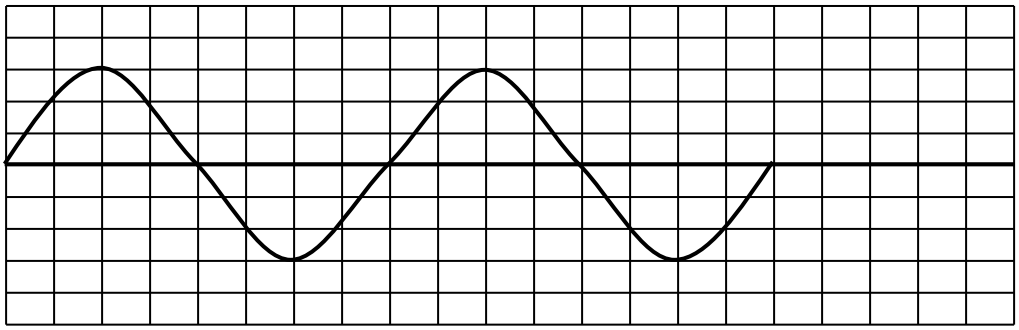
Physics 30S Exam Review Key

Extended Answer Key

I: Waves

1. On the grid below, each block represents **1 cm**. Sketch a wave that is two wavelengths long with the following characteristics:

   - wavelength of 8 cm
   - amplitude of 3 cm



2. Jerry is sitting in his fishing boat. He counts 12 waves go by in 10 seconds.

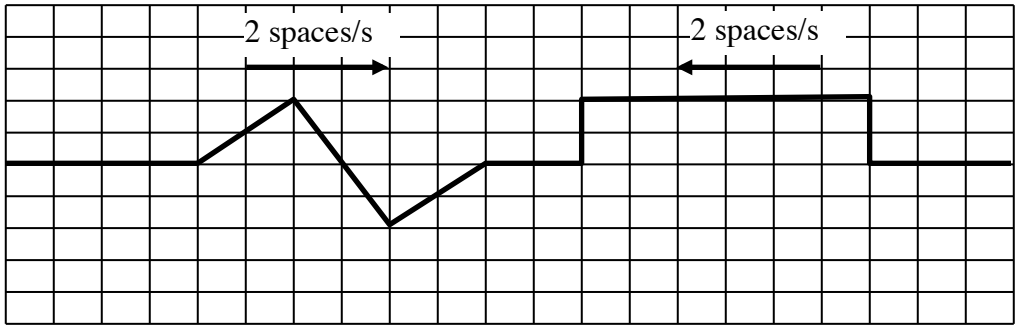
   a) What is the frequency and period of the waves?

$$f = \frac{cycles}{time} = \frac{12}{10} = 1.2\ Hz \qquad T = \frac{1}{f} = \frac{1}{1.2} = 0.83\ s$$

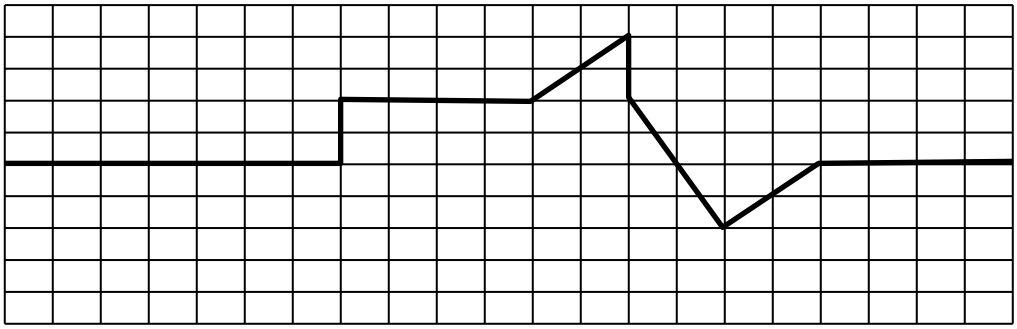
   b) If Jerry estimates the wavelength to be 1.25 m, what is the speed of the waves?

$$v = f\lambda = (1.2)(1.25) = 1.5\ m/s$$

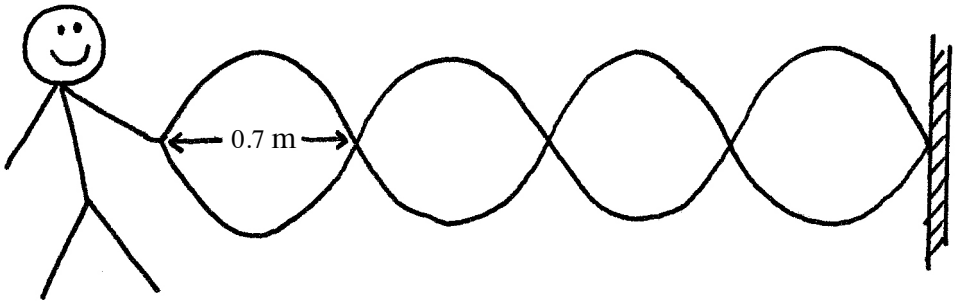
3. The waves, shown below, are moving toward each other at a rate of 2 spaces per second. Sketch the resultant wave pattern after 3 s.



t = 3 s



4. A student makes a standing wave pattern with a skipping rope as shown. If the waves are moving at 9 m/s, with what frequency does the student move her hand up and down?



Wavelength = 1.4 m given the information in the diagram.

$$f = \frac{v}{\lambda} = \frac{9}{1.4} = 6.4\ Hz$$

5. The light from an aquarium bulb travels from water (n = 1.33) to glass (n = 1.58).

   a) If a ray of light strikes the glass at an angle of 15°, at what angle will it be refracted?

$$\sin\theta_r = \frac{n_1 \sin\theta_i}{n_2} = \frac{(1.33)(\sin 15^\circ)}{(1.58)} = \frac{0.344}{1.58} = 0.218$$

$$\therefore \theta_r = 13^\circ$$

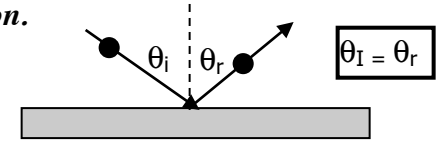
   b) Calculate the speed of light in the glass.

$$v = \frac{c}{n} = \frac{3\times10^8}{1.58} = 1.9\times10^8 \ m/s$$

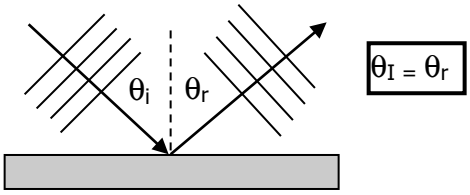
II: The Nature of Light

1. Briefly describe how both the particle and wave models of light can adequately explain the principle of reflection. A labeled diagram may be used in your response.

<u>Particle model</u>: In an elastic collision between hard spheres, the angle of incidence equals the angle of reflection.

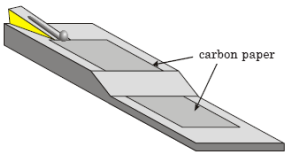


<u>Wave model</u>: It can be demonstrated using water waves that the angle of incidence is equal to the angle of reflection for waves.



2. Briefly describe how the particle and wave models of light differ in their explanation of refraction.

<u>Particle model</u>: Light particles will <u>speed up</u> as they pass through a less dense medium to a denser medium because the light particles are attracted to the particles in the denser medium. (Like a ball descending an inclined plane)



<u>Wave model</u>: Light waves <u>slow down</u> as they enter a heavier medium similar to a marching band entering a muddy field from grassy field.

3. Max is performing Young's Double Slit Experiment by shining light through two narrow openings 40 μm apart. He measures the distance between the central and fourth bright spots to be 6.9 cm on the screen 2 m away.

   a) What is the distance between consecutive bright spots on the screen?

$$\Delta x = \frac{l}{spaces} = \frac{6.9}{4} = 1.7\ cm$$

   b) What wavelength (in nm) of light did Max use?

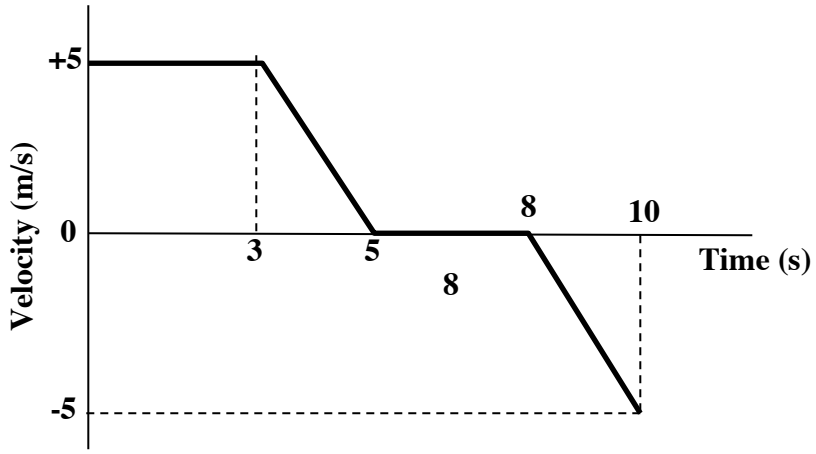
$$\lambda = \frac{d\Delta x}{L} = \frac{(40\times10^{-6})(0.017)}{2} = 3.4\times10^{-7}\,m = 340\ nm$$

   c) If the distance between the slits increases, describe what would happen to the interference pattern as seen on the screen.

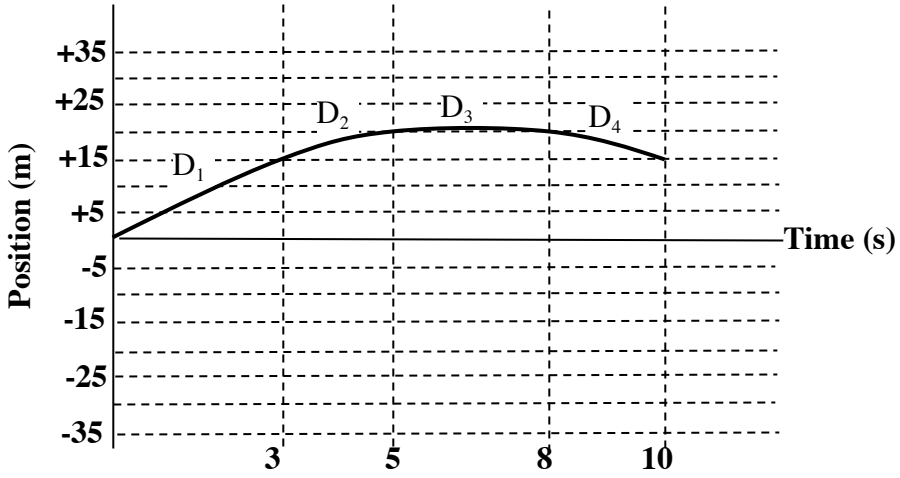
The interference pattern would squish together, that is, there would be more fringes in the same area on the screen.

III: Mechanics

1. The following graph shows the velocity of an object over a 10 s time interval.



Translate the velocity-time graph into a position-time graph in the space provided. You may assume the object starts at the origin.



$D_1 = (3)(5) = +15$ m

$D_2 = (2)(5)/2 = +5$ m

$D_3 = 0$ m

$D_4 = (2)(-5)/2 = -5$ m

2. Jenny goes for a ride on a waterslide. She starts at 1 m/s and accelerates at 2.3 m/s^2 all the way down.

   a) If it takes her 5 seconds to reach the bottom, how fast is she going at the bottom of the slide?

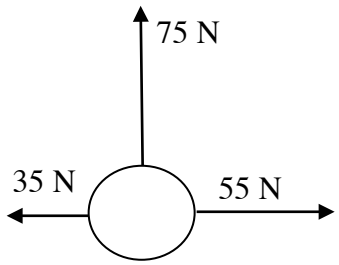
$$v_2 = v_1 + at = (1) + (2.3)(5) = 12.5\ m/s$$

   b) What is Jenny's average speed during her ride down the waterslide?

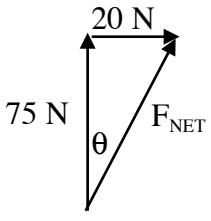
$$v = \left(\frac{v_1 + v_2}{2} \right) = \left(\frac{1 + 12.5}{2} \right) = 6.75\ m/s$$

3. Three dogs are pulling on a doggie toy. Great Dane pulls with a force of 75 N to the North, Boxer pulls with a force of 55 N East, and Beagle pulls with a force of 35 N West.

   a) Draw a free body diagram showing all the forces acting on the toy.



   b) Determine the net force acting on the toy.



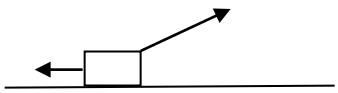
$$\Sigma \vec{F} = \sqrt{(20)^2 + (75)^2} = 78\ N$$

$$\theta = Tan^{-1}\left(\frac{20}{75} \right) = 15^\circ$$

$$\therefore \Sigma \vec{F} = 78\ N, 15^\circ\ E\ of\ N$$

4. Bobby is pulling his little brother Ralph (27 kg) on a toboggan along a horizontal surface. He pulls with a force of 62 N at an angle of 35˚ from the horizontal. A frictional force of 48 N acts between the toboggan and the snow.

   a) Calculate the net force acting on Ralph.



$$\Sigma\vec{F} = 62\cos 35^\circ - 48 = 2.8\,N, \textit{forward}$$

   b) Determine Ralph's acceleration.

$$\vec{a} = \frac{\Sigma\vec{F}}{m} = \frac{2.8}{27} = 0.1\ m/s^2, \textit{forward}$$

IV: Fields

1. An 80 kg man stands on a scale in an elevator. What is the scale reading, **in Newtons**, when the elevator is

   a) at rest?

   $F_{scale} = F_g = mg = (80)(9.8) =$ **<u>784 N</u>**

   b) accelerating downward at 1.4 m/s^2?

   $F_{scale} = F_g = mg = (80)(9.8 - 1.4) =$ **<u>672 N</u>**

   OR

   $F_N - F_g = ma$

   $F_N = ma + mg = (80)(-1.4 + 9.8) =$ **<u>672 N</u>**

2. A 450 kg car is traveling at a constant velocity along a horizontal highway.

   a) If the motor provides a 900 N force to keep the car moving forwards, what is the frictional force on the car?

   F_f = -900 N (900 N backwards)

   b) What is the coefficient of kinetic friction between the car and the road?

$$\mu_k = \frac{\vec{F}_f}{\vec{F}_N} = \frac{900}{(450)(9.8)} = 0.2$$

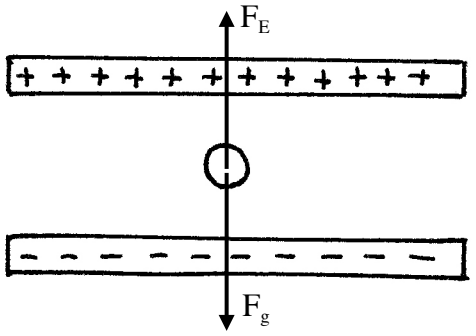
   c) Would you expect the value obtained in part b to be greater or less than the coefficient of **static** friction between the car and the road? Explain.

   Less.

   Any reasonable explanation such as static friction requires more force to <u>start</u> an object moving than to keep it moving due in part to inertia.

3. An oil drop of mass 1.96×10^{-15} kg is suspended (not moving) between two parallel plates creating an electric field of 24 000 N/C down as shown.

   a) Draw the force vectors acting on the drop.



   b) Is the charge on the oil drop positive or negative?

   Negative.

   c) Calculate the magnitude of charge on the oil drop in Coulombs.

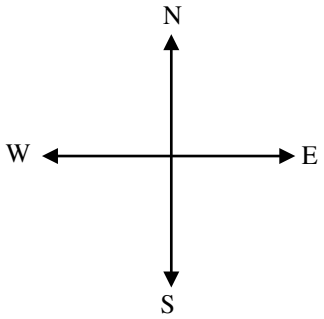
$$\vec{F}_E - \vec{F}_g = 0$$
$$\vec{E}q = m\vec{g}$$
$$\therefore q = \frac{m\vec{g}}{\vec{E}} = \frac{(1.96 \times 10^{-15})(9.8)}{(24000)} = 8 \times 10^{-19} C$$

   d) How many excess/deficit elementary charges are on the oil drop?

$$\#charges = \frac{8 \times 10^{-19}}{1.6 \times 10^{-19}} = 5e$$

4. An 8 m length of current carrying wire is placed in a magnetic field of 0.4 T West. If the wire experiences a force of 8.3 N into the page, what is the **magnitude and direction** of the current in the wire?

$$I = \frac{\vec{F}}{\vec{B}l\sin\theta} = \frac{(8.3)}{(0.4)(8)(\sin 90^\circ)} = 2.6\,A, South$$



Multiple Choice Key

Question	Answer		Question	Answer
1	B		26	D
2	A		27	B
3	A		28	B
4	D		29	A
5	C		30	B
6	C		31	B
7	B		32	D
8	D		33	A
9	A		34	C
10	D		35	B
11	C		36	A
12	B		37	B
13	A		38	C
14	D		39	A
15	D		40	D
16	C		41	B
17	D		42	C
18	D		43	A
19	A		44	C
20	B		45	B
21	A		46	B
22	C		47	A
23	A		48	D
24	C		49	B
25	B		50	D