INSIGHT

Year 11 *Trial Exam Paper*

2013

PHYSICS

Written examination 2

Worked Solutions

This book contains:

- correct solutions with full working
- mark allocations
- explanatory notes
- tips and guidelines.

SECTION A – Core

Area of study 1 – Motion

Question 1a.

Worked solution

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$
$$= \frac{210 + 188 + 200 + 290}{120}$$
$$= \frac{888}{120}$$
$$= 7.4 \text{ m s}^{-1}$$

7.4 m s^{-1}

Mark allocation: 2 marks

- 1 mark for converting 2 minutes to 120 seconds.
- 1 mark for the correct answer.

Question 1b.

Worked solution

Jonas is back where he started, so he has a displacement of zero.
Therefore, his average velocity is also zero.

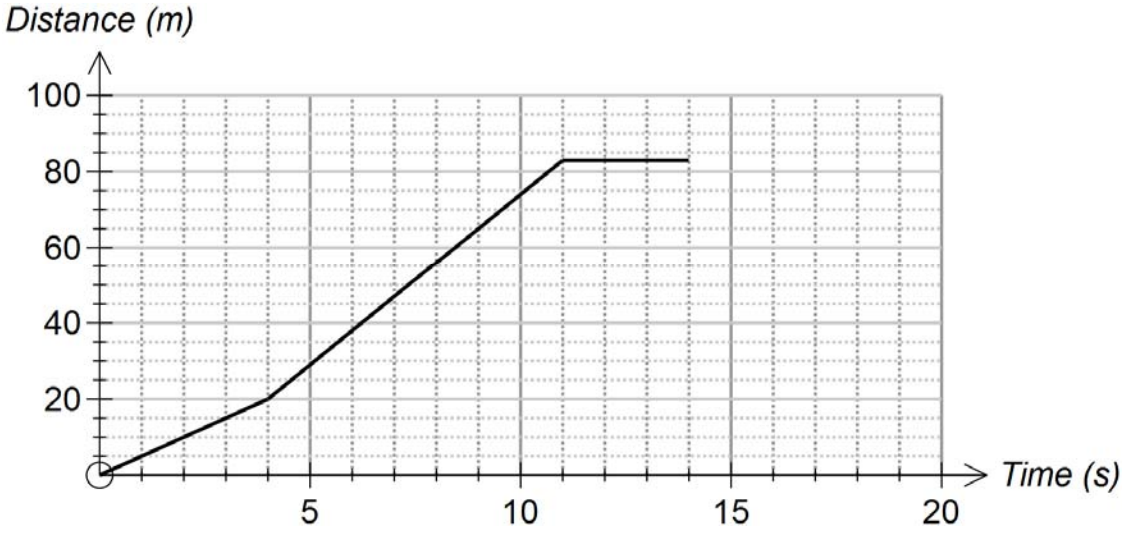
0 m s^{-1}

Mark allocation: 2 marks

- 1 mark for the correct answer.
- 1 mark for the correct explanation.

Question 1c.

Worked solution



Mark allocation: 3 marks

- 2 marks for correct slopes/points.
- 1 mark for correct scales.

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Question 2a.

Worked solution

$W = mg$

$= 2000 \times 10$

$= 20\,000 \text{ N}$

20 000 N

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Question 2b.

Worked solution

If the vehicles are travelling at a constant velocity, then the net force of the system is equal to zero. Therefore, the driving force will be equal to the addition of the frictional forces, which is 500 N.

500 N

Mark allocation: 2 marks

- 2 marks for the correct answer.

Question 2c.

Worked solution

First, must calculate the force required to accelerate a 1500 kg mass at 5 m s^{-2}.

$F = ma$

$= 1500 \times 5$

$= 7500 \text{ N}$

Then add 200 N to overcome friction, giving

$\text{Total} = 7500 + 200$

$= 7700 \text{ N}$

7700 N

Mark allocation: 3 marks

- 2 marks for calculating 7500 N.
- 1 mark for the correct answer.

Question 3a.

Worked solution

$GPE = mgh$

$= 85 \times 10 \times 140$

$= 119\,000$ J

119 000 J

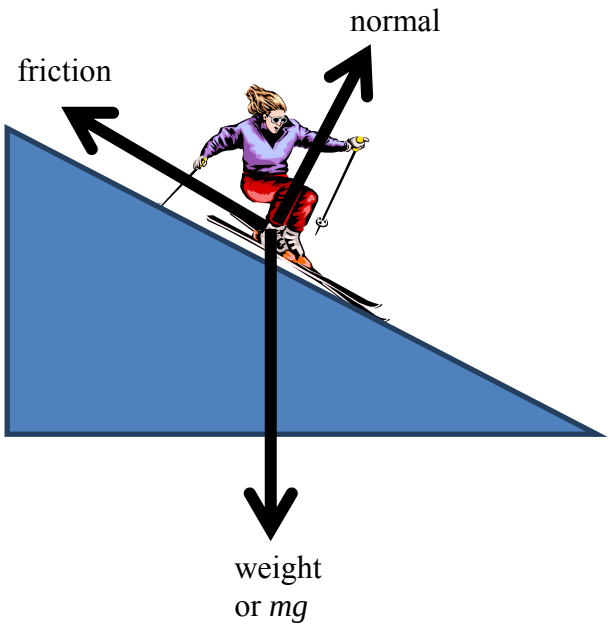
Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Question 3b.

Worked solution

As Jenny is travelling at a steady speed, there is a frictional force. Do not include a force going down the hill.



Mark allocation: 3 marks

- 1 mark for each correctly labelled force.

Question 3c.

Worked solution

If net force = 0, then

Frictional force up the hill = Force downhill

$$= mg\sin\theta$$
$$= 85\times 10\times \sin 25°$$
$$= 359.2 \text{ N}$$

359.2 N

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Question 3d.

Worked solution

Force downhill = $mg\sin\theta$

$$= 85\times 10\times \sin(25°)$$
$$= 359.2 \text{ N}$$

Net force is 359.2 – 100 = 259.2 N

$$F = ma$$
$$259.2 = 85\times a$$
$$a = 3.05 \text{ m s}^{-2}$$

3.05 m s^{-2}

Mark allocation: 3 marks

- 1 mark for calculating force downhill.
- 1 mark for finding net force.
- 1 mark for the correct answer.

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Question 4a.

Worked solution

k = gradient of line

$$= \frac{1000}{0.25}$$

$$= 4000 \text{ N m}^{-1}$$

4000 N m^{-1}

Mark allocation: 2 marks

- 1 mark for evidence of finding gradient.
- 1 mark for the correct answer.

Question 4b.

Worked solution

A 20 kg dog has a weight force of 200 N.
This equates to a displacement of 0.05 m.

Potential energy = area under graph

$$= 0.5 \times 200 \times 0.05$$

$$= 5 \text{ J}$$

5 J

Mark allocation: 2 marks

- 1 mark for finding dog's weight force and the displacement.
- 1 mark for the correct answer.

Question 4c.

Worked solution

The dog's total energy (kinetic energy plus gravitational potential energy) will remain constant.

While on the board, the dog's gravitational potential energy = mgh

$$= 20 \times 10 \times 3$$

$$= 600 \text{ J}$$

This is equal to what the dog's kinetic energy would be just prior to hitting the water.

Mark allocation: 2 marks

- 2 marks for the correct answer.

Question 5a.

Worked solution

$$\text{Car momentum} = mv$$
$$= 1000 \times 20$$
$$= 20\,000 \text{ kg m s}^{-1} \text{ east}$$
$$\text{Lorry momentum} = mv$$
$$= 8000 \times 10$$
$$= 80\,000 \text{ kg m s}^{-1} \text{ west}$$
$$\text{Total momentum} = 80\,000 - 20,000$$
$$= 60\,000 \text{ kg m s}^{-1} \text{ west}$$

60 000 kg m s^{-1}	Direction: west

Mark allocation: 3 marks

- 1 mark for finding the momentum of the car and lorry each.
- 1 mark for the correct answer.
- 1 mark for the correct direction.

Question 5b.

Worked solution

$$\text{Momentum of the system} = 60\,000$$
$$\text{Momentum} = \text{total mass} \times \text{velocity}$$
$$60\,000 = 9000 \times \text{velocity}$$
$$\text{Velocity} = 6.67 \text{ m s}^{-1}$$
$$\text{Speed} = 6.67 \text{ m s}^{-1}$$

6.67 m s^{-1}

Mark allocation: 2 marks

- 1 mark for using the correct formula.
- 1 mark for the correct answer.

Question 5c.

Worked solution

$$\begin{aligned}\text{Change in momentum of car} &= \text{mass} \times \text{change in velocity} \\ &= 1000 \times (20 + 6.67) \\ &= 1000 \times 26.67 \\ &= 26\,700\end{aligned}$$

$$\begin{aligned}\text{Change in momentum} &= Ft \\ 26\,700 &= F \times 0.75 \\ F &= 35\,600 \text{ N}\end{aligned}$$

$F = 35\,600$ N

Mark allocation: 3 marks

- 1 mark for finding correct change in velocity.
- 1 mark for calculating correct change in momentum.
- 1 mark for the correct answer.

Question 5d.

Worked solution

$$\begin{aligned}v &= 20 \\ a &= -5 \\ s &= 30 \\ u &= ? \\ v^2 &= u^2 + 2as \\ 20^2 &= u^2 + 2 \times (-5) \times 30 \\ 400 &= u^2 - 300 \\ u^2 &= 700 \\ u &= 26.46 \text{ m s}^{-1}\end{aligned}$$

$u = 26.46 \text{ m s}^{-1}$

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Section A

Area of study 2 – Wave-like properties of light

Question 1a.

Worked solution

i. Period is the time taken for one complete wave.

12 s

Mark allocation

- 1 mark for the correct answer.

Worked solution

ii. $f = \frac{1}{T}$

$= \frac{1}{12}$

$= 0.083 \text{ Hz}$

0.083 Hz

Mark allocation

- 1 mark for the correct answer.

Question 1b.

Worked solution

Amplitude is the height of the crest of the wave, i.e. the peak. This can be read straight from the graph.

0.1 m

Mark allocation: 2 marks

- Give only 1 mark for answer of 10 cm.
- 2 marks for the correct answer.

Question 1c.

Worked solution

λ = one full wavelength

$= 20$ cm

$= 0.2$ m

0.2 m

Mark allocation

- 1 mark for the correct answer.

Question 1d.

Worked solution

$$v = f\lambda$$

$$f = \frac{v}{\lambda}$$

$$= \frac{8}{0.2}$$

$= 40$ Hz

40 Hz

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

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Question 2a.

Worked solution

Light **never** has mass.

A

Mark allocation: 2 marks

- 2 marks for the correct answer.

Question 2b.

Worked solution

Light is an example of a *transverse* wave.
A transverse wave has the motion of the particles *perpendicular* to the direction of the wave.

Mark allocation: 2 marks

- 1 mark for each correct response.

Question 3

Worked solution

In all cases, the image is

- located on the object's side of the lens
- a virtual image
- an upright image
- reduced in size (i.e. smaller than the object).

B

Mark allocation: 2 marks

- 2 marks for the correct answer.

Question 4

Worked solution

One pair of polarising sunglasses will remove vertical (or horizontal) components of the light; the next pair will remove the horizontal (or vertical) components of the light. (1 mark)
Therefore, no light will reach Tommi's eyes. (1 mark)

Mark allocation: 2 marks

- 2 marks for the correct answer.

Question 5a.

Worked solution

The angle of incidence equals 90° minus the angle given.

42^{o}

Mark allocation

- 1 mark for the correct answer.

Question 5b.

Worked solution

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$1 \times \sin(42°) = 1.55 \times \sin\theta$$
$$\sin\theta = 0.43$$
$$\theta = 25.6°$$

25.6^{o}

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Question 5c.

Worked solution

The light will leave the glass at the same angle at which it entered.

42^{o}

Mark allocation

- 1 mark for the correct answer.

Question 5d.

Worked solution

$$\text{Critical angle} = \sin^{-1}\left(\frac{1}{n}\right)$$
$$= \sin^{-1}\left(\frac{1}{1.55}\right)$$
$$= 40.2°$$

40.2^{o}

Mark allocation: 2 marks

- 1 mark for substituting the correct values into the correct equation.
- 1 mark for the correct answer.

Question 5e.

Worked solution

When the critical angle is surpassed, then total internal reflection is achieved.
No light leaves the glass at that point.

Mark allocation: 2 marks

- 1 mark for each correct point given.

Question 5f.

Worked solution

Any two of optical fibres, binoculars, endoscopes, telecommunications, touchscreens etc.

Mark allocation: 2 marks

- 1 mark for each correct answer.

Question 6

Worked solution

Any two of polarisation, interference, diffraction, reflection, refraction, Doppler effect.

Mark allocation: 2 marks

- 1 mark for each correct answer.

Question 7

Worked solution

red and green

Mark allocation

- 1 mark for the correct answer.

Question 8

Worked solution

D

Mark allocation

- 2 marks for the correct answer.

SECTION B – Detailed studies

Detailed study 1 – Astronomy

Question 1

B

Question 2

D

Question 3

A

Explanatory notes

The diurnal motion of the stars is the apparent motion of the stars in a circular pattern during the night and is caused by the Earth's rotation on its axis.

Question 4

B

Question 5

C

Question 6

A

Worked solution

$$M = \frac{f_o}{f_e}$$
$$= \frac{84}{2.1}$$
$$= 40$$

Tip

- *Magnification does not have any units.*

Question 7

D

Question 8

D

Question 9

D

Question 10

B

SECTION B

Detailed study 2 – Astrophysics

Question 1

A

Explanatory notes

Stars are made from hydrogen, which undergoes fusion as a result of the immense temperatures and heat inside them.

Question 2

D

Question 3

D

Explanatory notes

A galaxy contains billions of stars.
A cluster is a few stars in close proximity to each other.
Stars in constellations may be spread far apart but *appear* to be close together when viewed from Earth.

Question 4

D

Question 5

B

SECTION B

Question 6

D

Question 7

C

Question 8

B

Explanatory notes

Yet it takes light 100 000 years to get out from the centre of the Sun!

Question 9

A

Explanatory notes

The Sun doesn't have a 'real star name' like Alpha Centauri.

Question 10

A

SECTION B

Detailed study 3 – Energy from the nucleus

Question 1

B

Worked solution

$$\begin{matrix}\text{nucleons}\\ \text{protons}\end{matrix}\text{Symbol}$$

Neutrons = Nucleons – Protons

Question 2

A

Question 3

A

Worked solution

$$\begin{aligned} E &= mc^2 \\ &= 0.1\times10^{-3}\times(3\times10^{8})^2 \\ &= 9\times10^{12}\ \text{J} \end{aligned}$$

Question 4

B

Explanatory notes

If it had an extra proton (option **A**), it would be helium.

SECTION B

Question 5

B

Explanatory notes

Control rods absorb neutrons, causing the chain reaction to slow down by limiting the number of neutrons available. Fuel rods supply the uranium, whereas radiation shields stop harmful radiation from escaping. A moderator slows neutrons.

Question 6

D

Question 7

B

Question 8

B

Explanatory notes

Australia has two nuclear reactors, in Lucas Heights, NSW, which provide research and medical material.

Question 9

C

Explanatory notes

The neutrons don't need to be slowed due to the use of Pu-239.

Question 10

A

Worked solution

Uranium absorbs 1 neutron and emits 3 neutrons. Then balance the top and bottom number equations.

SECTION B

Detailed study 4 – Investigations: Flight

Question 1

B

Question 2

C

Worked solution

$$\text{Glide ratio} = \frac{\text{Distance travelled}}{\text{Altitude lost}}$$
$$= \frac{8\text{ m}}{2\text{ m}}$$
$$= 4$$

Question 3

D

Question 4

D

Explanatory notes

Forces B (drag) and C (thrust) are equal in magnitude, therefore it cannot be accelerating or decelerating. As it is flying, it cannot be stationary.

Question 5

D

Explanatory notes

Forces A (lift) and D (weight) are equal in magnitude, therefore it cannot be rising or descending. As it is flying, it cannot be stationary.

Question 6

C

SECTION B

Question 7

D

Question 8

A

Explanatory notes

If the plane is travelling at a constant velocity and altitude, then the drag and the thrust must be equal.

Question 9

D

Worked solution

If the plane is travelling at a constant velocity and altitude, then the drag and the thrust must be equal.

$$\begin{aligned}\text{Lift force} &= \text{Weight force}\\ &= mg\\ &= 200\,000 \times 10\\ &= 2\,000\,000 \text{ N}\end{aligned}$$

Question 10

D

Worked solution

$$\begin{aligned}\text{The torque on the left side of the plane} &= \text{The torque on the right side of the plane}\\ \text{Left} &= \text{Right}\\ 10 \times 10\,000 + 5 \times 10\,000 &= 5 \times \text{Thrust}\\ 150\,000 &= 5 \times \text{Thrust}\\ \text{Thrust} &= 30\,000 \text{ N}\end{aligned}$$

SECTION B

Detailed study 5 – Investigations: Sustainable energy sources

Question 1

A

Question 2

A

Worked solution

$$\begin{aligned}\text{Power} &= V \times I \\ &= 3 \times 0.1 \\ &= 0.3 \text{ W for each cell}\end{aligned}$$

$0.3 \times 24 = 7.2$ W

Question 3

C

Worked solution

$$\text{Output} = 40\% \text{ of input}$$

$$1000 = \frac{40}{100} \times \text{input}$$

$$\text{Input} = 2500 \text{ W}$$

Question 4

D

Explanatory notes

Most of the energy is lost as heat through friction.

Question 5

A

Explanatory notes

Solar panels produce electricity without the need for a turbine. The others convert mechanical energy to electrical energy using a turbine.

SECTION B

Question 6

B

Question 7

B

Worked solution

Total coal mining deaths in the world averaged well over 5000 people each year in the past decade.

Question 8

C

Worked solution

Calculate cost for 1 year:
Lights use 1.2 kW per hour
So, 1.2 kW × 5 = 6 kW h per day
So, 6 × 365 days = 2190 kW h per year
2190 × $0.24 = $525.60

New lights use 85% less:
85% of $525.60 = $446.76

Question 9

D

Question 10

B

Explanatory notes

Coal (chemical energy) burns (heat), which heats the water and makes the turbine spin (kinetic energy), which produces the energy (electrical energy).

SECTION B

Detailed study 6 – Medical physics

Question 1

B

Explanatory notes

PET scans detect radioactive tracers that are injected into the human body.

Question 2

C

Worked solution

Receive sample at 20 000 Bq. Two months later it is at 10 000 Bq (1 half-life). Two months later again it is at 5000 Bq. Two months after that and it is down to 2500 Bq and is ineffective.

Question 3

A

Worked solution

$$f = \frac{1}{T}$$

$$f = \frac{1}{2.5 \times 10^{-21}}$$

$$= 4 \times 10^{20} \text{ Hz}$$

Question 4

D

Explanatory notes

Option D is simply a rotation of the original shown in Figure 1.

SECTION B

Question 5

D

Explanatory Notes

All types of emissions are used for therapy. Low-penetration alpha and beta radiation are used internally, and gamma radiation is used externally.

Question 6

C

Worked solution

γ are used as a tracer because the radiation must have enough energy to exit the body and be detected.

Question 7

B

Explanatory notes

Lead shields are used to protect people while carrying out X-rays. The other options can be absorbed by clothing.

Question 8

A

Explanatory notes

CT scans take X-rays at all angles to produce a 3D picture.

SECTION B

Question 9

B

Explanatory notes

Background radiation and radiation from the Sun far outweigh a few X-rays and radiation from mobile phones etc.

Question 10

A

Worked solution

$$v = f\lambda$$

$$\lambda = \frac{v}{f}$$

$$= \frac{3 \times 10^8}{1.8 \times 10^{14}}$$

$$= 1.67 \times 10^{-6} \text{ m}$$

Tip

- *In a vacuum, the speed of any electromagnetic radiation will always be 3 × 10^8 m s^{-1}.*

END OF SOLUTIONS BOOK

SECTION B