Physical World 1 - 11.30am
Test 3a - April 4, 2005

NAME: Answers ____________________ Student No. ____________________
(Last name, first name)

Academic honesty statement.
This exam will NOT be marked unless you sign the academic honesty statement below. Your signature indicates that you have **read**, **understood**, and **complied** with the meaning of this statement.

On my honor as a student I have neither given nor received unauthorized aid on this assignment.

Signature: ____________________

Twenty short answer questions. Each question is worth 4 points. (Total points = 80.)

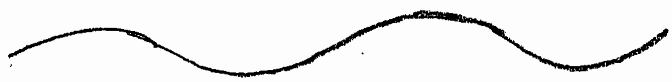
1. Heat can be transferred through a vacuum by
a) conduction.
b) convection.
c) radiation.
d) advection.

2. Circle the true statement.
a) The lower the temperature the higher the average kinetic energy of a molecule.
b) The lower the temperature the lower the average kinetic energy of a molecule.
c) The lower the temperature the lower the average potential energy of a molecule.
d) The energy of a molecule is not related to its temperature.

3. The diagrams below show two waves which are moving at the same speed.
The wave with the longest wavelength is ____(b)____.
The wave with the lowest frequency is ____(b)____.

(a)

(b)



4. If the wavelength of standing waves on a guitar string is 2m and the speed of the waves is 512m/s, what is the frequency of the note being played?

$\lambda = 2m \qquad v = 512 m/s$

$$f = \frac{v}{\lambda} = \frac{512}{2} = 256\ Hz$$

5. If you take a bite out of an apple pie, which comes straight from the oven, you often burn your tongue on the apple filling but not on the crust. This is because
a) the apple filling is at a higher temperature than the crust.
b) the apple filling has a large specific heat and mass compared with the crust.
c) the apple filling has a smaller specific heat capacity than the crust.
d) the apple filling has a larger latent heat than the crust.

6. Circle the true statement.
a) Different pitched sounds travel at different speeds.
b) The higher the pitch of a sound the longer the wavelength.
c) The higher the pitch of a sound the shorter the wavelength.
d) The higher the pitch of a sound the higher the energy.

7. Explain the difference between longitudinal and transverse waves. **Give an example of each.**

Longitudinal waves – particles oscillate parallel to the direction of motion of the wave (i.e oscillate in same direction as wave speed) eg sound

Transverse waves – particles oscillate perpendicular to direction of motion (or wave speed) of the wave eg water wave, wave on a string etc.

8. In a film clip about the Tacoma Narrows bridge, the bridge collapsed because
a) the frequency of the wind was much larger than the resonant frequency of the bridge.
(b) the frequency of the wind was at the resonant frequency of the bridge.
c) the frequency of the wind was much smaller than the resonant frequency of the bridge.
d) the wind was very strong. The collapse had nothing to do with the frequency of the wind.

9. Explain why you can't determine whether you are running a high temperature by touching your own forehead?

Both your finger & forehead have the same temperature therefore you cannot tell whether or not you are running a high temperature.

10. In a demonstration two tuning forks of **almost the same frequency** are set into oscillation. The tuning forks
a) modify each others frequency due to the Doppler effect.
b) interfere destructively so that there is no sound.
c) interfere constructively and hence sound much louder.
(d) create beats so that the loudness varies with time.

11. A sound wave has a wavelength of 1m. Determine the period of the wave.

$\lambda = 1m \qquad V = 330\ m/s$ for sound

$f = \frac{V}{\lambda} = \frac{330}{1} = 330\ Hz \qquad$ Period $T = \frac{1}{f} = \frac{1}{330} = 0.003\ s$

12. When you add the same amount of heat Q to 1kg of lead and 1kg of iron you find that they heat up by different amounts. Why is this?
(a) They have different specific heat capacities.
b) They have different latent heats.
c) One is an insulator and the other is a conductor.
d) They have different heat retentions.

13. Compare the sound of a fire engine siren, when it moves towards and away from you.
a) The frequency of the siren always sounds the same.
b) The wavelength is larger on approach compared with on departure.
(c) The wavelength is smaller on approach compared with on departure.
d) The wavelength of the siren always remains the same.

14. When ice is converted into water, heat must be added. If this ice-water mixture remains well mixed during this melting process

a) the temperature of this mixture increases above 0°C as the proportion of ice decreases.

(b) the temperature remains constant at 0°C until all of the ice has melted.

c) the temperature of this mixture decreases below 0°C as the proportion of ice decreases.

e) the temperature will increase in proportion to the amount of heat added.

15. a) For a standing wave, what is a node?

A node is a point of no motion

b) For a standing wave, what is an anti-node?

An anti-node is a point of maximum motion

16. A skipper on a boat notices wave crests passing his anchor chain every 5s. He estimates the distance between wave crests to be 10m. He also correctly estimates the speed of the waves. What is this speed?

$$\text{Frequency} = \frac{\#\text{ of cycles}}{\text{time}} = \frac{1}{5\,s} = \frac{1}{5}\,Hz$$

$$\lambda = 10\,m$$

$$v = f\lambda = \frac{1}{5} \times 10 = 2\,m/s$$

17. When you burn your finger on a hot stove, heat is transferred to your finger primarily via

(a) conduction.

b) convection.

c) radiation.

d) advection.

18. You hear a thunderclap 3.5s after observing a lightning strike. How far away did the lightning occur?

$$v = \frac{d}{t} \qquad d = v_{sound}\, t = 330 \times 3.5 = 1155\,m$$

19. Heat always flows from hot objects towards cold objects.

20. a) When a liquid is turned into a gas do you have to supply heat energy or take heat energy away?

Supply heat energy

b) When a liquid is turned into a solid do you have to supply heat energy or take heat energy away?

Take heat energy away

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Four longer questions. Each question is worth 5 points. (Total points = 20.)

Show all calculations!!

21. The following information will be useful in answering the questions below.
Latent heat of melting or freezing, L_m = 300,000 J/kg
Latent heat of vaporization or condensation, L_v = 2,000,000 J/kg
Specific heat capacity of ice, c(ice) = 2000 J/kg C
Specific heat capacity of water, c(water) = 4000 J/kg C

a) Determine how much heat is required to melt a 2kg block of ice at 0°C and convert it into water at 0°C.

$Q_1 = m L_{melt} = 2 \times 300,000 = 600,000 \text{ J}$

b) Determine how much additional heat is then required to increase the temperature of this water from 0°C to 50°C.

$Q_2 = m c_{water} \Delta T = 2 \times 4000 \times 50 = 400,000 \text{ J}$

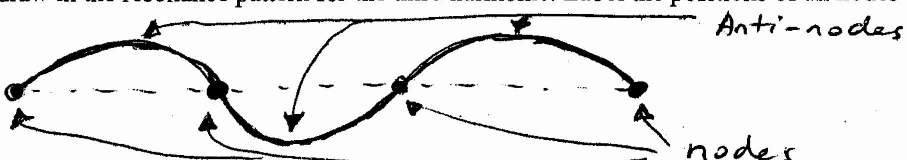
c) If your heat source can only supply 100,000 J of heat every hour how many hours does it take to melt the 2kg block of ice at 0°C, convert it to water, and heat this water up to 50°C.

Total heat required $Q_{TOT} = Q_1 + Q_2 = 600,000 + 400,000$
$= 1,000,000 \text{ J}$

The heat source supplies 100,000J/hour therefore it would take <u>10 hours</u> to supply 1,000,000 J.

22. Bob excites the third harmonic on a string which is 1m in length.
a) Carefully draw in the resonance pattern for the third harmonic. Label the positions of all nodes and anti-nodes.

3rd harmonic



b) What is the relationship between the length L of the string and the wavelength λ of the third harmonic?

$L = \frac{3}{2} \lambda$

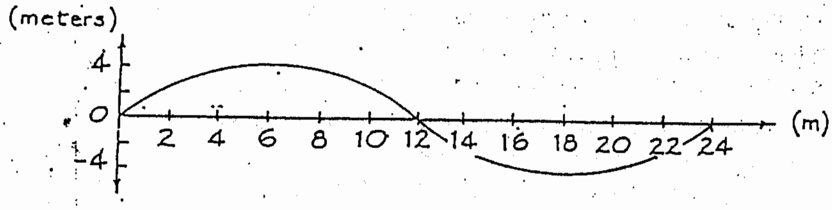
c) If waves move at a speed of 100m/s on the string, determine the frequency f of the third harmonic.

From (b) $L = 1\text{m}$ therefore $\lambda = \frac{2}{3} L = \frac{2}{3} \times 1 = \frac{2}{3}\text{m}$
$= 0.66\text{m}$

$v = 100 \text{ m/s}$

$f = \frac{v}{\lambda} = \frac{100}{0.66\text{m}} = 151.5 \text{ Hz}$

23.



The diagram above represents the shape of a sound wave at a particular instance in time.
a) Determine the amplitude of the wave.

Amplitude $A = 4 m$

b) Determine the wavelength of the wave.

$\lambda = 24 m$

c) Determine the frequency of the wave.

$$f = \frac{V_{sound}}{\lambda} = \frac{330}{24} = 13.75 Hz$$

d) If this sound wave is moving towards the right and you are running towards the sound, would the wavelength of the sound that <u>you hear</u> be the same as the answer in part b above?

No

If not, how would the wavelength differ?

λ would be smaller

24. What **two physics mistakes** occur in a science fiction movie that shows a distant explosion in outer space, where you see and hear the explosion at the same time?

<u>Mistake 1</u>: If you could see & hear the explosion you would see the explosion <u>before</u> you heard the explosion, ~~because~~ (because speed of light is greater than speed of sound)

<u>Mistake 2</u>: In fact, you would never hear the explosion because outer space is a vacuum & sound cannot travel through a vacuum.