AS SPECIMEN PAPER 2

Section A

Answer **all** questions in this section.

0 1 A student has a diffraction grating that is marked 3.5×10^3 lines per m.

0 1 . 1 Calculate the percentage uncertainty in the number of lines per metre suggested by this marking.

[1 mark]

percentage uncertainty = _____ %

0 1 . 2 Determine the grating spacing.

[2 marks]

grating spacing = _____ mm

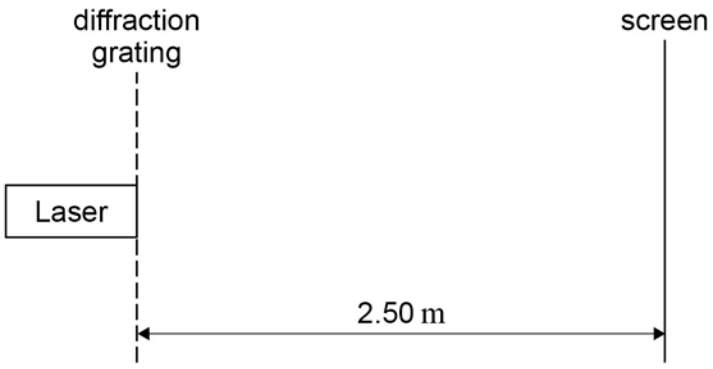
0 1 . 3 State the absolute uncertainty in the value of the spacing.

[1 mark]

absolute uncertainty = _____ mm

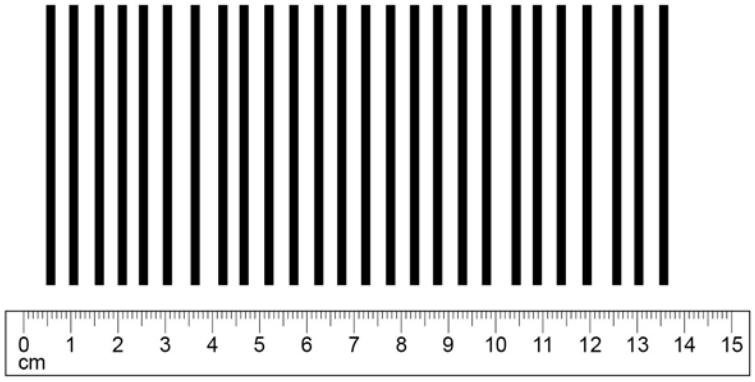
0 1 . 4 The student sets up the apparatus shown in **Figure 1** in an experiment to confirm the value marked on the diffraction grating.

Figure 1



The laser has a wavelength of 628 nm. **Figure 2** shows part of the interference pattern that appears on the screen. A ruler gives the scale.

Figure 2



Use **Figure 2** to determine the spacing between two adjacent maxima in the interference pattern. Show all your working clearly.

[1 mark]

spacing = _____ mm

0 1 . 5 Calculate the number of lines per metre on the grating.

[2 marks]

number of lines = _____

0 1 . 6 State and explain whether the value for the number of lines per m obtained in part 1.5 is in agreement with the value stated on the grating.

[2 marks]

_____

_____

_____

0 1 . 7 State **one** safety precaution that you would take if you were to carry out the experiment that was performed by the student.

[1 mark]

_____

_____

_____

Section B

Answer **all** questions in this section.

These questions are about ultrasound

Read the passage and then answer questions 3.1 – 3.6

The term **ultrasound** refers to vibrations in a material that occur at frequencies too high to be detected by a human ear. When ultrasound waves move through a solid, both longitudinal and transverse vibrations may be involved. For the longitudinal vibrations in a solid, the speed c of the ultrasound wave is given by

$$c = \sqrt{\frac{E}{\rho}}$$

where E is the Young modulus of the material and ρ is the density. Values for c and ρ are given in **Table 1**.

Table 1

Substance	c / m s^{-1}	ρ / kg m^{-3}
glass	5100	2500
sea water	1400	1000

Ultrasound waves, like electromagnetic radiation, can travel through the surface between two materials. When all the energy is transmitted from one material to the other, the materials are said to be **acoustically matched**. This happens when ρc is the same for both materials.

0 3 . 1 Calculate the magnitude of the Young modulus for glass.

[1 mark]

Young modulus = _____

0 3 . 2 State your answer to 3.1 in terms of SI fundamental units.

[1 mark]

0 3 . 3 The passage states that 'when ultrasound waves move through a solid both longitudinal and transverse vibrations may be involved'.

State the difference between longitudinal and transverse waves.

[2 marks]

_____

_____

_____

_____

0 3 . 4 Show that when two materials are acoustically matched, the ratio of their Young moduli is equal to the ratio of their speeds of the ultrasound waves.

[2 marks]

0 3 . 5 The wave speed in a material X is twice that in material Y. X and Y are acoustically matched.

Determine the ratio of the densities of X and Y.

[1 mark]

X = _____ Y = _____

0 3 . 6 Ultrasound waves obey the same laws of reflection and refraction as electromagnetic waves.

Using data from **Table 1**, discuss the conditions for which total internal reflection can occur when ultrasound waves travel between glass and sea water.

[3 marks]

1 4 A diffraction pattern is formed by passing monochromatic light through a single slit. If the width of the single slit is reduced, which of the following is true?

[1 mark]

	Width of central maximum	Intensity of central maximum	
A	unchanged	decreases	⬭
B	increases	increases	⬭
C	increases	decreases	⬭
D	decreases	decreases	⬭

1 5 A light source emits light which is a mixture of two wavelength, λ_1 and λ_2. When the light is incident on a diffraction grating it is found that the fifth order of light of wavelength λ_1 occurs at the same angle as the fourth order for light of wavelength λ_2. If λ_1 is 480 nm what is λ_2?

[1 mark]

A 400 nm ⬭

B 480 nm ⬭

C 600 nm ⬭

D 750 nm ⬭

1 6 Which of the following is correct for a stationary wave?

[1 mark]

A Between two nodes the amplitude of the wave is constant. ⬭

B The two waves producing the stationary wave must always be 180° out of phase. ⬭

C The separation of the nodes for the second harmonic is double the separation of nodes for the first harmonic. ⬭

D Between two nodes all parts of the wave vibrate in phase. ⬭

1 7 Sound waves cross a boundary between two media X and Y. The frequency of the waves in X is 400 Hz. The speed of the waves in X is 330 $\mathrm{m\,s^{-1}}$ and the speed of the waves in Y is 1320 $\mathrm{m\,s^{-1}}$. What are the correct frequency and wavelength in Y?

[1 mark]

	Frequency / Hz	**Wavelength / m**	
A	100	0.82	⬭
B	400	0.82	⬭
C	400	3.3	⬭
D	1600	3.3	⬭

1 8 Which of the following is a scalar quantity?

[1 mark]

A velocity ⬭

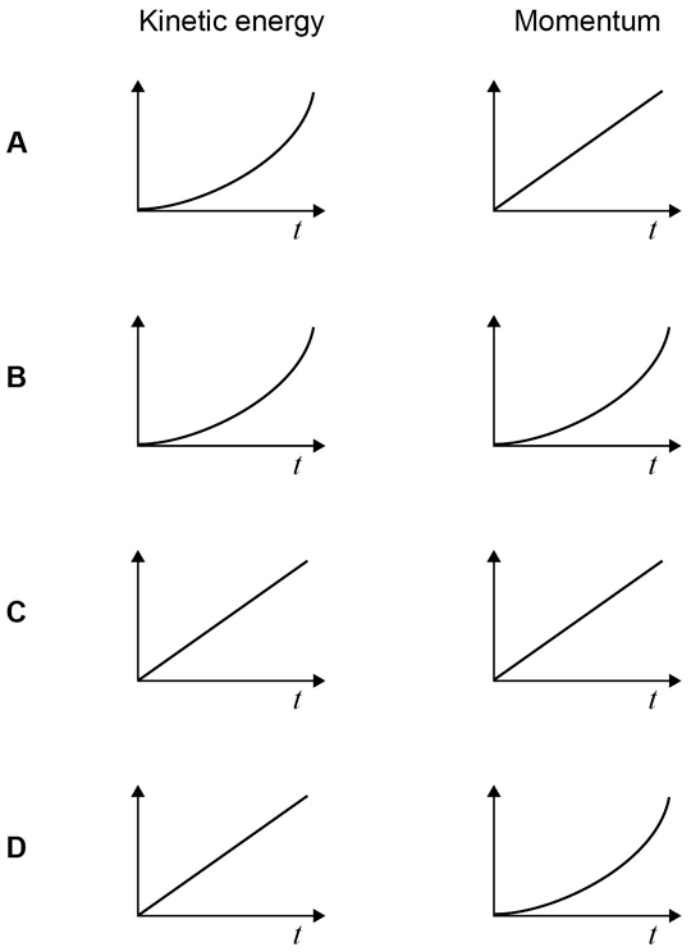
B kinetic energy ⬭

C force ⬭

D momentum ⬭

1 9 A object is accelerated from rest by a constant force F for a time t. Which graphs represent the variation of time with the change in the kinetic energy and the change in momentum of the object?

[1 mark]



A ⬭
B ⬭
C ⬭
D ⬭

2 0 An object is dropped from a cliff. How far does the object fall in the third second? Assume that $g = 10\ \text{m s}^{-2}$.

[1 mark]

A 10 m ⬭
B 20 m ⬭
C 25 m ⬭
D 45 m ⬭

2 1 A body falls freely, with negligible air resistance. What quantity of the body is its rate of change of momentum?

[1 mark]

A mass ⬭

B power ⬭

C kinetic energy ⬭

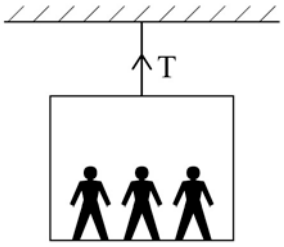
D weight ⬭

2 2 A firework rocket is fired vertically into the air and explodes at its highest point. What are the changes to the total kinetic energy of the rocket and the total momentum of the rocket as a result of the explosion?

[1 mark]

	total kinetic energy of rocket	**total momentum of rocket**	
A	unchanged	unchanged	⬭
B	unchanged	increased	⬭
C	increased	unchanged	⬭
D	increased	increased	⬭

2 3 A lift and its passengers with a total mass of 500 kg accelerates upwards at 2 m s^{-2} as shown. Assume that g = 10 m s^{-2}.



What is the tension in the cable?

[1 mark]

A 1000 N ⬭

B 4000 N ⬭

C 5000 N ⬭

D 6000 N ⬭

2 4 Which of the following is **not** a unit of power?

[1 mark]

A $\mathrm{N\ m\ s^{-1}}$ ⬭

B $\mathrm{kg\ m^{2}\ s^{-3}}$ ⬭

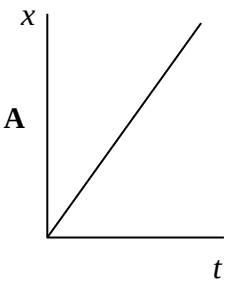
C $\mathrm{J\ s^{-1}}$ ⬭

D $\mathrm{kg\ m^{-1}\ s^{-1}}$ ⬭

2 5 A car accelerates uniformly from rest along a straight road. Which graph shows the variation of displacement x of the car with time t?

[1 mark]

A



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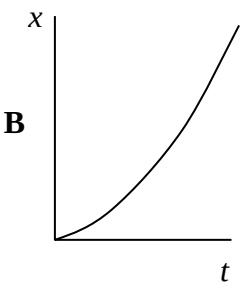

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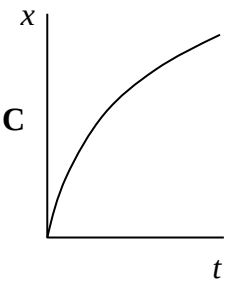

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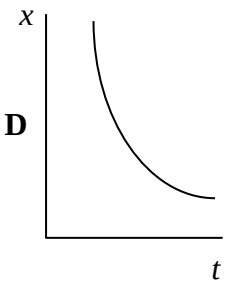


A ⬭

B ⬭

C ⬭

D ⬭

Turn over for the next question

2 6 Which of the following statements is correct?

The force acting on an object is equivalent to

[1 mark]

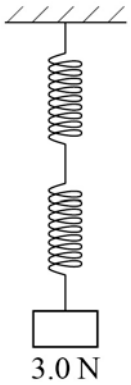
A its change of momentum. ⬭

B the impulse it receives per second. ⬭

C the energy it gains per second. ⬭

D its acceleration per metre. ⬭

2 7 A load of 3.0 N is attached to a spring of negligible mass and spring constant 15 $\mathrm{N\ m^{-1}}$.



What is the energy stored in the spring?

[1 mark]

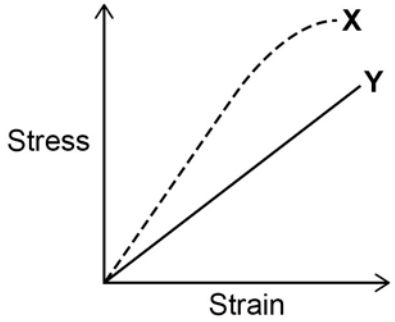
A 0.3 J ⬭

B 0.6 J ⬭

C 0.9 J ⬭

D 1.2 J ⬭

2 8 The diagram shows how the stress varies with strain for metal specimens X and Y which are different. Both specimens were stretched until they broke.



Which of the following is incorrect?

[1 mark]

A X is stiffer than Y ⬭

B X has a higher value of the Young modulus ⬭

C X is more brittle than Y ⬭

D Y has a lower maximum tensile stress than X ⬭

2 9 Three identical cells, each of internal resistance R, are connected in series with an external resistor of resistance R. The current in the external resistor is I. If one of the cells is reversed in the circuit, what is the new current in the external resistor?

[1 mark]

A $\frac{I}{3}$ ⬭

B $\frac{4I}{9}$ ⬭

C $\frac{I}{2}$ ⬭

D $\frac{2I}{3}$ ⬭

Turn over for the next question