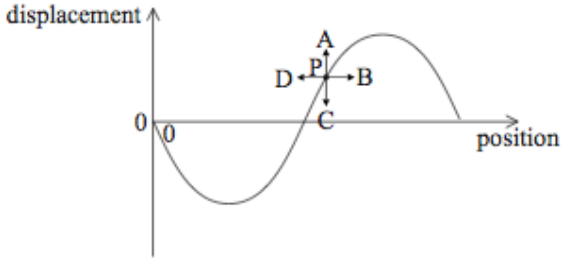
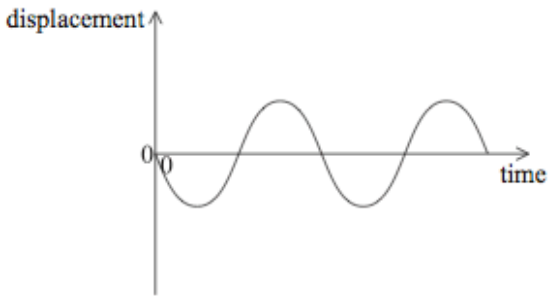
TOPIC 4 MAY 11

13. 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?

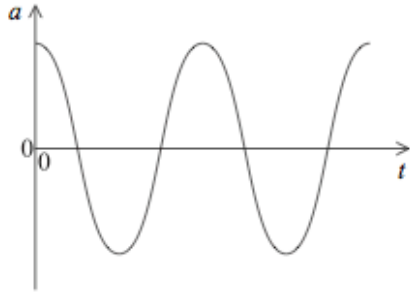


14. The graph shows how the displacement varies with time for an object undergoing simple harmonic motion.

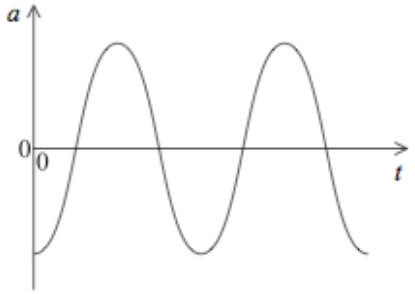


Which graph shows how the object's acceleration a varies with time t?

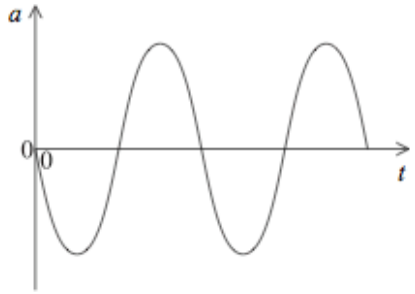
A.



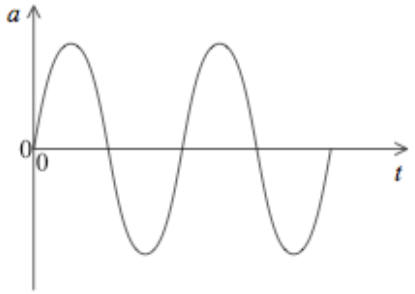
B.



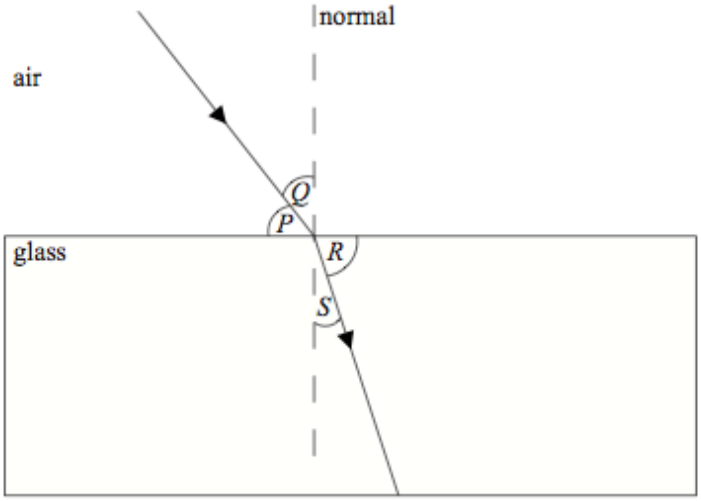
C.



D.



15. Light travels from air into glass as shown below.



What is the refractive index of glass?

A. $\frac{\sin P}{\sin S}$

B. $\frac{\sin Q}{\sin R}$

C. $\frac{\sin P}{\sin R}$

D. $\frac{\sin Q}{\sin S}$

16. Which of the following electromagnetic waves has a frequency **greater** than that of visible light?

A. Ultraviolet

B. Radio

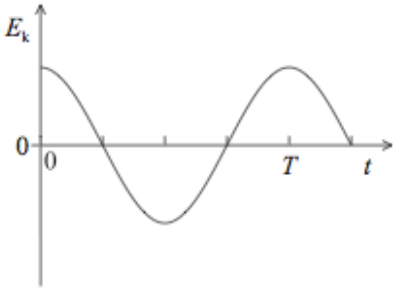
C. Microwaves

D. Infrared

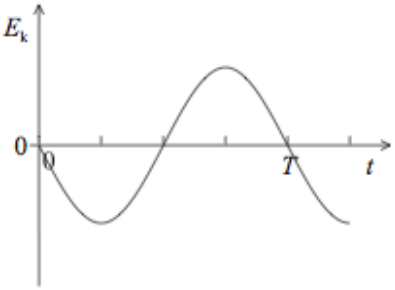
12. A particle oscillates with simple harmonic motion with period T.

At time $t=0$, the particle has its maximum displacement. Which graph shows the variation with time t of the kinetic energy E_k of the particle?

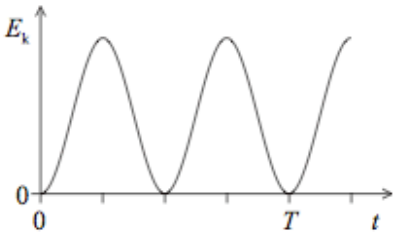
A.



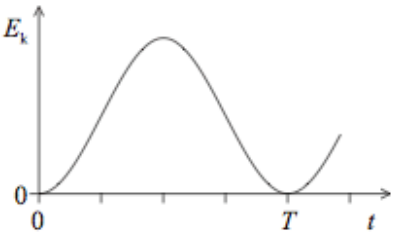
B.



C.

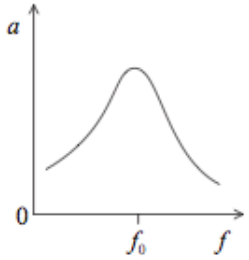


D.

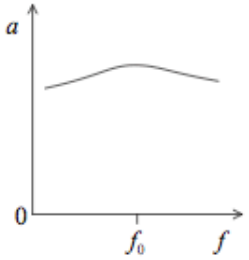


13. An object is undergoing simple harmonic motion with light damping. The natural frequency of oscillation of the object is f_0. A periodic force of frequency f is applied to the object. Which of the following graphs best shows how the amplitude a of oscillation of the object varies with f?

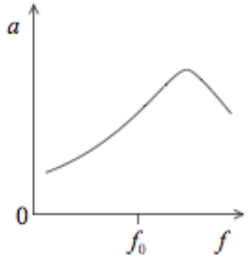
A.



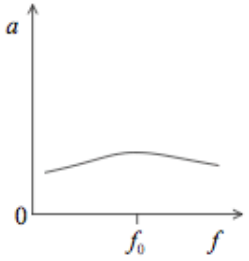
B.



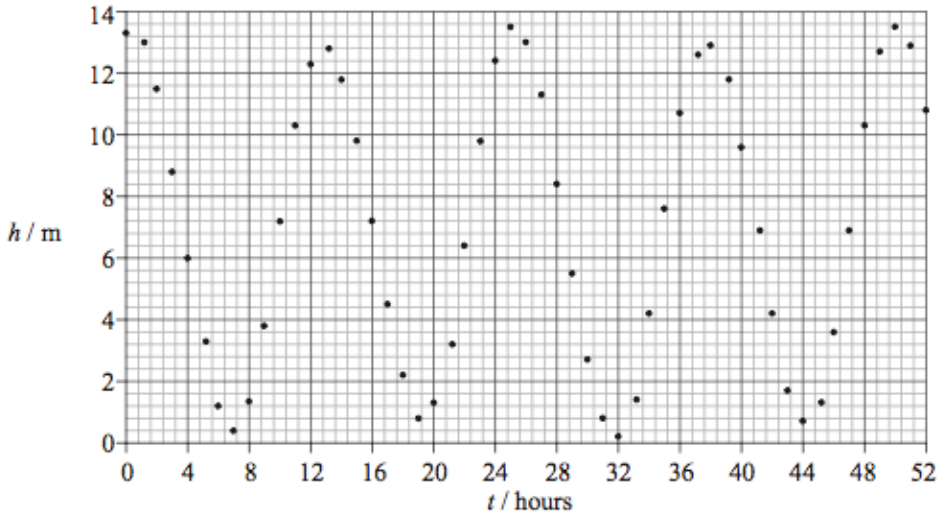
C.



D.



14. The graph shows measurements of the height h of sea level at different times t in the Bay of Fundy.



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

15. Two waves meet at a point. The waves have a path difference of $\frac{\lambda}{4}$. The phase difference between the waves is

A. $\frac{\pi}{8}$ rad.

B. $\frac{\pi}{4}$ rad.

C. $\frac{\pi}{2}$ rad.

D. π rad.

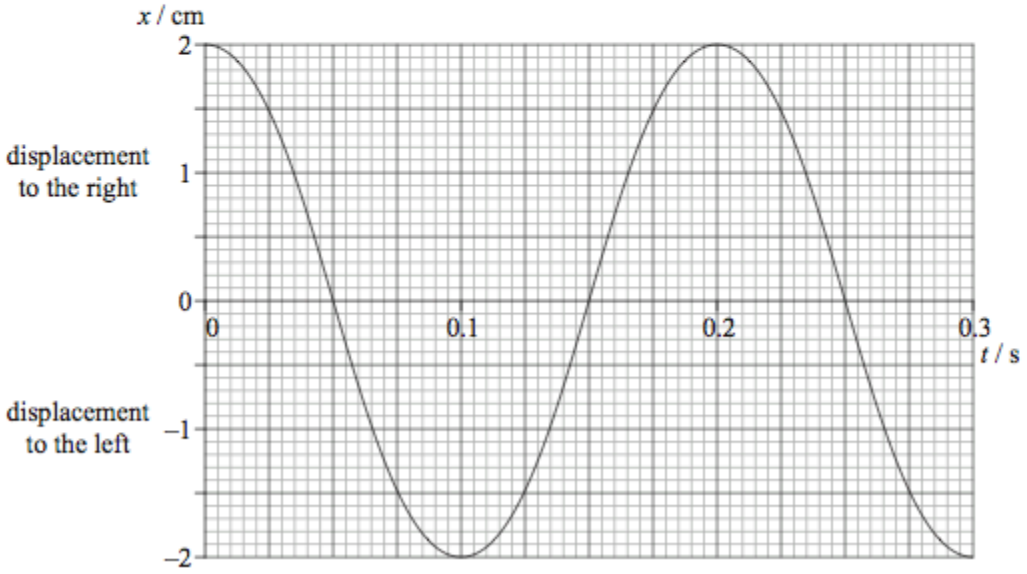
(Question B1 continued)

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



(a) For particle P,

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

. . . . . .

(Question B1, part 2 continued)

(ii) calculate the magnitude of its maximum acceleration. *[2]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .

(iii) calculate its speed at $t = 0.12\,\text{s}$. *[2]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .

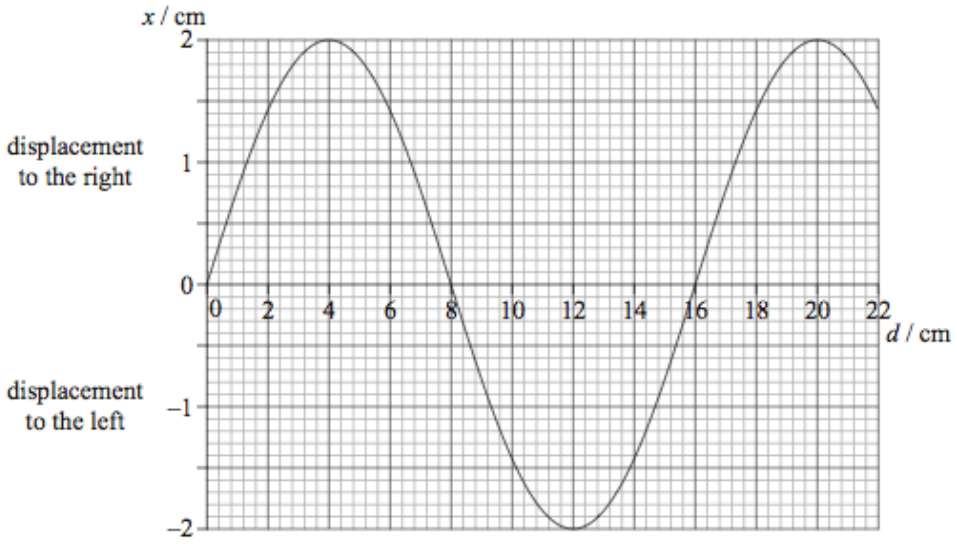
(iv) state its direction of motion at $t = 0.12\,\text{s}$. *[1]*

. . . . . .

(Question B1, part 2 continued)

(b) Graph 2 shows the variation with position d of the displacement x of particles in the medium at a particular instant of time.

Graph 2



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

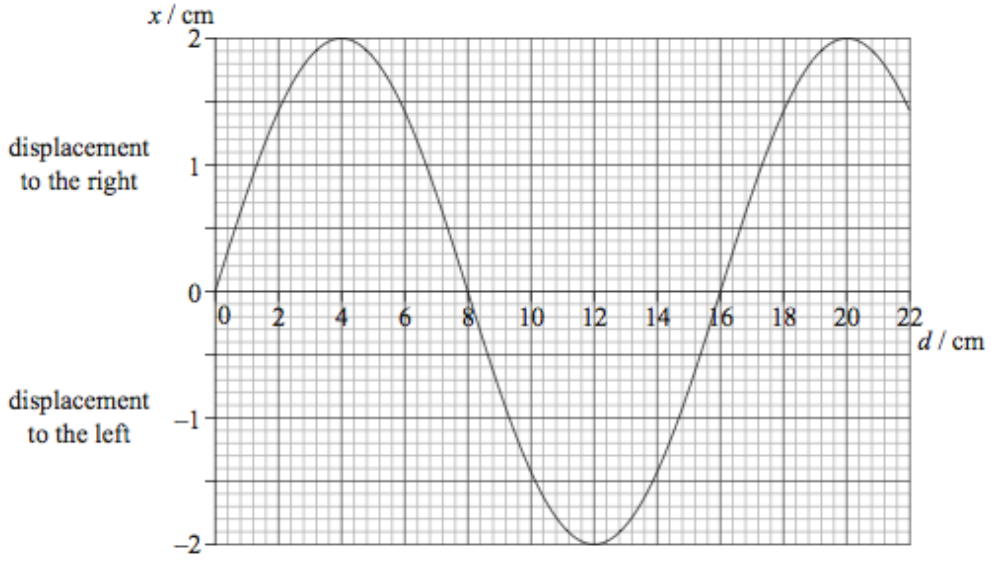
(i) the frequency. *[2]*

. . . . . .

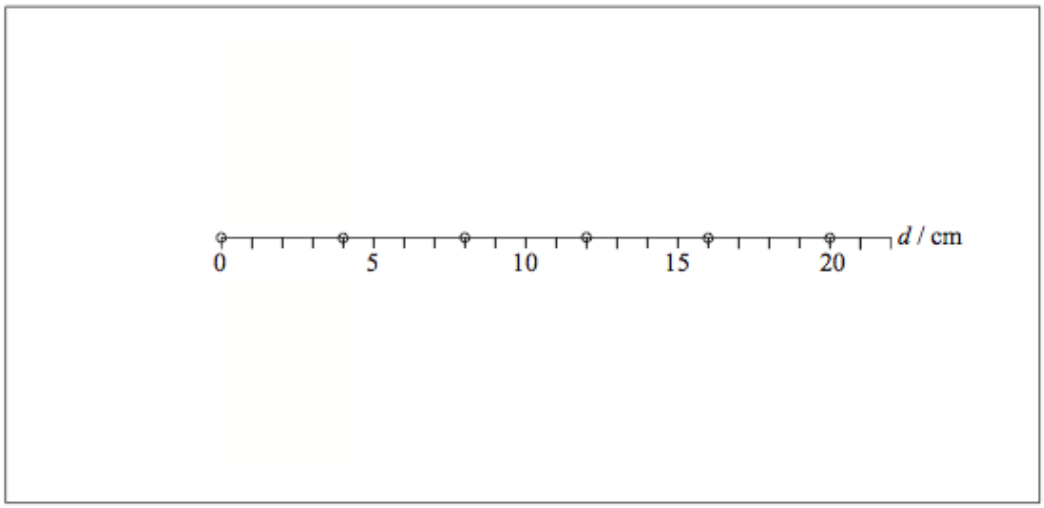
(ii) the speed. *[2]*

. . . . . .

Graph 2 – reproduced to assist with answering (c)(i).



(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. *[3]*

(ii) On the diagram above, label with the letter C a particle that is at the centre of a compression. *[1]*

SECTION B

*This section consists of three questions: B1, B2 and B3. Answer **one** question. Write your answers in the boxes provided.*

B1. 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

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

. . . . . .

. . . . . .

13. C
14. D
15. D
16. A

12. C
13. A
14. C
15. C

B1. Part 2 Simple harmonic oscillations

(a) (i) the amplitude is constant; ***[1]***

(ii) period is 0.20 s;

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

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

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

$$v\left(= \frac{2\pi}{T}\sqrt{x_0^2 - x^2} \right) = 31.4\sqrt{(2.0\times10^{-2})^2 - (1.62\times10^{-2})^2} = 0.37\,\text{m s}^{-1};$$

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

or

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

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

or

drawing a tangent at 0.12 s;
measurement of slope of tangent; ***[2]***
Accept answer in range 0.33 m s^{-1} to 0.38 m s^{-1}.

(iv) to the right; ***[1]***

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

and so $f\left(= \frac{1}{0.20} \right) = 5.0\,\text{Hz};$ ***[2]***

(ii) wavelength is 16 cm;
and so speed is $v\left(= f\lambda = 5.0 \times 0.16 \right) = 0.80\,\text{m s}^{-1};$ ***[2]***

(c) (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; ***[3]***

(ii) the point at 8 cm; ***[1]***