# Physics 11 - Optics Workpack
## Answer Section

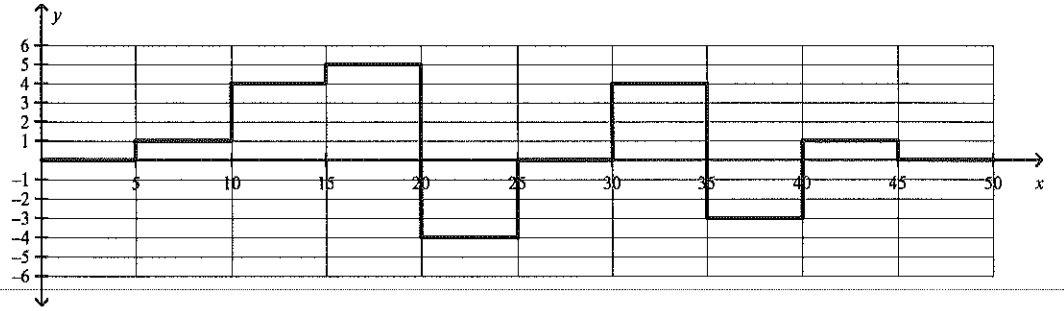
**MULTIPLE CHOICE**

1. D
2. B
3. B
4. C
5. D
6. C
7. D

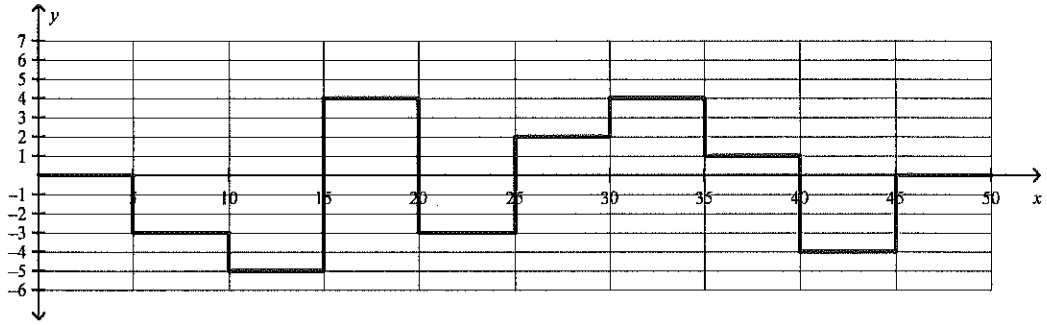
**SHORT ANSWER**

8. Sketch the result of superimposing the following two waves. **(2 marks)**
**ANSWER: (2 marks)**

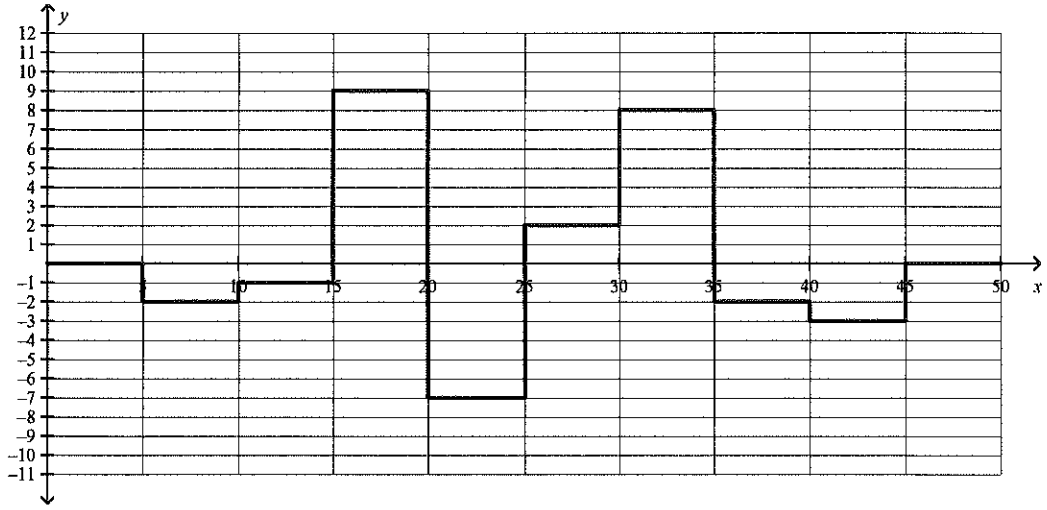
**Wave A**




**Wave B**

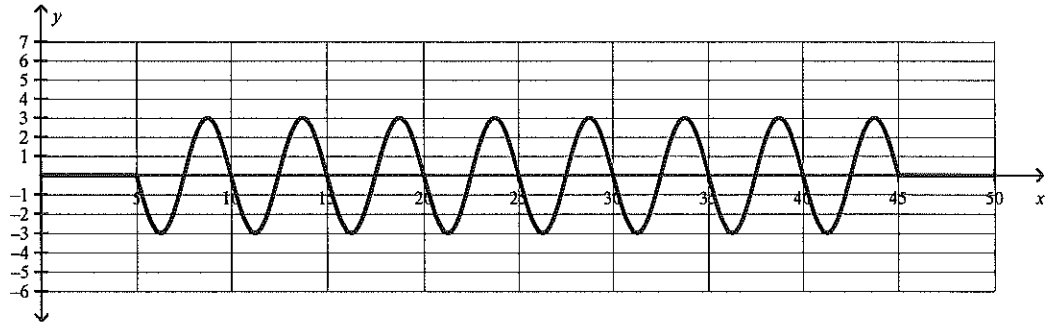



**Wave A+B**

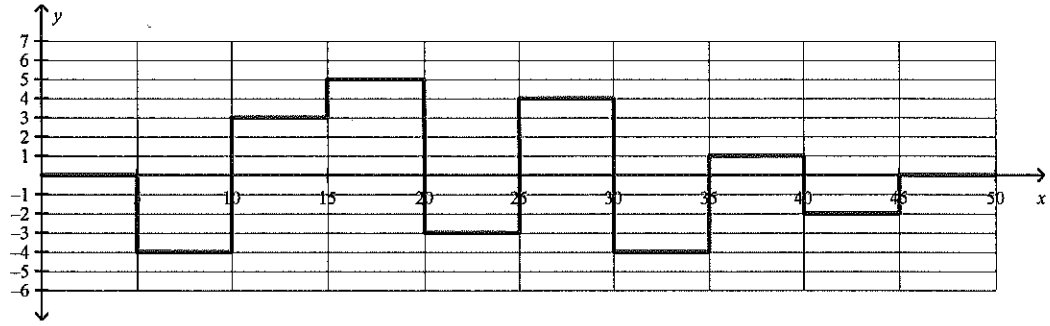


9. Sketch the result of superimposing the following two waves. **(2 marks)**
**ANSWER: (2 marks)**

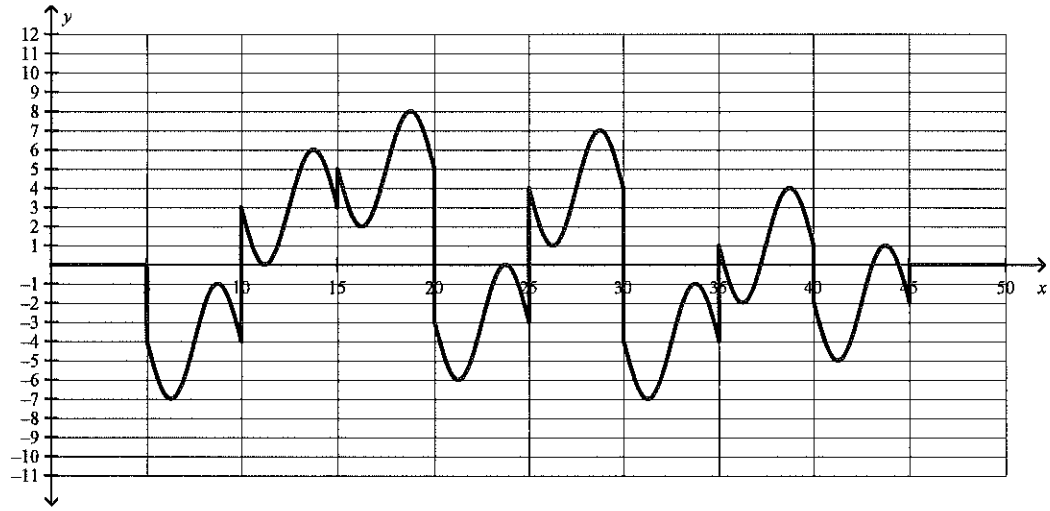
**Wave A**




**Wave B**

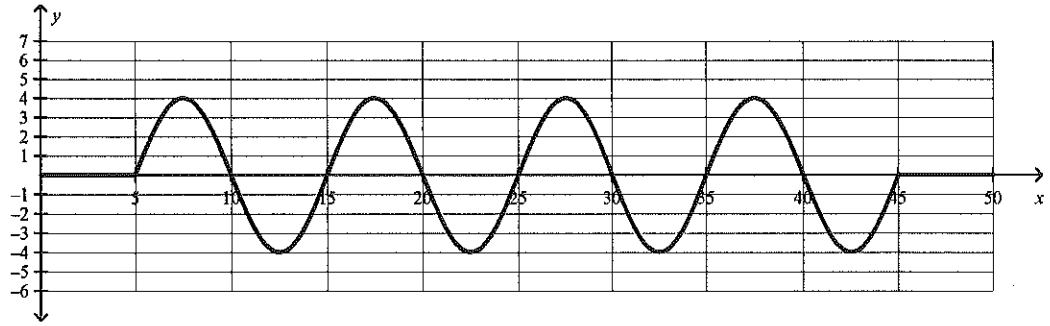



**Wave A+B**

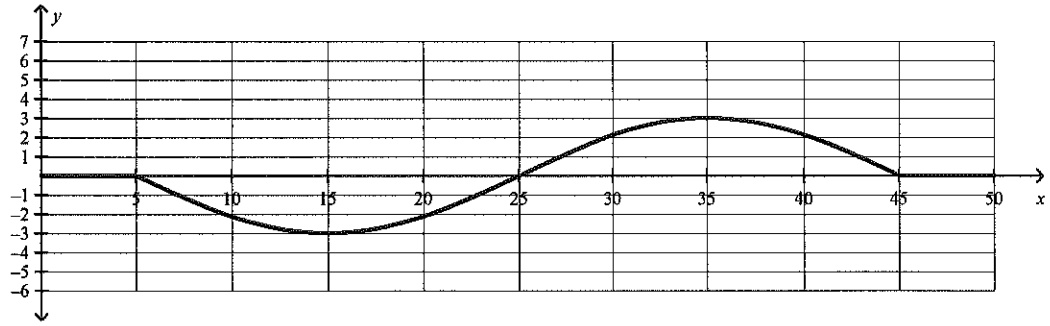


10. Sketch the result of superimposing the following two waves. **(2 marks)**
**ANSWER: (2 marks)**

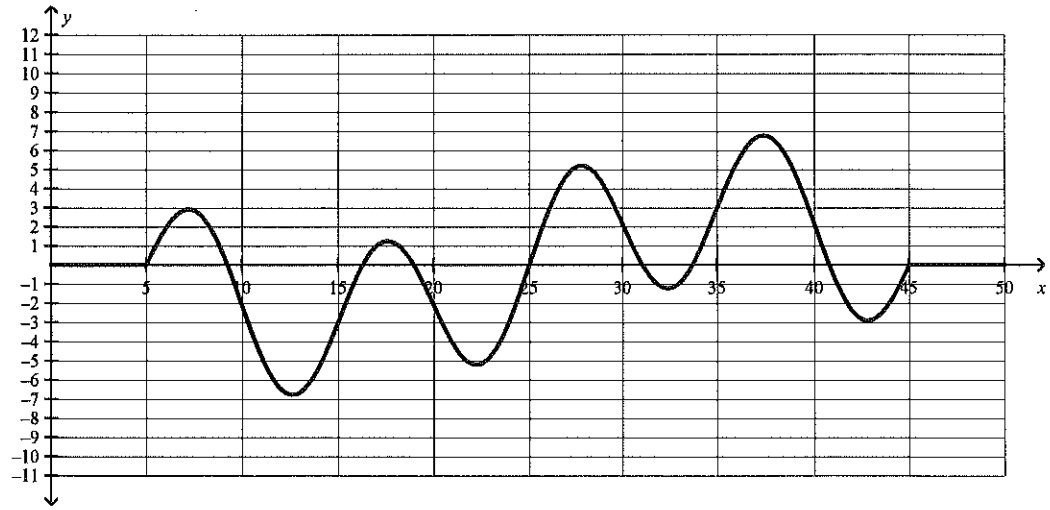
**Wave A**



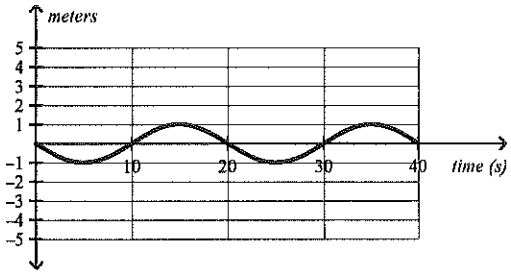

**Wave B**




**Wave A+B**



11. The wave shown below travels 200 m in 40 seconds. Answer the questions below.




**ANSWER: (6 marks)**

a) What is the amplitude of the wave? **(1 mark)**

$$amplitude = \underline{1m}$$

b) What is the wavelength of the wave? **(1 mark)**

$$v = f\lambda \quad \lambda = \frac{v}{f} = \frac{5m/s}{0.05Hz} = \underline{100m}$$

c) What is the velocity of the wave? **(1 mark)**

$$v = \frac{d}{t} = \frac{200m}{40s} = \underline{5m/s}$$

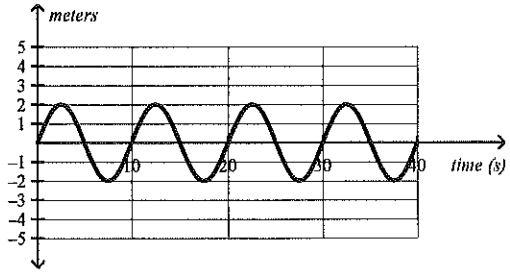
d) What is the frequency of the wave? **(1 mark)**

$$f = \frac{cycles}{\text{sec}} = \frac{2\ cycles}{40\ \text{sec}} = \underline{0.05Hz}$$

e) What is the period of the wave? **(1 mark)**

$$T = \frac{1}{f} = \frac{1}{0.05Hz} = \underline{20s}$$

12. The wave shown below travels 215 m in 40 seconds. Answer the questions below.




**ANSWER: (6 marks)**

a) What is the amplitude of the wave? **(1 mark)**

$amplitude = \underline{2m}$

b) What is the velocity of the wave? **(1 mark)**

$v = \frac{d}{t} = \frac{215m}{40s} = \underline{5.38m/s}$

c) What is the frequency of the wave? **(1 mark)**

$f = \frac{cycles}{\sec} = \frac{4\ cycles}{40\ \sec} = \underline{0.1Hz}$

d) What is the period of the wave? **(1 mark)**

$T = \frac{1}{f} = \frac{1}{0.1Hz} = \underline{10s}$

e)What is the wavelength of the wave? **(1 mark)**

$v = f\lambda \quad \lambda = \frac{v}{f} = \frac{5.38m/s}{0.1Hz} = \underline{53.75m}$

f) How many nodes and antinodes are there? **(1 mark)**

$\underline{nodes = 9} \qquad \underline{antinodes = 8}$

13. A standing wave in a clothesline has 10 nodes and 9 antinodes. The clothesline is 7 m long and is vibrating at 1.7 vibrations per second. What is the speed of the wave? **(3 marks)**

**ANSWER: (3 marks)**

The number of waves is:

$\#waves = \frac{nodes - 1}{2} = \frac{10 - 1}{2} = 4.5$

The wave length of each wave is:

$\lambda = \frac{length}{\#waves} = \frac{7m}{4.5} = 1.56m$

The velocity of the wave is:

$v = f \cdot \lambda = 1.7Hz \cdot 1.56m = \underline{2.64m/s}$

14. The speed of an ocean wave on the coast is 8 m/s; the wavelength is 9 m. What is the frequency with which the wave hits the beach? **(2 marks)**

**ANSWER: (2 marks)**

$v = f \cdot \lambda$

$f = \frac{v}{\lambda} = \frac{8m/s}{9m} = \underline{0.89Hz}$

15. A sound wave with a frequency of 480 Hz has a wavelength of 3.8 m. What is the velocity of the sound wave? **(2 marks)**

**ANSWER: (2 marks)**

$v = f \cdot \lambda = 480Hz \cdot 3.8m = \underline{1,824m/s}$

16. What is the speed of light in quartz (n=1.54)? **(2 marks)**

**ANSWER:**

$n_s = \frac{c}{v_s}$

$v_s = \frac{c}{n_s} = \frac{3 \times 10^8 m/s}{1.54} = \underline{1.95 \times 10^8 m/s}$

17. If light is travelling at 87% the speed of light in a translucent material, what is the index of refraction of the material **(2 marks)**

**ANSWER:**

$n = \frac{c}{v} = \frac{3 \times 10^8 m/s}{87\% \cdot 3 \times 10^8 m/s} = \underline{1.15}$

18. How far would a beam of light travel in a block of diamond (n=2.42) in $8.5 \times 10^{-7}$ seconds? **(3 marks)**

**ANSWER:**

$n = \frac{c}{v}$

$v = \frac{c}{n} = \frac{3 \times 10^8 m/s}{2.42} = 1.24 \times 10^8 m/s$

$d = v \cdot t = 1.24 \times 10^8 m/s \cdot 8.5 \times 10^{-7} s = \underline{105.37m}$

19. What is the index of refraction for a piece material that light can travel 7.6 m in $5.8 \times 10^{-8}$ seconds? **(3 marks)**

**ANSWER:**

$d = v \cdot t \qquad v = \frac{d}{t} = \frac{7.6m}{5.8 \times 10^{-7} s} = 1.31 \times 10^8 m/s$

$n = \frac{c}{v} = \frac{3 \times 10^8 m/s}{1.31 \times 10^8 m/s} = \underline{2.29}$

20. A ray of light passes from zircon (n=1.92) into flint glass (n=1.61) at an angle of incidence of 20°. Find the angle of refraction. **(3 marks)**

**ANSWER:**

$n_i \cdot \sin\theta_i = n_r \cdot \sin\theta_r$

$$\sin^{-1}\theta_r = \frac{n_i \cdot \sin\theta_i}{n_r} = \frac{1.92 \cdot \sin 20°}{1.61} = \underline{\underline{24.07°}}$$

21. A ray of light passes from air (n=1.0003) into crown glass (n=1.52) and refracts at an angle of 25°. Find the angle of incidence. **(3 marks)**

**ANSWER:**

$n_i \cdot \sin\theta_i = n_r \cdot \sin\theta_r$

$$\sin^{-1}\theta_i = \frac{n_r \cdot \sin\theta_r}{n_i} = \frac{1.52 \cdot \sin 25°}{1.0003} = \underline{\underline{39.96°}}$$

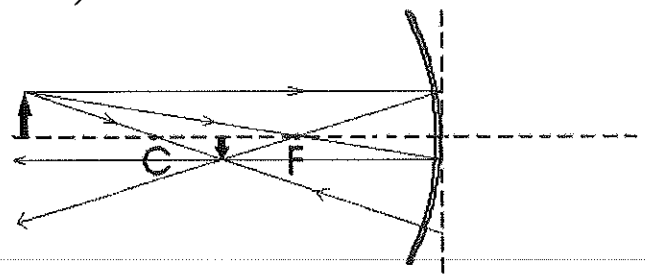
22. What is the critical angle of a light ray when passing from flint glass (n=1.61) into water (n=1.33) ? **(3 marks)**

**ANSWER:**

$n_i \cdot \sin\theta_C = n_r \cdot \sin 90°$

$$\sin^{-1}\theta_C = \frac{n_r \cdot \sin 90°}{n_i} = \frac{1.33}{1.61} = \underline{\underline{55.7°}}$$

23. There is a concave mirror that has a center with a radius of 60 cm.
The 10 cm object is located 85 cm from the mirror.
**ANSWER: Determine each of the following:**
a) Draw the ray diagram carefully (use arrows on your lines to indicate direction of light ray). Draw your lines to the veritical dotted line behind the mirror before reflecting. Clearly draw the image produced. **(1 mark)**




b) Find the distance to the image. **(2 marks)**

$$f = \frac{C}{2} = \frac{60cm}{2} = 30cm$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \qquad \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$$

$$d_i = \frac{1}{\left(f\right)^{-1} - \left(d_o\right)^{-1}} = \frac{1}{(30cm)^{-1} - (85cm)^{-1}} = \underline{46.36cm} \quad \text{(same side as object)}$$

c) Find the image height **(1 mark)**

$$\frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

$$h_i = -\frac{h_o \cdot \left(d_i\right)}{d_o} = -\frac{10cm \cdot (46.36cm)}{85cm} = \underline{-5.45cm} \quad \text{(inverted)}$$

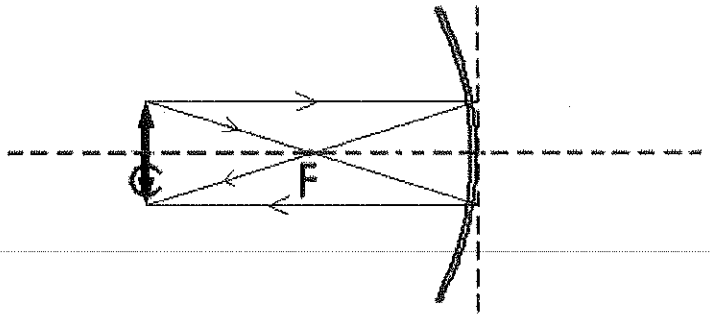
d) Determine if the image is real or imaginary/virtual. **(1/2 mark)**

**REAL**

e) Find the magnification factor. **(1/2 mark)**

$$m = \frac{h_i}{h_o} = \frac{-5.45cm}{10cm} = \underline{\underline{-0.545}} \qquad \text{OR} \qquad m = \frac{-d_i}{d_o} = \frac{-46.36cm}{85cm} = \underline{\underline{-0.545}}$$

24. There is a concave mirror that has a center with a radius of 48 cm.
The 9 cm object is located 48 cm from the mirror.
**ANSWER: Determine each of the following:**
a) Draw the ray diagram carefully (use arrows on your lines to indicate direction of light ray). Draw your lines to the veritical dotted line behind the mirror before reflecting. Clearly draw the image produced. **(1 mark)**




b) Find the distance to the image. **(2 marks)**

$$f = \frac{C}{2} = \frac{48cm}{2} = 24cm$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \qquad \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$$

$$d_i = \frac{1}{\left(f\right)^{-1} - \left(d_o\right)^{-1}} = \frac{1}{(24cm)^{-1} - (48cm)^{-1}} = \underline{\underline{48cm}} \text{ (same side as object)}$$

c) Find the image height **(1 mark)**

$$\frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

$$h_i = -\frac{h_o \cdot \left(d_i\right)}{d_o} = -\frac{9cm \cdot (48cm)}{48cm} = \underline{\underline{-9cm}} \text{ (inverted)}$$

d) Determine if the image is real or imaginary/virtual. **(1/2 mark)**

**REAL**

e) Find the magnification factor. **(1/2 mark)**

$$m = \frac{h_i}{h_o} = \frac{-9cm}{9cm} = \underline{\underline{-1}} \qquad \text{OR} \qquad m = \frac{-d_i}{d_o} = \frac{-48cm}{48cm} = \underline{\underline{-1}}$$