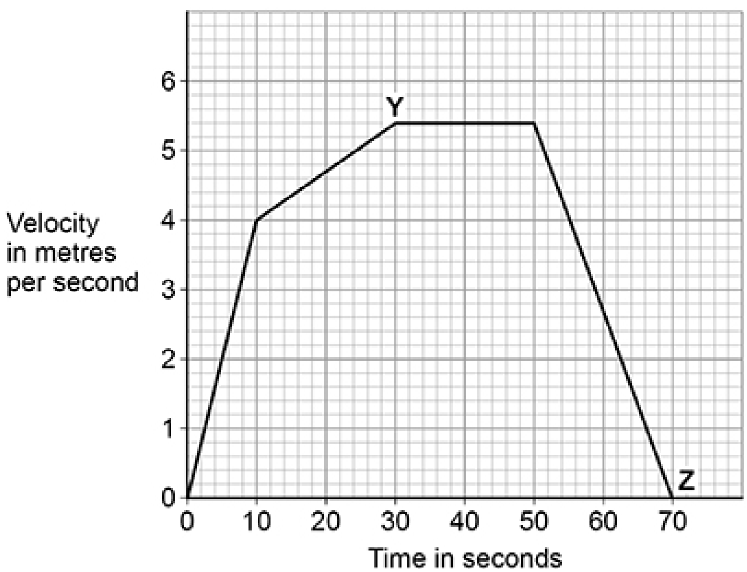
(a) What name is given to force **A**?

____

(1)

Figure 2 shows how the velocity of the cyclist changes during a short journey.

Figure 2



(b) Determine the distance travelled by the cyclist between **Y** and **Z**.

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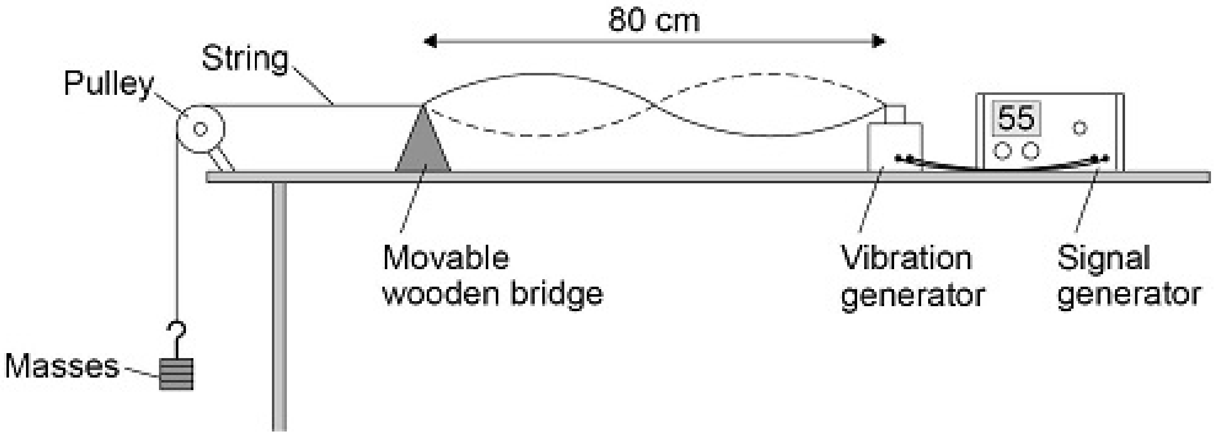
Distance travelled by the cyclist between **Y** and **Z** = _____________ m

(3)

(Total 4 marks)

Q3. The following figure shows the apparatus used to investigate the waves in a stretched string.



The frequency of the signal generator is adjusted so that the wave shown in the figure is seen.

At this frequency the string vibrates between the two positions shown in the figure.

(a) The wavelength of the wave shown in the figure above was measured as 80 cm

What piece of apparatus would have been suitable for measuring this wavelength?

____

(1)

(b) The string in the figure above vibrates at 55 Hz

Calculate the wave speed of the wave shown in the figure.

Use data given in the figure and the equation given on the equation sheet.

____

____

____

Wave speed = __________________________ m/s

(3)

(c) The frequency of the signal generator is increased.

This makes the wavelength of the wave change.

The wave speed stays the same.

Describe how the apparatus could be adjusted to show one complete wave without reducing the frequency.

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(2)

(d) A student wants to investigate how the speed of a wave on a stretched string depends on the tension in the string.

The student uses the apparatus in the figure above.

Describe a method the student could use for this investigation.

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(4)
(Total 10 marks)

End of Questions