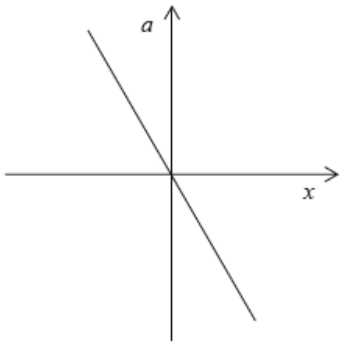
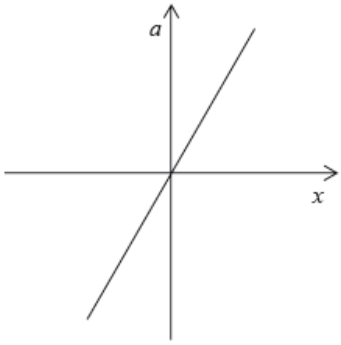
Topic 4 Review Packet A *[45 marks]*

1. Which graph correctly shows how the acceleration, a of a particle undergoing SHM varies with its displacement, x from its equilibrium position? *[1 mark]*

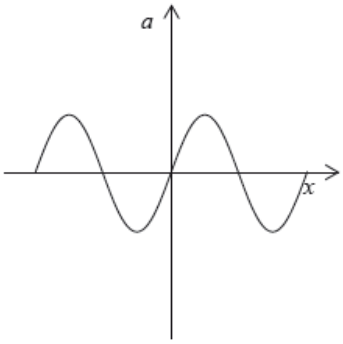
A.



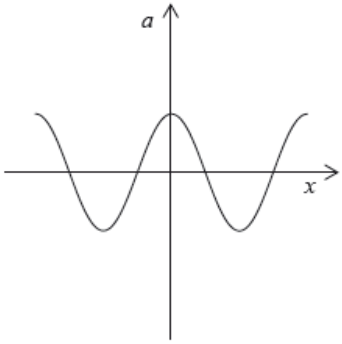
B.



C.



D.



Markscheme

A

2. In which of the following regions of the electromagnetic spectrum is radiation of wavelength 600 nm located? *[1 mark]*

A. microwaves

B. radio waves

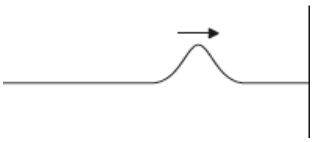
C. visible light

D. X-rays

Markscheme

C

3. One end of a horizontal string is fixed to a wall. A transverse pulse moves *[1 mark]* along the string as shown.



Which of the following statements are correct for the reflected pulse compared to the forward pulse?

I. It moves more slowly.

II. It has less energy.

III. It is inverted.

A. I and II only

B. I and III only

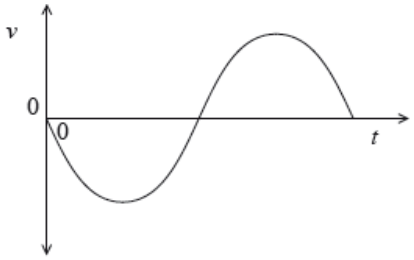
C. II and III only

D. I, II and III

Markscheme

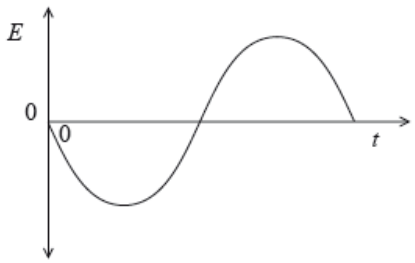
C

4. The graph shows how the velocity v of an object undergoing simple harmonic motion varies with time t for one complete period of oscillation. *[1 mark]*

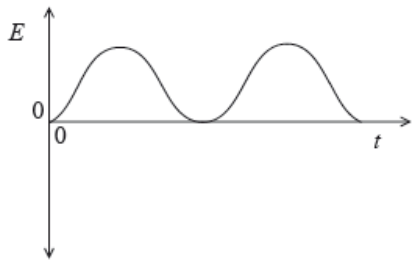


Which of the following sketch graphs best shows how the total energy E of the object varies with t?

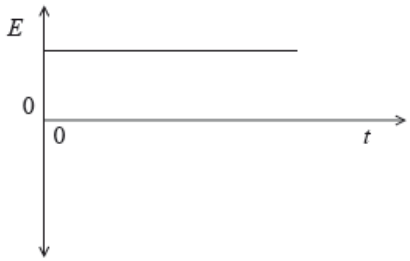
A.



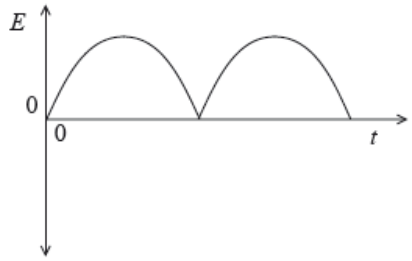
B.



C.



D.



Markscheme

C

5. Which of the following is a value of wavelength that is found in the visible region of the electromagnetic spectrum? *[1 mark]*

A. $4 \times 10^{-5}\ \text{m}$

B. $4 \times 10^{-7}\ \text{m}$

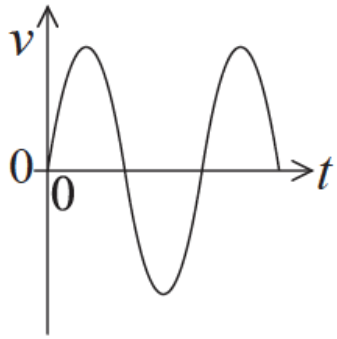
C. $4 \times 10^{-9}\ \text{m}$

D. $4 \times 10^{-11}\ \text{m}$

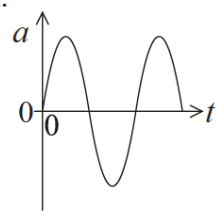
Markscheme

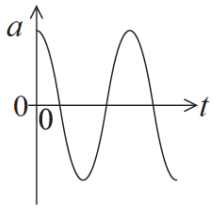
B

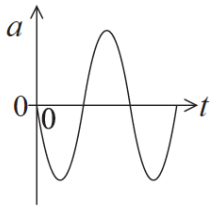
6. The diagram shows the variation of velocity v with time t for an object performing simple harmonic motion. *[1 mark]*

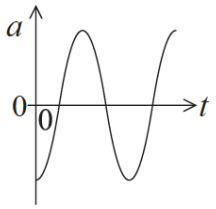


Which of the following shows how the acceleration a varies with t?

A.


B.


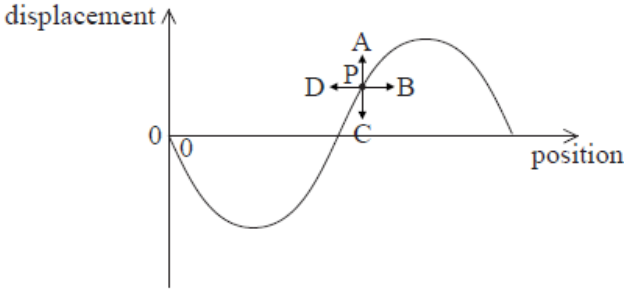
C.


D.


Markscheme

B

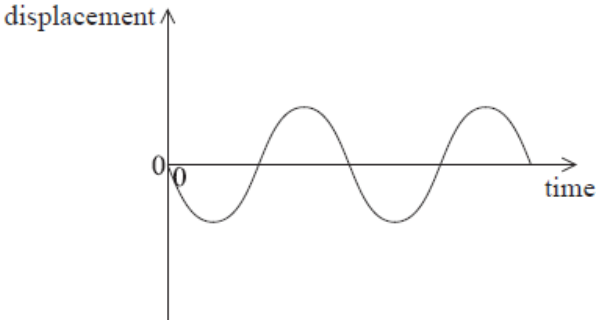
7. A transverse wave travels from left to right. The diagram below shows how, at a particular instant of time, the displacement of particles in the medium varies with position. Which arrow represents the direction of the velocity of the particle marked P? *[1 mark]*



Markscheme

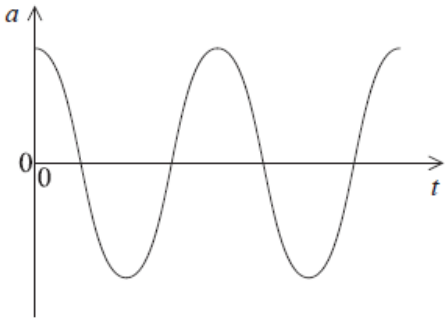
C

8. The graph shows how the displacement varies with time for an object undergoing simple harmonic motion. *[1 mark]*

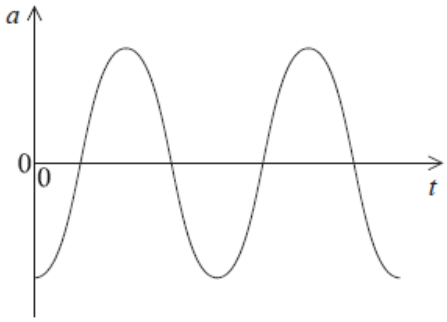


Which graph shows how the object's acceleration *a* varies with time *t*?

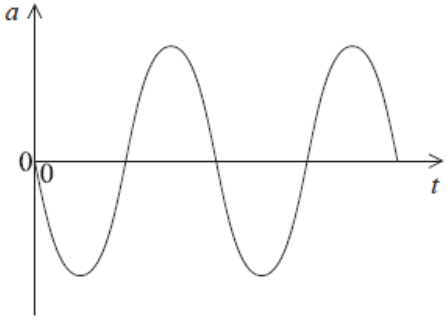
A.



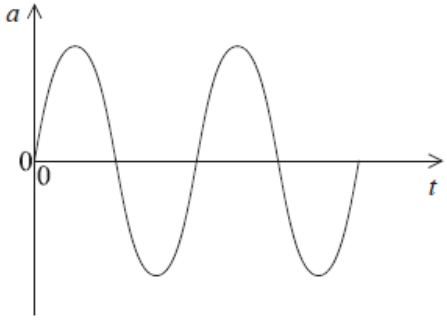
B.



C.



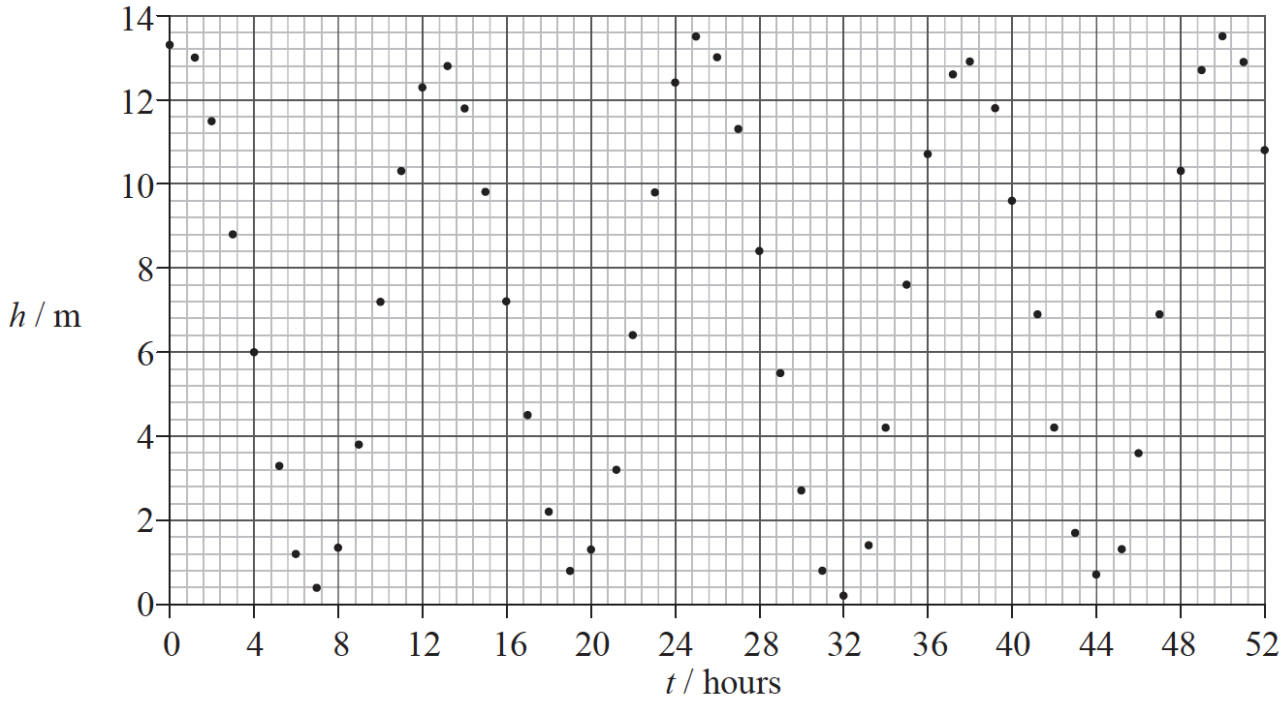
D.



Markscheme

D

9. The graph shows measurements of the height h of sea level at different times t in the Bay of Fundy. *[1 mark]*



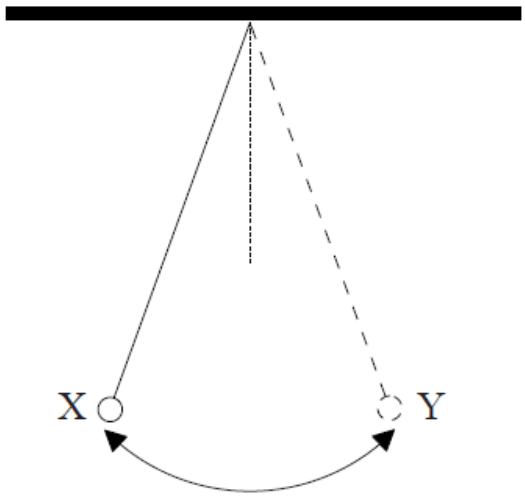
Which of the following gives the approximate amplitude and period of the tides?

	Amplitude	Period
A.	6.5 m	6 hours
B.	13 m	12 hours
C.	6.5 m	12 hours
D.	13 m	6 hours

Markscheme

C

10. A pendulum swings back and forth in a circular arc between X and Y. *[1 mark]*



The pendulum bob is

A. always in equilibrium.
B. only in equilibrium at X and Y.
C. in equilibrium as it passes through the central position.
D. never in equilibrium.

Markscheme

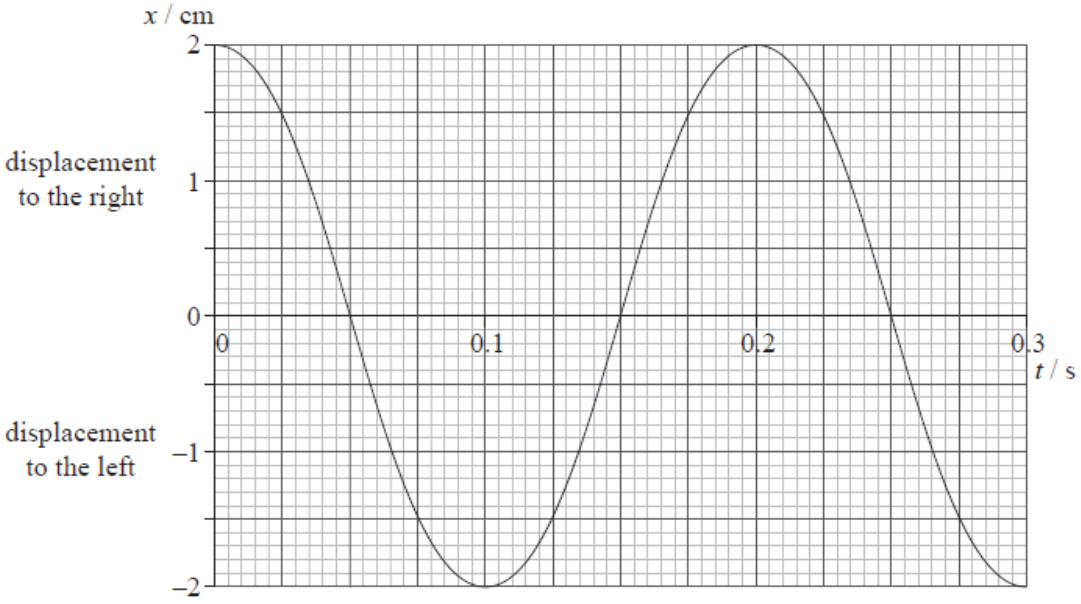
D

Part 2 Simple harmonic oscillations

A longitudinal wave travels through a medium from left to right.

Graph 1 shows the variation with time t of the displacement x of a particle P in the medium.

Graph 1



11a. For particle P, *[6 marks]*

(i) state how graph 1 shows that its oscillations are not damped.

(ii) calculate the magnitude of its maximum acceleration.

(iii) calculate its speed at t=0.12 s.

(iv) state its direction of motion at t=0.12 s.

Markscheme

(i) the amplitude is constant;

(ii) period is 0.20s;

$a_{\max} = \left(\left[\frac{2\pi}{T} \right]^2 x_0 = 31.4^2 \times 2.0 \times 10^{-2} \right) = 19.7 \approx 20 \text{ms}^{-2}$

*Award **[2]** for correct bald answer and ignore any negative signs in answer.*

(iii) displacement at t = 0.12cm is (−)1.62cm;

$v \left(= \frac{2\pi}{T} \sqrt{x_0 - x^2} \right) = 31.4 \sqrt{\left(2.0 \times 10^{-2}\right)^2 - \left(1.62 \times 10^{-2}\right)^2} = 0.37 \text{ms}^{-1}$;

Accept displacement in range 1.60 to 1.70 cm for an answer in range 0.33ms^{-1} to 0.38ms^{-1}.

or

$v_0 = \frac{2\pi}{T} x_0 = 0.628 \text{ms}^{-1}$;

$|v| = \left(\left| -v_0 \sin \left[\frac{2\pi}{T} t \right] \right| \Rightarrow |v| = |-0.628 \sin [31.4 \times 0.12]| = |0.37| \right) = 0.37 \text{ms}^{-1}$

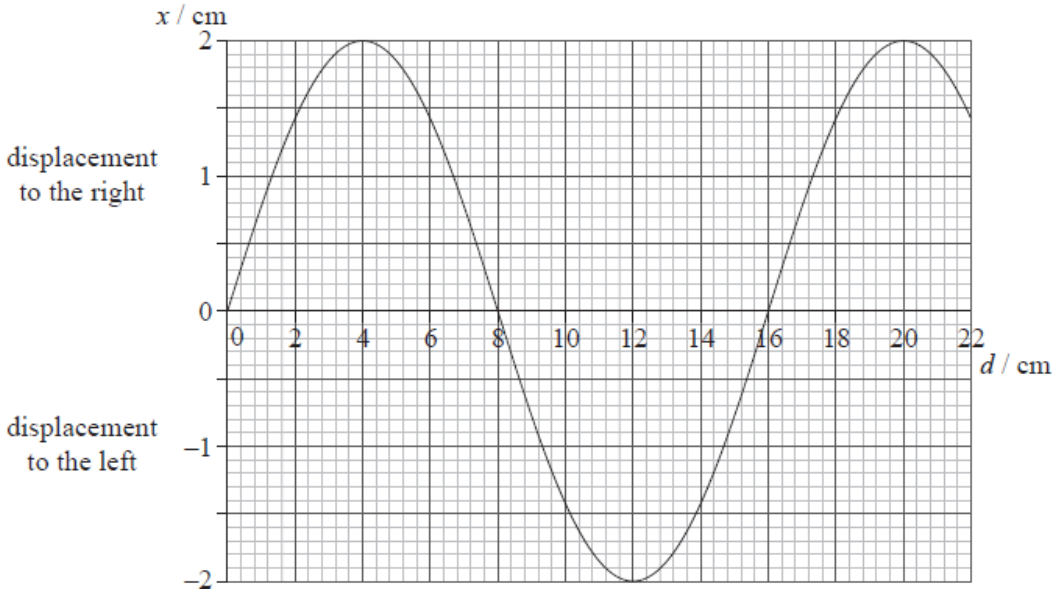
;

or

drawing a tangent at 0.12s;
measurement of slope of tangent;
Accept answer in range 0.33ms^{-1} to 0.38ms^{-1} .

11b. Graph 2 shows the variation with position *d* of the displacement *x* of particles in the medium at a particular instant of time. *[4 marks]*

Graph 2



Determine for the longitudinal wave, using graph 1 and graph 2,

(i) the frequency.

(ii) the speed.

Markscheme

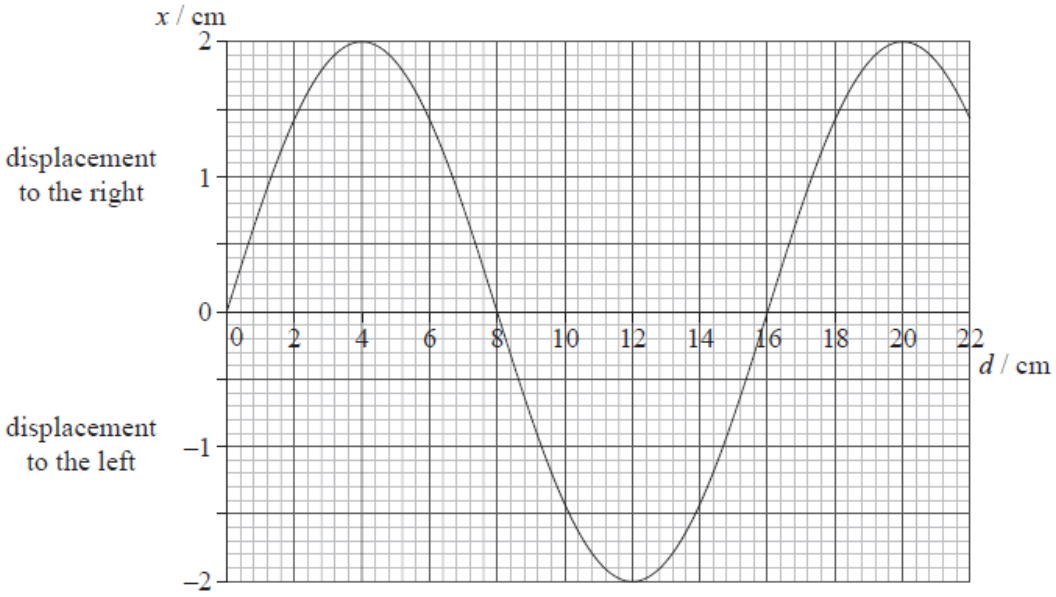
(i) use of $f = \frac{1}{T}$;

and so $f\left(= \frac{1}{0.20}\right) = 5.0\text{Hz}$;

(ii) wavelength is 16cm;

and so speed is $v(=f\lambda=5.0\times0.16)=0.80\text{ms}^{-1}$;

11c. **Graph 2** – reproduced to assist with answering (c)(i). *[4 marks]*



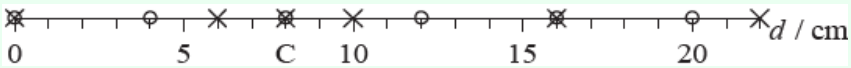
(c) The diagram shows the equilibrium positions of six particles in the medium.

(i) On the diagram above, draw crosses to indicate the positions of these six particles at the instant of time when the displacement is given by graph 2.

(ii) On the diagram above, label with the letter C a particle that is at the centre of a compression.

Markscheme

(i) points at 0, 8 and 16 cm stay in the same place;
points at 4 and 20 cm move 2 cm to the right;
point at 12 cm moves 2 cm to the left;



(ii) the point at 8 cm;

This question is in **two** parts. **Part 1** is about simple harmonic motion (SHM) and a wave in a string. **Part 2** is about the unified atomic mass unit and a nuclear reaction.

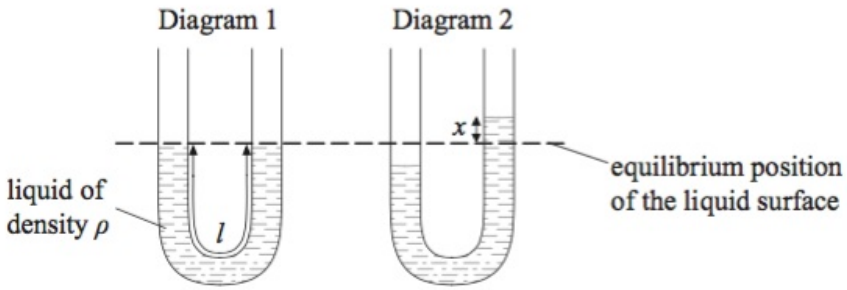
Part 1 Simple harmonic motion and a wave in a string

12a. By reference to simple harmonic motion, state what is meant by amplitude. *[1 mark]*

Markscheme

the maximum displacement of the system from equilibrium/from centre of motion / OWTTE;

12b. A liquid is contained in a U-tube. *[5 marks]*



The pressure on the liquid in one side of the tube is increased so that the liquid is displaced as shown in diagram 2. When the pressure is suddenly released the liquid oscillates. The damping of the oscillations is small.

(i) Describe what is meant by damping.

(ii) The displacement of the liquid surface from its equilibrium position is *x*. The acceleration *a* of the liquid in the tube is given by the expression

$$a = -\frac{2g}{l}x$$

where *g* is the acceleration of free fall and *l* is the total length of the liquid column. The total length of the liquid column in the tube is 0.32m. Determine the period of oscillation.

Markscheme

(i) the amplitude of the oscillations/(total) energy decreases (with time);
because a force always opposes direction of motion/there is a resistive force/ there is a friction force;
Do not allow bald "friction".

(ii) $\omega = \sqrt{\frac{2g}{l}}$;

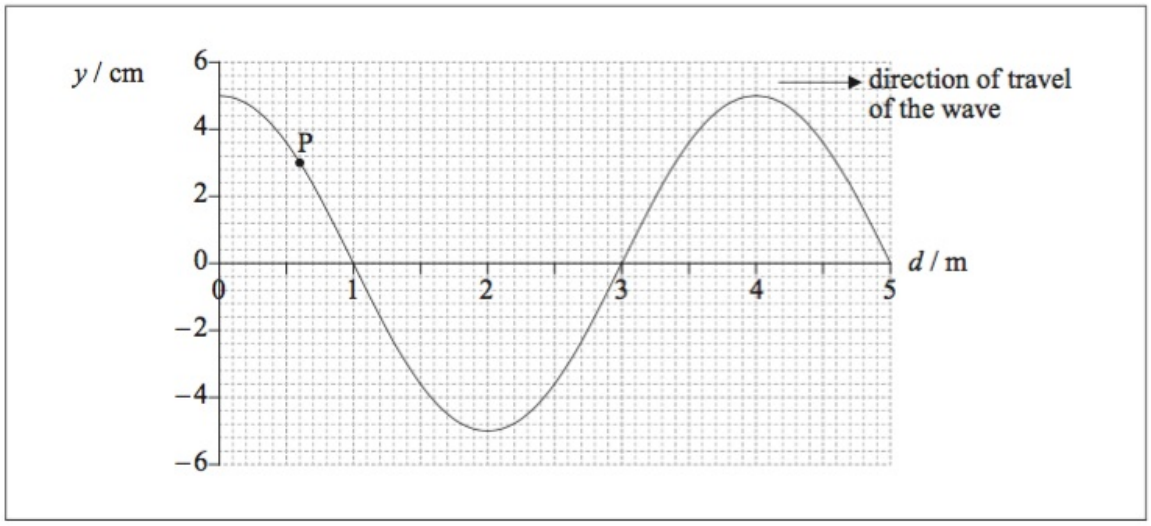
$T = 2\pi\sqrt{\frac{0.32}{2\times 9.81}}$;

=0.80s;

12c. A wave is travelling along a string. The string can be modelled as a *[9 marks]*

single line of particles and each particle executes simple harmonic motion. The period of oscillation of the particles is 0.80s.

The graph shows the displacement *y* of part of the string at time *t*=0. The distance along the string is *d*.



(i) On the graph, draw an arrow to show the direction of motion of particle P at the point marked on the string.

(ii) Determine the magnitude of the velocity of particle P.

(iii) Show that the speed of the wave is 5.0 ms^{-1}.

(iv) On the graph opposite, label with the letter X the position of particle P at *t*=0.40 s.

Markscheme

(i) upwards;

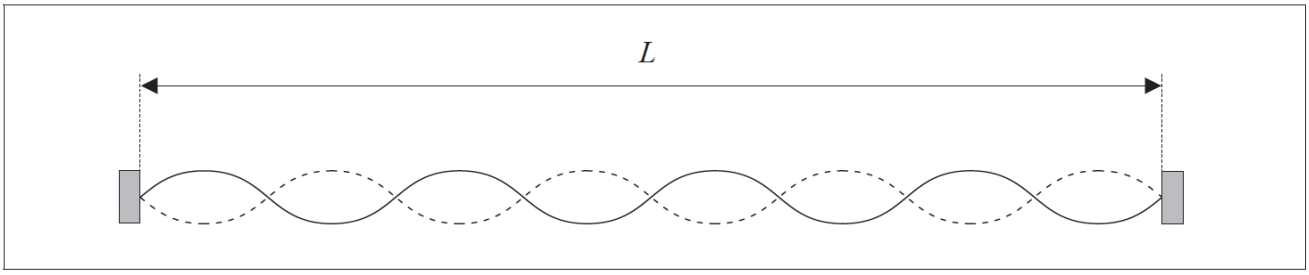
(ii) y_0 = 0.050(m) and y = 0.030(m);
$\omega = \left(\frac{2\pi}{0.80} =\right) 7.85 \left(\text{rads}^{-1}\right)$;
$v = 7.85\sqrt{[0.05]^2 - [0.03]^2}$;
=0.31ms^{-1} ; (*allow working in cm to give 31 cms^{-1}*);

(iii) λ=4.0m;
recognition that $f = \frac{1}{0.80}(= 1.25)$;
($f\lambda$=)v=1.25×4.0;
(=5.0 ms^{-1})

(iv) y=-3.0 cm, d=0.6 m;

This question is about standing (stationary) waves.

The diagram represents a standing wave of wavelength λ set up on a string of length L.



The string is fixed at both ends.

13a. For this standing wave *[3 marks]*

(i) state the relationship between λ and L.

(ii) label, on the diagram, **two** antinodes where the string is vibrating in phase. Label the antinodes with the letter A.

Markscheme

(i) L=4λ or $\lambda = \frac{L}{4}$;

(ii) two antinodes labelled;
with separation of integral number of wavelengths;

13b. The standing wave has wavelength λ and frequency f. State and explain, with respect to a standing wave, what is represented by the product $f\lambda$. *[3 marks]*

Markscheme

$f\lambda$ is the speed of the wave;
standing wave formed by interference of an incident and a reflected progressive wave;
speed is the speed of this progressive wave;