

PRACTICE WORKSHEET + FULL ANSWER KEY

Forces, energy and circuits

Senior secondary physics. Work through the sections in order, or choose the one that matches this week's topic.

QUESTIONS	SECTIONS	ANSWER KEY	WORKING SPACE
104	10	At the back	Ruled

Name _____ Class _____ Date _____

Before you start

Define the system, draw the forces or circuit and choose a model. Substitute quantities with consistent units, then ask whether the size and direction of the answer make sense.

WORKED EXAMPLE

A 2 kg object accelerates at 3 m/s². Find the resultant force.

- 1 Use $F = ma$ for the resultant force.
- 2 $F = 2 \times 3 = 6$.
- 3 The resultant force is 6 N in the direction of acceleration.

Use this method as your model. Set out your own working the same way.

Common mistakes to avoid

- Using mass as a force
- Mixing kilometres per hour with metres per second

There are 104 questions across 10 sections. Write in the ruled space, then mark your work against the answer key at the back. Topics covered: Motion and forces, Energy transfers, Electric circuits.

SECTION A Motion

Convert to SI units first, then choose the equation. Always state the direction where it matters.

1

A car travels 150 m in 10 s at constant speed. Find the speed.

2

Convert 72 km/h to metres per second.

3

A cyclist speeds up from 4 m/s to 10 m/s in 3 s. Find the acceleration.

4

State the difference between distance and displacement.

5

State the difference between speed and velocity.

6

Describe the motion shown by a horizontal line on a velocity-time graph.

7

What does the area under a velocity-time graph represent?

8

What does the gradient of a distance-time graph represent?

9

An object starts at rest and accelerates at 3 m/s^2 for 4 s. Find the final speed.

10

For that object, find the distance travelled in the 4 s.

11

A ball falls freely for 2 s. Find its speed, using $g = 9.8 \text{ m/s}^2$.

SECTION B Forces and Newton's laws

Draw the forces before you calculate. Check that the size and direction of your answer make sense.

12

A 2 kg object accelerates at 3 m/s^2 . Find the resultant force.

13

A 5 kg object has a resultant force of 20 N. Find its acceleration.

14

Find the weight of a 12 kg object, using $g = 9.8 \text{ N/kg}$.

15

Why does an object moving at constant velocity have zero resultant force?

16

State Newton's third law.

17

Explain why a skydiver reaches terminal velocity.

- 18 Find the momentum of a 1,200 kg car travelling at 15 m/s.

- 19 State the difference between mass and weight.

- 20 Explain why a seat belt reduces injury in a crash.

- 21 A 3 kg block is pushed with 15 N against 6 N of friction. Find the acceleration.

- 22 Explain what is meant by a resultant force.

SECTION C Energy and power

Name the energy store before and after the transfer, and give the unit with every answer.

- 23 Find the kinetic energy of a 2 kg object moving at 4 m/s.

- 24 Find the gravitational potential energy gained when 5 kg is lifted 3 m, using $g = 9.8 \text{ N/kg}$.

- 25 Find the work done when a 20 N force moves an object 6 m in the direction of the force.

- 26 Find the power when a device transfers 600 J in 30 s.

- 27 A 60 W lamp runs for 5 minutes. Find the energy transferred.

- 28 State the principle of conservation of energy.

- 29 A machine takes in 500 J and usefully transfers 350 J. Find the efficiency.

- 30 Name the useful and the wasted energy transfers for an electric motor.

- 31 Explain why loft insulation reduces heating costs.

- 32 Name two renewable energy resources and one limitation of each.

- 33 A hoist lifts 1,000 kg through 2 m in 8 s. Find the useful output power, using $g = 9.8 \text{ N/kg}$.

SECTION D Electricity

Identify series or parallel first, then apply $V = IR$ to the correct part of the circuit.

- 34 A 12 V supply drives 3 A through a resistor. Find its resistance.

- 35 Find the current when 24 V is applied across 6 ohms.

- 36 Find the power of a device drawing 2 A from a 230 V supply.

- 37 Two 6 ohm resistors are connected in series. Find the total resistance.

- 38 Two 6 ohm resistors are connected in parallel. Find the total resistance.

- 39 State how current behaves in a series circuit.

- 40 State how potential difference behaves across parallel branches.

- 41 Find the charge that flows when 3 A passes for 20 s.

- 42 Explain the function of a fuse.

- 43 Explain why a metal appliance case is connected to the earth wire.

- 44 A 2 kW heater runs for 3 hours. Find the energy used in kilowatt-hours.

SECTION E Waves and practical reasoning

Use $v = f \times \text{wavelength}$ with consistent units, and comment on uncertainty where it matters.

- 45 State the difference between a transverse and a longitudinal wave.

- 46 Find the speed of a wave of frequency 50 Hz and wavelength 4 m.

- 47 Find the frequency of a wave of speed 340 m/s and wavelength 0.5 m.

- 48 State the law of reflection.

49 Explain why light refracts when it enters glass.

50 Name two ways to reduce uncertainty when timing a pendulum.

51 Explain why a graph is more useful than a single measurement in a practical.

52 A student uses mass in grams in $E = 0.5mv^2$. Explain the effect on the answer.

53 Give one example of a systematic error and one of a random error.

54 Explain why quoting an answer to eight decimal places can mislead.

SECTION F Moments, pressure and density

Check that the distance is measured from the pivot and the area is in square metres.

55 Find the moment of a 20 N force acting 0.5 m from a pivot.

56 State the principle of moments.

57 A 30 N weight sits 0.4 m from a pivot. What force at 0.6 m balances it?

58 Find the pressure when a 200 N force acts on 0.5 m².

59 Explain why a sharp knife cuts more easily.

60 Find the density of an object of mass 240 g and volume 30 cm³.

61 Find the mass of 50 cm³ of a liquid of density 0.8 g/cm³.

62 Explain why ice floats on water.

63 Find the pressure at 10 m depth in water, using pressure = density $\times$ g $\times$ depth, with density 1000 kg/m³ and g = 9.8 N/kg.

64 Explain why atmospheric pressure falls with altitude.

SECTION G Thermal physics

Say what the particles are doing, then apply the equation.

65 State the difference between heat and temperature.

66 Name the three ways thermal energy is transferred.

67 Explain conduction in a metal.

68 Explain convection in a liquid.

69 Explain why a shiny surface is a poor emitter of radiation.

70 Find the energy needed to raise 2 kg of water by 10 °C, using $c = 4,200 \text{ J/kg}^\circ\text{C}$.

71 Explain what specific heat capacity means.

72 Explain why the temperature stays constant while ice melts.

73 Name one method of reducing heat loss from a house and explain how it works.

74 Explain why a vacuum flask keeps a drink hot.

SECTION H Radioactivity and the atom

Match each type of radiation to its charge, mass and penetrating power.

75 Name the three types of nuclear radiation.

76 State what an alpha particle is made of.

77 Order alpha, beta and gamma by penetrating power, least first.

78 State what stops alpha radiation.

79 Define half-life.

80 A sample has a half-life of 5 years. What fraction remains after 15 years?

81

A count rate falls from 800 to 100 in 6 hours. Find the half-life.

82

State one use of radioactivity in medicine.

83

State one safety precaution when handling a radioactive source.

84

Explain why background radiation is subtracted from a count.

SECTION I Magnetism and electromagnetism

Draw the field before you predict a force or an induced voltage.

85

State what happens when two north poles are brought together.

86

Describe the magnetic field pattern around a bar magnet.

87

Name three magnetic materials.

88

Explain three ways to make an electromagnet stronger.

89

State one advantage of an electromagnet over a permanent magnet.

90

State the motor effect.

91

State Fleming's left-hand rule and what each finger represents.

92

Explain how a generator produces a current.

93

State the purpose of a step-up transformer in power transmission.

94

A transformer has 100 primary turns, 500 secondary turns and 20 V input. Find the output voltage.

SECTION J Mixed review and graph skills

Read the axes first. Gradient and area both carry physical meaning.

- 95** A velocity-time graph slopes upwards from the origin. Describe the motion.

- 96** Find the acceleration from a velocity-time graph rising from 0 to 20 m/s in 5 s.

- 97** Find the distance travelled during that 5 s.

- 98** A force-extension graph is a straight line through the origin. State what this shows.

- 99** Find the spring constant when 6 N causes an extension of 0.03 m.

- 100** Find the energy stored in that spring, using $E = 0.5 F x$.

- 101** State the difference between a scalar and a vector, with one example of each.

- 102** Add forces of 8 N to the right and 3 N to the left. State the resultant.

- 103** State one reason for repeating a measurement in a physics practical.

- 104** Explain why a line of best fit is drawn rather than joining every point.

Answer key

Work each section before you check it. These are model answers: an equivalent method, or a different well-supported interpretation, can be just as correct.

SECTION A - MOTION

1. 15 m/s.
2. 20 m/s.
3. 2 m/s².
4. Distance is the total path length; displacement is the straight-line change in position, with direction.
5. Speed is a scalar; velocity is speed in a stated direction.
6. Constant velocity, so the acceleration is zero.
7. The displacement.
8. The speed.
9. 12 m/s.
10. 24 m, from $s = 0.5 \times 3 \times 4^2$.
11. 19.6 m/s, ignoring air resistance.

SECTION B - FORCES AND NEWTON'S LAWS

12. 6 N, in the direction of the acceleration.
13. 4 m/s².
14. 117.6 N.
15. Its acceleration is zero, so Newton's second law gives a zero resultant; individual forces may still act and balance.
16. When A exerts a force on B, B exerts an equal and opposite force on A.
17. Air resistance rises with speed until it balances weight, so the resultant force and the acceleration become zero.
18. 18,000 kg m/s.
19. Mass is the quantity of matter in kilograms; weight is the gravitational force on it, in newtons.
20. It increases the time over which the momentum changes, which reduces the force on the body.
21. 3 m/s², because the resultant force is 9 N.
22. The single force that would have the same effect as all the forces acting together.

SECTION C - ENERGY AND POWER

23. 16 J, from $0.5 \times 2 \times 4^2$.
24. 147 J.
25. 120 J.
26. 20 W.
27. 18,000 J, which is 18 kJ.
28. Energy cannot be created or destroyed, only transferred between stores.
29. 70%.
30. Useful: kinetic energy. Wasted: thermal energy and sound.

31. It lowers the rate of thermal energy transfer through the roof, so less energy is needed to hold the temperature.
32. For example wind, whose output varies, and solar, which depends on daylight and weather.
33. 2,450 W, from 19,600 J in 8 s.

SECTION D - ELECTRICITY

34. 4 ohms.
35. 4 A.
36. 460 W.
37. 12 ohms.
38. 3 ohms.
39. It is the same at every point in the circuit.
40. It is the same across each branch.
41. 60 C.
42. It melts and breaks the circuit if the current rises above a safe value.
43. It provides a low-resistance path to earth, so a fault current blows the fuse instead of charging the case.
44. 6 kWh.

SECTION E - WAVES AND PRACTICAL REASONING

45. Transverse oscillations are perpendicular to the direction of travel; longitudinal oscillations are parallel to it.
46. 200 m/s.
47. 680 Hz.
48. The angle of incidence equals the angle of reflection, both measured from the normal.
49. Its speed changes at the boundary, so the direction changes unless it enters along the normal.
50. Time several oscillations and divide by the number, and repeat the measurement.
51. It shows the pattern across a range and makes anomalies and the shape of the relationship visible.
52. The result is 1,000 times too large, because 1 kg = 1,000 g; mass must be in kilograms for an answer in joules.
53. Systematic: a metre rule read from a zero offset. Random: variation in reaction time when starting a stopwatch.
54. It implies a precision beyond that of the instruments; round to match the least precise measurement.

SECTION F - MOMENTS, PRESSURE AND DENSITY

55. 10 N m.

- 56. For a balanced object the total clockwise moment equals the total anticlockwise moment about the same pivot.
- 57. 20 N.
- 58. 400 Pa.
- 59. A smaller contact area gives a much greater pressure for the same force.
- 60. 8 g/cm^3 .
- 61. 40 g.
- 62. Ice is less dense than liquid water.
- 63. 98,000 Pa, which is 98 kPa.
- 64. There is less air above, so less weight of air presses down.

SECTION G - THERMAL PHYSICS

- 65. Temperature measures the average kinetic energy of the particles; heat is energy transferred because of a temperature difference.
- 66. Conduction, convection and radiation.
- 67. Free electrons and vibrating ions transfer energy quickly through the material.
- 68. Warmer, less dense fluid rises and cooler fluid sinks, setting up a circulating current.
- 69. It reflects rather than absorbs and emits infrared radiation.
- 70. 84,000 J.
- 71. The energy needed to raise the temperature of 1 kg of a substance by 1°C .
- 72. The energy supplied breaks the bonds between particles rather than increasing their kinetic energy.
- 73. Cavity wall insulation traps air, which conducts poorly and reduces convection.
- 74. The vacuum prevents conduction and convection, and the silvered surfaces reduce radiation.

SECTION H - RADIOACTIVITY AND THE ATOM

- 75. Alpha, beta and gamma.
- 76. Two protons and two neutrons, which is a helium nucleus.
- 77. Alpha, beta, gamma.
- 78. A sheet of paper, or a few centimetres of air.
- 79. The time taken for half the unstable nuclei in a sample to decay.
- 80. $1/8$.
- 81. 2 hours, because three halvings occurred.
- 82. Tracers for imaging, or radiotherapy for treating cancer.
- 83. Use tongs, keep exposure time short and store it in a shielded container.
- 84. The detector also records radiation from natural sources, which does not come from the sample.

SECTION I - MAGNETISM AND ELECTROMAGNETISM

- 85. They repel.
- 86. Field lines run from north to south outside the magnet and are closest together near the poles.
- 87. Iron, nickel and cobalt.
- 88. Increase the current, add more turns, or use an iron core.
- 89. It can be switched off, and its strength can be varied.
- 90. A current-carrying conductor in a magnetic field experiences a force.
- 91. First finger field, second finger current, thumb motion.
- 92. Moving a conductor through a magnetic field induces a potential difference, which drives a current in a complete circuit.
- 93. It raises the voltage, which lowers the current and so reduces energy lost as heat in the cables.
- 94. 100 V.

SECTION J - MIXED REVIEW AND GRAPH SKILLS

- 95. Constant acceleration from rest.
- 96. 4 m/s^2 .
- 97. 50 m, the area under the graph.
- 98. The extension is proportional to the force, so the spring obeys Hooke's law.
- 99. 200 N/m.
- 100. 0.09 J.
- 101. A scalar has size only, for example mass; a vector has size and direction, for example velocity.
- 102. 5 N to the right.
- 103. To spot anomalies and to reduce the effect of random error by taking a mean.
- 104. It shows the underlying trend and reduces the effect of random scatter in individual readings.

Review and next steps

Mark your work against the answer key, record your score for each section, then answer the three questions below. Bring this page to your next lesson so your tutor can start from what actually blocked you.

Which question did you find hardest, and what exactly stopped you?

Rewrite the corrected working for that question here.

Which section do you want to practise again before your next lesson?

Score record

SECTION	QUESTIONS	NUMBER CORRECT	PRACTISE AGAIN?
A. Motion	11		
B. Forces and Newton's laws	11		
C. Energy and power	11		
D. Electricity	11		
E. Waves and practical reasoning	10		
F. Moments, pressure and density	10		
G. Thermal physics	10		
H. Radioactivity and the atom	10		
I. Magnetism and electromagnetism	10		
J. Mixed review and graph skills	10		
Total	104		

Keep going with one-to-one support.

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